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SUMMARY

SOIL SCIENCES

CROP SCIENCES

ECOLOGICAL AGRICULTURE

AGRICULTURAL ENGINEERING AND RENEWABLE ENERGY SOURCES

AGRO-FORESTRY
AND CLIMATE CHANGES

APPLIED BIOLOGY
IN AGRICULTURAL SCIENCES

MISCELLANEOUS

SOIL
SCIENCES

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VARIATION OF K^+ AND NA^+ CONCENTRATIONS IN ROOT AND SHOOT OF OILSEED RAPE AS AFFECTED BY SALINITY

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Abstract

Considering the importance of salinity in some regions of our province specially the lands under cultivation of oilseed rape, an experiment was conducted at greenhouse conditions for study the effect of four levels of salinity, ie. 2, 3, 6 and 9 ds/m produced from NaCl and $CaCl_2$ and different cultivars of oilseed rapes. The framework of experiment was factorial with 3 replications based on RCBD design. Results showed that, with increase of salinity , the concentration of K^+ and Na^+ in root and shoot of plants, were varied and the ratio of K^+/Na^+ increased too. Amongst cultivars, cv. Okapi had the least K^+/Na^+ concentration ratio. This proves that this cultivar has more compatibility with salinity stress and seems to be suitable for cultivation in saline soils and producing logic seed yield.

Key words: *rapeseed, NaCl, $CaCl_2$, K^+/Na^+, stress.*

INTRODUCTION

Iran poses dry and semi-dry climate conditions with an average precipitation less than 240 mm and uneven distribution. So there is a potential for formation and development of saline soils in many areas of arable lands. On the other hand,water used for irrigation tends to be more saline compared to last decades. Application of low-quality water with thousands milligrams of dissolved salts in these areas, has resulted in lower topsoil quality, i.e. increased soil salinity. Oilseed rape is susceptible to excessive soil salinity although a few tolerant varieties have been identified (Bhogal et al., 2011). This crop is considered as moderately tolerant and can tolerate salinity up to levels of 5-6 dS/m electrical conductivity. However reduction in yield can be expected (Thomas, 2003; Ashraf & McNeilly, 2004). The dominant salts and agents in our lands are Ca^{+2}, Na^+ and Cl^-. Because of the imbalance of Na with Ca and Mg, soil erosion can also be pronounced. Excess concentration of Na^+ in toxic rates has a direct effect on dry matter accumulation in plant and also destruction of physical properties of soil. Rapeseed uptakes less Na^+ than K^+,but when the concentration of sodium in soil solution or irrigation water is increased, symptoms of toxicity as chlorosis of leaves and tissues appeared. Studies shows that, Na^+ causes loosening of the conjunction force between the calcium bands with the cell walls, then prevent Ca^{+2} entrance into the cell and accelerate the exit of this ion (Maathuis and Amtmann, 1999). So this process causes the rapid depletion of calcium reservoirs in cell wall and its activity is affected adversely (Flowers & Yeo, 1989; Robinson et al. 1997). Rapeseed has a vacuole Na^+/H^+ antiport mechanism that can deliver Na^+ to vacuole and reserves it in high salinity concentrations. Cultivars with this efficient mechanism can tolerate moderate salinity levels (Zarghami, 2004).

Potassium is different from most other essential nutrients since it does not become part of structural components in the plant. Instead, most of the K^+ in plants remains dissolved in the cell sap having several major functions like enzyme activation (Thomas, 2003). Salinity and increasing of Na^+ in soil solution is resulted to decreasing of K^+ absorption by roots and then in plant cells. Therefore maintenance of high K^+ levels for plants in salt affected soils has a important role for crop production (Zarghami, 2004). Healthy cell membranes are selective and concentrate more K^+ than Na^+, so that the increased cytosolic K^+/Na^+ ratio, the more salt stress tolerance. The

K^+/Na^+ ratio that ultimately prevails in plant cell will depend on the action of transport systems located at plasma and vacuolar membranes. It probably involves K^+ selective, Na^+ selective and nonselective pathways, that occur in soil / root-symplast interface; root / xylem interface and also partitioning which may occur at a cellular level, between cytoplasm and vacuole and at a tissue level, e.g. recirculation of Na^+ and K^+ between old and young leaves. The aim of this experiment was evaluation of K^+/Na^+ ratio and then selecting the most tolerant rapeseed cultivar for mentioned region.

MATERIALS AND METHODS

A greenhouse factorial experiment with three rapeseed cultivars (ie. SLM046, Fornax and Okapi) and four salinity levels of, ECiw 2, 3, 6, 9 *dS/m* was conducted on 2007. Saline irrigation water was prepared via a uniform mixture (2:1), from NaCl and $CaCl_2$ salts. Experiment was performed in Khorasan Razavi Agric. & Natural Resources Res. Center with 3 replications. Seeds were planted in vases with 25cm diameter and 30cm height, each ones filled with 5 kg soil, taken from the nearby arable lands, passed through 6 mm sieves. Irrigation with saline water was applied based on standards and physical characteristics of soil and weighing pots daily. After emergence, each vase thinned to three plants. At rosette stage (6 leaves), plants were pulled up from the soil with contact root, then washed with distilled water and prepared for laboratory analysis for Na^+ and K^+ content in shoot and roots. Oven dried and milled parts of plants in different treatments, used for Flame Photometery. Results were processed using Mstat-C statistical software and traits mean were compared with Duncan's multiple range test.

RESULTS AND DISCUSSIONS

Mean comparison of K and Na contents in roots and shoots and the K^+/Na^+ ratio under salt stress conditions has shown in Table 1. Salinity had a significant effect on these traits ($P = 0.01$), in both root and shoot. These concentrations varied between cultivars too. K^+ content in the first three levels of salinity in roots and shoots showed no significant differences, but it was in maximum rate in EC 9 ds/m salinity level. Generally the K^+ content in shoot was higher than in roots. Increasing of K^+ with increasing salinity is a result of salinity tolerance in that cultivar (Zarghami, 2004). The same trend was observed as well for Na^+ in above and underground parts of the plants. The content of Na^+ in shoots was more than roots and also more than the sole percentage of K^+ in shoots. It seems that, sodium hardly translocates from leaves to root. It accumulates in leaves with Cl^- and causes some growth disorders. The K^+/Na^+ ratio increased with increasing of salinity levels in both shoot and roots. The greatest K^+ content was achieved in Cv. SLM046 roots and Okapi leaves respectively. The K^+ content in roots of Okapi was rather high too. This suggests that the Okapi cultivar has a capability for uptake more potassium from saline soils. It has a good adaptation with this stress. Also this cultivar can concentrate Na ions in leaf cell vacuoles and prevents to its toxicity via Na compartmentation mechanism in cells (Zarghami, 2004).

Table 1. Mean comparison of K and Na contents in rapeseed cultivars under different salinity treatments.

Treatments	K^+_{root} (%)	K^+_{shoot} (%)	Na^+_{root} (%)	Na^+_{shoot} (%)	K^+/Na^+ (Root)	K^+/Na^+ (Shoot)
Salinity						
< 2ds/m	0.79b	0.99 b	0.26 c	0.34 c	0.33 c	0.35 c
3 ds/m	0.75b	0.97b	0.46 b	1.33 b	0.61 b	1.37 b
6 ds/m	0.72b	1.10b	0.55 a	2.08 a	0.77 a	1.88 a
9 ds/m	0.92a	1.34a	0.61 a	2.32 a	0.67 ab	1.72 a
Cultivars						
Okapi	0.79ab	1.18 a	0.45 a	1.61 a	0.57 b	1.31 a
Fornax	0.74b	1.1 ab	0.48 a	1.42 b	0.65 a	1.30 a
SLM046	0.86 a	1.05 b	0.49 a	1.52ab	0.59ab	1.42 a

Letters show significant differences based on Duncan's Test.

Table 2, shows the interaction effects of salinity × cultivars on K^+/Na^+ ratio variations in leaves and roots. Both Okapi and SLM046 cultivars, showed high K^+/Na^+ ratios in leaves and sometimes in their roots. These cultivars were more tolerant to salinity in this experiment. Potassium concentration in tolerant plant cells are kept under homeostatic control with cytosolic K^+ concentrations (Zhang et al. 2001). Then in high EC soils the more K^+/Na^+ ratio in plant tissues, the more cultivar tolerance to salinity stress.

Table 2. Mean comparison of K^+/Na^+ ratio in leaves and roots of rapeseed cultivars

Salinity (ds/m)	*Leaves*			*Roots*		
	Okapi	*Fornax*	*SLM046*	*Okapi*	*Fornax*	*SLM046*
< 2ds/m	0.36e	0.31 e	0.38 e	0.35 e	0.33 e	0.31 e
3 ds/m	1.37cd	1.30 d	1.48 bcd	0.58 d	0.65 cd	0.62 cd
6 ds/m	1.68bc	1.74 b	2.44 a	0.68bc	0.86 a	0.83 ab
9 ds/m	1.83bc	1.75 b	1.60 bcd	0.67bcd	0.76abc	0.60 cd

Letters show the significant difference range between treatments based on Duncan's Test.

CONCLUSIONS

There is a variability for salinity tolerance between rapeseed cultivars.

In this experiment Okapi and SLM046 cultivars showed adaptation and tolerance to high salinity levels in growing media.

In tolerant cultivars the K^+/Na^+ ratio tends to be increased because of the homeostatic control with cytosolic K^+ concentrations. Then plant can uptake more K^+ from soil solution compared to Na^+.

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ZINC POLLUTION OF SOILS LOCATED INTO THE INFLUENCE AREA OF THERMO-ELECTRIC POWER STATIONS DOICEŞTI AND ROVINARI

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Abstract

Some of the most complex polluters of the environment are thermo-electric power stations that are using coal as energy source. There are two types of environmental pollution sources: the main are baskets exhaust gases of coal combustion, so called high sources, and the secondary sources that are ash dumps resulted from the coal combustion activities, so called low sources. Thermo-electric power station Doicesti, located in the area of Sub-Carpathian hills, on Ialomiţa Valley, is a major source of environment pollution with sulphur, since 1952 when was built. By geographically point of view, the studied territory can be included into Sub-Carpathians' Curvature, more specify in the Prahova's Sub-Carpathian subunit.
Pedogenesis factors: rock, topography and parent matherial, have led the evolution of isolated, lythomorphic soils. In the investigated territory four soil classes: Luvisols, Cambisols, Vertisols and Protisols were identified, each of them with types and subtypes mentioned in the paper.
From the geomorphological viewpoint, thermo-electric power stations Rovinari belongs to the Câlnic-Câmpul Mare inter-hilly depression whose altitude, at the Rovinari, is 150 m. The soil forming factors causing the soil evolution have been the rock, parental material and relief, all of them determining the evolution of lithomorphic zonal soils. The soils in the analyzed area represented by the classes: luvisols, hydrisols, cambisols and protisols.
The subject of this paper is to analyze the loading degree of copper of the soils affected by emissions from thermo-electric power stations Doiceşti and Rovinari. Soil samples collected soil profiles distributed in all cardinal directions, were analyzed for pH, zinc contens.
In the investigated area, zinc pollution of soils, caused by zinc emissions from thermo-electric power stations Doicesti and Rovinari, were recorded. The zinc pollution phenomenon gathering way by changing the normal content of soil, plant, and consequently, could affecting the health of the inhabitants of this territory.

Key words: *pollution, soil, thermo-electric power station, zinc.*

INTRODUCTION

Zinc in the flue gases finally reach the soil and vegetation, as aerosols or acid rains. So far, expeditionary field research conducted in the area of main power stations could not show significant changes in soil reaction caused by emissions from coal-fired power plants. This fact is due to greater height of the flue chimneys, which allow distribution of gaseous pollutants on large land areas. Secondly, many soils developed in the area influenced by emissions are buffered, calcium carbonate reserves annihilating leaching and debazification processes (Dumitru, 1992).
Establishing of soil loading is very difficult given the fact that every soil is a separate entity characterized by specific chemical properties. However, large quantities of copper in burned coal are often found in the A horizon of soils in the area influenced by the emissions from the power plants.
The Doiceşti thermo-electric power station is located in the Subcarpathian hills, Ialomiţa Valley. At south of the Pucioasa city, the valley widens, its width exceeding 2 km in Doiceşti area. The Doiceşti, Cornetu and Brăneşti hills have various sizes and orientations, their height ranging between 375 and 518 m. Most of the peaks have heights lower than those of the power plant flue chimney, could be seen from the Pădurea Bălteanu slopes, located on the second line of hills, behind the Doiceşti hill.
In the case of the Rovinari thermo-electric power station, 189 ha have been lost from the economic land use until 2004 and other 110 ha land after 2004 being occupied by the ash Cicani and Beterega dumps.

In order to analyze the effects of the emissions from the Rovinari thermo-electric power station.
Along each direction, the sampling sites are located at every 1.5 km distance in between, the last sites being at 7.5 km far from the thermo-electric power station. This spatial distribution of sites permitted to analyze the dispersion of pollutants coming both from the emission of chimneys and the ash dumps, as well as their contents in the sterile dumps.

MATERIALS AND METHODS

Development of the present study needed field investigations field to collect soil samples and observations on materials constituting slopelands and terraces surrounding the Doiceşti and Rovinari thermo-electric power stations. Sampling was made on the 0-20 cm and 20-40 cm depth. Soil sampling points were located on the map. 24 soil samples have taken, from Doiceşti and 40 soil samples from Rovinari they being subject to the following set of analyses: pH and copper (Căpitanu et al., 1999).
In order to facilitate the interpretation of loading degree of potential pollutants and make a comparison between the contamination intensities of each pollutant element, an excessive coefficient of maximum normal content (Cn), proposed by Lăcătuşu 1995 and Florea 2003, has been calculated for each individual element. This Cn coefficient is defined as the ratio between the respective element content and the maximum normal content of that element. As concerns the potential polluting substances, the reference contents established by the Ministry of Waters, Forests and Environmental Protection (Order No. 756/1997) have been applied (Lăcătuşu, 1995).
The value 1 of this coefficient means the lack of a contamination, according to the official rules. Sub-unitary values mean a low geological background for the respective element, while the over-unitary values may mean a contamination with the respective element due to the pollution source, so much the higher as the value of this coefficient is higher.
To be able to evaluate the pollution degree, similarly, the coefficients corresponding to the thresholds of "warning" and "triggering", briefly called warning coefficient (Ca) and triggering coefficient (Ci) for each potential pollutant, dividing the value corresponding to warning level and triggering level by the maximum normal content of the respective pollutant.
As the exceeding coefficient of normal content (Cn) of each element is coming nearer to the warning coefficient (Ca) or the triggering coefficient (CI), so the contamination or the pollution of the respective site is more intensive, of course, depending on these values, the adequate measures are taken, consequently.
These relative values for the above mentioned coefficients permit a light comparison of pollution intensities of different chemical elements.

RESULTS AND DISCUSSIONS

The study of pollution of soils in zone of the Rovinari and Doicesti thermo-electric power stations necessitated an ample analysis of soil properties because these form a complex mantle determined by the diversity of relief, groundwater, rock and parent material conditions.
With in the area influenced by the Doiceşti thermo-electric power station, soil samples were taken from 24 profiles, mostly located on both sides of the Ialomiţa river, between the Pucioasa and Târgovişte municipalities and to the west of the Dâmboviţa river between the Izvoare and Drăgăeşti-Ungureni localities and the area of influence of Rovinari thermo-electric power station were taken 40 soil samples at two depths.
Further analysis will be part of the copper for every thermo-electric power station.
As concerns the copper content, it exceeds the normal content within the whole territory in the Ialomiţa floodplain - between the south alignment Teiş-Anina, Brăneşti in the north part and Lăculeţe valley in east part. Maximum values can exceed the normal content of 10 to 20 $mg.kg^{-1}$ content (20 $mg.kg^{-1}$), but well below the alert threshold, so there is threshold, that is there is a slight contamination (loading). In a single site (13 km NNW from the Doiceşti thermo-electric power station), in the 20-40 cm layer, the copper content reached 141 $mg.kg^{-1}$, that is, exceeded the alert threshold, probably

as the result of the plant protection treatments applied in grapevine, or a local geochemical anomaly (site ignored in the data interpretations).

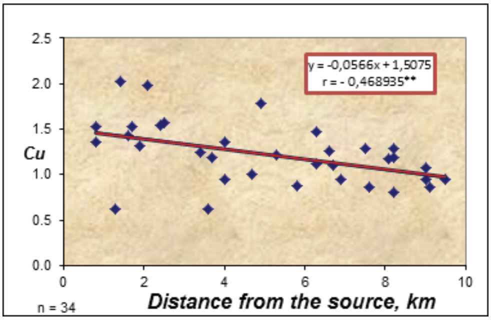

Figure 1. Variation of exceeding coefficient of the maximum normal content of zinc in soils (0-20 cm depth), depending on the distance from the Doiceşti thermo-electric power stations, in the area affected by its emissions (Correlation is distinctly significant)

Coefficient values exceeding the maximum normal content vary between 0.6 and maximum 2.4, being no pollution with copper. The coefficient corresponding to the alert threshold (4.76) is not exceeded.

As regards the territorial distribution (Figure 2), a coefficient exceeding two times the normal maximum content of more than 2 is observed on a reduced area to east of the Doiceşti thermoelectric power station and on an area located along the Ialomiţa valley with this coefficient of 1.25 to 2 which extends to north up to 5 km, and to the south in the dominant wind direction up to 7.5 km.

Thermo-electric power station Rovinari

The study of pollution of soils in zone of the Rovinari coal-fired power station necessitated an ample analysis of soil properties because these form a complex mantle determined by the diversity of relief, groundwater, rock and parent material conditions.

Soils in the analyzed area represent the classes: Luvisols (Typic and Stagnic Preluvosols, Typic and Stagnic Luvosols), Hydric Sols (Typic Stagnolosols) and Protisols (Typic Regosols, Eutric and Entic Alluviosols, Spolic Entianthrosols) (Florea and Munteanu, 2003).

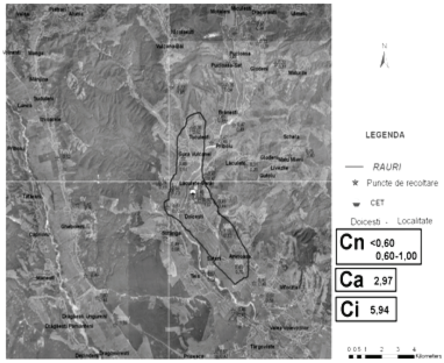

Figure 2. Distribution of exceeding coefficients of the normal maxim content of zinc in the area influenced by the Doiceşti thermo-electric power station

The mean coefficient exceeding the maximum normal contents for zinc, within the power station precinct, is sub-unitary (0.59). At the other distances (Figure 3) the mean of coefficient is over- unitary (between 11.05 and 2.49). The highest values are at 4.5 km (2.49) and 7 km (2.00) far from source.

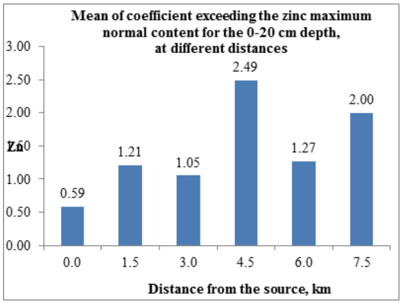

Figure 3. Variation of mean coefficient exceeding the zinc maximum normal content in soils in the zone affected by the influence of emissions coming from the Rovinari thermo-electric power station

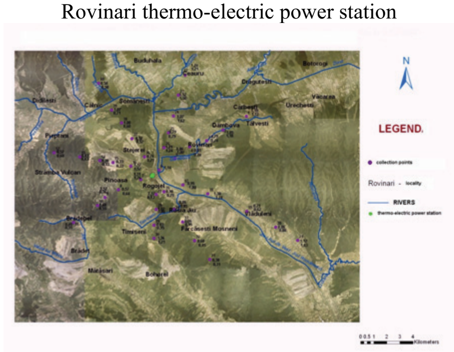

Figure 4. Zinc distribution and location of sites in the thermo-electric power station Rovinari

CONCLUSIONS

The area affected by the Doiceşti thermo-electric power station is located in the Prahova Subcarpations, in the Ialomiţa floodplain wide of 2 km in south part and 1 km north part, respectively.

Pedogenetic factors determined the occurrence of various soils, the most common being Fluvisols, followed by the Eutric Cambisols and Luvisols.

Most soils have a neutral-slightly alkaline reaction, being resistant to pollution with acid contaminants. The soils in the central-eastern area evolved on more acid materials (e.g. the Typical Luvisol site-5 SE).

General formation conditions determined an evident accumulation of small quantities of humus, receiving to some extent organic carbon derived from coal dust, fact illustrated by the C/N ratio, slightly higher than that of normal conditions.

The Doiceşti thermoelectric power station polluted area which extends along the Ialomiţa river south-north direction having as as boundaries Teiş-Săteni, Aninoasa in south; and Brăneşti in north and Glodeni in East. Within the above mentioned territory, soils that are sightly polluted with copper, and moderately-strongly polluted with coal dust and ash, which changed the humus content and texture.

The area of maximum influence of these particulates is located around the Doiceşti thermoelectric power station where the soil particle size distribution are drastically changed on the soil profile.

Self-purification processes are insufficient to ensure the environmental protection. In order to reduce the atmosphere pollution degree, the following recommendations are given:

- to improve the combustion;
- to reduce the sulfur content of fuels and increase the degree of retention of emitted sulfur;
- to increase height of chimneys and improvement of emission conditions;
- to improve capture of pollutants emitted in the form of dust and gas;
- to establish the special protection areas and warning areas.

These measures lead to the reduction or soil mantle contamination or pollution control.

Technologically depleted dumps should be reclaimed especially for forestry, as a measure for the protection of environment and people health.

In the area influenced by the Rovinari thermo-electric power station, some more important aspects have been emphasized.

The Rovinari thermo-electric power station, characterized by installed capacity of 1720 MW, represents a major source of soil pollution, by its sterile dumps provided by surface mining and ash dumps, as well as the gas emissions from the Rovinari thermo-electric power station chimneys, especially, dioxide sulfur emissions, carbon dioxide and nitrogen.

The analyzes show that, according to the coefficients exceeding the normal maximum content, for copper it is found that there are no exceed the alert coefficient.

As regarding the most intensively loaded direction, this is the southern direction, the values due to the wind coming from the northern part, which has a frequency two times higher as compared to the other directions.

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OBTAINING OF HUMATE-BASED LIQUID FERTILIZERS TO BE USED IN THE RECULTIVATION OF SLAGHEAPS

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Abstract

During the experiments, the potassium humate used in obtaining the fertilizer was extracted from the coal mass, lignite, as a potassium carbonate solution. The humic/fulvic mix present in the fertilizer matrix contained approximately 70% organic acids, whereof 50% derive from humic acids and 20% from fulvic acids. The treatments made with the new humate-based liquid fertilizer AH-N applied in two doses
(150 l/ha) showed an increase of the mobile phosphorus in the soil as compared to the non-fertilized control, from 58.20 mg/kg to 70.61 mg/kg due to the fertilizer containing NPK in its matrix. As for the mobile potassium upon application of the liquid fertilizers, increases were noticed by the application of the AH-I liquid fertilizer in two doses (150 l/ha), 199.20 mg/ha as compared to the non-fertilized control 186 mg/ha. By the application of the new liquid fertilizer AH-U 150 l/ha, it increased the mobile potassium content in the soil to 188 mg/kg as compared to the non-fertilized control of 170 mg/kg at the end of the experiments.

Key words: *recultivation, slag heaps, humate-based liquid fertilizers.*

INTRODUCTION

Open-cast coal mining is an activity of an outstanding complexity and it has a direct action with negative effects of the environment. As is takes place on large areas and for a time-span of decades, its impact on the environment, in its turn, is very complex, with local and regional, short-term and especially long-term, cumulative effects, throughout the active mining period and after it (Pecingină et al., 2008). In the mining basins of Oltenia (Gorj, Vâlcea and Mehedinţi), 14,890 hectares were rendered economically useless, where of 12,208 hectares of agricultural land and 2,682 hectares of forested land, and until the end of the mining 26,472 hectares will be affected, where of 15,490 hectares of agricultural land and 10,982 hectares of forest (Dumitru şi colab., 2000). The materials deposited in the heaps are very heretogeneous from a physical and chemical points of view, they are lacking biological activity and are very diverse from a mineralogic point of view, which results in a low fertility potential (Baican et al., 2002). Fertilization and in certain cases amendment are important components of the recultivation procedures (Skousen and Zipper, 1996). Among the organic fertilizers, the best results on the slag heaps were provided by a sort of compost obtained from urban mud and fermented manure (Hall, 1992). Research for the production of organo-mineral fertilizers based on lignite started in our country two decades ago and currently have been approved such fertilizers which have a quality of humic amelioration of the soil with a low humus content, which have high characteristics of incorporation of the nitrogen and of other nutrients in an organo-mineral matrix, in forms which ensure the expansion of the term of the states assimilable in the soil, reduction of nitrogen loss by levigation, and reduction in intensity of the processes of free phosphate retrogradation (Dorneanu et al., 2008). These organo-mineral fertilizers on lignite support represent a factor of crop increase on soils poor in the main nutritive elements. The positive effect on various crops of the fertilizers containing humic substances has been widely studied (Arancon et al., 2006) (Unlu et al., 2011) (Akinci et al., 2009). A basic tendency in the structure and production of chemical fertilizers, outlined during the past 35 years, is the expansion and diversification of the range of liquid fertilizers, regardless of the technologies of use (Cioroianu et al., 2009). The first "research" on the possibility to use liquid fertilizers started about 170 years ago and coincides with the beginning of the synthesis of chemical substances based on nitrogen and ammonia (Cioroianu et al., 2009). The liquid fertilizers have special advantages due to their rapid and easy application, as well as to their higher agrochemical efficiency as compared to the classical solid fertilizers (Cioroianu et al., 2009).

MATERIALS AND METHODS

The experimental scheme comprised 9 variants in 4 repetitions: V1- Control (Non-fertilized); V2- AH-I - 100 l/ha; V3- AH-I - 150 l/ha; V4- AH-U - 100 l/ha; V5- AH-U - 150 l/ha; V6- AH-N - 100 l/ha; V7- AH-N - 150 l/ha; V8- KH - 100 l/ha; V9- KH - 150 l/ha.

For the experiment organized on the slag heap for the corm crop, a basic fertilization was performed before sowing, with solid NPK 15:15:15 - type fertilizers applied N – 90 kg/ha, P_2O_5 – 90 kg/ha, K_2O - 90 kg/ha, and the fertilizer physically applied per hectare was 600 kg. Before the sowing, a basic fertilization was performed with $N_{90}P_{90}K_{90}$ and after the sowing the humate-based liquid fertilizers AH-I, AH-U, AH-N and KH were applied in a concentration of 100-150 l fertilizer/ha in 450-500 l of water. The weeding operation was performed 60 days after sowing. Soil samples were taken 150 days after the implementation of the experiment, after the first treatment applied in three stages, the second treatment was applied in three stages, 210 days after the first treatment and soil samples were taken 60 days after the second treatment.

The procedure to obtain the liquid fertilizer consisted in the neutralization of the phosphoric acid concentration of 85% with potassium carbonate concentration of 98%, resulting in a solution that contained mono- and dipotassium phosphate. The reaction took place under a continuous stirring at a constant temperature of 250-300°C, gradually adding an amidic, nitrate and ammonium nitrogen source, and maintaining the reaction temperature, and as a result a complex mixture of macro-elements was obtained. Under continuous stirring conditions, at a temperature of 25-30°C, a solution of microelements (Fe, Cu, Zn, Mg, Mn, B) was chelated with EDTA disodium salt and mixed with a solution of potassium humate (Sîrbu et al., 2010). The scheme to obtain the NPK fertilizers is presented in Figure 1.

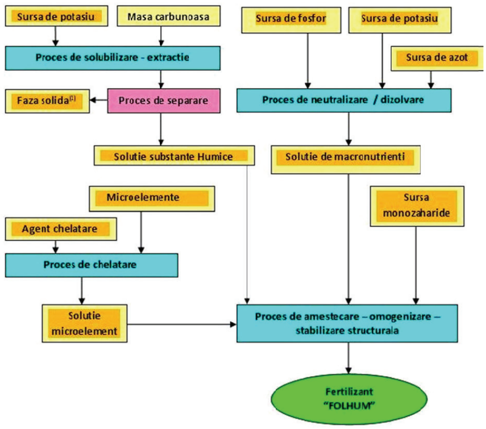

Figure 1. General scheme to obtain the NPK fertilizer with humic substances (according to Pârvan et al., 2012)

In the framework of the experiments performed, the potassium humate used to obtain the fertilizer was extracted from the coal mass, lignite, with the potassium carbonate solution.

The potassium humate extracted from lignite and used in obtaining the experimental fertilizer was thermally analyzed in the range of ambient temperature – 1000°C, in the air, with a 10 K/minute heating rate, simultaneously drawing the TGA (thermal gravimetric analysis), DTG (derivative *thermogravimetric analysis)*, DTA (differential thermal *analysis) and DSC (calorimetric analysis) curves* (Sîrbu et al., 2010). The measurements were made with a Perkin Elmer thermo balance which enabled mass determinations at an error of 1-2% in the temperature range of: ambient temperature – 1400°C and a heating rate of: 0.1-50 K/minute. The potassium humate obtained in the laboratory by alkaline extraction from lignite presented four main decomposition stages, namely: up to 85.3°C, loss 10.4%, which stage corresponded to drying by an endothermal process with a 57.9 J/g enthalpy; the second d process was also endothermal, in the range of 85.3-267°C, with an 11.6% mass loss and a 145.5 J/g process enthalpy. In the temperature range of 267-600°C the mass loss was 5.4%, when a slight exothermal effect could be noticed, with a 58.3 J/g enthalpy, the maximum heat eliminated being of 419.8°C for a heat flow of 1.12 mW. The fourth decomposition state took place in the temperature range of 600-800°C with a 4.7% mass loss. The humic/fulvic mix present in the fertilizer matrix contained about 70% organic acids, whereof 50% derive from humic acids and 20% from fulvic acids. The spectral analysis of the humic substances was made by Fourier transform infrared spectroscopy (*FTIR*) by means of the PerkinElmer Spectrum 100 and the VERTEX 70 spectrometers respectively, in the wave length range of 650-4000 cm^{-1} (Figure 2).

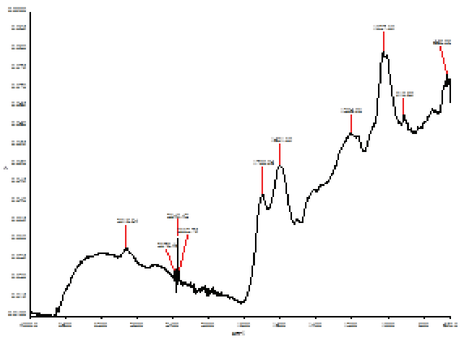

Figure 2. FTIR image of the humic acid extracted from the coal mass (lignite) (according to Pârvan et al., 2012)

Table 1. Composition of the AH-type fertilizers

Composition	AH FERTILIZERS		
	AH - I (g/l)	AH - U (g/l)	AH - N (g/l)
Humic acids	20.5	20.5	15.5
Total nitrogen (N)	90	55	165
Phosphorus (P_2O_5)	35	50	30
Potassium (K_2O)	35	50	30
Boron	0.2	0.15	0.18
Cobalt	0.005	0.005	-
Copper	0.1	0.15	0.2
Iron	0.25	0.3	0.4
Magnesium	0.1	0.15	0.4
Manganese	0.15	0.2	0.4
Molybdenum	0.005	0.005	-
SO_3	0.5	0.5	15
Zinc	0.1	0.15	0.2
EDTA	2.8	2.8	8.5
Total s.a	184.71	179.91	265.78

All the spectra were obtained by total infrared reflection with the ATR (Attenuated Total Reflectance) module. The resolution was 4 cm^{-1}, with the average of 4 up to 32 scans and the correction of the CO_2 and H_2O fund, in the transmittance mode.

Table 1 presents the physical - chemical characteristics determined for the fertilizers with humic acids obtained experimentally - AH-U, AH-N, AH-I, KH.

RESULTS AND DISCUSSIONS

Effects of the treatment with humate-based liquid fertilizers on the soil in the corn crop

In the first year of the experiment it was found that the application of one dose (100 l/ha) of the new fertilizer AH-I resulted in the reduction of the mobile potassium content in the soil as compared to the non-fertilized control. The values recorded were 144 mg/kg as compared to 170 mg/kg. Increase of the dose of humate-based liquid fertilizer to 150 l/ha resulted in the significant reduction of the K_{AL} in the soil, the value of the mobile potassium in the soil dropping to 120 mg/kg as compared to the value of the non-fertilized control, i.e. 170 mg/kg due to the fertilizer containing NPK in its matrix. By the application of the AH-U liquid fertilizer in two doses, the contents of mobile potassium in the soil increased significantly to 188 mg/kg as compared to the non-fertilized control of 170 mg/kg. Potassium humate applied in a 100 l/ha dose reduced significantly the K_{AL} content in the soil to 140 mg/kg as compared to the non-fertilized control of 170 mg/kg.

In the second year of the experiment on the slag heap the effects of the treatments with humate-based liquid fertilizers were noticeable by the drop of the mobile phosphorus in the soil as compared to the non-fertilized control. The potassium humate applied in one dose (100 l/ha) reduced the mobile phosphorus contents in the soil to the value of 46.72 mg/kg as compared to the non-fertilized control whose value was 47.95 mg/kg. As for mobile potassium, the application of the liquid fertilizers resulted in obvious increase following the application of the liquid fertilizer AH-I in two doses (150 l/ha): 199.20 mg/ha as compared to the non-fertilized control, 186 mg/kg, due to the fertilizer containing NPK in its matrix.

Table 2. Treatment efficiency in the two years of experimenting

No	Variant (average per repetitions)	First crop				Second crop			
		pH	ppm P_{AL}	ppm K_{AL}	% N	pH	ppm P_{AL}	ppm K_{AL}	% N
1	V1 (R1-R4)	7.78	58.20	170	0.15	7.68	47.95	186	0.18
2	V2 (R1-R4)	7.75	57.68	144	0.14	7.81	39.34	141	0.15
3	V3 (R1-R4)	7.80	43.67	120	0.14	7.74	41.83	199.2	0.18
4	V4 (R1-R4)	7.74	44.71	152	0.15	7.80	41.22	143.8	0.16
5	V5 (R1-R4)	7.72	47.42	142	0.13	7.80	39.96	152.6	0.14
6	V6 (R1-R4)	7.82	45.80	160	0.15	7.80	43.67	158.4	0.12
7	V7 (R1-R4)	7.52	70.61	188	0.15	7.82	31.35	116.2	0.12
8	V8 (R1-R4)	7.74	47.42	140	0.15	7.77	46.72	165.6	0.15
9	V9 (R1-R4)	7.77	49.04	168	0.15	7.75	42.45	187.4	0.18

The application of KH (potassium humate) in two doses (150 l/ha) also resulted in the increase of the mobile potassium contents in the soil as compared to the non-fertilized control, i.e. 187.40 mg/kg as compared to 186 mg/kg. By the application of one dose (100 l/ha) of AH-I, the total nitrogen in the soil dropped to 0.15% as compared to 0.18% in the non-fertilized control. The application of a double dose of AH-I (150 l/ha) did not change the total nitrogen contents in the soil. In the application of the treatment in the recultivation of the slag heap, one dose (100 l/ha) of AH-U reduced the total nitrogen contents in the soil to 0.16% as compared to 0.18% in the non-fertilized control. The increase of the AH-U liquid fertilizer dose resulted in the drop of the total nitrogen contents in the soil to 0.14% as compared to 0.18% in the non-fertilized control. The liquid fertilizer AH-N applied in one dose and two doses reduced the contents of total nitrogen in the soil to 0.12% as compared to 0.18% in the non-fertilized control. Potassium humate (KH) applied in one dose reduced the total nitrogen contents un the soil to 0.5% as compared to 0.18% in the non-fertilized control. By the application of a double dose of potassium humate the total nitrogen contents in the soil did not change.

CONCLUSIONS

By the application of treatments with humate-based liquid fertilizers in the recultivation of the Balta Unchiaşului slag heap we noticed as follows:

- the treatments performed with the liquid fertilizer AH-N in two doses (150 l/ha) resulted in the increase of the mobile phosphorus contents in the soil to 70.61 mg/kg as compared to the contents of 58.20 mg/kg in the first year of the experiment;
- in the case of the mobile potassium, the application of the liquid fertilizers resulted in increase, by application of AH-I in two doses (150 l/ha), to 199.20 mg/ha as compared to 186 mg/kg in the non-fertilized control. The application of the new liquid fertilizer AH-U 150 l/ha resulted in the increase of the mobile potassium in the soil to 188 mg/kg as compared to 170 mg/kg in the non-fertilized control, in the second year of the experiment;
- the use of the new liquid fertilizers AH-I, AH-N and AH-U in the two years of experiments on the corn crop of the slag heap had positive effects on the soil by the increase of its nutrient contents.

ACKNOWLEDGEMENTS

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INFLUENCE OF MINERAL NITROGEN FERTILIZATION ON THE PRODUCTION OF RAPESEED AND ITS EFFECTS ON THE FERTILITY OF REDDISH PRELUVOSOIL FROM MOARA DOMNEASCĂ - ILFOV

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Abstract

The experiment was carried out at the Moara Domneasca - ILFOV research station in 2011-2012 cropping year. It is a kind of bi-factorial experience, type 3x4 subjected to split plots method in four repetitions and studied the following factors: A - factor - rapeseed hybrid (a1- Exagone, a2 – Extend, a3 - DK Expower) and B - factor (b1 -N0, b2 -N60, b3 -N120, b4 -N180). In the experiment we applied a general content of P60. The most productive rapeseed hybrid in the Moara Domneasca - ILFOV was Exagone which attained an average fertilizing of 41.89 q/ha production. The Nitrogen dose which achieved the highest production was N180 with 51.28 q/ha. The Correlations show the dependence of the soil-enzymes on the applied doses of nitrogen. The total nitrogen (Nt%) and the soil pH also prove to depend on the nitrogen mineral application. The catalase activity is depending on the soil pH, it has a higher value at higher pH.

Key words: *rapeseed, soil fertility, chemical fertilization, soil enzymes.*

INTRODUCTION

The recommended spacing adopted in our country in the recent years is 25 cm (Picu and Tianu, 1983, Pop, 1985; D.I. Sandoiu and al., 2003). The recommended densities in Romania are 70-110 plants/sqm (Bîlteanu, 2001, Muntean et al., 2008, Gus et al., 2003).

According to the literature review of Hera et al. (1980, 1986), Boguslawski (1965), Stefanic et al. (1965, 2006, 2011), Dinca et al. (2011, 2012), Dick (1994), Sandoiu et al. (2012), Gil-Sotres et al. (2004), Bo Liu et al. (2007), the effect of mineral fertilizers over the soil biological activity can be assessed in a variety of ways. Some researchers found stimulating influences, some inhibitory and some without any influence.

The differentiated approaches of mineral fertilizers doses arise from the theories of Liebig (mineral nutrition law) and become more consistent after the works of: Barlog et al. (2004), Bell (1970), Bilsborrow et al. (1993), Borlan and Hera (1973, 1984, 1996) Hera and Davidescu (1964), Hera et al. (1994) demonstrated that applying nitrogen to the rapeseed culture brought an increase compared to the production provided by chemically unfertilized variants.

The purpose of this paper is to highlight the best performing rapeseed hybrid in Moara Domneasca-Ilfov, to highlight the most effective nitrogen fertilization dose for a maximum yield of rapeseed and to evaluate the mineral fertilizer application effects over the fertility of reddish preluvosoil in the agricultural year 2011-2012.

MATERIALS AND METHODS

The experiment was carried out at Moara Domnească-Ilfov in the 2011-2012 cropping year, it is a bi-factorial type experience subjected to the split plots method in four repetitions and had studied the following factors: A factor-rapeseed hybrid (a_1-Exagone, a_2 – Extend, a_3-DK. Ex-power) and B factor – the nitrogen dose (b_1-N_0, b_2-N_{60}, b_3-N_{120}, b_4-N_{180}). In the experiment it was applied a general content of P_{60}. The previous crop was winter wheat. A general content of $N_{60}P_{60}$ was applied. Rapeseed is sown on 13/09/2011 and ensured a density of 70 seeds germination/m^2, harvesting was done manually in each variant experience on 13/7/2012. Soil samples were collected on 13/09/2012 at the depth of 0-20 cm and were conditioned by the method of Peterbugski (1954) and Ştefanic (2006) and were subjected to biological analysis by Ştefanic (2006, 1994) and chemical by Elena Stoica et al. (1986), Conklin (2005), Rowell (1994).

The climatic conditions during the analyzed period are shown in the figures *1* and *2*. It is shown in May of 2012 with a rainfall surplus (112.9 mm) and the annual temperatures average exceeding the normal values. Climatic conditions are a factor with high influence over the soil characteristics and the production of rapeseed.

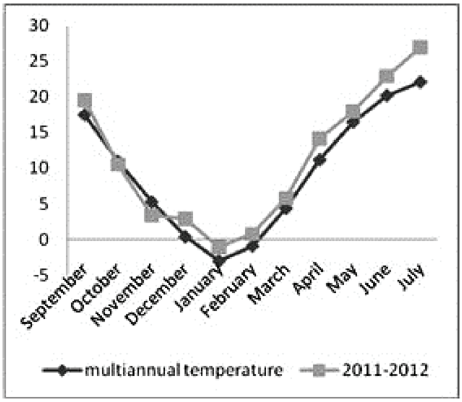

Figure 1. The monthly and multiannual average of temperatures in vegetation time of rapeseed cultures

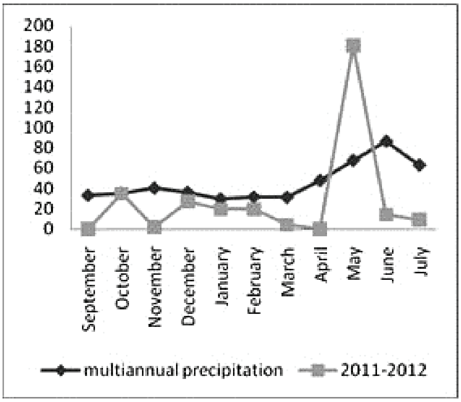

Figure 2. The monthly rainfalls and multiannual values from the vegetation time of rapeseed cultures

RESULTS AND DISCUSSIONS

1. The influence of mineral fertilization on rapeseeds hybrids.

Following the influence of the rapeseed hybrids on the average of the mineral fertilization with nitrogen (Table 1), it can be noticed that the hybrids Exagone and DK-Expower were classified in the first group with the production values of 41.89 q/ha and 40.86 q/ha, and at the lower level in the group *b* was ranged the Extend hybrid with a production value of 38.36 q/ha.

According to the fertilization influence on hybrids medium, it was observed that the application of nitrogen positively influenced the production of rapeseed, which at the application dose of N_{180} produced 51.28 q/ha, classified in the first group *a*, followed by the application of a N_{120} with production of 46.13 q/ha and was placed in values of group *b*. The unfertilized variants and the application of N_{60}-dose achieved a significantly lower production than the application of high doses of nitrogen which were placed in the group *c* level of confidence.

According to the combined influence of the nitrogen fertilization and the rapeseed hybrid assortment on the reddish preluvosoil the Moara Domneasca differentiation observed statistical ensured results on chemical nitrogen. The best yield of unfertilized content was obtained at the hybrid Extend which was classified in the group of values *a*. At N_{60} dose application have no statistical differences on hybrids. Based on N_{120} dose application, hybrids that responded best were Exagone and DK. Expower, and with the application of N_{180} dose hybrid DK. Ex-power best performed with a production of 57.45 q/ha. The hybrids Exagone and Extend did not respond to fertilization with mineral nitrogen at N_{180} dose application DK. Ex-power hybrid responded at N_{180} dose application with the production of 57.45 q/ha which was the highest production in the experiment followed by Exagone hybrid at N_{180} with a production of 52.53 q/ha.

Table 1. The influence of mineral fertilization on hybrids variety (q/ha)

Factor A \ Factor B	b_1-N_0	b_2-N_{60}	b_3-N_{120}	b_3-N_{180}	Average A
a_1-EXAGONE	a 30.71 b	a 32.41 b	a 51.92 a	b 52.53 a	a 41.89
a_2-EXTEND	a 35.75 b	a 34.50 b	b 39.34 a	c 43.87 a	b 38.36
a_3-DK. EXPOWER	b 28.32 c	a 30.50 c	a 47.16 b	a 57.45 a	a 40.86
Average B	31.60 c	32.47 c	46.13 b	51.28 a	
DL P	A	B	B*A	A*B	
5%	1.967	4.206	6.494	7.284	

2. The influence of mineral fertilization on chemical changes in the reddish preluvosoil of Moara Domneasca-ILFOV after the first year of experimentation.

Following the influence of mineral fertilization under rapeseeds in reddish preluvosoil chemical changes at Moara Domneasca-Ilfov we witnessed statistical differences (Table 2). The nitrogen doses application has negatively influenced the pH of soil, 3 level of fertilization were placed in the group *b* values ranging from 5.31 to a N_0 variant of 4.94 at the N_{180} dose. This was observed by Sandoiu et al. (2012), Stefanic and Sandoiu (2011) at other cultures and time periods. Following the influence of mineral fertilization over the soil organic matter content showed no difference because the observation time was short. The total N content has a significant increase up to N_{120} and decrease to N_{180}. The rapport C/N showed an opposite trend, the most favorable situation was at N_{120}.

Table 2. Influence of mineral fertilization on chemical changes in the reddish preluvosoil (Moara Domneasca-Ilfov)

Experimental Variants	pH of soil	O.M (%)	Ah (m.e./100g soil)	Sb (m.e./100g soil)	T (m.e./100g soil)	V (%)	Nt (%)	C/N
N_0	a 5.31	2.37	6.85	14.09	28.96	67.26	c 0.13	a 10.70
N_{60}	b 5.04	2.34	6.42	14.76	28.68	69.70	b 0.14	b 9.93
N_{120}	b 4.95	2.37	6.71	12.58	27.13	64.60	a 0.15	b 9.18
N_{180}	b 4.94	2.31	6.56	17.78	32.02	71.69	d 0.12	a 10.77
DL P								
5%	0.077	-	-	-	-	-	0.006	0.440
1%	0.117*	-	-	-	-	-	0.008*	0.660*
0.1%	0.189	-	-	-	-	-	0.014	1.060

3. The influence of mineral fertilization over some pedo-biological changes of reddish preluvosoil in the Moara Domneasca area-ILFOV after the first year of experimentation.

The Table 3 shows the influence of mineral nitrogen fertilization over the cellulolytic activity of the reddish preluvosoil. The best response was obtained with N_{120} application. The breathing potential activity of the reddish preluvosoil responded to doses of nitrogen application, which can lead to an eventual mineralization of organic matter. Soil-enzymatic activities were negative answer to nitrogen application doses as confirmed by Boguslawski (1965) which states that the enzymes are long responsible before chemical analysis.

Table 3. The Influence of mineral fertilization on some biological changes of reddish preluvosoil in Moara Domneasca-Ilfov County

Experimental Variants	Cellulose (mg cell)	Breathing (mg CO_2/100g soil)	Catalase (cm^3 O_2/100 g soil)	Phosphatase (mg P/100g soil)	Amidase (NH_4 mg/100g soil)
N_0	b 5.16	b 39.73	a 112.02	a 2.32	b 0.28
N_{60}	b 4.80	b 40.85	b 44.48	b 0.71	a 1.16
N_{120}	a 6.48	a 49.96	b 32.88	b 0.55	a 1.01
N_{180}	c 3.30	a 53.13	c 13.12	b 0.54	b 0.22
DL P					
5%	0.786	4.160*	30.486*	0.310	0.254
1%	1.192*	6.310	46.192	0.470*	0.386
0.1%	1.916	10.140	74.243	0.750	0.620

4. The dependence of the soil fertility factors related to the application of mineral nitrogen doses.

Between the nitrogen applied doses and pH values we show a negative correlations (Figure 3). Between pH values and catalase (Figure 4) is a positive correlation and with breathing (Figure 5) a negative correlation statistical significance. Catalasic activity (Figure 6) and phosphatasic activity (Figure 7) decrease with the increasing of nitrogen doses.

The amidase activity registered the maxim value at N_{60} dose and with nitrogen doses increase the amidase activity decrease with minim value at N_{180} (Table 3). The potential breathing activity is in dependence with the cellulolitic activity till its averages values (Figure 8). After due pH decreasing values the potential breathing activity increased with the increasing of fungus activity in acid soils.

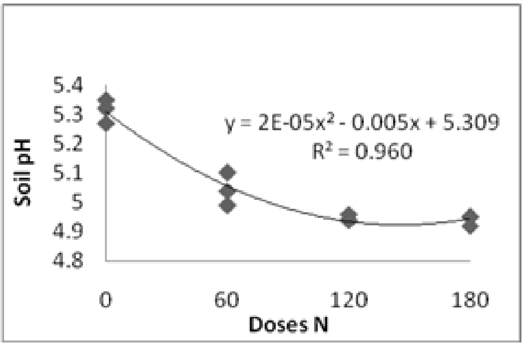

Figure 3. The influence of mineral nitrogen application on the soil pH

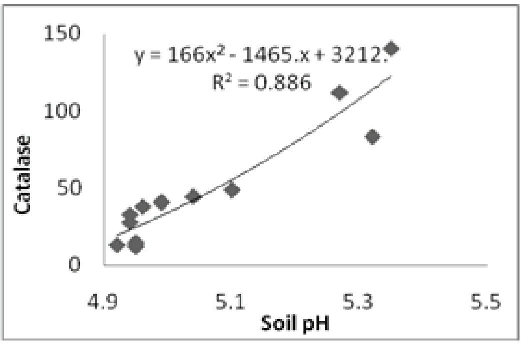

Figure 4. Dependence of catalase activities on chemical reaction of the soil

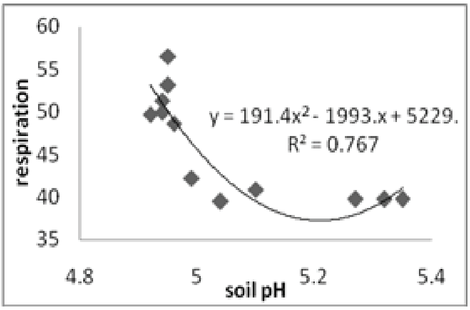

Figure 5. Dependence of breathing activities by chemical reaction of the soil

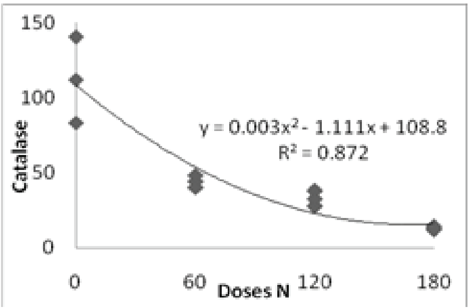

Figure 6. Dependence of catalase activities by nitrogen doses

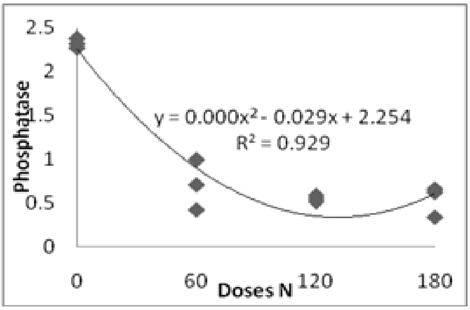

Figure 7. The influence of mineral nitrogen application on the phosphatase activity of the soil

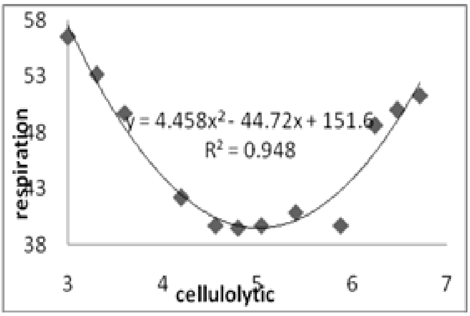

Figure 8. Dependence activities of breathing by cellulolytic activities

CONCLUSIONS

The Hybrid rapeseedseed was most productive in Moara Domneasca-ILFOV in 2011-2012 cropping year was Exagone which obtained a production average of 41.89 fertilization q/ha.

At rapeseeds hybrids the average nitrogen dose which attained the highest production was N_{180} with 51.28 q/ha.

The maximum production in experiment was 57.45 q/ha at the hybrid DK Expower and at N_{180} doses.

After the first year of experimentation the nitrogen application has negatively affected the soil pH, which decreased from 5.31 to 5.04 with N_{60} dose application to unfertilized.

The catalase activity and the phosphatase activity were sensitive to nitrogen dose application.

The Catalase activity is dependent on the soil pH, it has a higher value at higher pH.

The potential breathing activity is strictly dependent on the soil cellulolytic activity.

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PHYSICAL AND CHEMICAL CHARACTERIZATION OF DYSTRIC CAMBISOL FROM THE PIATRA CRAIULUI NATIONAL PARK

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Abstract

This paper presents the characterization dystric cambisol from Piatra Craiului National Park. Soil samples are collected from the Piatra Craiului National Park. Park has a surface of 14,800 ha.
This type of soil has the following diagnostic horizons: Ao, Bv, C are analyzed following parameters: pH, organic C, total N, SH, SB,
The soil is strongly acid reaction (pH = 3.45-4.57). High organic matter and total nitogen in the upper horizont.

Key words: *forest soil, organic carbon, nitrogen.*

INTRODUCTION

National Park extends over the counties of Brasov, Arges, including areas belonging localities Bran, Moeciu (villages Magura and Pestera), Bran, Rucar and Dambovicioara.
The total area of the Piatra Craiului National Park is 14,800 ha of which 7806 ha in Brasov and 6994 in Arges (Dumitru and Toader, 2004).

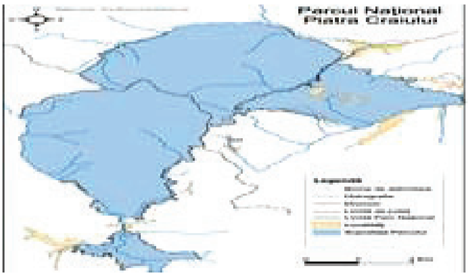

Figure 1. Map of Piatra Craiului National Park

Total carbon in forest ecosystems is given of existing content in biomass, dead wood, in the litter and soil. The highest amounts are found in living biomass and soil. Evolution of forest carbon stock in soil is influenced by natural factors and anthropogenic.
Globally, forests store large amounts of carbon sequestered from the atmosphere and retained in living and dead biomass and soil.

MATERIALS AND METHODS

The research was performed in the Piatra Craiului National Park and were followed some chemical indicators.
The soils pH was electri-chimically determinat in water, the reading being fulfilled wich Thermo Orion 3 pH-meter. The organic carbon was determined thoug the dry ignition method by using the Leco Tru Spect CN automatic analyser. The total nitrogen from de soil was established through the humid mineralization method and titrimetrical dosage-Kjeldahl method with the Gerhard mineralizor and still. (ICP forests, 2010) The exchange acidity the extract of potssium acetate. The basic cations (K^+, Na^+, Mg^{++}, Ca^{++}) were determined through the repeated blenders wiht ammonium acetat, total cationic exchange capacity (T), by summing SB + Ac, the saturation degree of base (V%), the formula V% = SB/T*100.

RESULTS AND DISCUSSIONS

The resultas regard distribution of values for physico-chemical indicators of surfaces with dystric cambisols from the Piatra Craiului National Park.

Table 1. Analytical data of the chemical features of the dystric cambisols from Piatra Craiului National Parks

No. profiles	Horizont	Depth cm	pH H_2O	pH $CaCl_2$	Nt (%)	Ct (%)	Ah (me/100g)	SB (me/100g)	K (me/100g)	Na (me/100g)	Mg (me/100g)	Ca (me/100g)	T (me/100g)	V (%)
1	Aou	0-10	3.27	2.49	1.173	12.09	61.54	4.97	2.25	0.11	0.09	2.52	66.51	7.47
	AB	10-20	3.39	2.76	0.363	7.06	37.43	1.52	0.52	0.08	0.66	0.25	38.95	3.89
	Bs1	20-40	4.07	3.43	0.223	4.36	24.38	0.93	0.28	0.05	0.53	0.06	25.30	3.66
	Bs2	40-80	4.36	3.81	0.168	4.06	21.71	0.54	0.16	0.06	0.28	0.04	22.25	2.42
2	Ao	0-10	4.01	3.14	0.476	7.82	21.66	5.00	1.06	0.05	0.48	3.40	26.65	18.75
	AB	10-20	4.40	3.66	0.112	2.06	11.43	2.67	0.15	0.03	0.64	1.85	14.10	18.95
	Bv1	20-40	4.60	3.76	0.056	1.10	9.25	2.46	0.14	0.04	0.23	2.05	11.70	20.98
	Bv2	40-80	4.86	3.85	0.035	0.59	7.45	2.02	0.14	0.06	0.30	1.52	9.47	21.31
3	Ao	0-10	4.81	3.79	0.363	4.78	15.51	11.76	0.66	0.05	0.77	10.29	27.27	43.13
	Bv1	10-20	4.94	3.84	0.111	1.45	9.03	4.25	0.22	0.04	0.64	3.35	13.28	31.99
	Bv2	20-40	4.93	3.75	0.055	0.90	11.48	3.48	0.18	0.03	0.41	2.85	14.96	23.28
	Bv/R	40-80	4.95	3.74	0.084	0.52	7.73	4.35	0.21	0.04	0.36	3.74	12.07	36.00
4	Ao	0-10	3.50	2.83	0.806	10.60	46.47	7.20	1.24	0.09	0.50	5.38	53.67	13.42
	Bv	10-20	4.40	3.60	0.334	3.60	18.17	2.10	0.28	0.05	0.68	1.10	20.28	10.37
	Bv/R	20-40	5.49	4.49	0.168	1.70	8.00	10.16	0.48	0.04	0.34	9.31	18.16	55.96
5	Ao	0-10	3.93	3.22	0.445	4.89	23.51	1.68	0.47	0.05	0.62	0.55	25.19	6.69
	Bv1	0-20	4.58	3.84	0.139	2.36	13.17	0.70	0.15	0.03	0.44	0.08	13.87	5.06
	Bv2	20-40	4.57	3.87	0.084	1.12	8.81	0.46	0.15	0.03	0.10	0.17	9.27	4.93
	Bv3	40-80	5.37	4.16	0.028	0.50	7.51	4.29	0.22	0.04	0.09	3.94	11.80	36.37
6	Ao	0-10	4.73	3.65	0.529	5.06	19.42	7.57	0.57	0.04	0.69	6.28	26.99	28.04
	Bv1	10-20	4.66	3.68	0.250	3.26	16.38	4.02	0.27	0.04	0.70	3.01	20.40	19.72
	Bv2	20-40	5.18	4.01	0.140	1.20	12.13	3.83	0.38	0.03	0.63	2.78	15.97	24.00

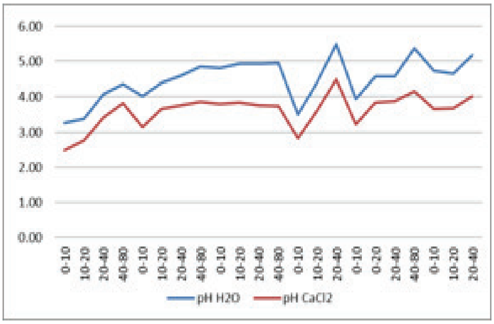

Figure 2. The depth variation of pH

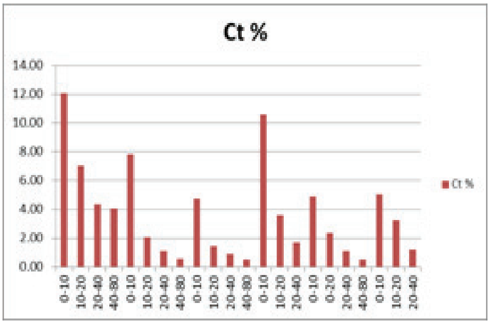

Figure 3. The depth variation of organic carbon

The results have shown that the mountain forest soils are strongly acidic, with a pH between 2.5–4.5 in saline extract

The largest amounts of organic carbon is in the top 20 cm of mineral horizons, due to more abundant crop residues and lignin rich in organic carbon decreases with depth.

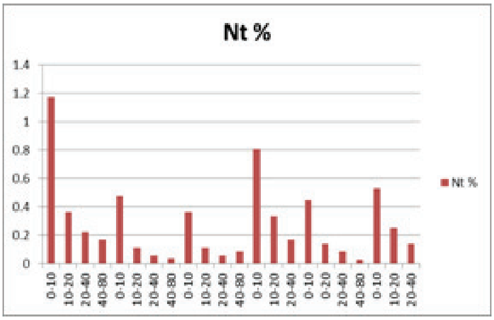

Figure 4. The depth variation of total nitrogen

Higher accumulation of total nitrogen in receive 10 cm of profile.

In the first 10 cm of soil is recorded greater amounts of Ca and K.

It is noted that among the six sections studied, which is the same type of soil there are some differences large and small, for some physico-chemical conditions caused by lithologic substrate, the composition of forest.

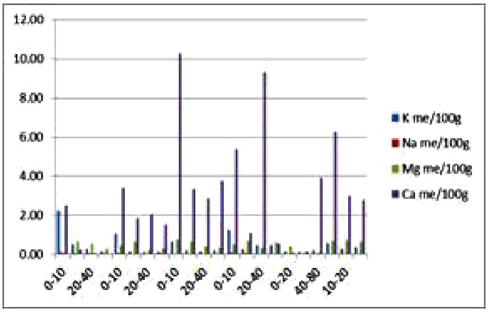

Figure 5. The depth variation of basic cations

CONCLUSIONS

The results have shown that the mountain forest soils are strongly acidic.

Organic carbon and total nitrogen is highest in the first 10 cm of the soil profile is increased due lignin-rich litter, and it decreases with depth.

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RESEARCH ON VARIABILITY OF SOIL PHYSICAL AND CHEMICAL INDEXES IN THE MOUNTAINS OF ROMANIA

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Abstract

This paper presents results of research conducted in 2010-2013 in the mountains, we studied 60 profiles with 260 horizons.
Are analyzed following chemical parameters: pH, organic C, total N, exchange acidity, base saturation level and physical texture.
The results refer to the type of soil formed under different types of forest stands in the first mineral horizon of the soil profile organic carbon and total nitrogen is higher than these lower horizons. Mountain soils are acidic and basic cations poorer. The values of C/N ratio of their correlation with altitude shows a degree of normal fertility.

Key words: *organic carbon, total nitrogen, forest soil, the C/N.*

INTRODUCTION

Influence of tree species on soil properties was studied by ecologists long (Muller, 1887). Were studied but more parameters influencing soil fertility. Recently the role of carbon in the soil as a source of greenhouse gases is studied in relation to the type of correlation to forest species (Binkley, 1995; Jandl et al., 2007).
To mitigate greenhouse effects, it is essential to provide managers and policy makers with accurate informat ion on the current state, dynamics, and spatial distribution of carbon sources and sinks (De Jong et al., 2000). Forest ecosystem, as a huge carbon pool, has been also proposed as a means to reduce net greenhouse gas emissions, by either reducing CO_2 sources or enhancing sinks (Kenneth et al., 2004). Forest carbon sink and stock would be possible to substantially offset the industrial emissions of carbon dioxide by expanding the forest areas (Wang et al., 2009).
As a result of strong association between soil organic and mineral fractions, a prerequisite to selective characterization of soil organic materials has been its separation from the mineral portion. Many studies of soil organic matter (SOM) have utilized chemical extractants or physical methods to fractionate soil organic matter (Stevenson et al, 1989). Chemical fractionation and characterization methods have not proven particularly useful in following the dynamics of organic material in soils (Oades and Ladd, 1977).

MATERIALS AND METHODS

The soil samples were harvest of the 10 research points with 3 repeated for each point, the following standard depth 0-10 cm, 10-20 cm, 20-40 cm, > 40 cm.
Preparation of soil samples is based on the ISO 11464 method (ISO 11464, 1994).
Collected samples should be transported to the laboratory as soon as possible and be air dried or dried at a temperature of 40°C. They can then be stored until analysis (Cools and De Vos, 2010).
Soil samples were collected on geometric horizons (standard) from 0-10 cm, 10-20 cm, 20-40cm, 40-80 cm for each profile and made five repetitions.
The soils pH was electri-chimically determinat in water, the reading being fulfilled wich Thermo Orion 3 pH-meter. The carbonates were goso-volumetrically determined with the Scheibler calcimeter (ICP forests, 2010). The

organic carbon was determined thoug the dry ignition method by using the Leco Tru Spect CN automatic analyser (LECO 1996, CNS-2000). The total nitrogen from de soil was established through the humid mineralization method and titrimetrical dosage-Kjeldahl method with the Gerhard mineralizor and still. The exchange acidity the extract of potssium acetate (ICP forests, 2010). The basic cations (K, Na, Mg, Ca) were determined through the repeated blenders wiht ammonium acetat, total cationic exchange capacity (T), by summing SB + Ac, the saturation degree of base (V%), the formula V% = SB/T*100.

RESULTS AND DISCUSSIONS

For the present article we have studied the soil sample gathered in the year 2010 and 2012, from 60 profiles and 260 soil horizons.
Selected sample areas are located between 410 and 1850 m.

Figure 1. The plots location

Most samples analyzed an acidic pH of between 3.0-5.5, only 40 of the 260 samples were carbonates. The soils are richest in organic carbon and nitrogen.
The total cation exchange capacity can be explained by the emphasized growth of the forest soils acidity and implicitly of the hydrogen cations at the same time with the atitude.

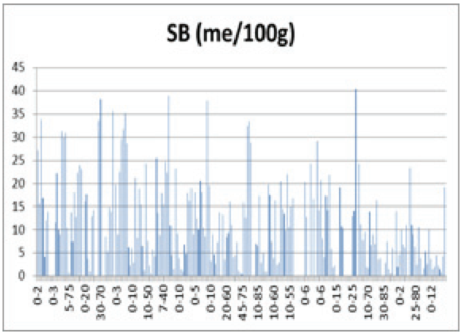

Figure 2. Correlation altitude – pH

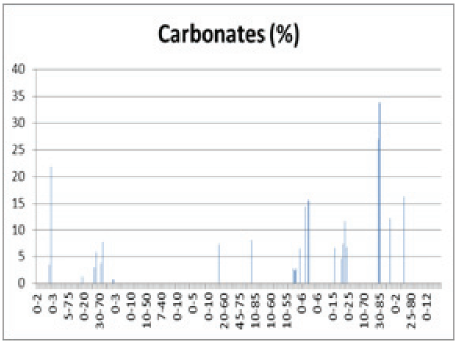

Figure 3. Correlation altitude – Carbonates

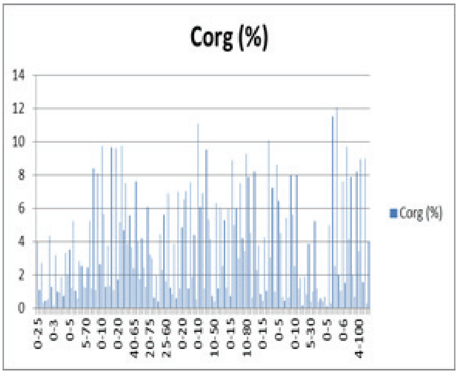

Figure 4. Correlation altitude – organic carbon

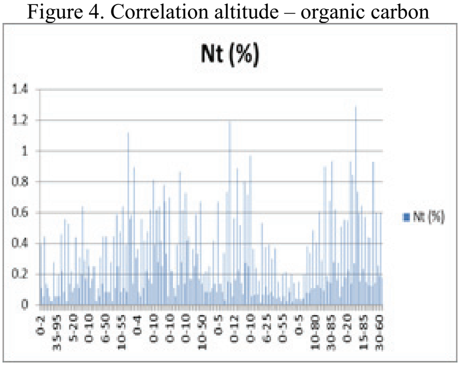

Figure 5. Correlation altitude – total nitrogen

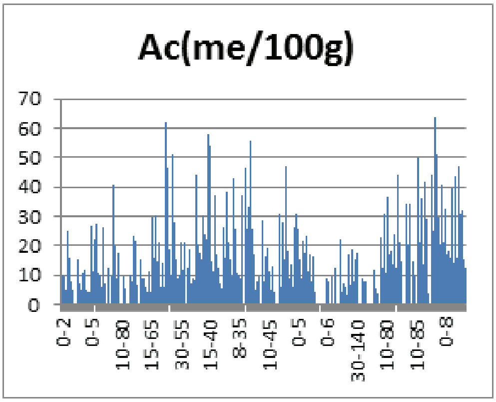

Figure 6. Correlation altitude – exchange acidity

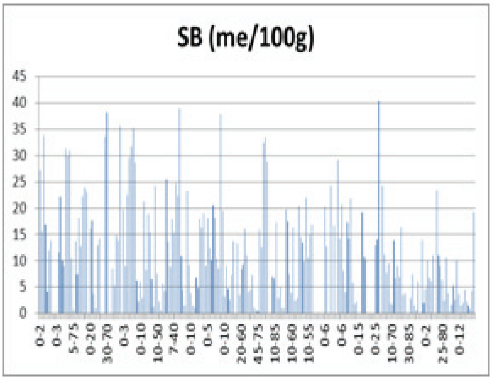

Figure 7. Correlation altitude – SB

CONCLUSIONS

The results have shown that the mountain forest soils are strongly acidic.

Soil organic matter (SOM) varies quantitatively and qualitatively, both within a single soil profile (vertical variability) and among different soils (horizontal variability). Correlation with altitude showed a degree of normal fertility.

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THE INFLUENCE OF SOIL TILLING SYSTEMS AND THE PRECULTURE PLANT ON THE SOYBEAN CULTURE PRODUCTION IN THE SOMEȘAN PLATEAU

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Abstract

The cultivated plant production is the result of the interaction of all factors which participate on way or another in the formation of the harvest. The level of harvest is proportional to the degree to which each factor and all of them together are getting close to the optimum values required by the biology of the plants, following that the soy production recorded in the experimental years in the Somesan Plateau is proportional to the soil tilling systems, the preculture plant and the climatic conditions. The analisys of soy productions by the soil tilling system and the preculture plant confirms the above mentioned, with larger productions with values between 1775 kg/ha and 1883 kg/ha after wheat preculture, and respectively 1467 kg/ha and 1757 kg/ha after corn preculture. The production differences determined by the preculture plant vary depending on the soil tilling system and have values between 5.8-21%. In the classic soil tilling system alternatives and the unconventional systems, the growth determined by the preculture plant is the smallest, with values between 6-7%, which means that their beneficial effect was taken over by the soil tilling, thus recording the largest productions, regardless of the precultures.In the harrow soil tilling system alternative, less favourable for the soy cultures, the harvest growth determined by the preculture plant reaches a maximum on experiment of 21.0%. A large increase determined by the preculture plant is also recorded in the chisel tilling alternative, in which the growth reaches 11.6%. From the above mention data analisys, it follows that when the soil tilling is favourable to the cultivated plant, the preculture plant`s contribution is less significant, and when the soil tilling doesn`t manage to favour the cultivated plant, we can suppose it`s the water factor in our situation. The preculture plant which ensures a larger period of time from harvesting to the soy culture sowing is more efficient concerning the level of production.

Key words: *soil tillage, production, crop rotation, soil fertility.*

INTRODUCTION

The production of each cultivated plant is the result of the interaction of all the factors which participate one way or another to the formation of the crop. The level of the crop is in direct connection to the degree in which every factor comes close to the optimum values required by the biology of the plant.

This global condition is rarely met in the natural life environment of the plants, but it can be improved by associating different practices: the way of preparing the soil, the sowing period, the density and the equipment used, the culture rotation, the soil or hybrid choice, the fertilizing and the application methods, control of the weeds, diseases and pests, so that the "offer of the place" is as close as possible to the biology of the cultivated plant.

To a large extent, the relationship between the soil tilling system and the production depends on the previous state of the soil and the precipitation level. The classical soil tilling system based on plowing with the mouldboard plough generally ensures the highest crops, exploiting however the natural fertility and exhausting the soil resources.

When elaborating the alternative soil tilling systems not only the immediate results (high productions) must be targeted, but also the long-term ones, which ensure the durability of the system in time.

The research conducted during more than fifty years of application confirms that the unconventional system ensures to the soy cultures productions which are close to those obtained in the classical system.

Synthetizing the data published in the specialist literature, comparatively between the two systems, classical and unconventional, similar levels of production emerge (Gus, 1995; Sandoiu, 1998; Lazureanu, 1997; Jitareanu, 2008).

MATERIALS AND METHODS

The results presented in this paper were obtained in the experimental fields of the agrotechnics discipline from the Jucu region in Cluj, on *argic-stagnic Faeoziom soil, with a humus content of* de 3.8% and 6.5 pH. From a climateric point of view, the hilly area where the experiments took place is characterised by medium annual precipitations between 550-650 mm. The thermal regime of the area is characterised by annual average temperatures between 8.0-8.2°C.

The aim of the research was to determine the influence of soil tilling systems and the pre-emerging plant on the soybean production.

The experimental factors were as follows:

Factor A – Tillage system:

- a_1 – worked with reversible plough
- a_2 – worked with chisel
- a_3 – worked with paraplow
- a_4 – worked with rotary harrow
- Factor B – Cultivated plant:
- b_1 – corn
- b_2 – soybean
- b_3 – wheat

RESULTS AND DISCUSSIONS

The soybean production analysis by the soil tilling system and the pre-emerging plant confirms the information mentioned (Table 1), with larger production, with values between 1775 kg/ha and 1883 kg/ha after wheat preculture and respectively 1467 kg/ha and 1757 kg/ha after corn preculture.

The production differences determined by the pre-emerging plant are different depending on the tillling system and have values between 5.8 -21%.

Table 1. Soybean production varying with the pre-emergent plant and the working system

Soil tillage system	Pre-emergent plant		Difference kg/ha
	Corn	Wheat	
	Soybean crop production, (kg/ha)		%
Reversible plough (a_1)	1757	1883	107.2
Chisel (a_2)	1613	1800	111.6
Paraplow (a_3)	1717	1817	105.8
Rotary harrow (a_4)	1467	1775	121.0

In the classical soil tilling alternatives (a_1) and unconventional ones (a_3), the increase determined by the pre-emerging plant is the smallest, with values between 6-7%, which means that its beneficial effect was overtaken by the soil tillage, thus obtaining the largest production regardless of the pre-emerging plant.

In the rotary harrow soil tilling alternatives, less favourable for the soybean culture, the harvest increase determined by the pre-emergent plant reaches a maximum on experience of 21.0%. Also, a high increase determined by the pre-emergent plant is recorded in the chisel tilling alternative, in which the increase reaches 11.6%.

From the analysis of the data mentioned (Table 1), it arises that when the soil tilling system is extremely favourable to the cultivated plant, the pre-emerging plant contribution is lower, and when the soil tilling system doesn`t manage to favour the cultivated plant, assuming the water factor in the Jucu situation, the pre-emerging plant which ensures a longer period of time from harvesting to the soybean culture sowing, is more effective regarding the production level.

Soybean crop production varying with the soil tillage system and the pre-emergent plant, wheat.

In the alternatives in which the pre-emerging plant was wheat, the soybean production recorded values from 1775 kg/ha to 1883 kg/ha. We can notice that the production differences determined by the soil tillage systems are blurred, so that, comparatively to the standard alternative, no production differences statistically ensured from other soil tilling methods are recorded.

Soybean crop production varying with the soil tillage system and the pre-emergent plant, corn

The recorded production was 1467-1757 kg/ha, reaching the maximum value in the reversible plough alternative, followed by the paraplow, chisel and rotary harrow alternatives. Distinct significant to negatively very significant differences can be noticed with the rotary harrow use and chisel use, and also insignificant differences in the situation of using the paraplow tilling system. This first observation leads to the idea that in the case of soybean cultures conditioned by the corn pre-emerging plant, we recommend using the reversible plough, respectively the paraplow.

Table 2. Soybean crop production varying with the soil tillage system and the pre-emergent plant, wheat

Soil tillage system	Production (kg/ha)	Production, (%)	Difference ±	Differences significance
Reversible plough (a_1)	1883	100	Mt.	Mt.
Chisel (a_2)	1800	95.6	-83	-
Paraplow (a_3)	1817	96.5	-67	-
Rotary harrow (a_4)	1775	94.2	-108	-

DL (p 5%) = 154 kg/ha;
DL (p 1%) = 233 kg/ha;
DL (p 0.1%) = 374 kg/ha.

Table 3. Significance of production differences evaluated through Duncan test

Soil working variant	Soybean production (kg/ha)	Classification
a_4	1775	A
a_2	1800	A
a_3	1817	A
a_1	1883	A

Table 4. Soybean crop production varying with the soil tillage system and the pre-emergent plant, corn

Soil tillage system	Production (kg/ha)	Production (%)	Difference ±	Differences significance
Reversible plough (a_1)	1757	100	Mt.	Mt.
Chisel (a_2)	1613	91.8	-144	00
Paraplow (a_3)	1717	97.7	-40	-
Rotary harrow (a_4)	1467	83.5	-290	000

DL (p 5%) = 91 kg/ha;
DL (p 1%) = 138 kg/ha;
DL (p 0.1%) = 221 kg/ha.

Table 5. Significance of production differences evaluated through Duncan test

Soil working variant	Soybean production (kg/ha)	Classification
a_4	1467	A
a_2	1613	B
a_3	1717	C
a_1	1757	C

CONCLUSIONS

The soybean production recorded in the exeperimental years is in connection to the soil tilling system, the pre-emerging plant and the climateric conditions of the Someseni Plateau area.

The productions recorded in the experimental years with corn as the pre-emerging plant have an average of 1639 kg/ha, and with wheat as the pre-emerging plant, an average of 1819 kg/ha, this meaning a positive difference of 180 kg/ha. This difference is determined by the wheat as pre-emerging plant, which proves to be superior to the pre-emerging corn.

The analysis of soybean productions by the soil tilling system and the pre-emerging plant confirms that the largest productions have values between 1775 kg/ha and 1883 kg/ha after pre-emerging wheat, respectivly 1467 kg/ha and 1757 kg/ha after pre-emerging corn.

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RESEARCHES ABOUT NICKEL REGIME FROM AGROECOSYSTEMS IMPROVED BY SEWAGE SLUDGE

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Abstract

Lately is deemed nickel (Ni) like a micronutrient (MICROn) essential to the entire food chain: plant-animal-man (Stevenson and Cole, 1999). This is, however, a chemical element in the category of heavy metals (Adriano, 2001). Expression in the agricultural environment of Ni concentrations between deficiency (Alloway, 2008; Bell, 2000) and excess can occur both in nature reserves in the soil, and the contribution of manure. To observe trends of Ni content in soil and plants were used progressive doses of sludge 0:50 t.ha^{-1}, together with chemical fertilizers. We generally mobile forms experienced declining trends between 6 and 4 mg.kg^{-1} d.w. in all four years of culture. It is possible that Ni is detained by forces stronger than the molecules of sludge. Plants have specific concentrations of Ni content in both leaves at flowering and the mature seeds. Correlations obtained in bloom shows increasing concentrations of maize (between 1 and 2 mg) and wheat (4) (3 to 4 mg), and decreasing in wheat (2) (from 3 to 2 mg) and soybean (10 to 6 mg). Mature beans contained Ni inverse relationship with the applied doses: 1 mg in maize, between 3 and 5 mg in wheat (2), between 45-30 mg soybean and between 4 to 3 mg of wheat (4). Such research shows aspects of plant nutrition and highlight the natural cycle of the Ni.

Key words: *luvisoil, Ni, processed sludge, maize, soybean, wheat.*

INTRODUCTION

Nickel (Ni) is the latest essential micronutrient highlighted (Bell and Dell, 2008). Research with specific fertilizers led to obtaining increases of vegetable matter (Brown et al., 1987). IFA studies, as well as other nutrients, Ni was found to be required in food plants (Epstein and Bloom, 2005; Fageria et al., 2002; Maschner, 1995), animals and even humans. It is naturally occurring in the earth's crust, and in soil (Lindsay, 1991), less as single chemical element, but as specific minerals combined: annaberge [$Ni_3(AsO_4)_2.8H_2O$], garnierte [$(Ni,Mg)_6(Si_4O_{10})(OH)_2$], millerite (NiS), nicheline (NiAs), pentlandite [$(Fe,Ni)_9S_8$], skutterudite [(Co,Ni) As_3], ullmannite (NiSbS) (Figure 1) and adsorbed by organic matter (OM) and clays. Of mineral deposits, and the enlightenment of soils, Ni continues to exist in cycles and can always be used to support life.

Figure 1. The ullmannite mineral (NiSbS)

The first confirm that micronutrient (MICROn) was made by Brown (1987), who showed that a concentration of 0.05 mg.kg^{-1} in plants is sufficient for normal vegetative cycle. Recently, American researchers (Wood et al., 2004) have demonstrated the harmful effect of Ni deficiency and thus confirmed that it meets the essential criteria in plants. Further research at the cellular level of Ni (Bou et al., 2006) has shown that its absence or deficiency led to impaired metabolism ureidas functionality, the amino acids and organic acids.

Ni sources for agricultural field include both natural mineral form, then the use of chemical fertilizers enriched with chemical elements (some companies produce such fertilizers) and organic sources. Organic sources include residues of crop plants, manure and sludge waste. Ni to be absorbed by plants, it is necessary that organic forms are mineralized by soil microorganisms. Under these conditions that like a culture system in soil, sludge waste that could bring an important contribution to improving it.

MATERIALS AND METHODS

During the four years (2004-2007) field experiment was initiated, and stationary complex. Within its plants were cultivated by the structure: first year maize, winter wheat second year, third year soybean and fourth year winter wheat. In normal cultivation technologies, these plants were fertilized organo-mineral. Thus, processed waste sludge was applied in fractions: 0, 5, 10, 25 and 50 $t.ha^{-1}$. Chemical fertilizers were differentiated into three levels: unfertilized, needs to ½ of normal and normal doses (1/1). Plants have received such $N_{50}P_{50}$/maize, $N_{60}P_{40}$/wheat, $N_{30}P_{30}$/soybean and $N_{40}P_{40}$/wheat for doses ½ and $N_{120}P_{80}$/maize, $N_{120}P_{80}$/wheat, $N_{60}P_{60}$/soybean and $N_{80}P_{80}$/wheat for the 1/1. Sludge doses were applied in the same quantities in the first two years, maize and wheat in the second year following that soybean and wheat in the past year to receive their residual effect.

The experimental variants were of area of 100 m^2, in three repetitions. Chemical analyses were performed by specialized laboratories, as follows: Ni in soil, total shapes of leaves and grains, according to ISO 11047-99, and Ni mobile forms of soil by Na_2EDTA solution. Plant samples were collected at two vegetation periods and analyzed: leaves during flowering, and mature seeds. Leaves were harvested from the right cobs of maize, appeared last three leaves, including standard wheat leaf and middle flower stems and pods formed at base for soybean. Soil samples were collected from arable horizon with agrochemical special instrument, during the blooming and maturity. The data obtained were processed statistically by variance analysis method, and using correlations and regressions

RESULTS AND DISCUSSIONS

Content of nickel (Ni) in cross-cultural environment. From measurements performed soil Ni contents were demonstrated by both heavy metal total and mobile forms. Total nickel in soil ranged from relatively normal values considered (Table 1). Thus, in the four years ranged from 15-22 $mg.kg^{-1}$ d.w. Ni like minimum and 21-33 $mg.kg^{-1}$ d.w. like maximum values. Recent results recommended that Ni in soil total forms to be around 20 $mg.kg^{-1}$ d.w. (Capatâna and Simionescu, 2007). Ni average of the four years ranged between 18 and 23 $mg.kg^{-1}$ d.w.

Table 1. The nickel (Ni) contents from soil (mg/kg d.w.) total forms

Heavy metal	Maize	Wheat, 2	Soybean	Wheat, 4	Toxic limits
Ni, limits media	20 – 24 22	22 – 26 23	17 – 21 18	15 – 33 21	$30^{EU.2010}$ 50^{344}

$30^{EU.2010}$-proposal; 50^{344}-Ord. 344

Depending on complex doses of sludge waste and chemical fertilizers into the soil, mobile nickel evolved negative in all four cases (Figure 2). In the first two years when sludge expressed direct effect, these trends are statistically well: r =-0.789*** for maize and r =-0.737*** for wheat in year two. The explanation is the nickel (Ni) may be in a state of adsorption something stronger, just on sludge molecules embedded in soil culture. In these circumstances the state proportion of nickel ions (Ni^{2+}) in exchange was to be relatively small. Thus, in the four years analyzed, the absolute values of mobile Ni were within between 6 and 4 $mg.kg^{-1}$ d.w. Literature data less refer to Ni (as Ni^{2+} ions) present in the soil of plant culture. Instead get some input data to us, having regard to farming new insurance supported nickel complex of conditions favorable for plant nutrition.

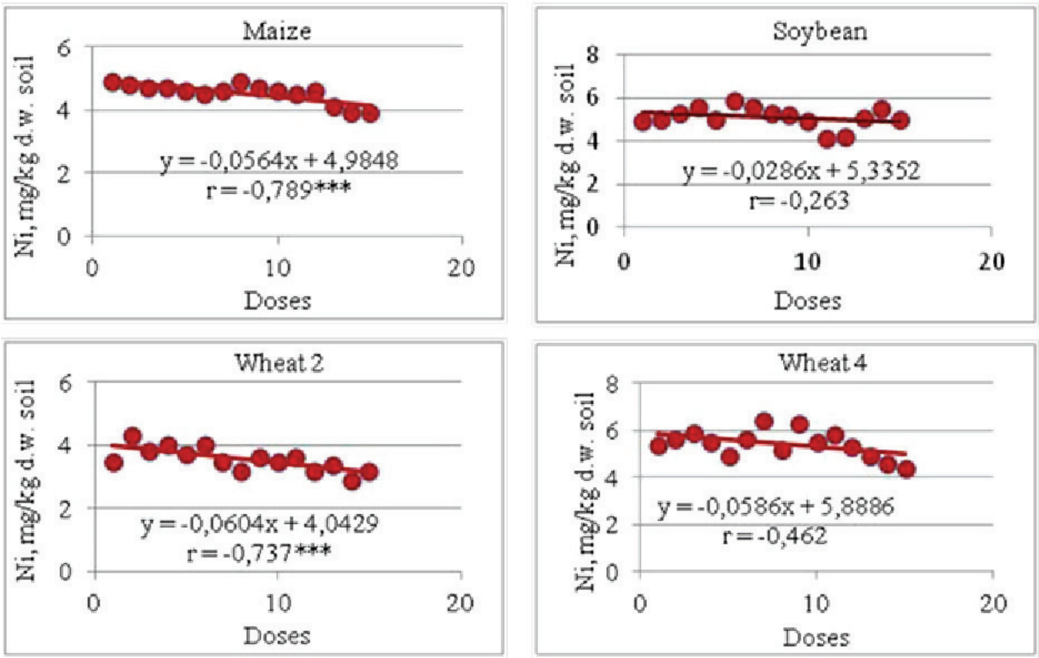

Figure 2. Correlations between Ni concentrations, mobile forms (NiMF) and sludge & chemical doses used

Influence of experimental factors on the content of Ni in leaves and grains. Given the soil conditions of culture, which forms the total Ni were located at relatively normal, and the mobile Ni have shown low concentrations and decreasing trend was expected that absorbtion of Ni^{2+} by plants occur in degrees characterized with great specificity.

And if Ni, high levels of Ni^{2+} ions in the soil can lead to phytotoxicity phenomena, as far other heavy metals have the environmental impact (Lindsay, 1991). In the extreme, of great importance is the analysis of plant, several moments of life. Both Ni and other chemicals, minerals, are selectively absorbed by each species of plant. Ni contents in plant leaves (Ni_{LV}) showed different aspects (Figure 3).

Maize Ni content in its leaves at flowering increased between 1 and 2 $mg.kg^{-1}$ d.w. Very clear experimental factors increased Ni content in leaves, r = 0.974***. The same extent (r = 0.519*), Ni in leaves of wheat have increased year 4 records with the values of the regression between 3 and 4 $mg.kg^{-1}$ d.w. Instead 2nd year wheat leaves were clearly decreasing Ni concentrations between 3 and 2 $mg.kg^{-1}$ d.w., with r =-0.631**. The explanation is that there are richer in heavy weather conditions. Soybean content in leaves was between 10 and 6 $mg.kg^{-1}$ d.w. Ni. Graph of this plant demonstrates the need for this micronutrient ($MICRO_n$) food, nickel (Ni). Concentrations of Ni contained soybean leaves were double and even triple from cereals: wheat and maize.

The correlations obtained between doses of sludge and fertilizer complexes with Ni concentrations in grain (Ni_{GR}) shows characteristic differences, different from leaves due to total negative trends (Figure 4). Thus, statistically decreasing states were obtained from maize in the first year with correlation coefficient r =-0.286, wheat second year, r =-0.327, soybean, r =-0.679** and wheat least year, r =-0.203. Negative states of Ni correlations show that mature grains plants had no need of this micronutrient. Yet exports of nickel (Ni) with grain yield was generally about 1 $mg.kg^{-1}$ in maize kernels, between 3 and 5 $mg.kg^{-1}$ for wheat and 30-40 $mg.kg^{-1}$ in soybean.

Agrochemical indices restricting Ni transfer in the agricultural environment. Recently succeeded in limiting the development of indices (Ord. 344/708/2004) of Ni concentrations in agricultural soil, when applying sludge waste (Table 2).

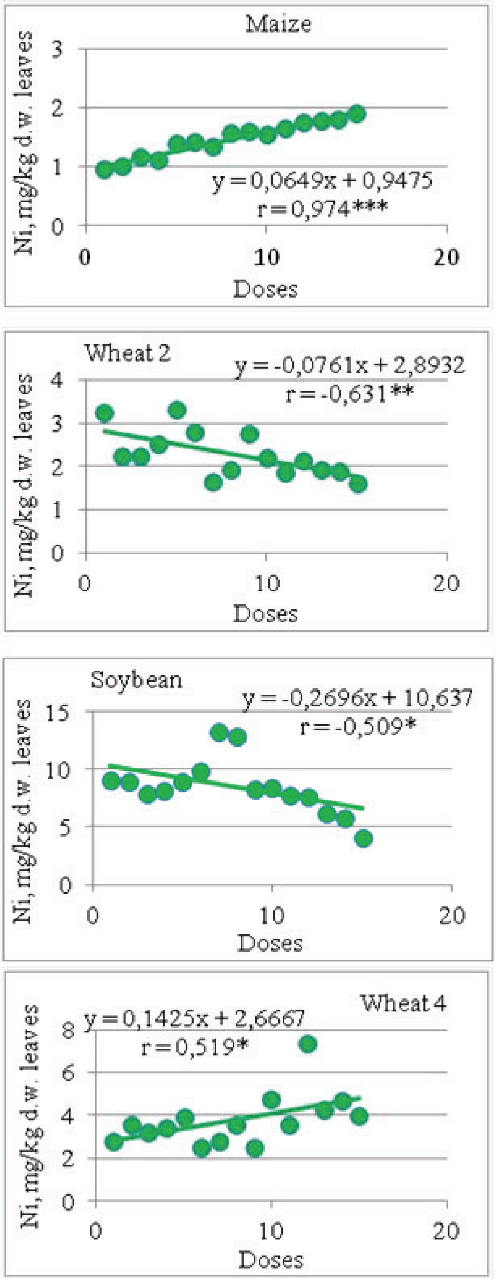

Figure 3. Correlations between Ni concentrations from plant grains (NiGR) and sludge & chemical doses used

Table 2. Ni (mg/kg d.w.) indices, used by the sludge application in the agricultural field (after Pusztai, 1988 quoted by Borlan, 1994)

Indices	Calculation
Level Considered Tolerable, LCT	LCT_{Ni} = 40.CEC/35 = = 13 mg.kg^{-1} d.w.
Maximum Tolerable Intake, MTI	MTI_{Ni} = 400.CEC/35 = = 128 mg.kg^{-1} d.w.
Applicable Annual Dose, AAD	AAD_{Ni} = 400.CEC/35.Ni* = 5 t.ha^{-1}.year^{-1}

CEC, cationic exchange capacity (11,16 me/100 d.w. soil)
*Ni from sludge, 27 mg.kg^{-1} d.w.

At first index, the level considered tolerable total soil Ni (LCT_{Ni}) should be less than 13 mg.kg^{-1}d.w. The data obtained prove slightly increasing from the index. Other index, maximum tolerable intake of nickel from waste sludge (MTI_{Ni}), will ensure that concentrations will be below the 128 mg.kg^{-1} d.w. Ni. Permanent analyzed sludge contained around 50 mg.kg^{-1} d.w. Ni. The third indicator, the annual allowable time waste sludge (AAT_{Ni}) was 5 t.year^{-1}.ha^{-1}. Thus, for a 4-5 year cycle of crop rotation, can be applied between 20-25 t.ha^{-1} sludge waste.

CONCLUSIONS

By using processed sludge (anaerobic digestion and dried) has been an improvement in nickel (Ni) albic luvisol eco-environment of the resort. Average levels of total soil Ni shown in the four years fit around values considered normal for this particular micronutrient with 20 mg.kg^{-1}d.w. Mobile forms of Ni showed annual decreases due to complex dose applied. Mean soil Ni_{MF} ranged between 6 and 4 mg.kg^{-1} d.w. and could be due to a longer Ni pronounced the higher doses of sludge introduced into soil.

Given the negative state of Ni^{2+} concentrations in soil solution (SSol), it was expected that plants absorb both selective and specific to the $MICRO_n$ Ni, of course correlated with the concentrations. Maize and wheat in year 4, Ni contained in the leaves of the flowering period increasing concentrations of between 1 and 2 mg.kg^{-1} d.w. and that between 2 and 4 mg.kg^{-1} d.w. Second year wheat and soybean leaves contained nickel in reports reverse negative between 3 and 2 mg.kg^{-1} d.w. and 10 and 6 mg.kg^{-1} d.w. Explanation of these states by both the specific need of each plant part for Ni and studied by conducting plant physiology.

Correlations obtained with useful production (grains) show that plants have used nickel (Ni) in vegetation, after which they stored by grain in a clear and total opposite. In the maturity stage was not necessary and that the contents: 1 mg.kg^{-1} d.w. maize, 5-4 and 3 mg.kg^{-1} d.w. wheat and 45-30 mg.kg^{-1} d.w. for soybean, and means the real exports of Ni.

Agrochemical indicators which limits the application of waste sludge doses are useful in the agricultural field and can give valuable information for users of agricultural products: sewage sludge. Level considered tolerable soil concentrations must not exceed 13 mg.kg^{-1} d.w. total Ni. Maximum tolerable intake levels of sludge for agricultural field will not exceed 128 mg.kg^{-1} d.w. Applicable annual sludge shall not exceed 5 t.ha^{-1}, which means that a rotation of 4-5 years can apply doses between 20-25 t.ha^{-1} sludge.

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STUDY ON CARBON, NITROGEN AND SULFUR IN LITTER *QUERCUS ROBUR*, *TILIA* SP., *CARPINUS BETULAS,* AND *FAGUS SYLVATICA*

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Abstract

The study was efectutat in the period 2011-2012 in four surfaces Stefanesti, Fundata Stalpeni and Mihaesti. The litter sampling was performed during the second half of the growing season.
In field collection was once in about two weeks throughout the growing season. Collectors were made of polyethylene and is provided rainfall evacuation holes to prevent decomposition of leaf material.
The following parameters are analyzed: organic C, total N and sulfur. The carbon organic, total nitrogen and sulfur have been analysed by the dry Dumars combustion method.
The results showed organic carbon found in the limits Nitrogen is a little higher and the amount of sulfur is in the normal range but suprefata from Stefanesti is a little bigger.

Key words: *oraganic carbon, litter, total nitrogen, sulfur.*

INTRODUCTION

Most of the research so far focused on highlighting the influence of differences between deciduous and coniferous stands on soil carbon and nitrogen (Alriksson and Eriksson, 1998; Fried et al., 1990; Wilson and Grigal, 1995). Thus, Nihlgard (1971) showed that in Central and Western Europe amount of C is higher under spruce stands than in the beech, in North America, and Finzi et al. (1998) found differences in soil C and N stands of beech, maple and oak.
With regard to litter, there was a great variability in the content of C and N between stands of deciduous and coniferous (Ovington, 1954; Versterdal, 2002). The influence of trees on soil nutrient content is detected first in the litter, while differences in the mineral soil is found later (Versterdal, 2002).

MATERIALS AND METHODS

The litter sampling was performed during the second half of the growing season.
Leaves collected at a certain date, grouped by circle sample were dried at a temperature of 105^{o}C and then weighed (Anonymous, 2011; Jonckheere et al., 2004).
The organic carbon, total nitrogen and sulfur was determined thoug the dry ignition method by using the Leco Tru Spect CNS automatic analyser (LECO, 1996).

RESULTS AND DISCUSSIONS

Research has been performed in the period 2011-2012 in four surfaces Stefanesti Fundata, Stalpeni and Mihaesti.
Every surface has been installed by 25 collectors, each with a reception area of 0.25 m^2, located in each of the five circles of sample points form five dice. In view limit the potential effects of wind, they were placed at ground height of approx. 1.3 m collectors were made of polyethylene and is provided rainfall evacuation holes to prevent decomposition of leaf material.
Following laboratory analysis to determine carbon, nitrogen and sulfur of research areas.
The results are presented in Tables 1, 2, 3, 4.

Total carbon values analyzed in four research points fit into normal, a little higher is recorded at the Fundata.

Table 1. Analytical data-Stefanesti

Nr. prb.	Species	Nr. circle	C (%)	N (%)	S (%)
1	*Tilia* sp.	C 1-25	44.77	1.329	0.11
2	*Carpinus betulus*	C 1-25	44.08	1.156	0.11
3	*Quercus robus*	C 1-25	47.37	1.659	0.15
1	*Tilia* sp.	C 1-25	44.48	1.290	0.12
2	*Carpinus betulus*	C 1-25	47.10	1.110	0.13
3	*Quercus robus*	C 1-25	43.99	1.382	0.10
1	*Tilia* sp.	C 1-25	46.99	1.330	0.13
2	*Carpinus betulus*	C 1-25	43.95	1.094	0.12
3	*Quercus robus*	C 1-25	44.00	1.598	0.10
1	*Tilia* sp,	C 1-25	43.94	1.285	0.17
2	*Carpinus betulus*	C 1-25	44.07	1.132	0.16
3	*Quercus robus*	C 1-25	46.96	1.554	0.17
1	*Quercus robus*	C 1-25	46.78	1.550	0.08
2	*Tilia* sp.	C 1-25	44.43	1.195	0.06
3	*Carpinus betulus*	C 1-25	44.17	0.980	0.06
1	*Quercus robus*	C 1-25	46.23	1.624	0.07
2	*Carpinus betulus*	C 1-25	43.90	1.176	0.08
4	*Tillia* sp.	C 1-25	45.26	1.156	0.12
1	*Quercus robus*	C 1-25	46.40	1.616	0.22
2	*Tilia* sp.	C 1-25	45.15	1.186	0.15
3	*Carpinus betulus*	C 1-25	44.18	1.341	0.07
1	*Quercus robus*	C 1-25	46.27	1.498	0.04
3	*Carpinus betulus*	C 1-25	44.03	1.295	0.06
4	*Tilia* sp.	C 1-25	44.22	1.175	0.08
1	*Quercus robus*	C 1-25	46.38	1.621	0.06
2	*Tilia* sp.	C 1-25	44.01	0.987	0.09
4	*Carpinus betulus*	C 1-25	43.51	1.180	0.07

Table 2. Analytical data-Stalpeni

Nr. Prb.	Species	Nr. circle	C (%)	N (%)	S (%)
1	*Fagus sylvatica*	C 1-25	45.71	0.616	0.13
2	*Quercus robus*	C 1-25	45.98	0.700	0.13
1	*Fagus sylvatica*	C 1-25	47.53	0.550	0.15
2	*Quercus robus*	C 1-25	45.46	0.680	0.10
1	*Fagus sylvatica*	C 1-25	45.48	0.660	0.09
2	*Quercus robus*	C 1-25	45.97	0.675	0.11
1	*Quercus robus*	C 1-25	46.05	0.686	0.07
2	*Carpinus betulus*	C 1-25	44.79	0.594	0.09
3	*Fagus sylvatica*	C 1-25	45.73	0.648	0.10
1	*Quercus robus*	C 1-25	45.79	0.854	0.08
2	*Fagus sylvatica*	C 1-25	45.03	0.637	0.09

Table 3. Analytical data-Mihaesti

Nr. Prb.	Species	Nr. circle	C (%)	N (%)	S (%)
1	*Quercus robus*	C 1-25	45.25	1.536	0.05
2	*Fagus sylvatica*	C 1-25	46.55	1.073	0.06
3	*Carpinus betulus*	C 1-25	44.43	1.180	0.07
1	*Quercus robus*	C 1-25	46.15	1.643	0.09
3	*Fagus sylvatica*	C 1-25	46.50	0.988	0.12
4	*Carpinus betulus*	C 1-25	43.98	1.090	0.10
1	*Quercus robus*	C 1-25	46.30	1.567	0.09
2	*Fagus sylvatica*	C 1-25	45.63	1.070	0.09
3	*Carpinus betulus*	C 1-25	44.33	1.110	0.11

Table 4. Analytical data - Fundata

Nr. Prb.	Species	Nr. circle	C, %	N, %	S, %
1	*Fagus sylvatica*	C 1-25	48.30	1.958	0.13
1	*Fagus sylvatica*	C 1-25	47.32	1.875	0.11
2	*Fagus sylvatica*	C 1-25	47.47	1.190	0.11
1	*Fagus sylvatica*	C 1-25	47.30	1.255	0.13
1	*Fagus sylvatica*	C 1-25	47.44	1.200	0.16

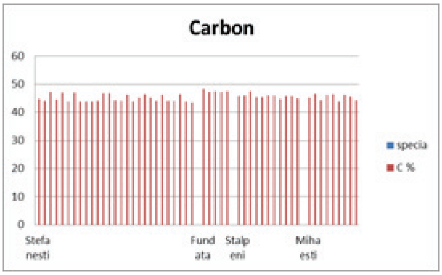

Figure 1. Carbon distribution in the litter sample

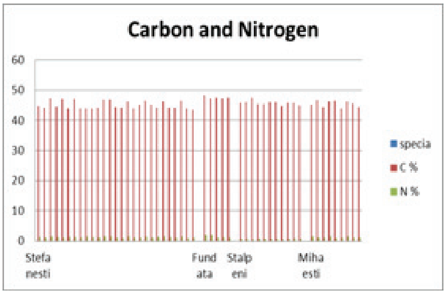

Figure 2. The relationship between nitrogen and sulfer

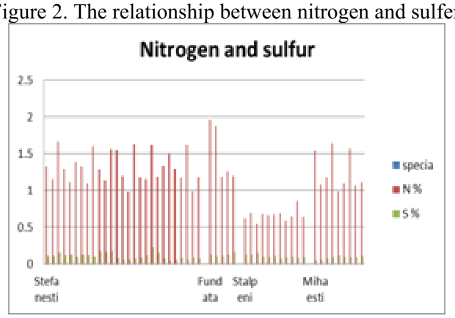

Figure 3. The relationship between nitrogen and sulfer

Surfaces at the bottom shows higher values of nitrogen and sulfur is within normal limits.

Surfaces to Stefanesti the largest amounts of nutrients elements, probably because these elements of wealth in the highway litter (*Tilia* sp., *Carpinus betulus*, *Quercus robus*).

CONCLUSIONS

Based on analyzes conducted to determine nutrient content and settled if within normal limits set at European level.

Sulfur content is within normal limits, with reduced industrial activity.

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BIOLOGIZATION OF AGRICULTURAL SYSTEMS – PREMISES AND OPPORTUNITIES

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Abstract

The genesis and evolution of chernozems in the Carpathian-Danubian-Pontic area were conducted synchronized with the evolution of steppe ecosystem; their driving forces are the soil-plant relationships. The substitution of natural biocenosis with agrophytocenosis led to the minimization reduction of biological component in development of chernozems on the agricultural regime. As a result, chernozems have lost a number of mechanisms for self regulation (self loosening, reproduction of aggregate composition, conservation and rational use of moisture). Their restoration is only possible through renaturation process of pedogenesis by restoring the soil-plant mutual relations. The present research has shown that basic elements of renaturation processes included in the pedogenetical processes are restoration of structural-functional integrated elementary processes in the soil ecosystem.

Key words: *agroecosystem, chernozems, renaturation processes.*

INTRODUCTION

The biological component function in the agroecosystem management is continuously increasing. Among economic and environmental opportunities which justify anthropogenic component substitution with biological we mention: transition to economical and environmentally safe technology resources; continuously increasing instability of the climate variability and respectively, size and quality of crop (main crop yield requires genetic and adaptive characteristics); insertions of multiple values of soil parameters at the critical level; need to increase not only the productive functions of the agroecosystems but as well the environmental (soil protections, extended reproduction of phytoresources, etc); weight increasing of agricultural uses belonging to less favourable climatic conditions due to climatic instability and soil cover aridization; adaptation of agroecosystems to potential climate change (ability to resist at extreme factors by applying agrotechnologies with high precision rational soil tillage (no plowing) and paraplow with discs); using plants as energy and fertilizer, technological requirements to diversify consumption by increasing assortment and quality of raw material; necessity to preserve and to create structures and mechanisms of agroecosystems.

In the context of above the biologization and ecologization of biological system characteristics are: self reproduction, self restoring and self remediation as well characteristics of natural phytogenesis. The biologization and ecologization is based on the maximum efficiency in the use of potential species and varieties of cultivated plants. In this context is known as the landscape conditions are drastic as more genotype agroecosystem and agricultural landscape should be higher. The fact is that the procedures mentioned are favoured by bioclimatic condition of Republic of Moldova and provides greater opportunities for a wide spectrum of cultures. Methods for assessing crops adaptability are based on evaluation of limitative factors given by particularities species. On these conceptual principles and practical approaches are stated: organization of crop rotation based on adaptive landscape condition with respect to plowing strictly differentiated according to topography and soil characteristics; maximum biologization of crop rotation by saturating with annual grasses and expanding intermediate beans; crops rotation are able to ensure self reproduction and self remediation of landscape; cropping should provide closed energy

substantial balance that means maximum return of biofile elements.
The principles outlined are registered in the regional resource-reproductive biotechnologies models adapted bioclimatic conditions of the Carpathian-Danubian-Pontic (Figure 1).

MATERIALS AND METHODS

The researches have been conducted in the north part of the Republic of Moldova during 2007-2012 under farming conditions units "Civea-Agro" (Edinet district), "Gospodarul-Rediu" (Falesti department), "Vatmol-Agro" (Donduseni district) and "JLC AGRO-MAIAC" (Ocnita district). In all the cases, soils have been represented by clay loam typical moderated humiferous chernozem (Table 1).

Table 1. Research methods

Analysis	Methods
Bulk density	In the field Kacinschi compact meter
Particle size composition	Fractional dry, Savinov method
Aggregate stability	Fractionation in water, Savinov method

RESULTS AND DISCUSSIONS

In the context of the specific models agroecosystems biologization represents a complex of agrotechnical measures, phytotechnical and agrochemical adapted to landscape local conditions. The landscape conditions are targeted on the optimization of soil-plant relationships (crop) aiming to renaturate the pedogenesis process and the rehabilitation and enlarged reproduction of soil ecosystem as well its functionality. Pursuant to this objective agroecosystems biologization presupposes displacement of the emphasis from plant and agroecosystems productivity to soil agroecosystems and its functionality. In the context of the above biologization is based on the following conceptual principles:

1. Restoration of energy flows within processes functioning of agroecosystems and respectively pedogenesis process.

The present agroecosystem characteristic is substitution of solar flux transformed into chemical energy through the phytosynthesis energy from the combustion of fossil fuels. This supposes diminishing of the weight of natural components within the pedogenesis process and soil ecosystem functioning. Inside agroecosystems the soil is subordinated to technological components. Therefore we are faced the situation where on the background of soil degradation the agroecosystem productivity is increasing.
Thus, within agroecosystem the soil is transformed into an inert layer modeled by agrotechnical measures, agrochemical administration amendment and irrigations. Investigations conducted in this field has shown that all mentioned aspects enhance soil degradation process thus deepening the difference between agroecosystems and natural ecosystems (Jigău, 2001, 2009; Dumitru et al., 1999) thereby favouring the desertification processes.

2. Favoring integration and functional structural organization processes of the soil ecosystem.

In terms of the integration processes concept and structural-functional organization of the ecosystem, the latest is distinguished from others bio-routinist system by its structure. As integrated product of all the constituent processes and development of soil phase components. The substitution of natural biocenosis with the agricultural phytocenosis and involvement of soil tillage led to the simplification of structuring processes and in same time initiated the degradation process of the structure materialized in boulders and breaking structure (Jigau, 2009).
The data presented in Table 4 indicate that extended plowing involves two opposed processes in the evolution of aggregate composition contrary to typical chernozems located in the northern part of Republic of Moldova – bouldering and spraying. Bouldering is oriented to the considerable enhancing compared to the uncultivated version of the aggregate content >10 mm. Contrary spraying is oriented on shredding soil structure and therefore the content of micro aggregates (<0.25 mm) increased compared to uncultivated version at 1.3 to 1.5 times. Following concomitant achievement of specified processes are reduced considerable content of agronomical valuable aggregate (10-0.25 mm).

Table 2. Resource reproductive impact of intermediate soil

No.	Resource reproductive impact
1	Ensures extended coverage of the soil, protecting it from various forms of degradation
2	Enhances the quantity of soil organic matter
3	Intensifies the microbiological activity
4	Improves the aggregation degree of soil mass and reduces the degrading impact of raindrops on soil
5	Reduces compaction and increases porosity of the soil
6	Reduces the physical evaporation on the soil surface
7	Enhances water infiltration into the soil, therby compensating the quantity of water used by intermediate crops
8	Ensures fertiliziers function for the soil and provides nutritive substances of succeeding crops
9	Protects the soil from weeds and retains weeds growth
10	Destroying parasitical circuit
11	Some of them (rye) helps soil clean, others contribute to the phosphorus accumulation in the upper and lower horizons and its transfer from the unassimilated mineral forms in the assimilated organic forms

Table 3. Resource reproductive impact of hidden crops

No.	Resource reproductive impact
1	Soil loosening through improvement of aggregation degree, porosity, water permeability and hydraulic conductivity
2	Ensuring stability and porous space conductivity
3	Reduction of soil cohesion and resistance to penetration
4	Radicular system of some hidden crops (sweet clover, lucerne) function as “biological plugin” and assures compaction of loosening layers
5	Improvement of soil water capacity
6	Formation of mulch protective layer on the soil surface
7	Formation of mulch protective layer on the soil surface
8	Weeds oppression
9	Accumulation of nitrogen in the soil through the biological fixation (legumes), restoring the nutritive substances flow, reducing losses of nutrients through the leaching
10	Creates favourable conditions for developing organisms in the soil and improving the soil biota
11	Creation of favorable conditions for water and nutritive substances assimilation by succeeding crops
12	Saturated crop rotations with different species of hidden crops which ensures biological balance and circulations as well contributes to the reduction of issues related to insects-pests and pathologies, constantly addition of organic debris contributes by increasing the organic matter content and soil reserves

The engagement into the agricultural circuit seriously affects aggregate stability of typical chernozems. From Table 4 we notice that extended plowing leads to reduction at 2 to 2.5 times the aggregates stability (>5 mm). The latest ensures determinable pores of regimes (hydrothermal, air-hydric, oxidation-reduction and biological). At the same time, aggregates water stability from 5 to 0.25 mm is reduced at 1.3 to 1.5 times. Therefore, over time within pore space is reduced the pore conductors volume of moisture which seriously affects the soil moisture regime. In contrast, increased aggregate content <0.25 mm, and therefore increased soil mass at specific area and lead to increased capacity of crusting arable layer.

The stability over time of the reorganization processes of structural aggregates of arable soil leads to formation of the soil profiles agrogen transformed, where horizons is clearly distinguished: arable (A_p) and sub arable (A_{ph}) that forming agrogen layer of arable soil profiles by which soil profiles is radically detached from the genetic profiles of the typical chernozems (Table 5). Agroecosystems biologization integration processes lead to reanimation of aggregates soil mass with restoration of structural aggregates of typical chernozems (Table 4).

Renaturation of pedogenesis processes and soil ecosystem functionality are materialized in the restoration of soil organic profile. The specified processes included the restoration of organic soil profile, expanded reproduction, optimization of biogeochemical volume and substances composition and enlarged reproduction of the soil fertility (Tables 6 and 7).

Table 4. Aggregate composition and hydro-stability aggregate within the various biotechnologies models resource-reproductive

Model	Depth, cm	Aggregate composition, %			Hydro stability composition, %		
		> 10 mm	10-0.25 mm	< 0.25 mm	> 5 mm	5-0.25 mm	< 0.25 mm
Natural (uncultivated)	0 – 10	6.3	85.6	8.1	27.0	52.0	21.0
	10 – 20	8.7	84.0	7.3	21.0	59.6	19.4
	20 – 30	11.3	79.2	9.5	23.6	58.2	17.6
Ecobiologic (5 crops)	0 – 10	11.3	80.3	8.4	9.7	52.6	37.7
	10 – 20	13.7	77.0	9.3	11.8	56.7	31.5
	20 – 30	14.8	75.5	9.7	10.4	53.0	36.6
	30 – 40	10.7	79.9	9.4	9.3	55.0	35.7
	40 – 50	9.4	82.0	8.6	9.3	61.5	29.7
Biologic (5 crops)	0 – 10	12.5	78.5	9.0	9.5	51.1	38.4
	10 – 20	14.7	74.6	10.8	11.4	52.0	36.6
	20 – 30	16.6	70.4	13.0	9.0	49.6	41.4
	30 – 40	15.0	73.6	11.4	9.9	48.3	42.7
	40 – 50	12.0	77.0	11.0	7.0	55.7	37.3
Bioorganic (5 crops)	0 – 10	13.8	76.0	12.2	7.1	33.3	59.6
	10 – 20	17.7	70.5	11.8	8.8	31.4	59.8
	20 – 30	21.8	66.8	11.4	9.4	36.1	54.5
	30 – 40	27.0	61.8	11.2	9.7	37.8	52.5
	40 – 50	18.0	61.0	11.0	10.3	47.0	52.7
Plowing 53 years	0 – 10	13.9	73.6	12.5	7.4	53.0	39.6
	10 – 20	19.7	65.0	14.3	4.4	49.0	46.6
	20 – 30	31.7	58.2	10.1	11.8	41.9	46.3
	30 – 40	30.3	56.9	12.8	10.7	44.4	44.9
	40 – 50	17.8	69.8	12.4	10.9	47.9	43.0
Plowing 47 years	0 – 10	12.5	68.0	19,5	7,7	52.0	40.3
	10 – 20	19.4	68.5	12.1	6.1	47.0	46.9
	20 – 30	30.7	58.0	11.3	9.7	42.0	48.3
	30 – 40	30.,3	56.9	12.8	10.3	41.5	48.2
	40 – 50	14.7	73.0	12.3	9.1	47.9	43.0

Table 5. Anthropogenic models of typical chernozem moderate humiferos in the profiles

No. field	Genetic horizon Thickness, cm	Bulk density		Aggregates composition, %			
		g/cm^3	Specifications	Polygonal	Block	Grain	Dusty
1	A_p 0-10	1.11	optimal	30	35	30	5
	15-20	1.54	extremely unfavorable	95	5	-	-
	A_{ph} 25-30	1.44	unfavorable	85	15	-	-
	38-42	1.32	favorable	70	20	10	-
	A_m 50-55	1.26	optimal	-	30	70	-
	A_mB 70-74	1.26	optimal	-	55	45	-
3	A_p 0-10	1.16	optimal	35	20	30	15
	A_{ph} 15-20	1.63	extremely unfavorable unfavorable	80	20	-	-
	30-35	1.46		60	20	20	-
	A_m 50-55	1.39	acceptable	25	30	40	5
	A_mB 70-75	1.34	acceptable	15	60	25	5

Table 6. Comparative assessment of various models of ecological systems

Ecological systems		
Natural	No-Till	Traditional
Closed system	Quasi-closed system	Open system
Balanced	Quasi-balanced	Unbalanced system
Biogeochemical circuit volume and high reproductive resources	Biogeochemical circuit volume and significantly reproductive resources	Biogeochemical circuit accompanied by losses of P, Ca, Mg, K, Na, etc.
Assurance enhancement with organic matter and nitrogen	Assurance increasing with organic substance and nitrogen	Losses of organic matter and nitrogen
Balanced amount of biomass	Active enhancement of biomass amount	Insufficiency of biomass
Optimal use of water from rainfall	High recovery of water from rainfall	Unsatisfactory recovery of water from rainfall
Minimal erosion	Insignificant erosion	Noticeable erosion
Attenuated variability in time of hydro-thermal regimes, air-hydric, oxidation-reduction and biological	Attenuated variability in time of hydro-thermal regimes, air-hydric, oxidation-reduction and biological	Contrasting variability in time of hydro-thermal regimes, air-hydric, oxidation-reduction and biological
Enlarged reproduction of soil fertility	Enlarged reproduction of soil fertility	Accelerated reduction of fertility
Self-management system	Self-management system	Anthropomanagement system

Table 7. Ecosystem development stages of the No-Till

Incipient stage	Transition stage	Constitution stage	Stabilization stage
Structural aggregates stabilization	Enhancing soil bulk density	Large quantity of vegetal residues	Accelerated accumulation of the vegetal residues
Low organic matter content	Increasing the content of organic debris	Increased coefficient of carbon content	Continuous variability of nitrogen and carbon
Restoring soil microbiota biomass	Increasing phosphorous content	Enhancing moisture content	Enhancing moisture content
Increasing nitrogen content	Nitrogen immobilization, mineralization	Nitorgen immobilization, mineralization reduction, intensification of biological substances cycle, optimization and increasing its volume	Proportion circuit of nutritional substances, consumption reduction of nitrogen and phosphorus
Time, years			
0-5	5 – 10	10 – 20	> 20

CONCLUSIONS

Agroecosystems biologization leads to renaturation of the pedeogenesis processes in the chernozem types. The basic elements of renaturation phenomenon are self-loosening, micro and macro structure of the soil, porous space optimization and pedogenesis regimes.

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DEGRADATION OF ORDINARY CHERNOZEM IN THE SOUTH OF MOLDOVA AND PHYTOTECHNICAL MEASURES TO REMEDY OF THEIR FERTILITY

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Abstract

The existing system of agriculture in the Republic of Moldova led to humus losses, compaction of arable layer and decrease of its resistance to degradation factors. Researches established that only radical corrective factor to cardinal remediate the degraded characteristics of chernozems is that which leading to the formation of this type of soil - steppe vegetation composed by grasses and legumes herbs with fasciculate root system. The chernozems with whole profile, being grassed 15 years in a system without utilization of vegetal aerial mass, recovered 70 percent of humus content in the profile and restore the initial soil typical characteristics. Lucerne with its pivoting root system contributed poorly to remediation the structure and increasing the content of organic matter in soils. Resulting from the fact that in the Moldova is excluded the possibility to cardinal remediation the soil quality status by grassed (0.4 hectares of arable land per capita) has decided to develop and test phytotechnical methods to remedy the soil characteristics without interrupting the production process from agriculture.

Key words: *soil degradation, phytotechnical measure, structure remediation.*

INTRODUCTION

Degradation of the physical, chemical and biological properties of Moldovan chernozems contributes to the extension of the land desertification processes and decreases the volume of agricultural production in the country. The existing system of agriculture does not ensure long-term preservation of soil quality status and lead to worsening economic and environmental situations. To overcome this situation is possible only through the gradual implementation the system of conservative agriculture, based primarily on the use of natural and biological resources, renewable household sources and only the second on purchased inputs. Preserved internal resources, soil with its attributes, water, and biodiversity are important features of sustainable agriculture and therefore combating the soil degradation and land desertification (Cerbari, 2011).

In the absence of the necessary volume of organic fertilizers to remediate the degraded soil characteristics, the only way to preserve their quality status are agrophytotechnical measures-environmentally friendly farming practices. Methods of implementation of environment friendly practices as part of the mandatory sustainable agriculture to protect soil can be established by special research, extensive and lengthy. Sustainable agriculture is defined as an integrated system of agricultural practices of crop and animal production, environmental friendly, adapted to local specificities, in the long term, provides human needs of food and other agricultural products, improving the environment and soil fertility, efficient use of renovated resources, improving quality of life (Doran, Parkin, 1996; Leah, 2012).

Purpose of the research is intended to develop and test environmentally friendly agrophyto-technical methods that will ensure to remedy the physical and chemical properties of chernozems in the agricultural production process, contribute to long-term preservation of their quality that will lead to increased volume of agricultural production.

MATERIALS AND METHODS

To assess the changes in status of physical and chemical properties of the arable ordinary chernozems under the influence of different agrophytotechnical environmentally friendly practices and measures were founded four experimental parcels in which were tested the variants:

1. Lucerne + Ryegrass;
2. Sainfoin + Ryegrass;
3. Winter vetch (as successive crop);
4. Manure 50 t/ha (once in 5 years).

The experimental parcels were located on the field presented by a broad ridge quasi horizontal and homogeneous surface covering by arable ordinary chernozems.

The geographical locations of the experimental parcels were established in the form of strips with 7-10 m in the width and 500-700 m in the length (Figure 1).

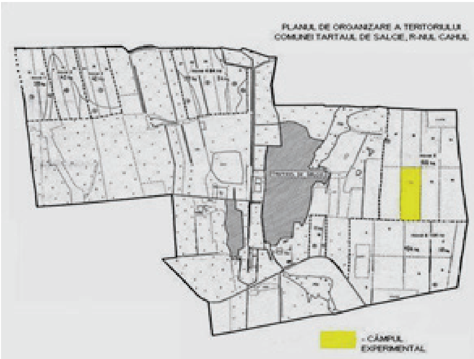

Figure 1. Experimental field lots location

In the center of experimental plots (strips) until the beginning of the experience were located one profile (Figure 2) and four semi profile of soil to assess the initial state of physical and chemical characteristics of experimental soil on the parcels.

The researches concerning morphological, physical and chemical properties of soils were performed according to conventional classical methods. Determination of roots in the studied soils was performed by washing soil samples as small monoliths by weight 4-5 kg. Annual crop size was performed on parcels of 1 m² surface for grass and cereals and 10-15 m² for maize and sunflower.

The obtained data were processed by different statistical methods using MS Excel program.

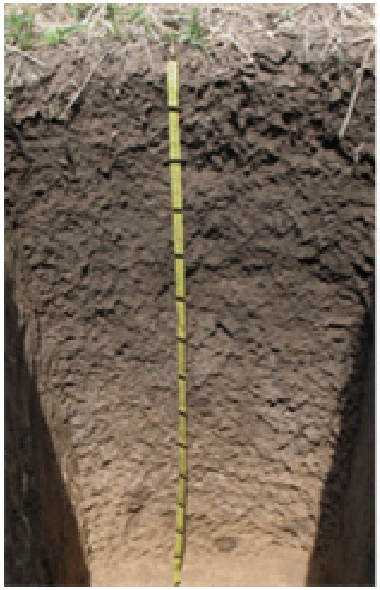

Figure 2. Profile of the ordinary chernozem

RESULTS AND DISCUSSIONS

Researches conducted on these problems showed the massive damage of natural structure of arable soils, initially excellent (Cerbari, Balan, 2010).

Maintaining a positive balance of humus contributes to remedy of soil quality status that is possible through the systematic introduction of organic fertilizers into arable land and the perennial herbs in the composition of which dominate grasses as a green manure. Given decreasing cattle numbers in 6 times, the accumulated quantities of manure are respectively in 6 times smaller than 20 years ago. Unfortunately these small quantities of organic fertilizers not used on the land for agricultural purposes. There was need to find other alternative sources of organic fertilizers to restore the soil fertility of degraded characteristics (Cerbari, et al., 2012; Shein, Milanovsky, 2002; Боронтов, 2004). The best conditions suited and effective sources of organic fertilizers for Moldova are green fertilizer used as intermediate crops. As a result of preliminary investigations carried out that winter and spring vetch are the best green manure for the chernozems as an intermediate crop used in agricultural rotation (Возняковкая, et al., 1988; Цандур, et al., 2011).

1. The initial parameters of ordinary chernozems characteristics.

The purpose of founding experimental strips is to develop and test the agrophytotechnical measures for remediation the state of degraded arable layer of ordinary chernozems while increasing their agricultural production capacity. Strips – variants with: Sainfoin + Ryegrass, Lucerne + Ryegrass and Manure, were founded in the spring of 2010. The variant with winter vetch was established (sown) in autumn 2009 and harvested 28 t/ha of green mass was incorporated into the soil as green manure in august of 2010. In September this parcel was prepared and sowing with winter wheat.

Initial parameters of investigation soil were carried out in autumn until to founding the experience. Data concerning the initial parameters of the investigated chernozems characteristics are presented in table 1-4.

Due the coarser texture, silt clay loam, with fine clay contain lower than chernozems from central Moldova, the ordinary chernozems are characterized by a more favorable state of physical quality. On the other hand, ordinary chernozem in the South of Moldova are less content of humus and poorer in the nutrients than central chernozems.

2. Modification of quality status of arable layer of ordinary chernozems under the influence of vetch as green manure.

In the experience was tested incorporation into the soil a crop of vetch green mass in size of the 28 t/ha that are equivalent to 6.1 t/ha of absolutely dry mass containing 4.2% nitrogen (Figure 3).

In result of this measure the content of organic matter in arable layer 0-25 cm of soil, increased by 0.19%, the soil structural status was improvement and the mobile phosphorus content increased.

The action of incorporation into the soil a mass of vetch as green manure increase the harvest of winter wheat with 1.3 t/ha of cereal units (Figure 4, Tables 5-7).

Table 1. The texture of the arable ordinary chernozem

Horizon and depth (cm)	Dimension of fractions (mm), content (%)						
	1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	< 0.001	< 0.01
Ahp1, 0-25	0.8	16.6	33.5	8.1	10.0	31.0	49.1
Ahp1, 25-34	0.8	16.6	33.5	7.3	11.1	30.7	49.1
Ahk, 34-49	0.6	15.5	33.9	8.2	11.0	30.8	50.0
Bhk1, 49-71	0.5	9.9	38.2	8.9	11.5	31.0	51.4
Bhk2, 71-96	0.5	8.1	40.0	8.2	11.8	31.4	51.4
BCk, 96-120	0.4	7.0	41.3	8.1	12.2	31.0	51.3
Ck, 120- 150	1.1	7.1	40.2	9.2	12.6	29.8	51.6

Table 2. Structural composition of the ordinary chernozems (numerator - dry sifting, denominator - wet sifting data)

Hori-zon and depth (cm)	Diameter of structural elements (mm) and content (%)				Quality of structure (dry sieve)	Hydro-stability of structure
	> 10	< 0.25	Sum 10-0.25	Sum >10+ < 0.25		
Ahp1 0-25	35.5 / -	14.0 / 70.2	50.5 / 29.8	49.5 / 70.2	medium	small
Ahp2 25-34	57.0 / -	2.9 / 75.2	40.1 / 24.8	59.9 / 75.2	medium	small

Table 3. Physical properties of the arable ordinary chernozems

Horizon and thickness (cm)		Hydro-scopicity coefficient	Den-sity	Total poro-sity	Degree of com-paction
		%	g/cm^3	%	
Ahp1	25	6.8	2.59	49.4	3
Ahp1	9	6.0	2.60	44.2	13
Ahk	18	5.8	2.63	49.0	4
Bhk1	23	5.8	2.65	47.9	7
Bhk2	25	5.4	2.67	47.6	7
BCk	19	4.7	2.68	-	-
Ck	30	4.3	2.70	-	-

Table 4. Chemical characteristics of genetic horizons of the arable ordinary chernozem

Horizon and thickness, cm	pH (H_2O)	$CaCO_3$	P_2O_5 total	Humus	N total	C : N	Mobile forms (mg/100 g soil)	
		%				P_2O_5	K_2O	
Ahp1 0-25	7.1	0	0.139	3.16	0.208	8.8	1.6	21
Ahp1 25-34	7.2	0	0.111	3.11	0.202	8.9	1.0	18
Ahk 34-49	7.3	0	0.080	2.85	0.190	8.7	0.8	14
Bhk1 49-71	7.6	1.4	-	2.60	-	-	-	-
Bhk2 71-96	7.8	4.0	-	1.84	-	-	-	-
BCk 1 96-120	7.9	6.6	-	1.00	-	-	-	-
BCk 2 120- 150	8.0	8.0	-	0.61	-	-	-	-

Figure 3. The strip with vetch, 2010

Table 5. Winter wheat yield on the parcel fertilized with green mass of vetch (numerator) and on the adjacent unfertilized variant (denominator)

No. of plots 15 m²	Harvest (t/ha)	Average harvest (t/ha)	Growth rate of the harvest (t/ha)
1	4.2/2.8	4.2/2.9	+1.3
2	4.2/2.9		
3	4.1/3.0		
4	4.3/2.8		
5	4.4/2.9		

Figure 4. The strip with winter wheat sown in soil after incorporation of vetch green mass

Table 6. Modification of the characteristics of arable layer of ordinary chernozem in result of incorporation into the soil the vetch as a green manure (numerator-the initial parameters, denominator – the modification characteristics)

Horizon and depth, cm	Balanced apparent density (g/cm^3)	Total porosity (%)	Sum of aggregates 10-0.25 mm (%)	Hydro-stability (%)	Humus (%)	Mobile forms (mg/100g soil)	
						P_2O_5	K_2O
Ahp1 0-10	1.25 1.21	51.7 53.3	50.5 68.8	29.8 43.4	3.16 3.36	1.6 1.9	21 21
Ahp1 10-25	1.35 1.30	47.9 49.8			3.16 3.34	1.6 1.8	21 21
Ahp2 25-34	1.45 1.43	44.2 45.0	40.1 41.5	24.8 38.6	3.11 3.06	1.5 1.4	18 18
Ahk 34-49	1.34 1.35	49.0 48.7	-	-	2.85 2.90	0.8 0.9	14 14

Table 7. Vetch harvest on the arable ordinary chernozem

Green mass yield (t/ha)	Humidity (% of wet green mass)	Dry mass (t/ha)	Cereal units (t/ha)	Ash	N	P_2O_5	K_2O	C
				% of dry mass				
28	78.2	6.1	5.6	11.4	4.12	1.00	2.38	35.1
Roots of 0-30 cm layer		5.6	-	19.7	1.51	0.27	0.85	28.7

3. Modification of the quality status of arable layer of ordinary chernozems under the influence of manure.

As a result of soil incorporation of 50 t/ha of fermented sheep manure in the arable layer 0-25 cm of soil the organic matter content increased by 0.20%. Simultaneously there is a tendency to improve the structural status of the soil and increase mobile phosphorus content (Table 8). Incorporation in the soil of 50 t/ha manure of sheep led to the increase of sunflower harvest by 0.4 t / ha (Table 9).

Table 8. Modification of the features of arable layer of ordinary chernozem as a result of incorporation of 50 t/ha of sheep manure into the soil (numerator-the initial parameters, denominator-modified parameters of soil)

Horizon and depth (cm)	Balanced apparent density (g/cm^3)	Total porosity (%)	Sum of favorable aggregates, 10-0.25 mm (%)	Hydrostability of favorable aggregate (%)	Humus (organic matter) (%)	Mobile forms (mg/100g soil)	
						P_2O_5	K_2O
Ahp1 0-10	1.25 1.23	51.7 52.5	50.5 57.5	29.8 31.8	3.16 3.37	1.6 1.9	21 22
Ahp1 10-25	1.35 1.33	47.9 48.6			3.16 3.35	1.6 1.8	21 21
Ahp2 25-34	1.45 1.43	44.2 45.0	40.1 42.1	24.8 25.8	3.11 3.16	1.5 1.5	18 19
Ahk 34-49	1.34 1.35	49.0 48.7	-	-	2.85 2.87	0.8 1.0	14 16

Table 9. Harvest of sunflower (absolutely dry mass) on the variant fertilized with 50 t/ha of sheep manure (numerator) and the adjacent unfertilized variant (denominator)

No. of parcel 15 m^2	Harvest on the parcel (kg)	Harvest (t/ha)	Average harvest (t/ha)	Growth rate of the harvest (t/ha)
1	3.5/2.8	2.3/1.9	2.4/2.0	+ 0.4
2	3.7/3.0	2.5/2.0		
3	3.7/3.0	2.5/2.0		
4	3.3/3.0	2.2/2.0		
5	3.6/2.9	2.4/1,9		

4. The influence of mixture of perennial grasses and grass hay sown on soil quality.

The influence of perennial herbs and grasses mixture sown as hay, on the soil quality status after the first and second years of vegetation is relatively small and will be assessed in the coming years. Visual and quantitative assessments are possible finding that in the condition of South Moldova the productivity of Sainfoin + Ryegrass mixture is much higher than Alfalfa + Ryegrass mixture productivity.

In the 2011 the harvest of green mass of Sainfoin + Ryegrass at about 80% humidity was equal to 35 t/ha (7 t/ha absolutely dry mass) and Alfalfa + Ryegrass at 76% humidity-17 t/ha (4 t/ha absolutely dry mass).

In the 2012 – a very drought year, the harvest of green mass of Sainfoin + Ryegrass mixture at the 72% humidity was equal to 18 t/ha (5 t/ha of absolutely dry mass) and Ryegrass + Alfalfa mixture at 69.5% humidity-10 t/ha (3 t/ha of absolutely dry mass).

Under the action of perennial Sainfoin + Ryegrass and Lucerne + Ryegrass mixtures in the second year of vegetation was shown a beginning process of remediation of degraded characteristics of arable layer of ordinary chernozems in the south of Moldova.

Drought of 2012 led to total loss of the corn grains crop on the all fields of country and experimental strips-variants, sown with this crop. Harvest of perennial grasses in the 2012 year decreased by 40-43 percent compared to 2011 year (Figure 5).

Figure 5. Strip with ryegrass + alfalfa in the third year of harvest (2012)

CONCLUSIONS

Given the fact that in the Republic of Moldova the remediation action of the soil quality status by grassing is excluded (0.4 hectares of arable land per capita) has decided to develop and test methods to remediate the soil characteristics without interrupting the agriculture production process.

Research has established that:

- the cardinal factor to radical remediate the degraded characteristics of chernozems is that which leading to the formation of this type of soil – the steppe vegetation when in its components dominate the grasses and legumes with fasciculate root system;

- the chernozems with whole profile being fallow during 15 years in the agricultural system without utilization of aerial mass, have;
- recovered 70 percent of the humus profile and initial typical soils characteristics;
- alfalfa with pivoting root system contributes slightly to remediation the structure and content of organic matter in soils.

Following use the ordinary chernozem under mixture perennial grasses and legumes (alfalfa+ryegrass), the crop production which used as fodder, it was established that this process along 5 years positive influenced the changes in the quality status of arable layer of degraded chernozem:

- in result of return in the 0-35 cm soil arable layer of about 25.5 t/ha of organic residues absolutely dry (annual 5.1 t/ha with average nitrogen content 1.9%) were created allowed the synthesis of about 5.6 t/ha of humus (1.1 t/ha annually); organic matter content in this layer increased on average by about 0.20% or 0.04% annually;
- the 0-12 cm soil layer, formed through disking, enriched with organic matter (0.43% in 5 years or 0.09% per year), became biogenic, and sufficient improved the structural layer, began the formation of follow stratum with thick of 3-5 cm.

Wide implementation of the remediation technology to restore the quality status of chernozems is possible only if the livestock sector will be restoration and allocation in perennial grasses about 13-15 percent of land or 200 thousand ha.

Direct economic effectiveness of technology:

- annual spending a whole 5 years of growing alfalfa + ryegrass mixture is 2300 MDL;
- annual net income is about 5500 lei/ha per year;
- annual net income as possible for the country on the surface of 200 000 ha-1100 million MDL.

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THE EVOLUTION OF TOTAL HETEROTROPHIC BACTERIA IN A CRUDE OIL POLLUTED SOIL

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Abstract

Crude oil bioremediation of soils is limited by the bacteria activity in degrading the spills hydrocarbons. Petroleum hydrocarbon pollution is one of the main environmental problems, not only by the important amounts released but also because of their toxicity. It is known that the main microorganisms consuming petroleum hydrocarbons are bacteria, so in this paper are presented the results obtained in a bioremediation laboratory experiment. The aim of this study is to enhance the bioremediation of soils polluted with crude oil by adding the natural biodegradable product and bacterial inoculum. A natural biodegradable product and bacterial inoculum was used for total petroleum hydrocarbon (TPH) removal from an artificial polluted soil. Soil polluted with 50000 mg/kg of TPH was treated with 0.25%, respective 0.5% and/or bacterial inoculum to increase the biodegradability rate. Also, the soil contaminated with 100000 mg/kg of TPH was treated with 0.5%, respective 1% and/or bacterial inoculum. The main objective of this work is to accelerate the biodegradation processes. The enhancement of petroleum hydrocarbons degradation was achieved under natural product treatment and bacterial inoculum. The bacterial inoculum was used to enrich indigenous microbes to enhance biodegradation rate in the green house experiment. In soil excessively polluted with crude oil, bacterial population size in conditioned variant with Ecosol maximum dose (1%) presented values comparable to those of inoculated variants, demonstrating the protective and stimulation effect of soil bacteria, including those involved in the degradation of petroleum hydrocarbons exercised by organic compound applied Ecosol.At each phase of the study, the natural biodegradable product was found to significantly enhance the biodegradation of petroleum hydrocarbons.

Key words: *biodegradation, total heterotrophic bacteria, polluted soil, a natural biodegradable product.*

INTRODUCTION

Pollution caused by petroleum and its derivatives is the most prevalent problem in the environment. The release of crude oil into the environment by oil spills is receiving worldwide attention. The interest in environmental pollution has increased for the entire population of the globe. Various institutions and organizations, some multidisciplinary other specialized publications, focused solely on pollution issues. There is no life without soil (Pepper et al., 1996; Alexander, 1997).

Many developing countries face serious problems with soil pollution, but environmental concerns seem to be a luxury given the economic situation in most countries of our days. Common soil clean-up technologies, like, e.g. high-temperature thermal desorption, are often beyond financial possibilities, especially if large areas or volumes of soil are contaminated. Furthermore, soil structure and biology can be dramatically disturbed or even destroyed making the land useless for agricultural purposes (Lee and Levy, 1989).

Crude oil is a complex mixture of hydrocarbons. It includes a saturate fraction, an aromatic fraction, asphaltenes, and resins (Atlas, 1992; Okoh and Trejo-Hernandez, 2006). Due to this complexity, petroleum hydrocarbons cannot be fully degraded by a single strain of microorganisms but its decomposition is achieved by microbial consortia and their broad enzymatic capacity (Norris and Matthews, 1994).

There are many genera of known oil-degrading microorganisms, including bacteria such as *Achromobacter, Acinetobacter, Actinomyces, Bacillus, Microbacterium, Pseudomonas, Streptomyces* and *Vibrio*, and fungi or yeast such as *Allescheria, Aspergillus, Candida, Debayomyces, Penicillium, Saccharomyces* and *Trichoderma*. Under natural conditions, these microorganisms in most areas comprise very few, compared with the total number of identified microorganisms. However, at petroleum hydrocarbon polluted soils, these populations may grow and increase because they use petroleum hydrocarbon as a carbon source (Alexander, 1997; Voiculescu et al., 2003).

MATERIALS AND METHODS

The main objective of this research is testing the natural hydrocarbon absorbent named ECOSOL. It is tested the capacity to increase the biodegradation of petroleum hydrocarbons by stimulating the bacteria. To achieve data concerning the bioremediation of polluted soil with petroleum hydrocarbons was realized a greenhouse experiment. The soil used for this experiment (calcic chernozems) was reaped from arable layer 0-20 cm (Teleorman). This type of soil was chosen because of its currency in our country, also, for its physical, chemical and biological properties favorable to plant growth.

The study focused on the application of the two major technologies known in bioremediation method such as: soil biostimulation based on environmental conditions improvement for microorganisms multiplication and activity to degrade petroleum hydrocarbons, and bioaugmentation based on enriching the soil with specific biodegrading hydrocarbons microorganisms.

Biostimulation - the first technological link included a innovation element based on using an organic compound made from cellulose fibers for soil polluted conditioning with additives to optimize its structure, water and air circulation regime in soil, and not least achieving a protective interface between degrading microorganisms and pollutant. Ecosol compound was chosen for experiment by analysing a series of organic compounds suitable for conditioning soil contaminated with organic pollutants, especially because of its biodegradability properties.

Bioaugmentation - the second technology link was achieved by soil inoculation with bacterial bioproducts made from specific bacteria selected and tested in the laboratory for their ability to degrade petroleum hydrocarbons.

The experiment was set up by artificial pollution of a cambic chernozem with different quantities of ECOSOL. After 21 days from pollution, the soil was inoculated with bacteria.

The bacterial inoculum was developed from microorganisms that occur naturally in the soil like *Pseudomonas*, *Mycobacterium*, *Arthrobacter globiformis* and *Bacillus megaterium*.

ECOSOL is an absorbent natural product, meant to facilitate quick and efficient biodegradation of hydrocarbons from contaminated soils. Accelerates biostimulation and favors the development of existing bacteria from the soil, with strong effects in crude oil biodegradation. This natural biodegradable product is obtained from vegetal fibers from celluloid waste, all treated and with additives, being used in order to bring soils back to normal fertility levels.

The experimental variants are:

- V_1, control (unpolluted soil);
- V_2, polluted soil with 5% crude oil;
- V_3, polluted soil with 10% crude oil;
- V_4, polluted soil with 5% crude oil + 50 g ECOSOL/20 kg polluted soil (0.25%);
- V_5, polluted soil with 5% crude oil + 50 g ECOSOL/20 kg polluted soil (0.25%) + bacterial inoculum;
- V_6, polluted soil with 5% crude oil + 100 g ECOSOL/20 kg polluted soil (0.5%);
- V_7, polluted soil with 5% crude oil + 100 g ECOSOL/20 kg polluted soil (0.5%) + bacterial inoculum;
- V_8, polluted soil with 10% crude oil + 100 g ECOSOL/20 kg polluted soil (0.5%);
- V_9, polluted soil with 10% crude oil + 100 g ECOSOL/20 kg polluted soil (0.5%) + bacterial inoculum;
- V_{10}, polluted soil with 10% crude oil + 200 g ECOSOL/20 kg polluted soil (1%);

V_{11}, polluted soil with 10% crude oil + 200 g ECOSOL/20 kg polluted soil (1%) + bacterial inoculum.

The values obtained by analyzing soil and plant samples were processed using more specific methods of mathematical statistics. Analysis of variance for establishing Fischer and Tukey tests determined for $\alpha = 0.05$, which shows the changes produced on soil and plant characteristics, the effects of treatments applied. ANOVA method provides information allowing the calculation of limit differences used in multiple comparison methods and the mean average for each graduation of studied factor. By correlation method was determined the linear correlation coefficient or the correlation ratio (index), for assessing the intensity of the relationship between variables. For the estimation of a link between the two characteristics studied, stochastic experiments were conducted by achieving regression equations.

RESULTS AND DISCUSSIONS

Bacterial inoculum application after 21 days from the experiment beginning was reflected in very significant increases in the levels of total heterotrophic bacteria (THB) determined in polluted soil.

Immediately after controlled soil pollution with crude oil, at impact, bacterial populations have decreased the multiplication rate, and later, after an adaptation and selection process, the resistance component will extensively proliferate. For soil polluted with 5% crude oil, the bacterial top, including those placed in the soil by inoculation was 30 days after impact, respectively 7 days after inoculum application, while in soil polluted with 10% crude oil, multiplication top of bacteria was observed in the determination made at 45 days after impact and 21 days after inoculum application, showing once again how necessary is for microorganisms habituation and adaptation to environment being a function of pollutant concentration.

In soil excessively polluted with crude oil, bacterial population size in conditioned variant with Ecosol maximum dose (1%) presented values comparable to those of inoculated variants, demonstrating the protective and stimulation effect of soil bacteria, including those involved in the degradation of petroleum hydrocarbons exercised by organic compound applied Ecosol.

The quantitative evolution of bacterial communities from soil polluted with crude oil clearly demonstrated that the Ecosol application decreases the time needed for microorganisms involved in petroleum hydrocarbons biodegradation to adapt at substrate and conditions of pollution.

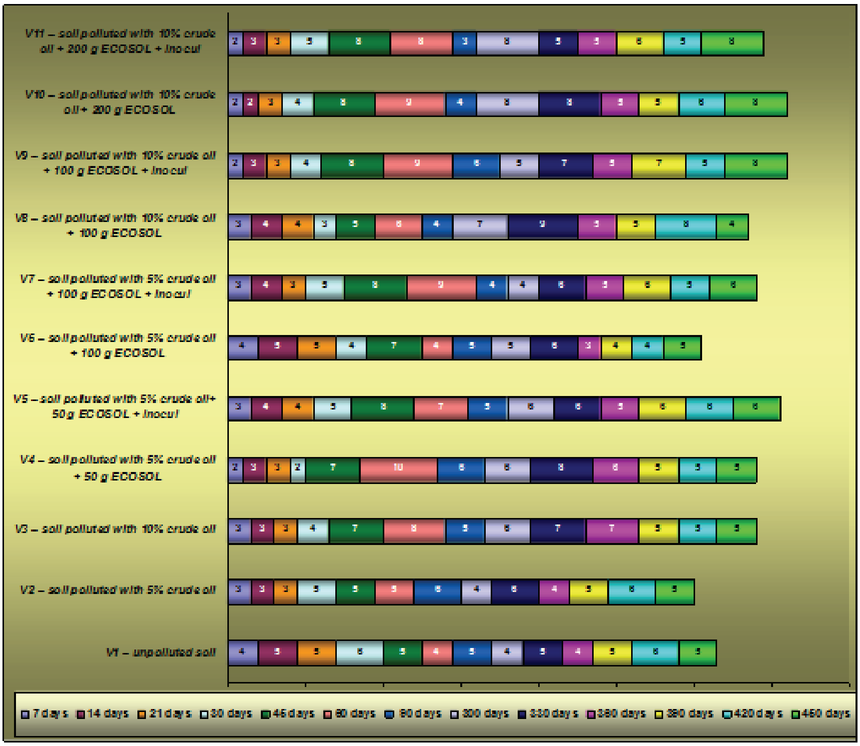

Figure 1. Diversity of heterotrophic bacteria in experimental variants at different determination moments

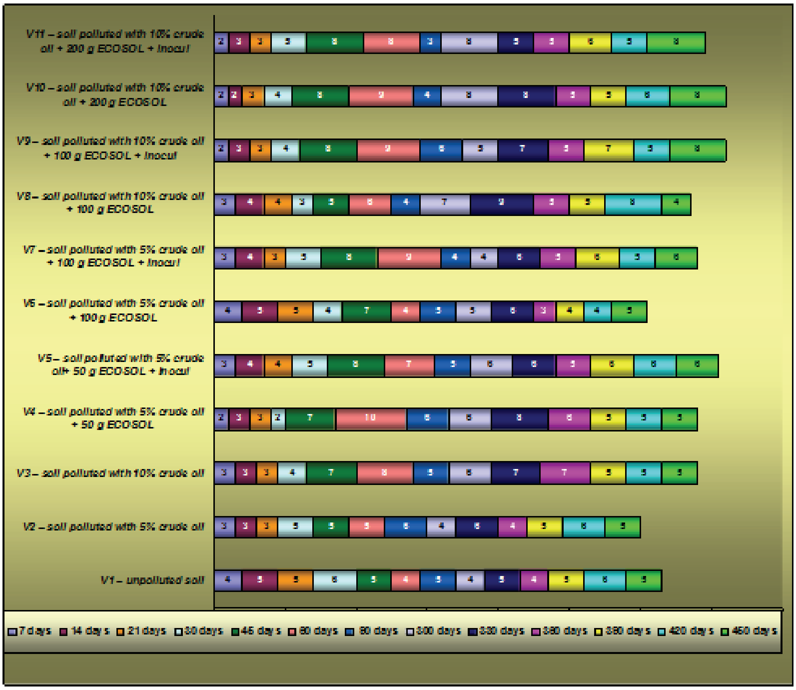

Figure 2. The presence of bacterial species with degradation potential in experimental variants at different determination moments

Frequent bacterial isolated from experimental variants, in most determination stages were: *Pseudomonas, Arthrobacter, Mycobacterium*, bacterial of the most reputable in terms of species with high capacities in hydrocarbon biodegradation.

Isolates of *Pseudomonas*, *Arthrobacter* and *Mycobacterium* led to the establishment of inoculum applied to the soil, and very high frequency showed a better survival rate and their adaptability to environmental conditions.

Bacterial isolated as *Pseudomonas* and *Arthrobacter* dominated the heterotrophic bacteria population in the majority of experimental variants, occasionally accompanied by species belonging to the genera: *Micrococcus*, *Enterobacter* and *Flavobacterium*.

Dynamics of microorganisms inoculated showed a slight adaptability in soil polluted with 5% crude oil, but complete inhibition in the first 30 days of experiment at 10% crude oil. After the acclimatization period by 30 days, the excessive concentration of pollutants has been massive multiplication of bacteria in inoculated variants, especially in the conditioned variant with Ecosol maximum dose. At 45 days, there was a real explosion in variants of bacteria inoculated with THB values double, triple compared with uninoculated variants. At 60 days, bacterial populations have begun to reduce their size, as the value of soil polluted with 10% crude oil and untreated. This demonstrates that the application reduces the time needed to adapt to Ecosol substrate for microorganisms involved in petroleum hydrocarbons biodegradation.

The value of the total heterotrophic bacteria (THB) in soil is a response to a large number of factors, including crude oil content, which causes new ecological conditions with a strong impact on microbial evolution. These conditions affect not only the size, but also the diversity of bacterial communities. The soil is mainly colonized by bacterial genera species able to use hydrocarbons from crude oil in its metabolism (Voiculescu et al., 2003).

Survival of microorganisms in petroleum hydrocarbons medium in uninoculated variants and after bacterial inoculation in the inoculated variants is a key deciding factor in the rate of biodegradation of hydrocarbons in soils.

CONCLUSIONS

For soil polluted with 5% crude oil, the bacterial top, including those placed in the soil by inoculation was 30 days after impact, respectively 7 days after inoculum application, while in soil polluted with 10% crude oil, multiplication top of bacteria was observed in the determination made at 45 days after impact and 21 days after inoculum application, showing once again how necessary is for microorganisms habituation and adaptation to environment being a function of pollutant concentration.

The microorganisms inoculated showed a slight adaptability in soil polluted with 5% crude oil, but complete inhibition in the first 30 days of experiment at 10% crude oil. After the acclimatization period by 30 days, the excessive concentration of pollutants has been massive multiplication of bacteria in inoculated variants, especially in the conditioned variant with Ecosol maximum dose. The application reduces the time needed to adapt to Ecosol substrate for microorganisms involved in petroleum hydrocarbons biodegradation.

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EVALUATION OF LAND POLLUTION WITH HEAVY METALS FROM PERI-URBAN PANTELIMON AREA

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Abstract

Toxic metals can affect the biosphere for long periods of time and their movement through the soil and contaminate groundwater. Using plants as food contaminated with heavy metals is a high risk to human health and animals (Wang et al., 2003).
The research was conducted in 2010-2011 in the Neferal-Acumulatorul area to identify pollution with heavy metals as a result of industrial activity in the area.
To determine the degree of pollution were performed research on physic and chemical characteristics of the soil in the area and retention degree of heavy metals in the upper soil profile especially zinc, copper and lead.
This paper presents the correlation between retention of heavy metals and main physical and chemical properties of soil in the study area.

Key words: *soil, pollution, heavy metals.*

INTRODUCTION

Environmental contamination with heavy metals has become a worldwide problem affecting crops, soil biomass and fertility, contributing to their accumulation in the food chain.
Heavy metals such as lead affect adversely the biological activity of soil because it blocks yeast (especially dehydrogenase and urease) by reducing the intensity of carbon dioxide elimination, by reducing the number of microorganisms.
Lead causes disturbances in metabolism of microorganisms, particularly affecting the breathing process, the cells multiplication.
Copper has a low mobility in soils rich in organic matter and clay. Pollutant effect of copper occurs mainly on physical and chemical properties of soil, soils contaminated with copper have a lower percentage of aggregate stability, leading to increased susceptibility to erosion and compaction. Increasing the concentration of copper in the soil causes increased mobile fraction of soil, changing composition of humus, increases of hydrolytic acidity and reduction of basic cations.
Copper ion inhibits enzymatic reactions by complexing substrate, by combining with active enzyme groups or by reactions with enzyme-substrate complex. Toxic action of copper on plants depends especially on the adsorption capacity and soil reaction.
Hani and Gupta (1983) appreciated that trace elements from soil can be grouped into 5 groups: (1) water soluble, (2) exchangeable, (3) adsorbed, chelated or complexed and precipitated, (4) secondary clay minerals and metal oxides with poor solubility, and (5) primary minerals. The first three groups are in balance and are the most important in ensuring microelements for plants during the growing season.
Zinc excess causes changes in physical and physic-chemical properties of soil, reducing soil biological activity. Zinc acts on organisms directly and indirectly, disturbing transformation processes of organic matter in the soil. Toxic action of zinc excess on microorganisms is slow physiological processes. Borlan and Hera (1973) estimated that in arable horizon of reddish brown forest soils (Chromic Luvisols) that do not suffer from the influence of emissions, varies between

50 and 100 mg/kg and appreciated that normal values of copper in these soils are 20 mg/kg.
Among the micronutrients, copper forms the most stable links with organic matter is largely bioaccumulation in upper soil horizon, it can be linked up to 50% of total copper. It is accepted that this form with carboxylic and phenolic groups of organic substances, as the humic, most stable compounds.

MATERIALS AND METHODS

The research was conducted in 2010-2011 in the Neferal - Acumulatorul area to track lead, copper and zinc pollution. For this aim were collected from 15 profiles 30 soil samples on the N, S, SE and V direction (Figure 1). Soil samples were collected at 0-20 cm and 20-40 cm depth and were made the following determinations: soil reaction with field pH meter HACH HQ 40D, organic carbon content - wet oxidation and titrimetric dosing (after Walkley Bleack - Gogoașă change), the content of Pb, Zn and Cu using X-met device, were determined in the surface horizon and soil texture (particle size analysis pre-treatment followed by granulometric fractions separation by sieving and pipetting) to track how the main soil characteristics influence retention of heavy metals.

Figure 1. Distribution of soil profile

Also was made a soil profile of the unpolluted area to identify the soil type. Soils in the investigated area is from Luvisols class, Chromic Luvisols is the dominant soil type, in depression areas with moisture excess the soil type is Stagnic Luvisols. Also on concentrations of heavy metals from soil were conducted directions of pollution load in horizons surface of the investigated area.

RESULTS AND DISCUSSIONS

Elements concentration in the upper horizon investigated show that their movement toward depth is reduced as ionic form and occurs only like clay-humic complexes. Research has shown that heavy metals are strongly retained especially soil surface where they are bound by chelating with soil organic matter and their mobility is conditioned of soil texture and its reaction (Gâță et al., 2006).
The Bt horizon at a depth of 40 cm proportion soluble is obviously reduced and most elements are included in the network minerals in the soil and probably less leaching. However, chelated proportion of organic material cannot be neglected while concentrating trace elements from the soil surface is unlikely their leaching.
Soil reaction ranges from 5.34 to 6.59 (moderately acid to weak acid). In the event of soils with moderate acid reaction heavy metals mobility is generally higher. Organic matter content varies between 2-3.5%, of low to medium content (Table 1).
We mention that the land is rich in plant debris because lately has not been cultivated. Under these conditions at some points high organic matter content is attributed to accumulation of spontaneous crop residues left on the soil surface each year.
Higher content of organic matter causes a strong retention of heavy metals in horizons surface.
The low electrical conductivity values what show that soluble salts and calcium carbonate were removed to depth.
Heavy metal content in the studied area presents very high values above the maximum allowable 20 mg/kg Cu, Pb and 100 mg/kg Zn in most studied points (Figures 2, 3, 4 and 5).
In the area immediately adjacent to the pollution source levels are very high with for lead, copper and zinc.
Increasing distance from the source of pollution shows a decrease in the concentration of these heavy metals in soil.
Soil texture can play a very important role in the migration of heavy metals to the depth. Generally, in the investigated points texture of surface horizon is loamy and to the depth is

medium clay loamy. Higher content of clay in lower horizons leads to a low mobility of these heavy metals in soil profile given great thickness to Bt horizon of Luvisols from this area (Table 2).

A very important aspect is the spread of pollutants, such Pb, on the East direction concentrations vary between 199 and 436 mg/kg, Cu with concentrations from 57-116 mg/kg and Zn from 138-256 mg/kg (Figure 6).

Table 1. Characterization of soil reaction, organic carbon and electrical conductivity

No profile	Depth (cm)	pH	Organic carbon (%)	Electrical conductivity (µS)
1	0-20	6.47	3.5	205
	20-40	6.46	3.2	215
2	0-20	5.72	2.8	105.2
	20-40	5.97	2.2	128.2
3	0-20	5.50	2.7	115
	20-40	5.82	2.3	118
4	0-20	6.00	3.1	129.9
	20-40	6.16	2.5	117.7
5	0-20	5.60	2.9	125
	20-40	5.34	2.4	131
6	0-20	6.57	3.6	145
	20-40	6.59	3.4	130
7	0-20	5.58	3.0	123
	20-40	5.80	2.4	114
8	0-20	5.91	2.9	112
	20-40	5.85	2.4	110
9	0-20	5.97	2.8	131
	20-40	5.92	2.5	120
10	0-20	6.12	3.5	145
	20-40	6.05	2.7	132
11	0-20	5.56	2.8	126
	20-40	5.68	2.1	117
12	0-20	5.78	2.6	112
	20-40	5.96	2.0	125
13	0-20	5.45	2.5	108
	20-40	5.65	2.4	113
14	0-20	5.87	2.8	121
	20-40	5.90	2.4	128
15	0-20	6.12	3.2	146
	20-40	6.14	2.4	132

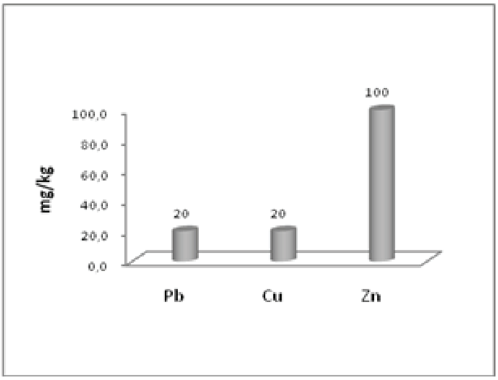

Figure 2. Normal concentration of Pb, Cu and Zn in soil

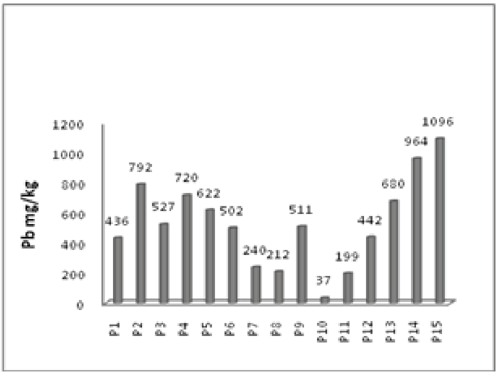

Figure 3. Lead content in soil

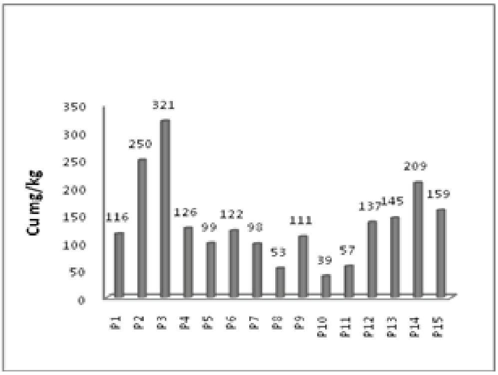

Figure 4. Copper content in soil

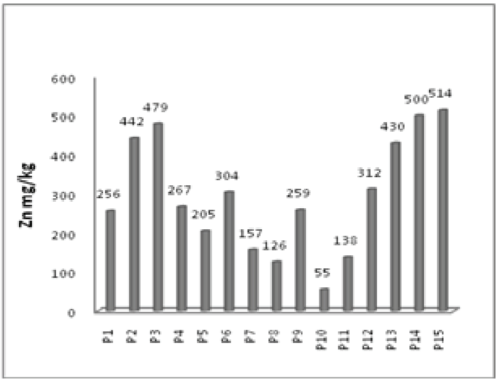

Figure 5. Zinc content in soil

Table 2. The particle size distribution of the Chromic Luvisols

No. profile	Depth (cm)	Soil texture				
		Coarse sand (2.0-0.2 mm)	Fine sand (0.2-0.02 mm)	Loamy (0.02-0.002 mm)	Clay (<0.002 mm)	Clay (<0.001 mm)
1	0-20	1.0	36.0	32.7	30.3	51.1
	20-40	0.9	34.8	32.6	31.7	52.6
2	0-20	0.9	39.2	31.0	28.9	50.7
	20-40	0.9	37.8	30.4	30.9	50.6
3	0-20	1.2	38.7	30.6	29.5	51.4
	20-40	0.9	36.6	29.4	33.1	53.1
4	0-20	1.9	35.6	29.5	33.0	52.0
	20-40	2.0	34.7	30.5	32.8	51.9
5	0-20	1.0	38.7	29.7	30.6	50.7
	20-40	1.0	37.5	30.4	31.1	50.8
6	0-20	0.9	38.4	31.4	29.3	49.4
	20-40	1.0	36.9	32.1	30.0	49.6
7	0-20	1.0	36.1	31.4	31.5	52.6
	20-40	0.9	37.9	29.8	31.4	50.0
8	0-20	0.9	37.9	29.9	31.3	50.2
	20-40	0.9	35.7	32.1	31.3	45.5
9	0-20	1.2	37.5	31.4	29.9	44.1
	20-40	1.0	36.2	31.2	31.6	45.4
10	0-20	0.9	35.2	29.4	34.5	75.9
	20-40	1.1	34.7	29.9	34.3	49.4
11	0-20	1.3	40.3	29.4	29.0	42.7
	20-40	1.2	38.1	29.8	30.9	45.1
12	0-20	1.1	38.1	31.4	29.4	44.4
	20-40	1.0	36.0	33.1	29.9	45.8
13	0-20	2.4	44.6	23.7	29.3	40.9
	20-40	1.9	43.8	25.3	29.0	41.3
14	0-20	8.6	39.6	22.8	29.0	39.8
	20-40	6.5	38.9	24.1	30.5	41.9
15	0-20	1.8	41.5	27.4	29.3	42.7
	20-40	1.6	36.3	24.9	37.2	17.4

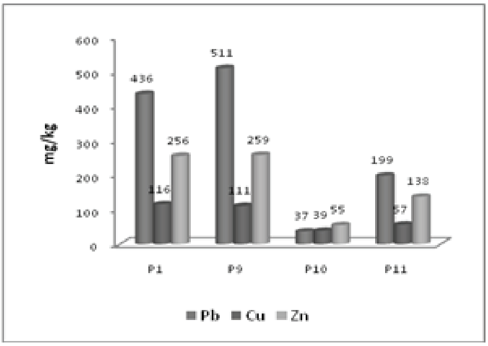

Figure 6. Distribution of heavy metals to the East

Higher concentrations of heavy metals were recorded in a North direction from 792-442 mg/kg Pb, Cu 250-137 mg/kg and from 442 to 312 mg/kg Zn (Figure 7).

In the South direction were found among the lowest concentrations in Pb from 502-212 mg/kg, at Cu from 122-53 mg/kg and 304-126 mg/kg for Zn (Figure 8).

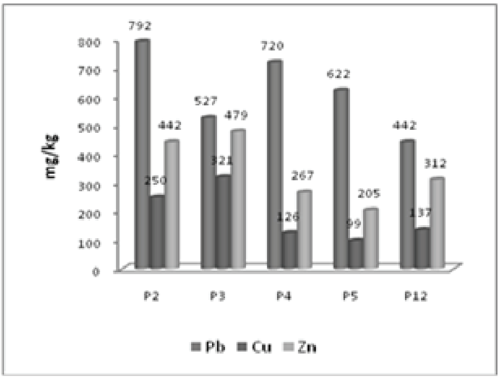

Figure 7. Distribution of heavy metals to the North

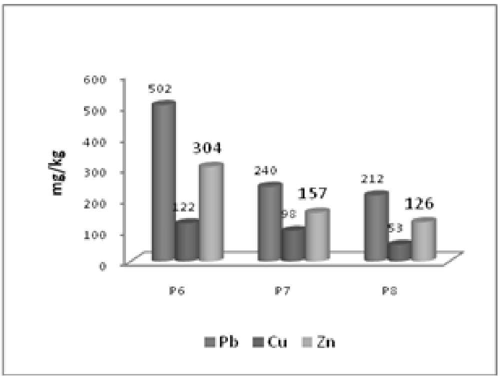

Figure 8. Distribution of heavy metals to the South

High concentrations were recorded in West and North direction. If the majority of points with increasing distance from the source of pollution heavy metal concentrations have decreased on the west concentrations of Pb, Zn and Cu grew to the point farthest from the source of pollution (Figure 9).

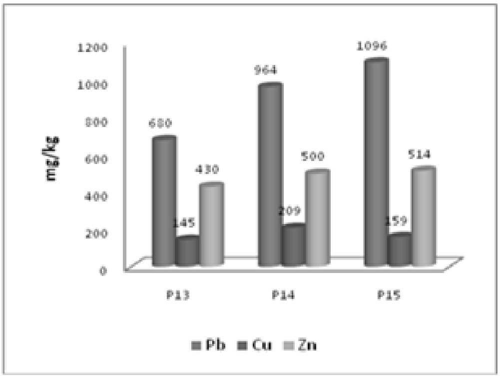

Figure 9. Distribution of heavy metals to the West

This is explained by the dominant wind direction researched area and the fact that pollution is increasing by intense traffic of the area.

CONCLUSIONS

Research conducted in the Neferal - Acumulatorul area revealed concentrations above the maximum limits for lead, copper and zinc.

The highest concentrations are recorded in surface horizons where heavy metals are closely related in particular lead by chelating with organic matter of soil.

Heavy metal mobility on soil profile is influenced by soil texture, is loamy on the surface and the depth is clay-loamy, resulting a retention of heavy metals and their reduced mobility on profile.

High concentrations of lead, copper and zinc were recorded on prevailing wind direction, on the west, where lead values ranged from 680-1096 mg/kg.

In assessing land from area investigated an important aspect is area of pollutants distribution and their concentrations.

From the presented data it can be concluded that most charging lead and copper have soil samples collected in northern of factory and lower have samples from the south.

Among the three, the highest load factor is lead, followed by copper and then zinc.

Heavy metal concentration increased by reducing the distance from pollution source.

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EFFECT OF HEAVY METALS ON MICROARTHROPOD COMMUNITY STRUCTURE AS AN INDICATOR OF SOIL ECOSYSTEM HEALTH

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Abstract

Microarthropod community structure reflects soil ecosystem health and is influenced by the soil environment directly and/or indirectly by affecting the soil micro-flora and fauna that they graze. In this study, ecological indices for soil microarthropod community structure in soil contaminated (CS) with heavy metals in Plovdiv region and of a nearby non-contaminated area (NC) were examined during the three seasons from April through November 2011 to reveal influence of heavy metals on the soil microarthropod community structure. The QBS index as a tool has been applied to assess soil biological quality. Comparison of QBS index between CS and NC indicates that it was decreased in CS, indicating that soil health and function were adversely affected. Seasonal changes in the QBS index during the study period showed that the effect of heavy metals on microarthropod community structure is influenced by seasonal changes in environmental conditions.

Key words: *microarthropods, heavy metals, soil health, QBS, Plovdiv.*

INTRODUCTION

Humans have extensively altered the environment and caused a reduction in the level of biodiversity. Disturbances linked to human activity can alter the quantity and quality of detritus availability and the chemical-physical properties of habitats of soil organisms. Soil as a non-renewable resource is a key factor for agriculture; preservation of high soil quality is one of the main goals of sustainable agriculture. In this context the monitoring of soil quality plays an important role in preserving biodiversity to achieve sustainable management of renewable resources.

The number of bio-indicator systems using soil invertebrates is relatively high; some approaches use nematodes, mites, collembolans, dipterans, coleopterans or all of the microarthropod communities (Pankhurst, 1997; Gilley et al., 2001: Ruf at al., 2003). According to the soil heavy metals pollution many authors use the nematodes as bio-indicator of the soil health. Nematodes are among the simplest metazoan occupy key position in soil food webs. They do not rapidly migrate from stressful condition but respond rapidly to disturbance and enrichment (Bongers and Ferris, 1999). Likewise the microathropod are very abundant, sensitive to changes of soil properties and most of them are sedentary and unable to respond spatially and temporally to soil property changes (Bird et al., 2000).

In the last decade, different authors proposed new methods for soil health assessment, based on soil microarthropods. Some of these methods are based on the general evaluation of microarhropods (Parisi, 2001), while others are based of evaluation of single taxon (Paoletti, 1999; Cassagne et al., 2004; Hodkinson and Jackson, 2005). The QBS index-i.e. “Qualità Biologica del Suolo” evaluates the entire microarhropod community (Parisi, 2001). This index is based on the concept that the higher the soil quality is the higher the number of microarthropod groups well adapted to soil habitats (Parisi and Menta, 2008).

In Bulgaria an evaluation of the soil quality using QBS index has not presented until our study. The aim of this article is to present the results of the research carried out in the region of Plovdiv, (south Bulgaria), a region characterized by very intensive agroecosystems and heavy metals pollution of the soil in small parts of this region. Particular attention was focused on comparison of microarthropod communities in two different types of soil (contaminated (CS) and non-contaminated (NC) with heavy metals) during the three seasons in 2011.

MATERIALS AND METHODS

Study areas

The sampled areas are located in the region of Plovdiv. The five CS sites are nearby the production plant for mineral raw materials processing, and production of different kind of metal products (14 kilometres south from Plovdiv). The five NC sites are located in 25 kilometres north-east from Plovdiv.

The soil type of the two different areas is cinnamon forest soils, and the landscape is dominated by agricultural land use.

According to the climatic data (National Institute of Meteorology and Hydrology, BAS – branch in Plovdiv), the average air temperature from April through November 2011 was 22.5°C. The average rainfall for the investigation period was 295 mm.

Soil sampling

In each site three soil cores, 10 cm × 10 cm and 10 cm depth were picked up in the spring, summer and autumn in 2011. In the study sites above plant cover was removed before sampling and only soil was taken. Soil samples for QBS calculation were collected when soil moisture ranged between 30 and 70% of field capacity.

Because of climate and logistical reasons the sites were not sampled simultaneously. The soil samples were placed in plastic bags and transported to the laboratory.

Extraction of microarthropods

A Berlese-Tullgren funnel was used for microarthropd extraction (Phillipson, 1971). The soil core was carefully placed on mesh above the funnel together with all the soil lost from sample during handling before inserting a bottle filled with preservative liquid (2 parts 75% ethanol and 1 part 25% glycerine). Extraction duration was proportionate to the soil sample water content (never less than 5 days).

Specimen observation

Extracted specimens are observed under a stereomicroscope at low magnification (usually 20-40× is sufficient) in the same preservative liquid. The specimens were identified at different taxonomical levels: classes, orders and families.

Determination of biological forms and calculation of QBS index

Within each higher taxon, QBS method requires searching for the biological form (morpho-type) that is most adapted to soil. This type receive a score named the EMI (eco-morphological index), which ranged from 1 to 20 in proportion to degree of adaptation. As a general rile, eu-edaphic (i.e. deep soil-living) forms receive an EMI = 20, hemi-edaphic (i.e. intermediate) forms get an index rating proportionate to their degree of specialization, while epi-edaphic (surface-living) forms score EMI = 1. The QBS index value is obtained from the sum of the EMI of all collected groups. If in a group, biological forms with different EMI scores are present, the higher value (more adapted to the soil form) is selected to represent the group in the QBS calculation (Parisi et al., 2005).

Table 1. Characteristics of sample sites

Site number	Land use	Crop	Sampling dates-2011	Heavy metals contamination mg/kg
	SC			
1.	Arable land	Cherry trees	28/04; 04/07; 29/10	Pb-301.8; Zn-641.6; Cu-82.1; Cd-9.01
2.	Arable land	Lavender	30/04; 07/07; 03/11	Pb-275.6; Zn-543.4; Cu-71.1; Cd-6.92
3.	Arable land	Alfalfa	01/05; 08/07; 04/11	Pb-253.2; Zn-528.6; Cu-69.1; Cd-6.03
4.	Arable land	Lavender	01/05; 08/07; 04/11	Pb-270.8; Zn-550.2; Cu-76.2; Cd-5.98
5	Permanent grassland	-	03/05; 11/07; 06/11	Pb-223.4; Zn-502.1; Cu-53.5; Cd-5.74
	NC			
1.	Arable land	Apple trees	06/05; 15/07; 09/11	Pb-17.2; Zn-53.6; Cu-4.2; Cd-0.22
2.	Shrubland	-	06/05; 15/07; 09/11	Pb-19.8; Zn-63.5; Cu-5.6; Cd-0.26
3	Arable land	Alfalfa	06/05; 15/07; 09/11	Pb-15.1; Zn-42.6; Cu-3.7; Cd-0.17
4.	Permanent grassland	-	09/05; 18/07; 11/11	Pb-17.9; Zn-55.1; Cu-4.3; Cd-0.20
5.	Arable land	Spearmint	09/05; 18/07; 11/11	Pb-14.3; Zn-39.2; Cu-2.8; Cd-0.11

RESULTS AND DISCUSSIONS

In the soil under study microarthropodial fauna was well differentiated. In both CS and NC soils of different land agroecosystem have been determined species belong to 6 classes, 9 orders and 7 families.

Phylum *Arthropoda*
Class *Entognata*
Order *Collembola*
Class *Chilopoda*
Class *Diplopoda*
Class *Malocostrata*
Order *Isopoda*
Class *Insecta*
Order *Diplura*
Order *Orthoptera*
Order *Hemiptera*
Family *Membracidae*
Order *Coleoptera*
Family *Elateridae*
Family *Staphylinidae*
Family *Tenebrionidae*
Family *Curculionidae*
Family *Carabidae*
Family *Melolonthidae*
Order *Lepidoptera*
Order *Hymenoptera*
Class *Arachnida*
Order *Orbitida*

The taxa of the three edaphic forms were represented in the sampling sites. The eu-edaphic forms were presented from *Collembola, Chilopoda, Diplopoda, Diplura* and *Arachnida*. The semi-edaphic microarthropods were presented from *Isopoda, Orthoptera, Coleoptera, Lepidoptera* and *Hymenoptera*. Hemipterans were representative for epi-edaphic biological forms.

It is interesting to note that some important groups, such as *Protura* and *Pauropoda* were entirely lacking in both CS and NC soils. Similarly Gardi et al. (2002) and Menta et al. (2008) observed that these two taxa were not presented in five evaluating site in north Italy even the condition are favorable. The authors also observed that *Chilopoda* occurs only in two soil samples. In contrast we found species belong to this taxon in 4 CS sites and all NC sites. In Tables 2 and 3, the soil microarthropod taxa extracted from soil samples and associated EMI are shown.

Table 2. Soil microarthropod taxa, associated EMI and QBS value (bold row) with soils contaminated with heavy metals

Microarthropods groups	Site 1	Site 2	Site 3	Site 4	Site 5
	Spring				
Collembola	10	10	10	10	-
Chilopoda	10	10	-	-	20
Diplopoda	-	-	-	5	5
Isopoda	-	-	10	-	-
Diplura	-	-	20	20	-
Orthoptera	-	-	-	-	-
Hemiptera	-	-	-	-	-
Coleoptera-larvae	-	10	10	-	10
Coleoptera – adults	-	-	5	5	10
Hymenoptera	-	-	5	5	-
Lepidoptera-larvae	-	-	-	-	-
Arachnida	-	20	20	-	20
QBS value	**20**	**50**	**80**	**45**	**65**
	Summer				
Collembola	10	10	10	10	-
Chilopoda	-	-	10	-	20
Diplopoda	-	-	-	-	5
Isopoda	-	-	-	-	-
Diplura	-	-	20	20	-
Hemiptera	-	-	-	-	-
Orthoptera	-	-	-	-	-
Coleoptera-larvae	-	-	-	-	-
Coleoptera – adults	-	10	10	10	10
Hymenoptera	-	5	-	-	-
Lepidoptera -larvae	5	-	10	10	-
Arachnida	-	20	20	-	20
QBS value	**15**	**45**	**70**	**50**	**55**
	Autumn				
Collembola	10	10	20	10	-
Chilopoda	-	-	10	-	10
Diplopoda	-	-	-	5	5
Isopoda	-	10	10	-	10
Diplura	-	-	-	20	20
Orthoptera	-	-	-	-	-
Hemiptera	1	-	1	-	-
Coleoptera-larvae	5	10	10	-	10
Coleoptera – adults	5	10	-	-	5
Hymenoptera	-	5	5	5	-
Lepidoptera -larvae	5	-	10	-	-
Arachnida	-	20	20	20	20
QBS value	**26**	**65**	**86**	**60**	**80**

There are visible differences between QBS value of CS and NC soils in all sites during the three evaluation seasons. QBS values of SC sites ranged between 40 and 90, while the index value of NC soil was obviously higher – above 90, except site 5 in the summer (Table 2). The lowest QBS value (15-26) was found in site 1 of CS (Table 2). In this site QBS value was affected by the highest level of heavy metals contamination. According to van Straalen (2004) biodiversity of soil microarthropods is influenced by heavy metals contamination in the soil, especially by Zink (Zn). Zn content in site 1 ranged from 502 to 641 during our research work (Table 1). Others authors such as Cortet et al. (1999) and Brussaard et al. (2007) reported that the

Pb content in the soil affected microarthropod communities in the high level and QBS index of contaminated with Pb soils is lower than 40. In the present research the Pb content in the soils nearby the production plant was about 14.2-17.4 times higher than the soils of the non-contaminated area. Probably because of this reason QBS value of CS soils was 1.6-5.4 times lower than index value of NC. The highest QBS value (101-151) was observed in site 1 of NC soils, following by site 3 with index value ranged between 95 and 145 (Table 3).

In CS sites all the arable land parcels, except site 1, have a quite similar QBS value and higher than 45. Site 3 was an old alfalfa (*Medicago sativa*) meadow and the highest QBS value may have resulted from the lowest heavy metal content compared with the other arable land sites (1, 2 and 4, Table 2). Parisi et al. (2005) also reported the highest QBS value in alfalfa sites but as a result from the long period without any soil disturbance.

Many authors discussed that the highest QBS value is usually calculated in the shrublands and grassland (Gardi et al., 2009; Menta et al., 2011; Blasi et al., 2012). In contrast our research showed that the highest QBS value was calculated in arable areas with apple trees. This probably due to the relatively well preserved habitats of soil microarthropods in this site, because of presence of grass in/between rows of growing apple trees.

Figure 1 presents seasonal changes in QBS value in CS and NC soils. In both spring and summer the climatic conditions were favorable for soil microarthropods development, especially for the typical eu-edaphic forms, such as *Diplura* and *Arachnida*.

As a result of that, the QBS value was 96-25.4% higher than the summer. The effect of climatic impact was more distinguishable in NC sites. The difference between QBS value in CS sites during the study period seasons was less remarkable. In NC soils QBS value of 53, 47 and 63.4 was recorded in spring, summer and autumn, respectively. It have been discussed the seasonal changes in climatic factors affect predominantly semi-edaphic and ep-edaphic microarthropods and some species from orders *Collembola* and *Diplura*.

In agreement with this hypothesis, the present data demonstrated the highest seasonal fluctuation in orders *Hemiptera, Orthoptera, Coleoptera* and *Lepidoptera* and some species of *Collembola* and *Chilopoda*.

Table 3. Soil microarthropod taxa, associated EMI and QBS value (bold row) with non-contaminated with heavy metals soils

Microarthropods groups	Site 1	Site 2	Site 3	Site 4	Site 5
	Spring				
Collembola	20	20	10	20	10
Chilopoda	20	10	10	20	20
Diplopoda	5	5	5	5	-
Isopoda	10	10	10	10	10
Diplura	20	20	20	20	-
Orthoptera	20	-	20	-	20
Hemiptera	1	-	-	1	1
Coleoptera-larvae	10	10	10	10	10
Coleoptera-adults	10	5	5	5	10
Hymenoptera	5	5	-	5	5
Lepidoptera-larvae	10	-	10	-	-
Arachnida	20	20	20	20	20
QBS value	**151**	**100**	**120**	**116**	**106**
	Summer				
Collembola	10	10	10	10	10
Chilopoda	10	10	10	10	10
Diplopoda	5	5	5	-	-
Isopoda	10	10	10	10	10
Diplura	20	20	20	20	-
Orthoptera	-	-	-	-	-
Hemiptera	-	1	-	1	1
Coleoptera-larvae	10	10	10	10	10
Coleoptera-adults	10	-	-	5	10
Hymenoptera	5	5	-	-	5
Lepidoptera -larvae	10	-	10	10	-
Arachnida	20	20	20	20	20
QBS value	**101**	**96**	**95**	**96**	**76**
	Autumn				
Collembola	20	20	10	20	20
Chilopoda	10	20	20	20	10
Diplopoda	5	5	5	5	5
Isopoda	10	10	10	10	10
Diplura	20	20	20	20	20
Orthoptera	20	-	20	-	20
Hemiptera	-	-	-	-	-
Coleoptera-larvae	10	10	10	10	-
Coleoptera – adults	10	10	5	10	5
Hymenoptera	5	5	5	5	-
Lepidoptera -larvae	10	-	10	-	-
Arachnida	20	20	20	20	20
QBS value	**140**	**120**	**145**	**120**	**110**

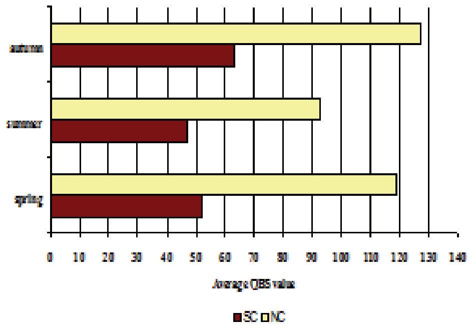

Figure 1. QBS value in three different seasons

CONCLUSIONS

In the period April-September 2011 for the first time in Bulgaria QBS index have been applied for assessment of microarthropod community structure in contaminated soil (CS) with heavy metals and non-contaminated soils (NC).

Differences between QBS value of the polluted with heavy metal soils and non-contaminated soils allows assessing the degradation level of soil. Nevertheless this method is biotic index and as such its diagnosis capability can be limited.

The results of this study suggest that not only the permanent grassland but also the arable land can be appropriate agroecosystems for preserving the soil microarthropod communities even in the heavy metals contaminated soils.

Differences among the studied habitats were not only observed in taxa diversity but also in seasonal population dynamics, another factor of diversity in soil communities.

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OBSERVATIONS ON THE PRESENCE RHODI-EUTRIC CAMBISOLS (TERRA ROSSA) IN ROMANIA

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Abstract

Rhodi-eutric cambisols is a dominating in the mediterranean regions, its presence being connected to limestone that is the most times jurassic. The soil origin material is represented by the residues of the limestone dissolving.
Rhodi-eutric cambisols also appears locally in the west side of the country and in submediterranean climate conditions (Banatului Mountains) and in climate conditions (humid climate) with oceanic influences (Apuseni Mountains) and in the most frequent cases associated with rendzic leptosols, eutri-lithic leptosols and rocks.
From the most recent field and laboratory data results that the rhodi-eutric cambisols soils develop also in present if some morfohidroclimatic conditions are fulfilled.

Key words: *rhodi-eutric cambisols, limestone, rubescent.*

INTRODUCTION

Rhodi-eutric cambisols is a dominating in the mediterranean regions, its presence being connected to limestone that is the most times jurassic.
In Romania was separately under the name of terra rossa on the first map of the soils by G. Murgoci (1910). Much later (1952) M. Popovat and M. Spirescu publishes a note on red soil, naming them 'red soils of cones' and passes them into the category of terra rossa soils, because at the same time, there is a tendency to refer to terra rossa any red soil.
In 1970, M. Popovat et al. consider soil type terra rossa as relict have been delivered two main ways of developing it: one, in big bags or sinkholes formed on limestone dissolution in their (the bath), another on hillsides, as deposits delluvial (Mehedinti Plateau, town North Nadanova).
Terra rossa is in fact in Romania in the West and southwest of the country where it occupies an area of about 50.000 ha (0.2%), both in the sub-mediterranean climatic conditions (Mehedinti Plateau, Banat Mountains), as well as in the more humid climate conditions, with oceanic influences (Apuseni Mountains).

MATERIALS AND METHODS

The field studies consisted of mapping and spatial reambulating the studied area on maps at 1:10.000 and 1:25.000 scale, with collection of numerous soil and groundwater samples, with observations on relief, micro-relief, parent material, etc.
The basic basic research and mapping unit of the areas with chromic luvisols was the soil profile, thus allowing the study of morphological characteristics of the soils. As a result, soils were classified based on intrinsic properties, namely the soil profile, taking into account diagnostic horizons and characteristics.
Soil profiles were located on the ground so that to form a network of studied points. The method of parallel routes, located almost at equal distances has been used, to cover more or less uniformly the whole working area.
The morphological description of soil profiles was done according to the Romanian System of Soil Taxonomy (SRTS, 2003, 2012), ICPA, Bucharest.
In order to establish the soils diagnosis, their morphological features have been taken into account, namely the thickness of morphological

horizons, color, texture, structure, composition, adhesion, etc.
Soil samples were taken from genetic horizons both in modified and unchanged settings.
In modified settings, soil samples of 20 cm thickness were taken in bags, for the chemical characterization to be carried.
In natural (unchanged) settings, soil samples were taken using a metal cylinder of known volume (200 cm^3), to characterize the physical and hydro-physical features, as well as the momentary soil moisture.
The following methods have been used for the physical and hydro-physical features:
Particle size analysis (granulometry) :
- pipette method for fractions < 0.002 mm, including;
- wet sieving method for fractions from 0.002 to 0.2 mm and dried sieving method for fractions > 0.2 mm

For the the textural classes and subclasses, we used the Romanian system, according to the Methodology developed for soil studies, ICPA, 1987.
Bulk density (AD) method: metal cylinder of known volume (200 cm^3) for the momentary soil moisture.
Total porosity (TP): by computing PT = (1-AD/ D) *100
The chemical characteristics were determined using the following methods:
Total nitrogen (Nt): Kjeldahl method, decomposition of H_2SO_4 at 350°C, catalysts: potassium sulphate and copper sulphate.
pH: potentiometrically, with glass and calomel combined electrode, in aqueous suspension, at the ratio of ½, 5.
Humus: wet oxidation (Walkley-Black method, modified) and results expressed in percentage.
The base saturation degree (V%) and total cation exchange capacity (T me/100 g soil), by calculation.

RESULTS AND DISCUSSIONS

The soil origin material is represented by the residues of the limestone dissolving and in terms of relief, its current physiognomy is due to the space and time in a hybrid of those two factors morfogeneticy, are in a close interaction, namely the litologycal and hydrologycal. The morphological type of karst topography, at least in the Apuseni Mountains, the plateau is the major features advanced flattening, sometimes and a pronounced development of closed endorheic Basins (Figure 1).

Figure 1. Depression Ocoale

In dolines shallow (2-3 m) and very flared, terra rossa formation is taking place from calcaric cambisols and very deep for the leptosols and rocks prevailing.
Karst morphology is present, moreover, in the territory through a range of specific forms of relief of dissolution, which frequently occur buried ditches and dolines, the latter varying sizes, from a few meters to tens of meters in diameter and up at 10-15 m depth (Figures 2 and 3).

Figure 2. Dolines with microdolines the perimeter Mununa

Figure 3. Buried ditches the perimeter Poiana Calineasa

As regards the genesis of terra rossa soils there were different opinions. According to some authors (Reifenberg, Whittles, 1947) the formation of these soils would be limestone that the deterioration in the conditions of a mediterranean climate, generate residual formations of red color. Are considered relict paleosols and soils which could keep rubescent in contemporary conditions, but which develops some soil materials present.
N. Florea et al. (1968) believes that the present climate conditions where today the terra rossa soils are favorable to rubescent. They seem to have developed under a warmer climate the geological epochs earlier when rubescent was used. The current climate only allows keeping original colour of these soils under certain conditions of the relief.
V. Glavan (1973) believes that current conditions are not favorable climate terra rossa soil formation, the more they favor keeping the color red for some time, as the soil is less deep and creates a drier topoclimate.
A team from the ICPA (1987), dealing with the chemistry and mineralogy of bauxite material formed rhodi-eutric cambisols from Ciucarul Grand Massif, believes that the genesis rhodi-eutric cambisols (terra rossa) is mainly determined by parent material nature. Their occurrence is explained by parental rock composition containing kaolinite and iron oxides which conveyed land.
In our opinion the formation of terra rossa soils is possible and if the conditions are met, the hidroclimatice rock and the geomorphological. Not all conditions of the drainage of the soil work rubescent.
Coloring intensity is conditional on the state of hydration of iron in limestone residues and iron content of these residues. In the area of Ghetari-Poiana Calineasa (Bihor Mountains), where the climate is favorable humidity pseudogleizarii (annual average temperatures of 4.5°C and rainfall in excess of 1.400 mm/year frequently) on parental materials generated from limestone, but in different drainage conditions are rendzinas, eutric cambisols and rhodi-eutric cambisols.
The latter appear on the soil surface, although distinct family buried limestone crevices and ditches, water loses a first time favoring iron hydroxide hydrate and then hydrate it with the formation of goethite (Fe_2O_3) and hematite.
In other words, during spoilage develops a very active manner physico-chemical interaction when soils rich in calcium carbonate and iron oxide hydrate and dehydrate.
In the absence of such active interactions in soil instead of terra rossa is built calcaric cambisols or rendzinas characterized by a high humification, low thickness and can with great content of skeleton.
The territories to which we have referred, terra rossa profile is characterized by a type *Ao-AB-Bv-R* poorly developed (50-80 cm), clay content of between 43-57%, apparent density (1.10 to 1.29 g/cm3), high total porosity (54-58%) and permeability medium (2.0 to 3.6) (Table 1, Figures 4 and 5).

Table 1. Physical and hydro-physical concerning the rodhi-eutric cambisols

Horizon	Depth (cm)	Clay (< 0.002 mm)	DA (g/cm^3)	PT (%)	K (mm/h)
Ao	0-12	43.1	1.10	58	2.4
AB	12-25	46.3	1.21	54	3.6
Bv1	25-63	48.7	1.21	56	2.0
Bv2	63-140	56.5	1.29	56	0.6


Figure 4. Rhodi-eutric cambisols (Terra rossa)

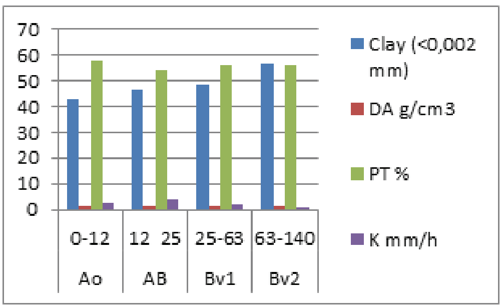

Figure 5. Variation of the physical and hydro-physical of rodhi-eutric cambisols

From a chemical reaction these soils have a moderately weak acid (5.5 to 6.8) and a small-medium humus content (4.0 to 6.5%). They have a high base saturation between 63-75% and a good supply of nitrogen (0.200 to 0.300%) (Table 2, Figure 6).

Table 2. Chemical data concerning the rodhi-eutric cambisols

Horizon	Depth (cm)	pH	Humus (%)	V (%)	Total N (%)
Ao	0-12	5.5	4.5	63	0.224
AB	12-25	5.7	3.9	70	0.195
Bv1	25-63	5.7	1.9	75	0.097
Bv2	63-140	6.8	-	-	-

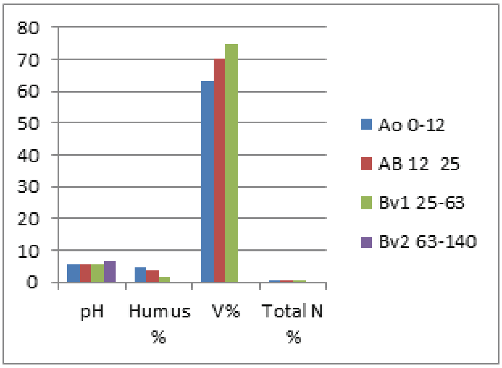

Figure 6. Variation of the chemical of rodhi-eutric cambisols

CONCLUSIONS

Genesis terra rossa soil is not sufficiently known. Different opinions were issued, focusing on the fact that these soils would be formed on limestone, but only under a sub-sediterranean and mediterranean climate or interpreted as paleosols and relict soils.

Our view is that such soils are formed under certain conditions hydroclimatic now, draining the soil and geomorphological rubescent work.

Terra rossa soils have a low volume edaphic small – medium, fertility forest but relatively good for pastures and meadows.

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ENVIRONMENTAL CONDITIONS OF SOILS NEAR IVAYLOVGRAD IN APPLYING THE HERBICIDES FOR WEED CONTROL IN VINEYARDS

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Abstract

During the 2010-2011 year near Ivaylovgrad herbicides Flazasulfuron and Glyphosate were tested alone and in combination for weed control in vineyards. Against this background, identified some soil characteristics such as soil reaction, content of carbonates, particle size composition, organic matter, content of basic nutrients. Made from the two-year studies found that the combination of herbicides Flazasulfuron at a dose 3 g/da + Glyphosate at a dose 83 g/da to control greatly weeds in vineyards, especially persistent weed Convolvulus arvensis. Data from soil analyzes showed no significant changes in agroecological soil conditions.

Key words: *organic farming, allelopathy, mixed vegetable crops.*

INTRODUCTION

Many factors influence the growth, development and productivity of the vine and the quality of grapes and wine as more important ones are: climate, soil + subsoil, orography and terrain exposure, varietal composition sanitary condition of seedlings the fight against weeds, diseases and pests, technology of cultivation of vineyards and winemaking technology. Weeds are a limiting factor in growing perennial crops-vineyards, orchards and berries (Tonev, T, Dimitrova M, Kalinova Sht, Zhalnov Iv, Spasov V, 2007). Vineyard requires keeping the soil surface clear of weeding. Clean soil is evenly illuminated by the sun and gives temperetura at night, which helps to better ripening of the grapes. Vine Weeds compete in terms of nutrients and water. At the same time they limit the natural ventilation in the stand, creating the premises for longer retain excess moisture and development of various diseases (Tonev T, 2000).

In many countries in Europe vineyard weed problem in terms and cleaning shoots vines in vineyards is decided by the soil treatments. Disadvantage of soil treatments is that they are destroying the soil structure must be performed frequently and are relatively expensive agrotechnical event. These disadvantages can be avoided by using appropriate herbicides.

The aim of this study is to trace the effects of herbicides used to combat weeds on the main soil characteristics such as mechanical structure, organic matter, soil reaction and others.

MATERIALS AND METHODS

The study was carried out during 2010-2011 year in vineyards in the region of Ivaylovgrad.

Municipality of Ivaylovgrad is located in the farthest southeastern part of the Rhodopes. To the east it borders on the Republic of Greece and its neighbours to the north and west are the municipalities of Lubimets, Madzharovo and Krumovgrad.

Ivaylovgrad is located at the edge of the Eastern Rhodopes along the middle current of the River Arda and its tributaries Byala and Luda reka.

The climate is transitional and Mediterranean. The terrain is characterized by low hills and valleys and altitude above the sea level varies from 70 to 700 m.

Amid options herbicide soil samples were taken at a depth of 0-40 cm.

Soil samples were prepared and analyzed in the Department of Soil Science at the Agricultural University-Plovdiv (Trendafilov K, Popova R, 2007). Certain soil parameters are as follows:

- Particle size composition of photosedimentografy on FRITISCH;

- Organic matter by Tiurin;
- pH (H_2O) value-potentiometric;
- Total carbonatesby Shaibler;
- Mobile potassium -in 2n HCL;
- Mobile forms of phosphorus – according to Egner-Reem;
- Nitrate and ammonium nitrogen with 1% KCL;
- Quantity of the water – soluble salts – conductometric.

Table 1. Variants of experiment

Preparation	Active substance	Dose
1. Untreated – undug		
2. Katana 25 WG + Nasa 360 SL	Flazasulfuron + Glyphosate	1 g/da 72 g/da
3. Nasa 360 SL	Glyphosate	216 g/da
4. Katana 25 WG	Glazasulfuron	3.75 g/da
5. Katana 25 WG + Nasa 360 SL	Flazasulfuron + Glyphosate	3 g/da 108 g/da

RESULTS AND DISCUSSIONS

The main soil varieties within the area include significantly leached *Chromic-eutric cambisols* to slightly podzolized (luvisols) maroon forest soils (*Chromic luvisols*) with another differentiated profile. The leached maroon forest soils with non-differentiated or slightly differentiated profile take the high and the relatively most eroded parts of the terrain. At some places they have the morphology of the significantly eroded or weak maroon forest soils.

They have been formed on eluvium consisting of a huge variety of massive rocks – granite, rhyolite, trachyte, basalt, andesite, gneiss, sandstone, marble and others and have a more shallow profile, relatively more skeletons, smaller deposits of nutrients (Gjurov and Artinova, 2001; Teoharov, 2011).

These soils are characterized by brown A horizon with a small quantity of humus, slightly acid (pH 6.4-6.5) in the upper horizons and slightly alkaline (pH 8) in the lower horizons, which is typical of this type of soils – the carbonates have been displaced 80 m and above due to the influence of the fulvic acids contained in the humus, which are formed by forest plants and move the carbonates deeper into the profile – this explains the variation of the soil reaction from being slightly acid in the upper horizons to being slightly alkaline in the lower horizons where carbonates are found.

Based on the contents of clay along the profile, in terms of mechanical content the soils are defined as slightly and moderately sandy clay. The higher values of clay refer to the middle section of the profile. The content of clay and physical clay (<0.01 mm) in the surface horizons of the leached maroon forest soils is less compared to the lower sections of the soil profile (Tables 2 and 3). This difference is a typical feature of the maroon forest soils regardless of the nature of the bed rock /alluvial or massive. This can be explained by the stronger claying inside the soil in the middle and the lower sections of the profile and it is possible for the different intensity of this process along the profile to be influenced by a type of underground water close to the surface that is characterized by changeability of its distribution and delivery rate.

Table 2. Physico-chemical characteristics of Chromic-eutric cambisols in depth 0-40 cm

Variants	pH (H_2O)	$CaCO_3$ (%)	Organic matter (%)	Particle size composition (= 0.01 mm) (%)
1. No treat – No digging	6.4	no	1.02	26
2. Katana 25 wg + Nasa 360 sl	6.5	no	1.01	23
3. Nasa 360 sl	6.5	no	1.01	24
4. Katana 25 wg	6.4	no	0.95	22
5. Katana 25 wg + Nasa 360 sl	6.4	no	0.88	25

The small reserves of humus, nitrogen and phosphorus and the medium reserve of potassium in these soils, the shallow profile and the good natural drainage do not provide sufficient quantities of nutrients and water for the plants (Table 4).

The movement of the herbicides inside the soil depends on the structure of the soil, the hydrology and the soil and weather conditions as well. There are many authors working in that sphere (Leibman and Davis, 2000; Carter, 2000; Valcheva et al., 2011; and others) who found that herbicides can move to deeper layers and this depends on the characteristics of the terrain of the surface.

Table 3. Physico-chemical characteristics of Chromic-eutric cambisols in depth>60 cm

Variants	pH (H_2O)	$CaCO_3$ (%)	Organic matter (%)	Particle size composition (= 0.01 mm) (%)
1. No treat – No digging	7.9	21.75	0.72	38
2.KATANA 25 WG + NASA 360 SL	8.0	31.01	0.88	36
3. NASA 360 SL	8.1	33.83	0.49	37
4.KATANA 25 WG	7.8	22.03	0.59	34
5.KATANA 25 WG + NASA 360 SL	7.9	29.03	0.47	35

Table 4. Agro-chemical properties by variants

Variants	NO_3^{2-} (mg/kg)	NH_4^+ (mg/kg)	NO_3^{2-} NH_4^+ (mg/kg)	P_2O_5 (mg/100g)	K_2O (mg/100)g
1. No treat – No digging	13.2	22.3	35.5	9.3	25
2.KATANA 25 WG + NASA 360 SL	11.3	19.2	30.5	8.6	18
3. NASA 360 SL	9.5	15.4	24.9	8.9	21
4.KATANA 25 WG	8.7	10.3	19.0	5.6	19
5.KATANA 25 WG + NASA 360 SL	9.3	18.6	27.9	6.6	23

The purpose of the drainage is to remove the excess water from the soil or the surface of the ground. The interaction and the ways for the movement of the herbicides in the soil is a complex process and the results are varied. In this case, we have not established any significant changes in the soil of the examined region.

CONCLUSIONS

The soils in the region of Ivaylovgrad has comparatively shallow soil profile and are characterized by a low content of humus, nitrogen and phosphorus.

These soils have slightly to moderately sandy clay mechanical composition, moderately acid soil reaction in the upper horizons /pH 6.4/ and alkaline in the lower horizons /pH 8/ where carbonates are found.

Based on the conducted two-year survey we can state that the combination of the herbicides flazasulfuron in a dose of 3 g/da and glyphfosate in a dose of 83 g/da controls to a large extent the weeds in the vineyards.

Used in various doses of herbicides to combat weeds do not lead to a change in the values of soil characteristics such as article size composition, organic matter, soil reaction and others.

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RESTORATION OF BIOTA IN ARABLE CHERNOZEMS BY GREEN MANURING AND PERENNIAL GRASSES

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Abstract

The status of biota of old-arable chernozems in conditions of the green manure and perennial grasses applications has been evaluated statistically. Two experimental sites located in the central and southern zone of the Republic of Moldova have been tested by biological indicators during 2010-2012. The application of vetch as a green manure and grasses-and-legumes created conditions for the improvement of the biota's vital activity in the soil which degraded as a result of a long-term arable use. The effect of green manure was manifested in the increase of the share of Lumbricidae family in the total number of invertebrates by 12.1-20.8% and the microbial biomass productivity of 1.4 to 1.5 times. The use of the mixture of ryegrass + lucerne during 3-5 years led to the growth of the number of invertebrates and Lumbricidae family by 2.5 and 3.0, their biomass - by 1.6-2.0 times in comparison with the control plot. Invertebrates' diversity has improved. The microbial biomass content and dehydrogenase activity in the 0-25 cm layer were increased in average by 1.4 times. The microbial biomass accumulated in the soil in amounts of 494.6-830.1 kg ha^{-1} or an average of 132.5 kg ha^{-1} annually. The population growth of worms reached of 74.4 ex m^{-2} (744.000 ex ha^{-1}), or 14.9 ex m^{-2} (149.000 ex ha^{-1}) annually. An interconnection of biological parameters of the soil quality is under discussion.

Key words: *soil biota, restoration, green manure, perennial grass.*

INTRODUCTION

The intensification of the anthropogenic soil degradation and desertification in the Republic of Moldova has caused the destruction of the soil biota habitat. The biological degradation accompanies all types of the soil degradation, and in some cases even amplifies their (Senicovscaia et al., 2012). The edaphic fauna and microorganisms in degraded soil are under stress for a long time and require to be restored. Soil biota needs an easily available carbon with a simultaneous optimization of moisture, aeration, chemical and physical parameters of habitat. This may be achieved by using environmentally friendly agricultural technologies based on the utilization green manure crops, perennial grasses and organic fertilizers. These methods create the basis for solving the problem of the soil resistant formation with a high level of biodiversity and metabolic activity. This in turn, will increase the flow of carbon and nitrogen through the soil biomass, soil quality restoration, maintaining fertility potential and obtaining of ecologically pure products.

The purpose of the research was to determine the influence of different restoration management practices on the biological properties of soils, to develop scale parameters of the soil biota stability and to suggest methods for the biota's restoration of soils, degraded as the result of the long-term agricultural utilization.

MATERIALS AND METHODS

Experimental sites. Two experimental sites located in different zones of the Republic of Moldova have been tested. Various techniques of restoring the soil biota in the conditions of field experiments have been analyzed (Cerbari et al., 2012; Cerbari and Ciolacu, 2012).

The first site was located in the center of the country, in the Ivancha village, Orhei region (Figure 1). The long-term arable soil with crop rotation without fertilizers (control), farmyard manure and green manure treatments, grass mixture (ryegrass + lucerne and ryegrass + sainfoin) cultivation were tested. Farmyard manure was introduced in the dose of 50 t ha^{-1} in2010. Vetch was planted twice in 2009 and in 2010 and its green mass in the amount of 19 t

ha^{-1} was plowed under disc in 2010. Plots under mixtures of perennial grasses (ryegrass + lucerne) were founded in the autumn of 2007. The mixture of ryegrass + sainfoin was seeded in the autumn of 2010.
The soil is the leached chernozem with humus content of 3.43% and pH = 6.6 in the 0-25 cm layer.

Figure 1. Experimental plots in the central zone of the Republic of Moldova (Ivancha village, Orhei region, May 2012)

The second site was located in the southern zone, in the Tartaul de Salchie village, Cahul region (Figure 2). These were plots with long-term arable (control), sheep manure and green manure treatments, mixture of ryegrass and lucerne and mixture of ryegrass and sainfoin.
Sheep manure was introduced in the dose of 50 t ha^{-1} in September 2009. Manure management plots served for the comparison. Vetch was used once as green manure.Vetch was planted in the autumn of 2009 and its green mass in the amount of 28 t ha^{-1} was plowed under disc in July 2010. Plots under mixtures of perennial grasses (ryegrass + lucerne and ryegrass + sainfoin) were founded in the spring of 2010.
The soil is the ordinary chernozem with humus content of 3.16% and pH = 7.1 in the 0-25 cm layer (Cerbari et al., 2012).
Soil samples were collected from the 0-25 cm layer of the experimental plots during 2010-2012.

Status of invertebrates. The state of invertebrates was identified from test cuts by manually sampling the soil layers to the depth of soil fauna occurrence (Gilyarov and Striganova, 1987). The identification of invertebrate's diversity at the level of families was carried out with the implementation of Gilyarov and Striganova's method (1987).

Figure 2. Experimental plots in the south zone of the Republic of Moldova (Tartaul de Salchie village, Cahul region, May 2011)

Microbiological properties. The microbial biomass carbon was measured by the rehydratation method based on the difference between carbon extracted with 0.5 M K_2SO_4 from fresh soil samples and from soil dried at 65-70^{o}C for 24h, with K_c coefficient of 0.25 (Blagodatsky et al., 1987). K_2SO_4 - extractable carbon concentrations in the dried and fresh soil samples were measured simultaneously by dichromate oxidation; K_2SO_4-extractable carbon was determined at 590 nm using a СФ 46 spectrophotometer.
Counts of microorganisms (heterotrophic bacteria, actinomycetes, fungi, polysaccharides - forming microorganisms) were obtained on agar plates (Zvyagintsev 1991, Skvortsova, 1981).

Enzymatic activity. The (potential) dehydrogenase activity was determined by the colorimetric technique on the basis of triphenylformazan (TPF) presence from TTC (2, 3, 5-triphenyltetrazolium chloride) added to air-dry basis of soil (Haziev, 2005). The (potential) polyphenoloxidase and peroxidase activities were determined colorimetrically using hydroquinone as a substrate (Karyagina and Mikhailovskaya, 1986).
The biological indices were evaluated statistically using the variation analysis. Statistical parameters of the state of soil invertebrates were calculated taking into account the depth of soil fauna occurrence, microorganisms and enzymes – for the layer of 0-25 cm.

RESULTS AND DISCUSSIONS

Invertebrates. The use of manure and green manure management led to the increase of all zoological indices in chernozems (Figures 1 and 2).

In conditions of the farmyard manure application in the leached chernozem the number of invertebrates increased on average from 55.0 to 94.0 ex m^{-2}, the number of *Lumbricidae* family – from 38.0 to 66.0 ex m^{-2}. A similar regularity was recorded in the ordinary chernozem when using the sheep manure. Invertebrates' population increased from 48.1 to 82.6 ex m^{-2}, the number of fam. Lumbricidae - from 25.6 to 51.1 ex m^{-2}.

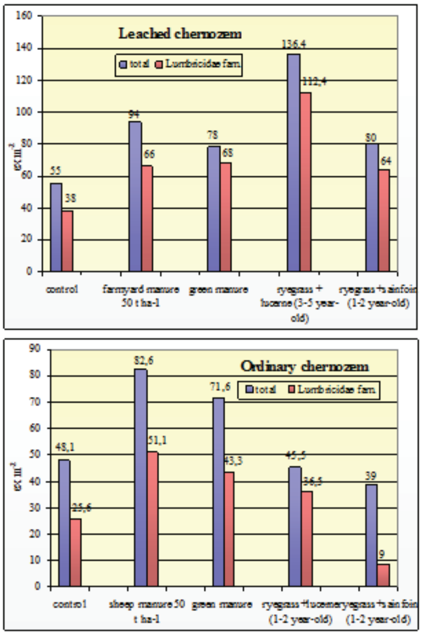

Figure 3. The influence of the manure, green manure application and perennial grasses on the number of invertebrates in chernozems (mean values, n = 6-12, P≤0.05)

The biomass of invertebrates increased of 1.4-1.5 times in both soils, biomass of *Lumbricidae* family – of 2.0 times, only in the leached chernozem (Figure 4). The family of *Lumbricidae* occupies a dominant position in the edaphic fauna. According to the statistical parameters its share in the total number of invertebrates increased from 69.1% to 70.2% in the leached chernozem, and from 53.2% to 61.9% in the ordinary chernozem when applying the manure management.

The favorable effect of the green manure management on invertebrates in chernozems has been noted both as the average values of indicators and as the confidence intervals. The number of invertebrates in the chernozem leached increased from 55.0 to 78.0 ex m^{-2}, in the ordinary chernozem – from 48.1 to 71.6 ex m^{-2}, the number of worms – from 38.0 to 68.0 ex m^{-2} and from 25.6 to 43.3 ex m^{-2} respectively. The biomass of invertebrates and *Lumbricidae* family remained practically unchanged in the leached chernozem, while these indices grew from 7.6 to 10.4 and from 6.2 gm^{-2} to 7.8 gm^{-2} in the ordinary chernozem. The share of worms in the total population increased from 69.1% to 87.2% in the leached chernozem, and from 53.2% to 60.5% in the ordinary chernozem.

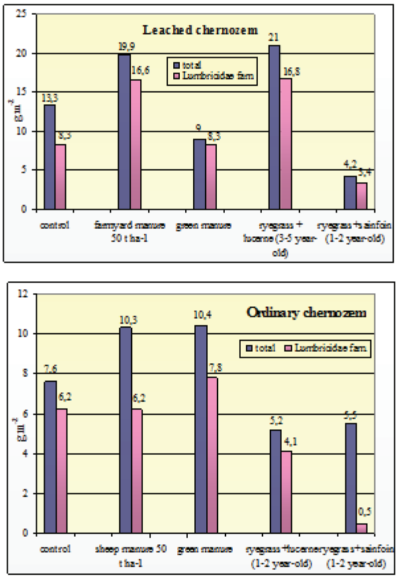

Figure 4. The influence of the manure, green manure application and perennial grasses on the biomass of invertebrates in chernozems (mean values, n = 6-12, P≤0.05)

The application of perennial legume-cereal grass mixtures led to the restoration of the total number of invertebrates and the *Lumbricidae* family. Statistically significant growth of soil zoological indicators has been registered after the third year of investigations on plots with grass mixtures (Figure 5). The number of invertebrates in average was 2.5 times higher compared with the control plot, the total biomass – 1.6 times respectively. This method is especially effective for restoring the *Lumbricidae* family. Their number in the leached chernozem increased by 3.0, and biomass – by 2.0 times. The population growth over 5 years constitutes 74.4 ex m^{-2} (744.000 ex ha^{-1}) or 14.9 ex m^{-2} (149.000 ex ha^{-1}) annually.

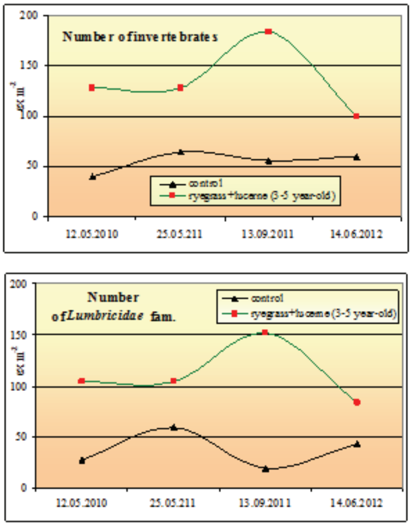

Figure 5. Restoration of invertebrates and Lumbricidae family in the leached chernozem by the perennial grasses' application

The application of grass cultivation improved the invertebrates' diversity in the leached chernozem after 5 years. The grass cultivated soil is characterized by a greater diversity of invertebrates. In addition to the *Lumbricidae* family, species of the *Formicidae, Gloremidae, Coccinelidae* and *Carabidae* families were found. *Lumbricus terrestris* and *Allolobophora terrestris* species are the most typical representatives of the *Lumbricidae* family in the chernozem under perennial grasses. The abundant presence of the *Formicidae* family represents is observed. In general, the soil under grass mixture with ryegrass and lucerne contains 5 families of invertebrates, while the soil controls – only 3 (Table 1).

Table 1. Diversity of invertebrates in the leached chernozem after 5 years of the cultivation of grass mixtures ryegrass + lucerne (14.06.2012)

Variant	Family	Number of invertebrates, ex m^{-2}	
		families	total
Control	*Lumbricidae*	44	60
	Gloremidae	8	
	Coccinelidae	8	
Ryegrass+lucerne (3-5 year old)	*Lumbricidae*	84	100
	Gloremidae	4	
	Coccinelidae	8	
	Carabidae	4	
	Formicidae	+++	

Microorganisms. The utilization of manure and green manure contributed to the increase of the microbial carbon content from 275.8 to 350.9-384.6 µg C g^{-1} soil in the leached chernozem and from 216.2 to 299.4-313.5 µg C g $soil^{-1}$ in the ordinary chernozem (Figure 6).

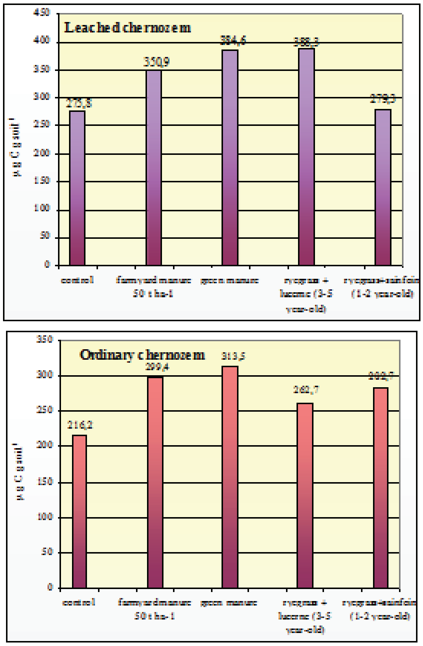

Figure 6. Microbial biomass in chernozems in conditions of the application of different restoration methods (mean values, n = 9-15, $P \leq 0.05$)

Reproduction and stimulation of the growth of bacteria and fungi were observed. The number of polysaccharides-forming microorganisms, which play an important role in the formation of water-stable soil structure and the retention

of moisture in arable layers, increased by 1.3-1.8 times in the application of manure. The effect of green manure crops to polysaccharides-forming microorganisms was significant only in the leached chernozem, their numbers increased by 1.4 times.
The use of phytorestoration procedures with legume-cereal grass mixtures creates advantageous conditions for the existence and functioning of autochthonous microorganisms and activates the internal reserves of microbiological systems of degraded soils.
The grass cultivation during 1-2 years stimulates the restoration of bacteria and actinomycetes in the leached chernozem, fungi – in the leached chernozem and ordinary chernozem. Microbial biomass increases significantly only in the ordinary chernozem (Figure 6, Table 2).

The process of natural recovery of the soil biota composition and activity in degraded soils is slow. Therefore, statistically valid changes in the restoration of the microbial community were registered for 3-5 years cultivation of ryegrass and lucerne. The mixture of ryegrass with lucerne contributes to increase the microbial biomass from 231.8 to 319.8 μg C g^{-1} soil to 316.8 to 459.8 μg C g^{-1} soil, stimulates the recovery of bacteria, actinomycetes and fungi.
Enzymatic activity. The tendency to activate the enzymes in fertilized with manure and green manure chernozems has been identified. Dehydrogenase activity in the leached chernozem increased on average of 1.4 times under the influence of farmyard manure. Some growth of the activity of polyphenoloxidase in the ordinary chernozem with sheep manure application was observed.

Table 2. Recovery of the biota of long-term arable soils in conditions of the land management with farmyard manure, green manure and perennial grasses (confidence intervals, $P \leq 0.05$)

Variant	Number of invertebrates, ex m^{-2}		Biomass of invertebrates, gm^{-2}		Microbial biomass, μg C g^{-1} soil	Polysaccharides-forming microorganisms, CFU g^{-1}soil*10^6	Dehydrogenase, mg TPF $10g^{-1}$ soil $24h^{-1}$	PPO, mg 1,4-p-benzoquinone 10 g^{-1} soil 30 min^{-1}
	total	*Lumbricidae* family	total	*Lumbricidae* family				
Leached chernozem (n=6-12)								
Control	35-75	20-56	3.5-23.1	0-17.2	214-320	1.8-2.8	0.5-1.8	4.3-6.1
Farmyard manure 50 t ha^{-1}	40-148	23-109	6.7-33.1	4.5-28.7	328-374	1.2-4.8	1.1-2.1	4.7-6.7
Green manure (vetch)	44-112	32-104	3.2-14.8	2.4-14.2	331-439	2.0-4.4	0.8-1.4	4.2-6.2
Ryegrass+lucerne (3-5 year-old)	103-170	83-142	12.5-29.5	8.8-24.8	317-460	2.2-2.8	1.4-1.8	4.1-5.5
Ryegrass+sainfoin (1-2 year-old)	15-145	6-123	1.4-7.1	0.6-6.3	237-319	2.2-2.8	1.0-1.6	3.9-5.7
Ordinary chernozem (n=6-15)								
Control	32-65	13-38	3.0-12.2	1.4-11.0	206-227	1.4-2.2	0.9-2.1	7.8-14.0
Sheep manure 50 t ha^{-1}	45-120	31-71	4.6-16.0	3.6-8.8	243-356	2.0-4.4	1.2-1.7	9.1-13.1
Green manure (vetch)	36-108	12-75	3.3-17.5	1.1-14.5	283-344	1.4-2.0	1.3-1.8	6.7-11.3
Ryegrass+lucerne (1-2 year-old)	12-79	8-65	1.7-8.7	0.5-7.7	229-297	1.0-2.6	1.8-2.3	6.6-12.5
Ryegrass+sainfoin (1-2 year-old)	16-62	1,4-17	0.2-10.8	0-1.9	249-317	1.4-2.8	1.7-2.2	7.2-13.0

[1] CFU – colony forming units
[2] PPO – polyphenoloxidase

The downward trend of the peroxidase activity was registered in both soils. This shows that the intensity of the decomposition of humus compounds in the soil amended with manure and green manure decreases. Ratio between polyphenoloxidase and peroxidase
activities characterizing the process of humus accumulation increases from 0.19 in the control

plot to 0.22-0.23 in the plot with application of manure and green manure on the leached chernozem.

The use of the mixture of perennial grasses had a stimulating effect regarding to the dehydrogenase in both soils. Its activity has increased on average by 1.4 times in the conditions of the ryegrass and lucerne mixture application. The cultivation of ryegrass and sainfoin mixture led to the stimulation of the dehydrogenase activity in the leached chernozem by 14%, in the ordinary chernozem – by 30%. In contrast, activities of polyphenoloxidase and peroxidase have not been changed statistically significant.

It should be noted that the indicators of edaphic fauna and microbial biomass responded more quickly to the application of biological methods of the soil quality restoration in comparison with the number of microorganisms and enzymatic activity indicators. The biomass of biota is restored quicker, its diversity and enzymatic activity – to a lesser extent.

CONCLUSIONS

The application of organic fertilizer in the forms of farmyard and sheep manure, green manure by vetch according to most biological indices contributes to the regeneration of the biota in chernozems, which was degraded as a result of the long-term utilization in conditions of the Republic of Moldova. The common characteristic of these methods is the growth of the number and biomass of invertebrates and microorganisms, the multiplication and development of the young generation of *Lumbricidae* family, increasing the number of polysaccharides-forming microorganisms.

The positive action of farmyard and sheep manures on the soil biota manifests through the activation of polysaccharides-forming microorganisms by 1.3-1.8 times and the intensification of polyphenoloxidase activity.

The effect of green manure on the soil biota manifests by the increase of the share of *Lumbricidae* family in the total number of invertebrates by 12.1-20.8% and the microbial biomass productivity of 1.4 to 1.5 times.

The effective restoration of the biota in degraded arable chernozems occurs as a result of the cultivation of perennial grasses. The use of the mixture of ryegrass + lucerne during 3-5 years led to the growth of the number of invertebrates and *Lumbricidae* family by 2.5 and 3.0, their biomass - by 1.6-2.0 times in comparison with the control plot. The microbial biomass accumulates in the soil in amounts of 132.5 kg ha^{-1} annually. The annual population growth of worms reaches of 14.9 ex m^{-2}.

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RESEARCH REGARDING THE IMPACT OF COMPOST OBTAINED FROM MANURE AND DELUVIAL SOIL ON THE FERTILITY OF MODERATELY ERODED ORDINARY CHERNOZEM

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Abstract

Currently, the total area of land subjected to erosion in the Republic of Moldova is of about 863,000 ha or 25% of the total surface (Rozloga Iu., 2010). The chernozems that occupy 788,000 ha (91% of the eroded surface) are most affected by erosion. The damage to the national economy caused by erosion is huge and is estimated at U.S. $ 200 million. Annually, an average of 30 tons of fertile soil is lost per hectare, or 26 million tons from the whole eroded surface of the Republic of Moldova. The areas affected by erosion continue to expand. The compost made from manure and deluvial soil can serve as an important source for the restoration of eroded arable soil fertility. The present paper attempts to highlight these opportunities.

Key words: *compost, deluvial soil, erosion, manure, ordinary chernozem.*

INTRODUCTION

The soil is the main natural wealth of the Republic of Moldova on which its food security, economic potential and people's welfare is based. Regretfully, the soil is lately being subjected to strong degrading pressure, the main factor being the erosion caused by water (Krupenikov, 2004). In the past 25 years, the amount of organic fertilizers was reduced by 65 times and constitutes 0.1 t/ha; the surface planted with alfalfa decreased by 4-5 times, the vegetal wastes are burned on large surfaces. As consequence, the amount of humus is soil is negative: minus 1.1 t/ha. According to the latest estimates, 2.4 million tons of humus are annually lost from the agricultural lands. Forecast calculations show that, given the present situation, the quantity of humus in the soils from Moldova will decrease to the critical level of 2.5/2.8% by the year 2025 (Andrieș et. al., 2008).

The issue of restoring the fertility of soil affected by erosion, in the current management, can be partially solved by exploiting the local organic fertilizers on a well-set anti-erosion background.

The composts obtained from manure and deluvial soil present interest in this context (Figure 1).

Figure 1. Compost preparation

Besides the fact that they contain all nutrients necessary for the plants, when used as fertilizers, the composts also contribute to the restoration of soil fertility, which, in essence, means increasing the organic matter content of the soil (Lixandru, 2006).

MATERIALS AND METHODS

In order to test the efficiency of compost as fertilizer (manure, 80%, + deluvial soil, 20%), a long-term experimentation was founded at the experimental station of the Institute of Pedology, Agrochemistry and Soil Protection named after "Nicolae Dimo" in the village

Lebedenco, Cahul district in 1996, situated on land with an inclination of 5-6^0 to the northeast (Figure 2).

Figure 2. Experimental field

The soil is moderately eroded ordinary chernozem. The chemical and physical properties of the soil are presented in Tables 1 and 2.

Table 1. Agro-chemical indicators of moderately eroded ordinary chernozem

Horizon and depth	pH (H_20)	$CaCO_3$	Humus	P_20_5	K_20
		%		mg/100 g soil	
Bhkp1 0-10	7.8	6.9	2.36	1.63	17.0
Bhkp1 10-22	7.9	7.0	2.16	1.32	16.0

Table 2. Physical properties of moderately eroded ordinary chernozem

Horizon and depth	Clay (<0.001 mm)	Physical clay (<0.01 mm)	Den-sity	Bulk density	Porosity (%)
	(%)		(g/cm^3)		
Bhkp1 0-10	25.8	45.0	2.58	1.21	53.1
Bhkp1 10-22	25.9	45.9	2.60	1.29	50.4

The experimentation was done in three repetitions. The plots are rectangles placed in a single line across the slope (6 m x 40 m = 240 m^2). The long sides of the plots are oriented along the slope. Before founding the experiment, initial soil samples were collected from each plot. The preparation and incorporation of the compost was done according to the recommendations and instructions in force (Ţurcan et al., 1993; Banaru, 2001).
The chemical properties of the compost used in the experiment are presented in Table 3.

Table 3. Chemical composition of the compost obtained from manure and deluvial soil

Compost index	Dry substance	Organic matter	Nitrogen	Phosphorus	Potassium
Manure, 80% + diluvial soil, 20%	43.2	18.4	0.58	0.26	1.24

RESULTS AND DISCUSSIONS

In the Republic of Moldova, deluvial soils, formed as a result of erosion, are common and it represents an important reserve for the restoration of the eroded soils fertility. Therefore the most effective way of using them would be composting them with nutrient-rich and microbiologically active ingredients. In this sense, animal manure is a very suitable material. Research has found that fertilization with compost made from manure, 80%, and deluvial soil, 20%, on moderately eroded ordinary chernozem led to a significant increase in the humus content (Table 4).

Table 4. Modification of agro-chemical properties of moderately eroded ordinary chernozem in the 0-20 cm layer as result of fertilization with compost from manure and deluvial soil

Variant	Humus		P_20_5		K_20	
	Content	Increase	mg/100 g sol			
			Content	Increase	Content	Increase
1996 (before compost incorporation)						
Control	2.07	-	1.89	-	16.7	-
Compost, 100	2.35	-	1.69	-	16.3	-
1997 (1^{st} year of experiment)						
Control	2.04	-0.03	1.91	0.02	16.8	0.1
Compost, 100	2.76	0.41	3.12	1.49	27.7	11.4
2001 (5^{th} year of experiment)						
Control	2.00	-0.07	1.86	-0.03	16.8	0.1
Compost, 100	2.74	0.39	3.18	1.49	24.7	8.4
2005 (9^{th} year of experiment)						
Control	1.97	-0.10	1.69	-0.10	16.2	-0.5
Compost, 100	2.32	0.25	2.26	0.37	21.0	1.7

In the first year of experimentation, the humus content increased by 0.41% compared to the original one (before incorporating the compost). In the fifth year of experimentation, the same content of humus (0.39%) was observed. It should be noted that beginning with the sixth experimental year the value of the humus content is decreasing. The increase of the humus content constituted 0.25% in the ninth year of experimentation.
The content of mobile forms of phosphorus and potassium also increased in the variant fertilized with compost. The highest increase was observed in the 5^{th} year of

experimentation. The increase of mobile phosphorus and potassium was of 1.49 mg/100 g and 8.4 mg/100 g of soil respectively. Fertilization with compost favourably influences on the physical properties of the moderately eroded ordinary chernozem (Table 5).

Table 5. Impact of compost obtained from manure and deluvial soil on the physical indicators of moderately eroded ordinary chernozem in the ploughed layer, 2005

Variant	Fractions (%)		Density (g/cm^3)	Bulk density (g/cm^3)	Porosity (%)	Resistance to penetration (kgF/cm^2)
	<0.001	<0.01				
Control	25.9	45.9	2.66	1.26	52.6	23.4
Compost, 100 t/ha	25.7	45.6	2.63	1.18	55.1	13.3
DL 05%	2.1	3.2	0.9	0.04	1.3	6.2

The increase of organic matter content in the variant fertilized with compost results in the reduced density and the bulk density of the soil. These modifications led to the increase of the lacunar space by 55%, a value that classifies the soil in the category 'high'. Fertilization with compost in the amount of 100 t/ha has a positive impact on the mechanical properties of the eroded soil. The researches reveal the fact that incorporating compost into the soil has reduced the resistance to penetration by about 10 kgF/cm^2 or by 43% compared to the original soil.

Table 6. Impact of fertilization with compost obtained from manure and diluvial soil on crops on moderately eroded ordinary chernozems at the station from Ursoaia, Cahul

Culture and year / Variant	Control	Compost, 100 t/ha	DL 0.5%
Yield for the control variant and the increase for the variant fertilized with compost, q/ha grain units			
Winter barley, 1997	29.6	6.2	5.4
Maize, 1998	33.3	13.7	7.1
Vetch (peas + oats), 1999	56.6	26.6	8.1
Winter wheat, 2000	12.4	11.1	5.1
Maize, 2001	31.7	7.2	5.0
Winter barley, 2002	14.3	3.1	3.8
Maize, 2003	34.2	5.8	5.9
Sunflower, 2004	12.7	3.9	4.1
Winter wheat, 2005	14.3	2.6	3.0
Total yield increase for 9 years, grain units	198.7	60.1	-

Consequently, optimal conditions for the growth and development of crop root system were provided.

All tested cultures exhibited significant increases in the yield (Table 6) as result of fertilization with compost over a period of five years (1997-2001).
Reduced yield of field crops in 2002-2005 demonstrates a decreased supply of nutritive elements for the plants.
The total increase for the period of nine years was of 60.1 g/ha grain units, or 6.7 g/ha annually.

CONCLUSIONS

The compost made from manure, 80%, and deluvial soil, 20% contains an average of 43.2% dry matter, 18.4% organic matter, 0.58% nitrogen, 0.26% phosphorus, 1.24% potassium.

Administration of compost on moderately eroded ordinary chernozem leads to significant increased values of humus content and of mobile forms of phosphorus and potassium for a period of five years, after which a decrease is observed. In the fifth year of experimentation the increase of the humus content was of 0.39%, of mobile phosphorus and potassium of 1.49 mg/100 g and 8.4 mg/100 g of soil respectively.

Fertilization with compost has a favorable impact on the physical properties of moderately eroded ordinary chernozem. The density and the bulk density of the soil were reduced, which led to the increase of the lacunar space by 55%. The value of the resistance to penetration decreased by 43%. Consequently, optimal conditions for the growth and development of crop root system were provided.

Using the compost as fertilizer on moderately eroded ordinary chernozem results in obtaining significant increases of crop yields for a period of five years, which is followed by decreases in the coming years. The overall increase for the period of nine years was of 60.1 q/ha grain units. The decrease of crop yield affirms the reduction of the plant supply with nutritive elements.

On slopes, it is recommended to apply the compost made from manure and deluvial soil simultaneously with the basic ploughing in a dosage of 50/100 t / ha every 4/5 years.

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THE TRANSITION PERIOD TO THE MARKET ECONOMY AND THE DECREASE OF N_2O EMISSIONS FROM THE ROMANIAN AGRICULTURAL SOILS

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Abstract

An inventory of nitrous oxide (N_2O) emissions from Romanian agricultural soils was carried out in 2012 for a period of 22 years (1989-2010) using the IPCC (2000) approach. Activity data comes from the Romanian Institute for Statistics and IPCC default emissions factors were used as any country-specific emissions factors were developed since Romania ratified the Kyoto Protocol in 2001. Direct emissions of N_2O, resulted from anthropogenic activities (i.e. from the soils to which the N is added) and indirect emissions (through volatilization as NH3 and NOx and subsequent redeposition, and through leaching and runoff) were calculated using the IPCC (2000) Guidelines equations (Tier 1a and Tier 1b). The total soil emissions decreased from 46.29 Gg N-N_2O in 1989 to 20.18 Gg N-N_2O in 2000. Between 2001 and 2010, only in 2004 there was an important growth of N_2O emissions, but not more than 24.42 Gg N-N_2O respectively. This decrease of total soil emissions of N-N_2O is mainly due to the dissolution of state agricultural entreprises and agricultural cooperatives and to the reforms of this economical sector. In order to improve the quality of the estimations and to reduce uncertainty, for further inventories, national data will be necessary.

Key words: *emissions, soil, nitrous oxide.*

INTRODUCTION

Land Law No. 18/1991 changed the structure of the agricultural holdings in Romania. This law abolished the agricultural cooperatives, which were economic structures resulting from the nationalization before 1962 and allowed the rural population, mostly farmers to recover their own land. Thus, compared with the situation prior to the law, when every rural community had only one agricultural holding of 1500 ha (in case of small villages) and up to 4000 ha (in case of large communes), the number of parcels, as well as the number of farmers, increased after this law was enforced. In Romania, in 2010, there were more than 2 million farms with an area greater than 1 ha. This split land ratio was still higher in the 1990s. Small farmers had no means and some of them lacked also the required knowledge to apply technology previously used in agricultural production cooperatives. Under these conditions, crop production gradually decreased. These changes have completely unintentionally influenced the amount of greenhouse gas emissions produced by agriculture.

In 2001, Romania ratified the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). Parties that ratified the Convention, "shall develop, periodically update, publish and make available…national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies…". An emissions inventory that identifies and quantifies a country's primary anthropogenic sources and sinks of greenhouse gases is essential for addressing climate change (EPA, 2011). The term "anthropogenic", in this context, refers to greenhouse gas emissions and removals that are a direct result of human activities or are the result of natural processes that have been affected by human activities (IPCC / UNEP / OECD / IEA 1997).

As it was already reported, agriculture is a major source of gaseous emissions contributing to air pollution and climate change (Gac et al., 2007; Wang et al., 2011) through a variety of different processes: domestic livestock, which refer to enteric fermentation and manure management; rice cultivation, which refer to flooded rice fields; prescribed burning of savannas; field burning of agricultural residues and agricultural soils (IPCC, 1996 a). Agricultural soils may emit or remove nitrous oxide (N_2O), carbon dioxide (CO_2), and/or methane (CH_4) (IPCC, 1996 b). Soils are the dominant source of N_2O worldwide, releasing an estimated 9.5 Tg N_2O-N year-1 to the atmosphere (65% of global N_2O emissions), of which 3.5 Tg N_2O-N year-1 originate in soils and 1 Tg N_2O-N year-1 in temperate grasslands (IPCC 2001a).

Nitrous oxide (N_2O) is produced naturally in soils through the microbial processes of nitrification (the oxidation of ammonia (NH_3) to nitrite (NO^{2-}) and nitrate, NO^{3-}) and denitrification (the reduction of NO^{3-} to NO^{2-}, nitric oxide (NO), N_2O and ultimately N_2 – where facultative anaerobe bacteria use NO_3- as an electron acceptor in the respiration of organic material when molecular oxygen (O_2) is in short supply). A number of agricultural activities add nitrogen to soils, increasing the amount of nitrogen (N) available for nitrification and denitrification, and ultimately the amount of N_2O emitted. The emissions of N_2O that result from anthropogenic N inputs occur through both a direct pathway (i.e. directly from the soils to which the N is added), and through two indirect pathways (i.e. through volatilisation as NH_3 and NOx and subsequent redeposition, and through leaching and runoff). Direct and indirect emissions of N_2O from agricultural soils are estimated separately (IPCC, 2001b). Anthropogenic input into agricultural systems include synthetic fertiliser, nitrogen from animal wastes, nitrogen from increased biological N-fixation, and nitrogen derived from cultivation of mineral and organic soils through enhanced organic matter mineralisation (IPCC, 1996 a).

The aim of this paper is to present the results of an inventory of estimated N_2O emissions from the Romanian agricultural soils, for 1989-2010 period. This period was one of transition to the market economy, which was characterised by different kind of reforms regarding the agriculture and the market. In order to estimate the N_2O emissions, the IPCC 2000 Guidance methodologies were used. Also, as in Romania, until present, there are not available national values for the emission factors, there were used the default values from the IPCC (1996) Good Practice Guideline. Even some uncertainties were calculated, both for activity data and for the emission factors, the goal of this work is to reveal the important decrease of the greenhouse gases emissions due to the changes in the structure of the soil property, to the agricultural holdings and farms structure, and also due to the decrease of the synthetic fertilisers quantities used in agriculture, the decrease of the cultivated area or to the application of a wrong thechnology.

MATERIALS AND METHODS

General approach

Direct emissions of N_2O, resulted from anthropogenic activities (i.e. from the soils to which the N is added) and indirect emissions (through volatilization as NH_3 and NO_x and subsequent redeposition, and through leaching and runoff) were calculates using the IPCC (2000) Guidelines equations (Tier 1a and Tier 1b). The Tier 1b equations represent increased precision due to expansion of the terms in the equations. Tier 1a equations were considered appropriate when the activity data needed to use Tier 1b equations were not available.

Direct emissions of N_2O from agricultural soils due to applications of N and other cropping practices accounts for anthropogenic nitrogen (N) inputs from the application of: synthetic fertilisers (FSN) and animal manure (FAM); the cultivation of N-fixing crops (FBN); incorporation of crop residues into soils (FCR); and soil nitrogen mineralisation due to cultivation of organic soils (i.e. histosols) (FOS). Indirect emissions refers to the leaching and runoff of applied N in aquatic systems, and the volatilisation of applied N as ammonia (NH_3) and oxides of nitrogen (NO_x) followed by deposition as ammonium (NH_4) and NO_x on soils and water (IPCC 2000).

In this inventory, soil nitrogen mineralisation due to cultivation of organic soils (i.e. histosols) (FOS), as part of direct emissions, were not take in account because the lake of statistical data, as well as the nitrogen resulted from sewage sludge, as part of indirect emissions.

Activity data

Activity data comes from the Romanian Institute for Statistics: annual amount of synthetic fertiliser nitrogen applied to soils; number of each livestock category; surfaces cultivated annualy with different crop categories; crop productions. The animal categories and sub-categories were grouped according to the main production system, and follow international inventory formats. The main categories were: cattle, buffaloes, pigs, sheep, goats, mules and donkeys, horses and poultry. The classes of crops were defined based on Romanian crop production within the main production system, and follow international inventory formats and comprise: cereals, legumes, textil plants, oil plants, industrial plants, medicinal and aromatic plants, vegetables, forrage plants. Nitrogen excretion rates were calculated for each sub-category.

Emissions factors were used as IPCC (1996a) default values as any country-specific emissions factors were developed since Romania ratified the Kyoto Protocol in 2001 (EF1 = 0.0125 kg N-N_2O/kg N; EF4 = 0.01 kg N_2O per kg NH_3 and NO_x; EF5 = 0.025 kg N_2O per kg N).

For different parameters used for emissions estimation, default values (IPCC 1996a) or assumed values by the experts were used (FracGASF = 0.1 kg NH_3-N + NO_x-N/kg; FracGASM = 0.2 kg NH_3-N + NO_x-N/kg). For the parameters FracFUEL-AM, FracFEED-AM, and FracCNST-AM experts assumed the value “0” as no available source of national official data. For ResBF/CropBF, FracDMi and FracNCRBFi default values (IPCC 1996a) were used as is presented below:

Parameter	Peas	Beans	Soy bean	Other grain legumes	Alfalfa for green grass	Clover for green grass	Other perennial legumes
$Res_{BF}/Crop_{BF}$	1.5	2.1	2.1	1.8	0	0	0
$Frac_{DMi}$	0.87	0.82-0.89 average 0.85	0.84-0.89 average: 0.865	0.85	0.85	0.85	0.85
$Frac_{NCRBFi}$	0.0142	0.03	0.0230	0.03	0.03	0.03	0.03

For ResOi/CropOi the IPCC default values were used as for FracNCROi and FracNCRBFj. For FracBURNi/j, Frac FUEL-Cri/j, FracCNST-Cri/j and FracFODi/j experts assumed different values in relation with the different type of crops and with the habits of the rural population in particular.

The manure quantity is calculated using the prototype parameters for different types of animals in the Eastern Europe region, given in the IPCC Guidelines (2000).

RESULTS AND DISCUSSIONS

The values of the total, direct and indirect estimated emissions are presented in the Table 1a, Table 1b and Figure 1. The total soil emissions decreased from 46.29 Gg N-N_2O in 1989 to 20.18 Gg N-N_2O in 2000. Between 2001 and 2010, only in 2004 there was an important growth of N_2O emissions, but not more than 24.42 Gg N-N_2O respectively. This decrease of total soil emissions of N-N_2O is due especialy to the dissolution of state agricultural entreprises and agricultural cooperatives but also to the inability of small farmers to manage their own crops and farms. In the same time, the decrease of N_2O soil emissions it is also a consequence of the some other reasons such as: the decrease of cultivated area (Figure 2), the decrease of the quantities of mineral fertilizers used per hectare (Table 2), as it was observed by Hera (2009) and, not in the end, the small quantities of organic fertilizers that were used.

From the total soil estimated emissions, the direct one are representatives in relation with the indirect emissions (Figure 3) during all the period. So as, the direct emissions represented more than 60% from the total soil emissions with a biggest value in 1999 (68.37%) and the indirect one represented more than 30%, the biggest have been noted in 2007 (38.44 %).

Table 1a. Direct, indirect and total N-N_2O soil emissions (1989-1999)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Direct emissions (Gg N-N_2O)	30.08	26.10	19.68	15.75	17.59	16.91	17.08	16.16	16.66	15.78	15.90
Indirect emission (Gg N-N_2O)	16.21	15.52	9.78	8.73	9.69	9.03	9.00	8.47	8.03	7.89	7.36
Total soil emissions (Gg N-N_2O)	**46.29**	**41.63**	**29.46**	**24.48**	**27.29**	**25.94**	**26.08**	**24.63**	**24.68**	**23.67**	**23.25**

Table 1b. Direct, indirect and total N-N_2O soil emissions (2000-2010)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Direct emissions (Gg N-N_2O)	12.82	15.12	15.10	15.79	14.42	15.93	15.37	12.79	14.58	14.74	15.11
Indirect emission (Gg N-N_2O)	7.36	7.69	7.46	7.66	8.05	8.49	7.89	7.98	8.05	8.11	7.77
Total soil emissions (Gg N-N_2O)	**20.18**	**22.81**	**22.56**	**23.45**	**22.47**	**24.42**	**23.26**	**20.77**	**22.64**	**22.85**	**22.88**

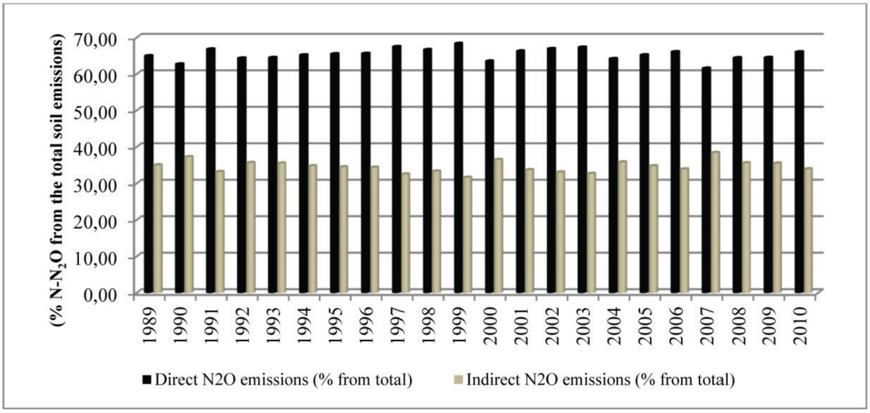

Figure 1. The trend of total (direct and indirect N_2O) soil emissions

Table 2. The quantities of mineral fertilisers used ($N+P_2O_5+K_2O$) in the Romanian agriculture (Hera, 2009, from Dumitru, 2002-ICPA)

Year	Total (t a.m.*)	Agricultural land (kg ha^{-1})	Arable land (kg ha^{-1})
1950	5.921	0.4	0.6
1970	594.347	39.8	61.0
1990	1.103.075	74.8	117.0
2000	342.174	23.0	36.4

*active matter/substance

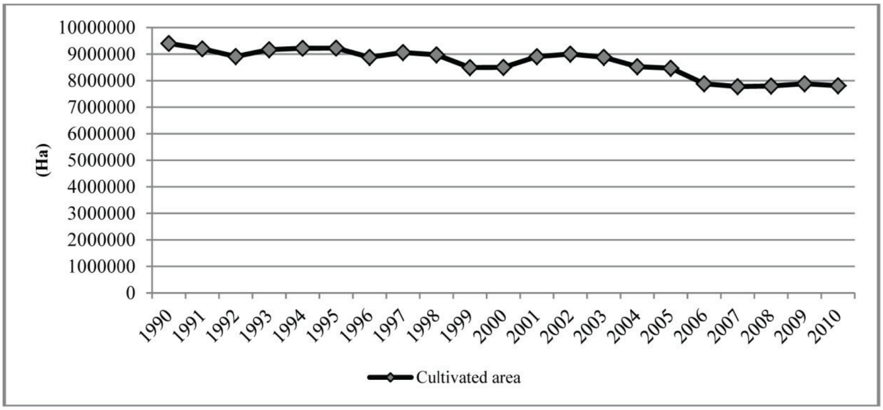

Figure 2. The decrease of cultivated area during the period 1910-2010

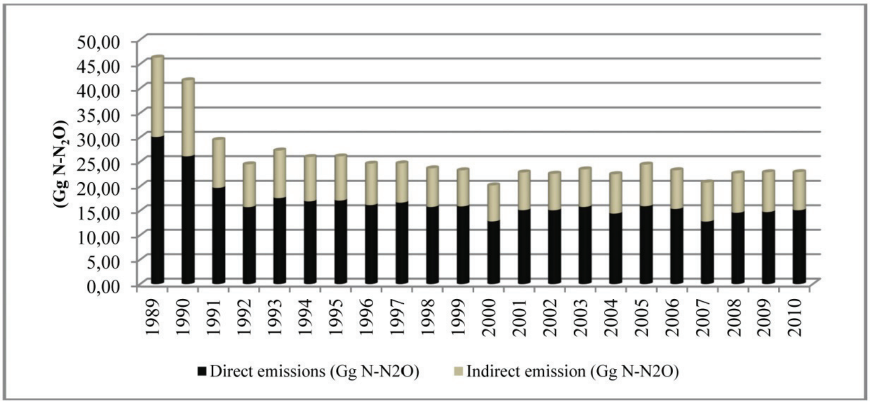

Figure 3. Contribution of each category (direct and indirect) to the total estimate of N_2O emissions

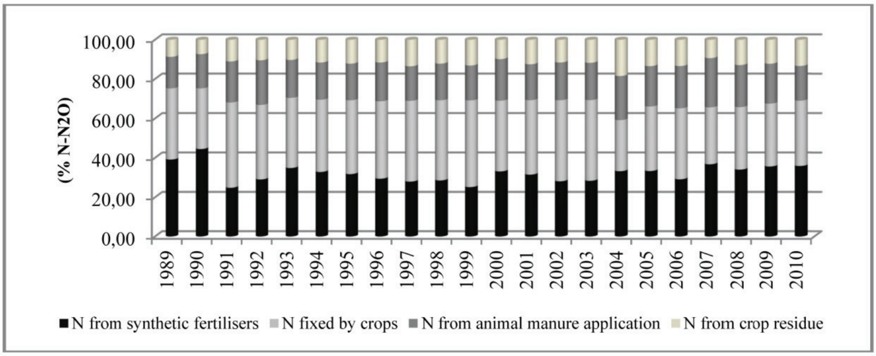

Figure 4. Contribution of each sub-category to te total of direct N_2O emissions estimate

As it can be observed in Figure 4, the values of the sub-categories "N from synthetic fertilizer" (from 24.70 % in 1991 to 44.43% in 1990) and "N fixed by crops" (from 26.03% in 2004 to 44.12% in 1999) have been the most important into the structure of the direct emissions from soil. The contribution of the "N resulted from animal manure application" (from 15.92% in 1989 to 24.94% in 2007) and "N from crop residues" (from 7.35% in 1990 to 18.52% in 2004) to the direct soil emissions were less important.

The contribution of each sub-category to the indirect soil emissions is presented in the Figure 5. The leaching nitrogen contributes with more than 80 % and the atmosphere deposition nitrogen contributes with less than 20%.

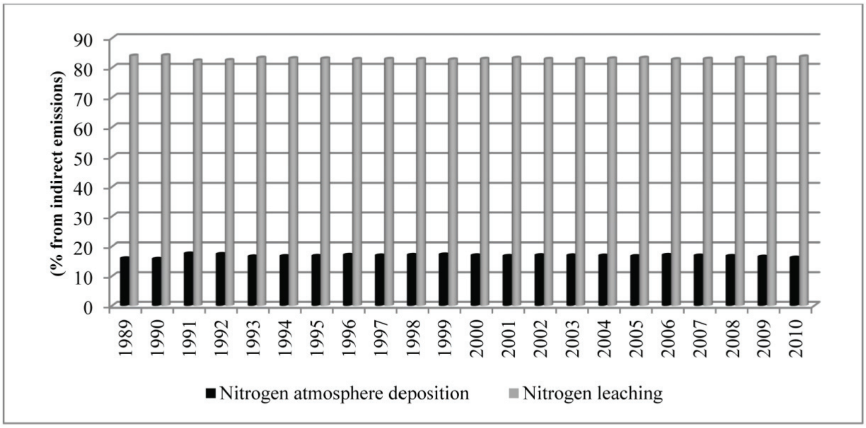

Figure 5. Contribution of each sub-category to the total of indirect N_2O emissions estimate (Gg)

Even the values of the total soil emissions were small, we cannot compare any values of estimated soil emissions with any other values reported by others. As it was already presented in the part of "Material and methods/Activity data", there is a lake of national data, especially referring to the emissions factors and parameters that are very important for the accuracy of the emissions calculation. So, for this inventory they were assumed large uncertainties. So, for further inventories, national data will be necessary to increase the quality of estimation and to reduce uncertainty.

CONCLUSIONS

The agricultural reforms made after 1990, especially those related to land ownership as well as to the size of farms and the application of production technologies have led to decreased amounts of N_2O emissions.

Romania must take advantage of this situation in terms of maintaining emissions at a low level through technological measures. Also, producing national values for the activity data and the emission factors as well as making up a national portofolio of publications in the field seems to be necessary.

As in other EU countries, Romania also needs to develop working groups of experts in estimating the GHG emissions, who run constant scientific activities in the field and international cooperation activities in the scientific research of this emission effects and who will contribute to the improvement of emission data collection, the improvement of calculation methodology and the development of computational models and some recommendations regarding the quality assurance.

In the medium and long term, the estimation of GHG emissions must be an ongoing process, a current activity that allows considering much more details in order to reduce uncertainty.

AKNOWLEDGEMENTS

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REGARDIN TABULAR SOILS FROM ROMANIA

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Abstract

Presently, in the category of sandy soils we find those soils that in the control section (2 m) present a coarse and/or a middle coarse texture, hence those that contain less than 12% sand under 0.002 mm and a small quantity of organic matter.
In Romania, the sandy soils cover a surface of over 439.000 ha, out of which 272.000 ha are of Aeolian nature, grouped in 18 perimeters.
In the case of the tabular soils, one can notice the presence, into their profile, of some shallow layers (frequently of 1-8 cm in thickness) of finer material, in which the clay under 0.002 mm appears a little bit increased (2-7%) compared to the interlayer.
The layers-interlayers sequence is specific only to the soils formed on Aeolian sandy sediments.

Key words: *tabular soils, sandy sediments, layers, interlayers.*

INTRODUCTION

These kinds of soils appear in our country only on sands of Aeolian origin and are represented only by some subdivisions of the eutricambosoil, preluviosoil and luvosoil types (SRTS, 2012).

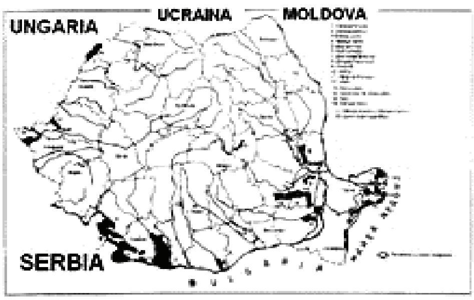

Figure 1. The map of sandy soils occurrence in Romania (scale 1:3,500,000)

As it is known, in the category of sandy soils one can find those soils that represent at least on a thickness of 50 cm (but usually on more than 2 m) a coarse texture (sandy or sandy clay, having less than 12% clay 0.002 mm) and a small/medium content of humus (0.6-1.5%).

In Romania, these kinds of soils can be found in many geographical regions, but on larger surfaces they appear in the Western Plain, the Plain of Oltenia, Baragan Plain, Buzau-Siret Plain, Coast-Deltaic Plain and Brasov Depression, grouped into 18 perimeters totalizing 272,000 ha (Figure 1).

MATERIALS AND METHODS

The identification of the tabular soils was done based on the pedological mapping on medium-scale (1:25,000; 1:50,000) according to the pedological studies elaboration methodology of the National Institute of Research and Development for Pedology, Agro-chemistry and Environment Protection of the Academy of Agrarian and Sylvain Sciences from Romania. Thus, more than 5000 soil profiles have been opened, on depths of 1.0 to 2.5 m, out of which 5 to 10 samples have been taken from the genetic horizons and, respectively, from the layers and interlayers, on depths of 20 cm at most and 3 cm at least. These samples have undergone physical and chemical analyses (grading, pH, humus, base saturation value, N, P, K, etc.).

Laboratory results have been interpreted according to the above mentioned ICPA methodology.

RESULTS AND DISCUSSIONS

Regarding the tabular soils, we have to keep in mind the fact that these are to be found only in some of the abovementioned regions, such as Carei Plain, Blahnitei Plain, Romanati Plain, Tecuci Plain and Negru River Depression. A thing that can be noticed in the case of these soils is the presence in the profile of some thin layers (frequently of 1-8 cm) of fine material, in which under 0.002 mm fraction appears slightly raised compared with the interlayers by 2-7% (Table 1, Figure 2).

Table 1. Physical and chemical data regarding the Date tabular preluvosoils (Blahnita Plain)

Horizon	Depth in cm	Granulometric composition			
		0.002 mm	0.002-0.02 mm	0.02-0.2 mm	0.2-2.0 mm
Ap	0-15	6.2	6.9	36.5	50.4
Ao	20-55	7.6	7.3	34.0	51.1
AB	50-65	6.0	7.6	34.2	52.2
Bt	85-100	5.6	7.4	34.0	53.0
	110-116	14.4	7.6	30.6	47.4
	120-130	9.7	6.4	31.8	52.1
	142-147	12.3	5.4	26.1	56.2
	150-170	5.3	4.0	24.9	65.8
	200-205	6.0	1.3	33.8	58.9
	215-220	12.4	1.0	30.4	58.2

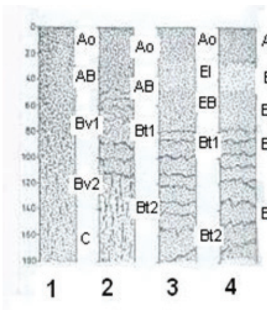

Figure 2. The thin strip of fine material on the profile of soils types 1. Eutric cambisols; 2. Lamellic luvisols; 3. Lammellic luvisols; 4. Albic luvisols

The content of dust and fine sand in these soils present a continuous decrease within the Bt horizon, but with a layer-interlayer association it remains constant: the coarse sand increases continually with depth and, as opposed to dust and fine sand, it presents 4-9% variations within layer-interlayer association, decreasing within layer.

This distribution of dust, fine sand and coarse sand fraction on the profile within a layer-interlayer association points out the lithological discontinuities in soil material at different depths.

Given the conditions of an exclusively illuvial process within the layer-interlayer association considered homogeneous under the granulometric aspect, the illuvial process should change only the percentage content of different granulometric fractions by concentration or dilution, but not their proportion. The existence of nf-ng different proportions within the same layer-interlayer association pleads for the different granulometric nature of the respective material

Secondly, the lithological discontinuities existent within the soil material at different depths as well as within a layer-interlayer association, the multilevel evolution of the soil and the variation of the alteration process intensity on profile prove the fact that the genesis of such a Bt horizon is complex.

The morphological study of the land pleads rather for the sedimentogene character of the layer-interlayer sequence; the layers reach the most reduced dimensions and they distance themselves between the positive limits of the Aeolian relief, namely advancing to the apex of the dunes, while in the case on interdunes they become thicker and thicker and come closely together becoming on single horizon up to 30-40 cm.

In another area from the country (Motru Piedmont, Ohaba-Pestenuta perimeter), under the conditions of a hilly relief having altitudes up to 350 m, on dacian sands and under durmast forest (*Quercus petraea),* we have identified both typical luvosoils and whitish luvosoils, but without noticing any layer-interlayer sequence. Within the granulometric composition of the luvosoils prevails the sand: the coarse one represents 21 to 23%, and the fine one not more than 45%. The clay content presents a slight decrease on the profile, from 6-7% in the superior horizon (Ao) to over 21% in Bt (Table 2).

Table 2. Physical and chemical data regarding the typical tabular luvosoils (Motru Piedmont)

Horizon	Depth in cm	Granulometric composition			
		2.0-0.2 mm	0.2-0.02 mm	0.02-0.002 mm	0.002 mm
At	0-5	23.2	43.9	26.5	6.4
Ao	10-25	23.1	42.3	27.9	6.7
El	25-37	21.6	43.9	27.1	7.4
EB	37-50	21.6	43.6	25.6	12.6
Bt1	70-90	21.3	44.6	12.6	21.5
Bt2	125-145	22.0	43.9	16.1	18.0

From the abovementioned we can notice the fact that the layer-interlayer sequence is specific only to the soils formed on the sandy sediments of Aeolian nature and this happens when (for example, in the Romanati Plain) the frequency of the wind from the western sector (north-western) is three times bigger (64%) than that of the wind from the eastern sector; the currents from the western sector dominate the whole year: January – 64%, April – 63%, July – 70% and October – 63%.

The persistent action of the wind has created sand dunes in the entire Oltenia Plain. Ordinarily, in this region, mainly in the Blahnita and Romanati Plain, the wind speed is big (11 m/s) more than 60 days (68) per year.

The air movement under the form of wind has a special influence mainly on the geographical landscape. Through its action of erosion, transport and accretion it creates forms of Aeolian relief – dunes – that continuously advance in the direction of the wind, excavations, tree uprootals, but also a specific microrelief of „ripple marks” (Figures 3, 4, 5, and 6) that eventually could, very well, explain the layer-interlayer sequence characteristic of the tabular soils.

Figure 3. Deflation processes (S Ciuperceni)

Figure 4. Aeolian excavation (Sud Smârdan)

Figure 5. Aeolian erosion at the west of Desa (trees uprootal)

Figure 6. Aeolian erosion at the west of Desa

The air-mass interferes with the overflow surface, so that it carries up in the atmosphere appreciable quantities of fine material that are deposited within the lines of the ripple marks microrelief after the phenomenon ends. Both the number and depth of the layers, the formation of the tabular soils depend on their gravity, duration and the repeatability of the phenomenon.

CONCLUSIONS

Tabular soils (with Bt horizon in layers) formed on Aeolian sands appear in Romania only in some of the 18 perimeters. The laboratory analyses have confirmed the genesis of such a horizon, while the morphological study pleads rather on the sedimentogene character of the layer-interlayer sequence.

In forming the layer-interlayer association, an important role was played by the climate, through the wind regime (direction, speed, frequency). Through its action, the wind creates not only a rippled relief of dunes-interdunes, but also a specific „ripple marks" type microrelief, in whose lines the finest materials from the atmosphere are deposited after the wind suddenly stops. The process presents a certain repeatability, a thing that leads to the sedimentogene sequence on layers-interlayers.

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ELEMENTS OF SOIL MOISTURE REGIME AT MAIZE CROP, WITHIN A FARM LOCATED IN MITOC - BOTOŞANI COUNTY, UNDER DROUGHT CONDITIONS CORRESPONDING TO 2012 AGRICULTURAL YEAR

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Abstract

Agricultural year 2012 was characterized, in terms of climate, by high temperatures in all cultivated areas of the country and small amounts of precipitation. According to official data it was estimated that, among the spring crops, the most affected by prolonged drought at national level was maize crop, on more than its half cultivation area. Climatic drought was completed by pedological drought, which led to installation of severe drought respectively, a soil moisture whose values were more below the values appreciated as optimum for field crops, according to specialized institutions. In this context, drought effects have also been strongly manifested in Moldavian Tableland and Plain region, especially in certain counties where, in the absence of irrigation systems, caused severe disturbances in spring crops development. Based on these considerations, the present work-paper highlights a few aspects regarding the soil moisture regime, during the vegetation period of maize crop, within a non-irrigated agricultural farm, specialized on plant production and located in north of Moldova (respectively Mitoc, Botosani county).
In order to get information on soil humidity and water reserve, determinations were made on soil momentary moisture in the field, at intervals corresponding to different development stages of maize. For establishing the range of soil water availability for maize plants, soil moisture was estimated in correlation with active humidity interval, using soil active moisture index (Iua). Active moisture index showed that, in the first stage of vegetation, soil water was very easily accessible to plants. Thus, maize plants benefit of a proper start in vegetation, covering the emergence - 8 leaves stage under very favourable conditions. At the end of June - early July, the active moisture index showed the tendency of soil moisture to decrease significantly, approaching - in terms of value - the wilting coefficient. Decreased soil moisture coincided with the beginning of maize critical period for water. In the period between panicle emergence - maturity, due to lack of rainfall, associated with pronounced increased temperatures, a drastic decrease of soil moisture could be registered; in this case, active moisture index showed a very low water accessibility for plant, the values being almost equal to the wilting coefficient. It can be state that, in year 2012, maize production in the investigated farm began to be influenced, in the sense of its diminution, since panicle emergence stage, drought manifesting until the end of the vegetation period. Thus, maize had not properly covered all its vegetation stages, reaching maturity much earlier. The 3.5t/ha average yield obtained was estimated as significant under the productive potential of the used hybrid, soil fertility and inputs applied.

Key words: *drought, maize, north of Moldova, active moisture index, soil water reserve.*

INTRODUCTION

In terms of climate, agricultural year 2012 was characterized by high temperatures in all agricultural areas of the country and small amounts of precipitation. Thus, July of 2012 was ranked as the second driest July in100 years, with precipitation that had not exceed the average 30 l/m, according to the official data provided by Romanian National Meteorology Administration (www.anm.meteoromania.ro). At country level, the total area affected by drought was estimated at approximately 3.7 million hectares, representing 40% of the arable land. Among the spring crops, maize has been one of the most affected by drought, on approximately 81.2% of its sown area, followed by sunflower, with 45.8% of the cultivated surface (www.madr.ro). Drought recorded to soil level (pedological drought) was added to the meteorological one, resulting a severe drought, respectively a soil moisture between 300-600 m3/ha, considerably low, taking into account that optimal value is usually considered between 1250-1600 m^3/ha (www.anm.meteoromania.ro).

Under these conditions, Moldavian region made no exception, in terms of lack of rainfalls effect; here, the drought was accentuated manifested, especially in certain counties where, in the absence of irrigation systems, has caused severe disturbances in the development of spring crops (especially to the species where weeding is applied), disturbances which limited drastically the possibility of obtaining adequate agricultural yields. In this context, it appears right that "the high degree of climate variability is one of the biggest risk factors for production and producers have to continuously consider this aspect in modern agriculture" (Nagy, 2010) especially when the droughty years are significantly more frequent in the last decades. More, the capacity of soils to maintain plants life essentially depends on their state of moisture, as Chiriță specified (1974) and larger yields are only achieved with higher precipitation, as it was also demonstrated in a long-term experiment carried out in Debrecen, Hungary (Nagy, 2010).

Based on these considerations, the work-paper highlights a few aspects regarding the soil moisture regime, during the vegetation period of maize crop, within an agricultural farm, specialized on crop production, located in north of Moldova, respectively Mitoc-Botosani county. Like in many other cases, the entire farm area does not benefit of irrigation facilities, so it is clear that water becomes a restrictive factor in the very droughty years.

In 2012, the agricultural unit has had the next crop structure: winter wheat (200 ha), maize (250 ha), sunflower (150 ha) and soybeans (100 ha). The dominant soil type is represented by phaeozem, with the following features: loamy texture (with 29.8% clay content in the first horizon and 30.5% in the second one), medium humus content (4.8-4.32%), neutral soil reaction (pH 7.1-7.5), good supply in potassium, moderate supply in nitrogen and low phosphorus content (Ştefan C. and Ştefan G., 2012). In the paper, the soil water regime is regarded in correlation with the symptoms that maize plants manifested, as a natural physiologic response to drought, the way it could be found by observation during plant vegetation.

MATERIALS AND METHODS

In order to monitor soil moisture and soil water reserve, observations and measurements were made in the field, at intervals corresponding to different developmental stages of maize, in this way emphasizing the critical periods for water. Thus, at the crop setting up and throughout the maize vegetation, soil moisture was monitored using a portable MLMO750 soil moisture meter, by sampling from 0-20 cm and 21-60 cm. In total, 9 determinations on momentary moisture (W%) were done, as follows: 1 in April, 2 in May, June and July, and 1 determination in August and September.

The value of soil clay content allowed the calculation of field water capacity-CC(%) and wilting coefficient-CO(%) indicators, based on formula: CO=0.05+0.35A, CC=21.2+0.0626A (A-clay content% corresponding to the analysed horizon) (Udrescu et al., 2002). Estimation of CO and CC indicators was made in accordance with the limits set by the specific methodology (Udrescu et al., 2002; R.M.S.S.E., 1987).

To highlight the amount of soil water that can be used by maize plants in various stages of their vegetation, it appeared the necessity to estimate the soil moisture in correlation with active humidity interval (IUA), by calculation of active humidity index: Iua or W(%IUA). Iua points out how much soil moisture, determined at a given time, represents (in percentage) of active humidity interval, based on the formula: W(%IUA) or IUA = W-CO/CC-CO x 100 (Chiriţă, 1974) taking into account that the difference between CC and CO is the active humidity interval (or soil usable water capacity). The determination of active humidity indices presents a great practical importance because they express the degree of water accessibility for plants (Chiriţă, 1974).

The obtained values were framed based on the intervals: W(%IUA)/Iua < 0 inaccessible humidity; W(% IUA)/Iua = 0-20 - very difficult to access humidity; W(%IUA)/Iua = 20-50 – medium accessible humidity; W(% IUA)/Iua = 50-90 - easily accessible humidity; W(% IUA)/ Iua = 90-100-very easily accessible humidity; Iua = 100, when W = CC; Iua > 100, when W > CC and Iua = 0, when W=CO (Chiriţă, 1974; Petcu, 2012).

The momentary moisture and bulk density (BD-g/cm^3) values allowed the calculation of moisture as a percent of soil volume (Wv%): Wv% = W x BD. Based on the value of Wv%, soil water reserve (m3/ha) on 0-60 cm interval could be estimated later on: W(m^3/ha) = Wv x H, where H - soil depth (cm) (Udrescu et al., 2002). The results on momentary moisture and active moisture index were periodically recorded and correlated with the changes that occurred on maize plants, as a result of drought.
As for the investigated maize crop, the applied technology consisted of: winter wheat as previous crop; ploughing in autumn at 35 cm depth with advanced machinery equipment; seedbed preparation conducted with combiner; sowing in April 2012, between 12-17th,with an aggregate consisting of tractor and Amazon precision drill, at 70 cm distance rows and 5-6 cm depth. Seed material was represented by 4490 DKC semi-early maize hybrid, pre-treated with plant protection products (insecticides and fungicides), assessed as high efficient and currently existing on the market. 63,000 seeds/ha was the assured density in the field, a value recommended for the used hybrid in non-irrigation conditions. Fertilization was performed with NPK complex fertilizer 15:15:15 (250 kg/ha). For weed control during vegetation, two herbicides mixture was applied; the maize crop also benefit by application of a zinc and manganese foliar fertilizer.

RESULTS AND DISCUSSIONS

First determination on soil momentary moisture was performed after sowing. It was then also when bulk density values were registered: 1.21 g/cm^3 in 0-20 cm interval and 1.23 g/cm^3 for 20-60 depth (Table 3). The calculated values for field water capacity and wilting coefficient are: 23-23.1%, in case of field water capacity (rated as medium-limits between 21-25%) and 10.1-10.7%, in case of wilting coefficient (rated also as medium-limits between 9-12%).
As a result of first determination on moisture, it has been noted that maize crop shall benefit of a good start at the beginning of its vegetation; moisture values ranged from 20.1% at 0-20 cm depth to 22.1% at 21-60 cm, reflecting a soil water content assessed as easy and very easily accessible for plants, according to the calculated values of active humidity index: Iua=77.2% on 0-20cm, respectively 92.6% on 20-60cm (Table 3, Figure 1).
As a consequence of that, soil water supply favoured an uniform germination and emergence of plants, as it could be observed while monitoring the field; the very good start in vegetation ensured a 63,000 plants/ha density, overall.
In the first decade of May, due to the recorded precipitation corresponding to late April that provided a favourable moisture level, the momentary moisture values indicated that humidity was very close to field water capacity level, respectively 23.1% on 0-20cm depth and 23.7% on 21-60 cm (Table 1, Table 2). Active moisture index showed, in case of both measurements from May, that soil water was very easily accessible to plants: 100.5%-105.6% at the beginning of month and 118.3%-122.7% at the middle of month (Figure 1). In this way, maize plants started well in their vegetation, covering the emergence - 8 leaves stage under very favourable conditions.
At first determination on soil moisture in early June, active moisture index showed that water was still easily accessible to plants, becoming medium accessible in the second half of the month (Figure 1). At the end of June-beginning of July, water availability for plants continued to decline, as the index showed the tendency of soil moisture to approach the wilting coefficient, recorded values being noted as: between 42.4 to 30.7% on 0-20 cm interval, respectively from 43.8 to 30.8% on 21-60cm interval (Figure 1). The drought installation effects began to become observable to plants level, consisting of front leaves twisting (noticeable especially during 12-16 hour interval).
Soil moisture decreasing coincided with the beginning of maize critical period for water, respectively 8 leaves – panicle emergence stage (Table 3).
In stage 3 of plant vegetation (panicle emergence-maturity), due to lack of rainfall, correlated with the sharp increase of temperatures value (consecutive days with temperatures above 38ºC), it could be registered a drastically decrease of soil moisture. Thus, it was observed that, on both depth considered, soil moisture values

decreased to near wilting coefficient and active moisture index is between 0 and 20%, which indicates a very difficult accessibility of water for plants (Figure 1).

The soil water reserve (m^3/ha), which values were cumulated for the two depth considered (Table 3) reflects the evident variation of water quantity during maize vegetation: 1573 m^3/ha at the beginning (in accordance with optimal limits) and continuous diminution up to 776 m3/ha, in early September.

Table 1. Average amount of precipitation (l/m^2) in 2012 registered at Avrameni-Boto? ani meteorological station

Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
19.4	80.8	39.0	32.9	30.2	29.7	2.4	31.1	21.8

Table 2. Field water capacity (FWC/CC) and wilting coefficient (CO), estimated by indirect method (calculation)

Depth (cm)	Clay content (%)	CC (%)	CO (%)
0-20	28.8	23	10.13
20-60	30.5	23.1	10.7

Table 3. Elements concerning soil moisture regime, in correlation with maize vegetation stage

Maize vegetation stage	Determination date	Soil depth	Soil moisture (W%)	BD (g/cm^3)	Soil moisture (Wv%)	Soil water reserve/depth (m^3/ha)	Soil water reserve (m^3/ha) (0-60 cm)
Stage 0: sowing, germination-emergence	20.04.2012	0 - 20	20.1	1.21	24.3	486	1573
		20-60	22.1	1.23	27.1	1087	
Stage 1: emergence-8 leaves	2.05.2012	0 - 20	23.1	1.21	27.9	559	1725
		20-60	23.7	1.23	29.1	1166	
	12.05.2012	0 - 20	25.4	1.21	30.7	614	1883
		20-60	25.8	1.23	31.7	1269	
Stage 2: 8 leaves - panicle emergence	3.06.2012	0 - 20	17.8	1.21	21.5	430	1330
		20-60	18.3	1.23	22.5	900	
	15.06.2012	0 - 20	15.6	1.21	18.8	377	1169
		20-60	16.1	1.23	19.8	792	
	5.07.2012	0 - 20	14.1	1.21	17	340	1053
		20-60	14.5	1.23	17.8	713	
Stage 3: panicle emergence –maturity	26.07.2012	0 - 20	12.7	1.21	15.3	307	951
		20-60	13.1	1.23	16.1	644	
	14.08.2012	0 - 20	11.2	1.21	13.5	271	846
		20-60	11.7	1.23	14.3	575	
	10.09.2012	0 - 20	10.15	1.21	12.2	245	776
		20-60	10.8	1.23	13.2	531	

Wv (%) = Wg x BD; W(m^3/ha) = Wv x H

In the field, it could be directly observed the emphasized effects of symptoms caused by lack of water: phenomena of irreversible wilting leaves that were associated with an obvious diminution of plant growth rhythm. Soil level drought associated with atmospheric drought caused the shortening of silking period, a low development of male and female inflorescences, which then generated the shortening of the pollination period; as a consequence of that, a large number of low developed cobs resulted. As a whole, the acceleration of the metabolic processes caused by installation of drought led to the evident shortening of the vegetation period (Figure 2). More, dry time that has followed, corresponding to August-September period, has caused poor grain filling, characterized by a high percentage of shrivelled grains.

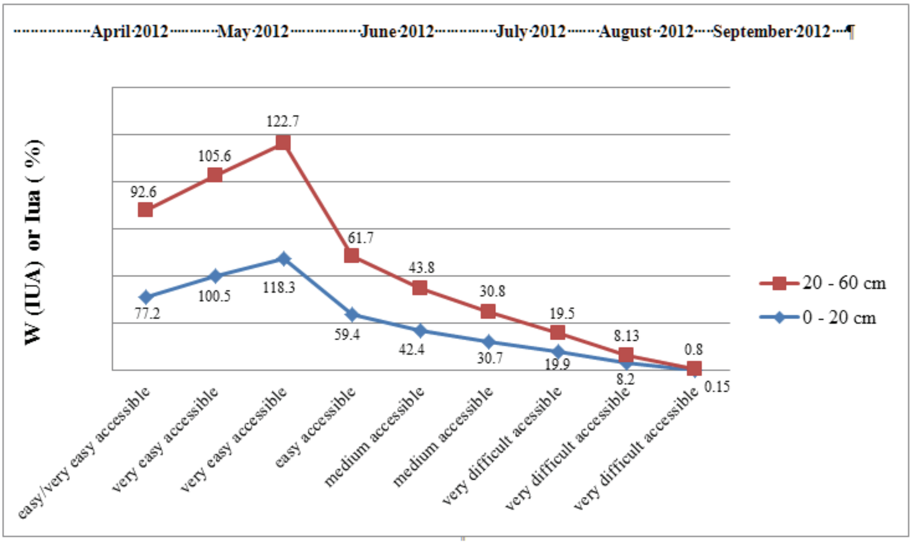

Figure 1. The availability of soil water to maize crop in 2012 agricultural year, within the analyzed farm, illustrated by the variation of active humidity index IUA (%), determined based on soil moisture, wilting coefficient (CO) and field capacity (CC) indicators-Mitoc, Botosani

Also, it was observed a decrease of the cobs size, a decrease of cob rows and grains per row, which conducted to the thousand kennels weight (TKW) diminution. All these symptoms have been observed in the field, in the mentioned period.

As a result of severe drought, the maize crop in the investigated farm has reached maturity much earlier, compared to its natural vegetation period. In this context, it appeared the necessity to initialize harvesting, which began in September, the 15th.

In the end, the effects of drought have been reflected by the medium yield registered: 3.5 t/ha, estimated as significant under the productive potential of the used hybrid, soil fertility and inputs applied.

Figure 2. Crackers at the soil layer as an effect of drought (left) and general aspect of maize crop in mid August (right) (original)

CONCLUSIONS

Severe drought that affected Botoşani agricultural region in 2012 has generated accentuated disturbances in agricultural cycle. An eloquent example in this respect was recorded at a field crop agricultural unit located in Mitoc where, despite the proper technology application and inputs applied, it conducted to the increased diminution of maize yield level.

In soil, the installation of drought was reflected by the momentary moisture values, active moisture index and soil water reserve, which indicated that water has become a limitative factor for plants since the middle of June and continued to decrease drastically in the following period.

Due to the small level of precipitations in July and August, correlated with high level of temperatures, drought effects were manifested at maize until the end of vegetation period, an aspect which accelerated the metabolic processes and led to necessity of harvesting before time.

As a result of that, maize crop did not properly covered all its vegetation stages and yield has shown the tendency to decrease since the panicle emergence stage.

It can be state that, in the next years, the amount of rainfalls and most of all, its repartition during field crops vegetation shall continue to represent the most influential factor for agricultural production, in the absence of irrigation.

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IMPACTS OF CLIMATE CHANGE ON AGRICULTURAL TECHNOLOGY MANAGEMENT IN THE TRANSYLVANIAN PLAIN, ROMANIA

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Abstract

The Transylvanian Plain, Romania is an important region for agronomic productivity. However, limited soils data and adoption of best management practices hinder land productivity. Soil temperatures of the Transylvanian Plain were evaluated using a set of twenty datalogging stations positioned throughout the plain. Each station stores electronic data of ground temperature on 3 different levels of depth (10, 30 and 50 cm), of soil humidity at a depth of 10 cm, of the air temperature at 1 meter and of precipitation. Monitoring the thermal and hydric regime of the area is essential in order to identify and implement sets of measures of adjustment to the impact of climatic changes. After analyzing the recorded data, thermic and hydric, in the Transylvanian Plain, we recommend as optimal sowing period, advancing those known in the literature, with 5 days for corn and soybeans, and maintaining the same optimum period for sunflower and sugar beet. Water requirements are provided in an optimum, of 58.8 to 62.1% for the spring weeding crops during the growing season, thus irrigation is necessary to ensure optimum production potential. The amount of biological active degrees registered in Transylvanian Plain shows the necessity to reconstruct crop zoning, known in the literature, for the analyzed crops: wheat, corn, soy, sunflower and sugar beet.

Key words: *climate monitoring, agricultural technology management, Transylvanian Plain.*

INTRODUCTION

Romania is placed in the area with the lowest capacity to adapt to climate change existing and that is going to occur, and the Transylvanian Plain (TP) is among the most affected areas (Ranta et al., 2008; Hemadi et al., 2011; Ramirez-Villegas et al., 2012; Lereboullet et al., 2013). Now and in the future are proposed a number of strategies and plans to counter climate change, but for their implementation requires a close monitoring of temperature and water regime of the area, for identifying and implementing adaptation measures to climate change (Fuhrer, 2003; Eastwood et al., 2006; Fowler et al., 2007; Casas-Prat and Sierra, 2012; Marin et al., 2012; Raymond and Robinson, 2013; Srinivasan et al., 2013). Very important are considered the measures for reducing the extreme weather events, agricultural use of new structures drought resistant plants, or even a review of optimal planting periods so that plants receive during the growing season optimum water intake (Bucur et al., 2011; Domuta et al., 2012; Stanila et al., 2012).

The last research upon the evolution of the climate inside the Carpathian basin, pointed out an increase of the air temperature in the last one hundred years with about 0.7°C. This fact is also shown by the fact that, six of the warmest years of the 20th century were registered in 1990's. Contrary to its name, the TP is not a geographically flat plain, but rather a collection of rolling hills approximately 300 to 450 m above sea level in the south and 550-600 m above sea level in the north. Climate of the TP is highly dynamic, ranging from hot summers with high temperatures of > 25°C to very cold winters with lows ~-5°C (Climate charts, 2007). The southern TP generally has a xeric moisture regime with steppe vegetation while moisture increases somewhat in the northern TP as an udic moisture regime (Moraru and Rusu, 2010; Coman and Rusu, 2010).

In this context, the paper present an analysis of temperature and water regime of soils in the TP (temperature and soil moisture, air temperature and precipitation) with 20 stations, located on microclimatic areas, analysis and processing of data in connection with the main 5 recommended crops in this area and development of accurate agrotechnical measures to develop sustainable agricultural technologies (Molnar et al., 2012).

MATERIALS AND METHODS

The thermal and hydric regime monitoring of the TP (soil temperature and humidity, air temperature and precipitations) has been achieved during the period 2008-2012. Twenty datalogging HOBO Micro Stations (H21-002, On-set Computer Corp., Bourne, MA, USA) have been deployed across the TP on divergent soil types, slopes, and aspects. Soil types where the stations were located: chernozem (Caianu), Phaeozem (Balda, Band, Craiesti, Triteni, Dipsa, Jucu, Ludus, Cojocna, Voiniceni), eutricambosoil (Matei, Silivasu de Campie, Branistea, Unguras, Zau de Campie), districambosoil (Filpisu Mare), preluvosoils (Taga, Nuseni, Sic, Zoreni). The majority have a loam-clay texture, pH between 6 to 8.69 and humus content of 2.5 and 4.15 in the 0-20 cm horizon. The stations were placed so as to cover the three subunits of TP: Low Hills Plain, High Hills Plain and Bistrita-Sieu Hills Plain. HOBO Smart Temp (S-TMB-M002) temperature sensors and Decagon EC-5 (S-SMC-M005) moisture sensors were connected to HOBO Micro Stations. Additionally, at 10 of the 20 sites, tipping bucket rain gauges (RG3-M) were deployed to measure precipitation (On-set Computer Corp., Bourne, MA, USA). Each station stores electronic data of ground temperature on 3 depths (10, 30, 50 cm), the humidity at the depth of 10 cm, the air temperature (1 m) and precipitations. Data was downloaded from the Micro Stations every two months via laptop computer using HOBOware Pro Software Version 2. 3. 0 (On-set Computer Corp., Bourne, MA, USA). Table 1 shows the stations' configuration (Weindorf et al., 2009; Haggard et al., 2010).

Table 1. Stations' configuration in the Transylvanian Plain

Station number	Station name	Latitude	Elevation, m / Exposition	Rain gauge
1	Balda (MS)	46.717002	360 / NE	No
2	Triteni (CJ)	46.59116	342 / NE	No
3	Ludus (MS)	46.497812	293 / NE	Yes
4	Band (MS)	46.584881	318 / SE	No
5	Jucu (CJ)	46.868676	325 / V	Yes
6	Craiesti (MS)	46.758798	375 / N	No
7	Sillivasu de Campie (BN)	46.781705	463 / NV	Yes
8	Dipsa (BN)	46.966299	356 / E	Yes
9	Taga (CJ)	46.975769	316 / N	No
10	Caianu (CJ)	46.790873	469 / SE	Yes
11	Cojocna (CJ)	46.748059	604 / N	Yes
12	Unguras (CJ)	47.120853	318 / SV	Yes
13	Branistea (BN)	47.17046	291 / V	Yes
14	Voiniceni (MS)	46.60518	377 / SE	Yes
15	Zau de Campie (MS)	46.61924	350 / S	Yes
16	Sic (CJ)	46.92737	397 / SE	No
17	Nuseni (BN)	47.09947	324 / SE	No
18	Matei (BN)	46.984869	352 / NE	No
19	Zoreni (BN)	46.893457	487 / NV	No
20	Filpisu Mare (MS)	46.746178	410 / S	No

NE = northeast; SE = southeast; V = west; N = north; NV = northwest; E = east; SV = southwest; S = south MS = Mures county; CJ = Cluj county; BN = Bistrita-Nasaud county

RESULTS AND DISCUSSIONS

The research conducted in this study allow us to see how and if the optimal sowing period of crop plants has changed over time and with all the climatic changes taking place, by comparing data recorded in the 20 locations where located stations with data in the literature on optimal sowing period in the TP. Research of optimal sowing period included: first and last frost date, recording of the minimum temperature of germination, ensuring optimal soil moisture, monitoring of days with temperatures above 30°C.

For the monitoring period, 2008-2011, the earliest frost of autumn, at 10 cm soil depth was recorded at Balda, on October 19, 2008 (-2.10°C), then, at all stations for the period, soil frost was recorded in November and 13 November 2011-to Triteni (-1.07°C) and Taga (-0.68°C), followed by November 18, 2011-Zoreni (-0.2°C) and November 18, 2008-Band (-0.14°C). At the same time there were stations reaching the first frost is soil next year at the latest, on February 17, 2010 Silivasu de Câmpie (-0.06°C), on February 16 2011 at Triteni (-0.12°C) and on February 5, 2010 at Branistea (-0.06°C). The latest spring frost was recorded for the period 2008-2011, on March 13, 2011 (-0.06°C) at stations Taga, Triteni and Zoreni, followed by March 7 2009 at Dipsa (-0.26°C) and March 3 2009 at Caianu (-0.31°C) and Silivasu de Câmpie (-2.28°C). In the same time we have station that recorded the last frost in January 26, 2011 (-0.12°C, Craiesti), and most stations show last frost to 10 cm in the soil, in February.

The conclusion of the analysis on the first and last frost for the monitoring period, 2008-2011, is that these values do not affect the optimum time of sowing for the studied crops, with no risk. Throughout the period and at all stations, the last frost in the spring was March 13 and the first in autumn on 19 October.

To analyze data on optimum sowing time we considered the recorded minimum temperature for seed germination, which for 3 consecutive days does not fall below this value and tends to increase in the days ahead. These temperatures were: 8°C for corn (figure 1), 7°C for soy, 7°C for sun flower, 6°C for sugar beet.

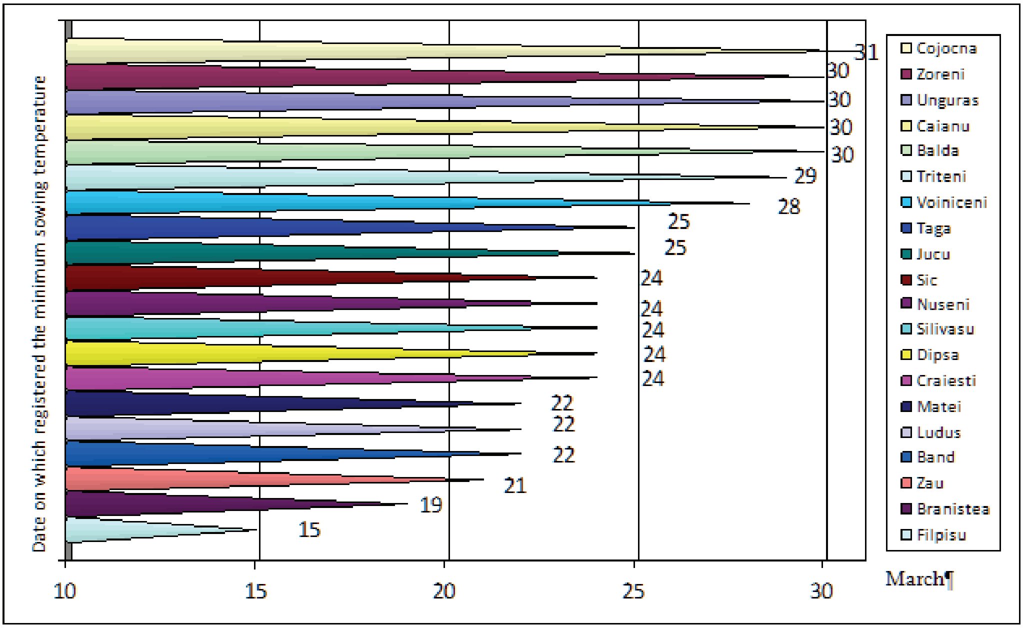

Figure 1. Date on which registered the minimum sowing temperature for corn in the Transylvania Plain (2009-2012)

After analysis of data recorded at stations, we can say that the minimum temperature for corn germination was recorded, compared to the considered optimal, even 15 days earlier, sunflowers by 5-7 days earlier, the beet sugar 3-4 days earlier, except 2010 and 2011, where for some stations the optimum temperature has been registered earlier even with 6-9 days. Regarding soybean, minimum germination temperature for sowing recorded earlier by about 15 days.

Amount of biological active degrees or Thermic Constant (TC), was calculated taking into account the longest period of growth in primary cultures analyzed, hybrids / varieties late or semi late, and base temperature or biological threshold (temperature below which no longer visible growths) was: > 0^0C for wheat, 290 days; 8^0C for corn, 150 days; 10^0C for soy, 150 days; 7^0C for sun flower, 140 days; > 0^0C for sugar beet, 183 days.

Wheat, from 25 September to 12 July, the plant needs 1800-2300°C to develop. At all stations in all years studied biologically active degree requirements for wheat, ensures maximum or exceed specified limits from literature, provides between 2182-2874°C.

For corn, the TP is surrounded by literature in the III area, the amount of biologically active temperature is 800-1200^0C. In most of the station in plants growing season for the monitoring period, during 2008-2011, were accumulated the biologically active temperature levels needed for corn, beyond the limits specified in the III area. TC were recorded between 1229-1868°C, placing culture in the I and II area. Stations with TC over 1400^0C are: Filpisu Mare (1599-1868^0C), Craiesti (1513-1708^0C) and Triteni (1339-1508^0C) especially the stations in central and southern of TP, placing the culture in I area. Stations with TC under 1400^0C are: Sic (1296-1344^0C) and Zoreni (1229-1416^0C), the stations in the west and north of the TP, falling maize crop in the II area.

For soybeans, the TP is surrounded in literature, in the IV area, with a thermal potential of 1100-1250^0C. Amount of biological active degrees registered for soybean, during 2008-2011 in the TP, is between 1044-1568^0C, placing the culture in the II, III and IV area not only in the IV area, as shown in the literature. Specifically, station with values equal to the II culture area is Filpisu Mare (1430-1568^0C), station with values equal to the III culture area is Craiesti (1221-1396^0C), respectively with values equal to the IV culture area station Zoreni (1126-1183^0C) and Sic (1044-1193^0C).

For sun flower, the TP is surrounded in literature, in the II area, with a thermal potential of 1100-1250^0C 1400-1600^0C. Amount of biological active degrees registered for sun flower, during 2008-2011 in the TP, is between 1250-1890^0C, is a great diversity of conditions registered from culture area I, II, and III. Near I culture area we have the stations (1582-1890^0C), Craiesti (1487-1763^0C), in II culture area, Triteni (1387-1562^0C), respectively III culture area, Sic (1250-1463^0C) and Zoreni (1250-1463^0C). Zoning is similar to that of corn, the central and southern TP is favorable for semi late hybrids, and the north, hilly area, for early hybrids.

For sugar beet, we took into account the vegetation period equal to 183 days, the plant needs 2400-2900^0C, in the first year of vegetation and 1800^0C, in the second year. At all stations, the necessary of biologically active degrees is accumulated in the growth period of sugar beet, values ranged from 2954^0C at Sic and 3857^0C at Filpisu Mare.

The optimum humidity range for plants, is the range in which plants grow properly, and is equal to 60-90% from active humidity range. Insurance percentage averages of the optimum humidity range for plants, during 2008-2011, at all stations in the TP looks its best insurance for wheat crop, or 63.8% of the vegetation, humidity values are below the optimal range in 20.8% of the wheat growing season, and 15.4% were insured humidity values over this range. Spring crops have a much higher moisture deficit, which is between 37.9 to 38.9% for sugar beet and soybean, 40.9 to 41.2% for sunflower and maize during the growing season time the soil moisture is below optimum humidity range for plants. Water requirements are provided in an optimum, in 58.8 to 62.1% of the crop during the growing season of spring weeding crops.

To determine periods when moisture is not provided necessary we determined periods of droughts (figure 2). For Romania, dry periods are characterized by lack of rain for a period of at least 14 consecutive days within the cold of the year (October to March) and at least 10 days during warm (April to September). Droughts analysis shows a number of 36 (Branistea)-86 (Caianu) days without precipitations, in 2009, 15 (Branistea)-40 (Silivasu de Câmpie) days in 2010 and 57 (Caianu)-83 (Dipsa) drought days in year 2011.

Temperatures above 30^0C during flowering, accompanied by atmospheric heat (dry winds and low relative humidity) causes significant damage output, both in maize (optimum 18-24^0C) and sunflower (optimal 16-20^0C), because pollen loses viability and significantly reduce the production of grain and seeds, and sunflowers oil percentage. Average number of days at all stations, with temperatures above 30^0C were 16.33 days in 2008, 58.04 days in 2009, 47.8 days in 2010 to 53.96 days in 2011. These days occurred in 20-25% since June, but the majority of the days in July and August. Amplitudes temperatures above 30^0C during the day and below 10^0C at night, that occur during flowering and grain filling, prevents anther, pollen default development and the normal process of fecundation. Thermal shock after fecundations disturb accumulation of reserve substances in beans and corn shrivelled phenomenon occurs.

Amplitude of high temperatures adversely affect crops in the summer months, June-July-August and vegetation phases of flowering and grain formation, when droughts are most common, soil moisture is very poor. Maximum amplitude of temperature is recorded on a station located on a southern slope – Filpisu Mare, in the southeastern part of the Transylvanian Plain, where there were differences between high and low in the following days: 28 June 2009, 9.83-47.97^{0}C (38.14^{0}C); 7 July 2010, 13.74-48.44^{0}C (34.7^{0}C); 1 June 2011, 11.3-49.31^{0}C (38.01^{0}C). Brani? tea station on a slope which faces west, representative of the northern and north-western Transylvania Plain maximum thermal amplitude recorded in 24 hours, was: 15 June 2009, 7.98-42.4^{0}C (34.42^{0}C); 7 June 2010, 10.36-41.23^{0}C (20.87^{0}C); 22 August 2011, 8.58-42.16^{0}C (33.58^{0}C).

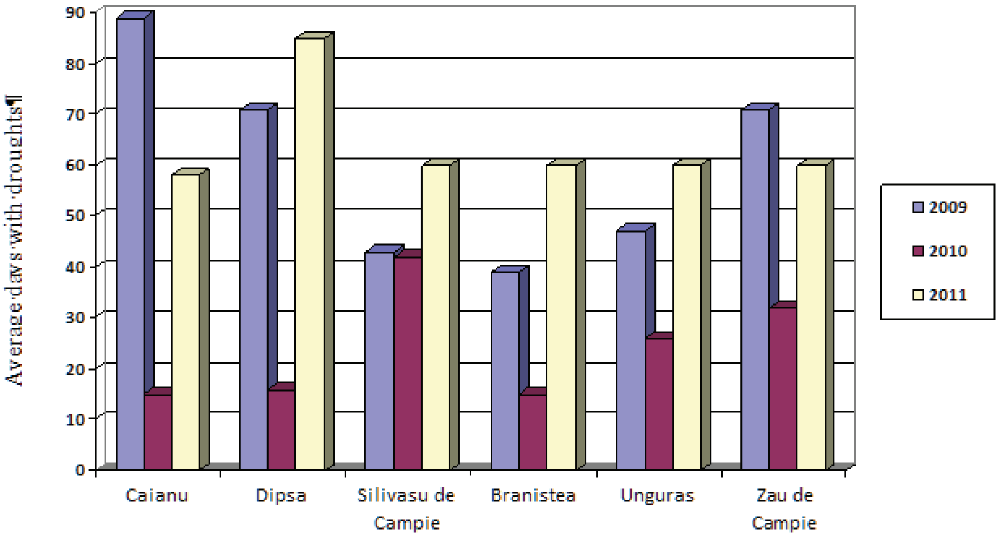

Figure 2. Days with droughts recorded during 2009-2011

CONCLUSIONS

After analyzing the recorded data, thermic and hydric, in the Transylvanian Plain, we recommend as optimal sowing period, advancing those known in the literature, with 5 days for corn and soybeans, and maintaining the same optimum period for sunflower and sugar beet, thus: Corn: 5 to 25 April; sunflower: March 25 to April 10, sugar beet: March 20 to April 10; soybean: April 5 to 15. Great differences are recorded from one station to another, the results are influenced by soil type and its exhibition, so in practice it is very important to take into account the differences in slope morphology. For crop growing season of spring (April to October) southern, south-eastern and eastern slopes have lower precipitation with approx. 43.8 mm, higher temperatures with 0.37^{0}C in air, with 1.91^{0}C at 10 cm in soil, with 2.22 ^{0}C at 20 cm and with 2.43^{0}C at 30 cm depth in soil, compared to northern, north-western and western slopes.

Water requirements are provided in an optimum, of 58.8 to 62.1% for the spring weeding crops during the growing season, thus irrigation is necessary to ensure optimum production potential. Droughts are recorded in June-July-August, in a total of 36 (Branistea, 2009)-83 (Dipsa, 2011) droughts days, overlapping temperatures above 30^0C, between 47.8 – 58.04 days, during 2008-2012.

The amount of biological active degrees registered in Transylvanian Plain shows the necessity to reconstruct crop zoning, known in the literature, for the analyzed crops: wheat, corn, soy, sunflower and sugar beet, ensuring higher levels for their zoning, respectively the possibility of cultivation of varieties/hybrids semi late or late in a higher percentage.

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RELATIONSHIPS BETWEEN SOIL SALINITY AND VASCULAR PLANTS IN INLAND SALT MEADOW NEAR THE TOWN OF RADNEVO

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Abstract

Inland salt meadows are exclusively rare in Bulgaria. One of the most representative localities of this habitat in the country are the Inland salt meadows near the town of Radnevo. The object of this study is the inland salt meadow located north of the town of Radnevo near the village of Daskal Atanasovo between coordinates 42^{o}19.60 and 42^o 19.185 N, 25^{o}53. 890 and 25^o 54.506 E.It was developedonGleycVertisols, surface water logging, slightly saline soil.
The aim of the study was to investigate the relationship between soil salinity and the vascular plants in the Inland salt meadows near the town of Radnevo.
The survey was conducted in 2011-2012. A total of 60 soil samples were taken from a depth of 0-20 cm. In each sample taking point the vascular plants existing there were also collected. Electrical conductivitiy (EC) and pH of soils were analyzed. The relationship between soil EC values and the recorded 57 vascular plants was studied. A different saltiness level has been registered on the territory of the inland salt meadow. Four species - Taeniatherum caput-medusae (L.) Nevski, Trifolium repens L., Elymus elongatus (Host.) Runemark, Cynodon dactylon L. have been found at locations with varying saltiness level from weak to medium, and six species - Carex divisa Huds, Hordeum hystrix Roth, Alopecurus geniculatus L., Bromus commutatu Guss. ex Steuds, Carex distans Host. and Trifolium resupinatum L. have been found both on saline and non-saline soils. The dominating species on the studied territory have also been specified.

Key words: *EC, Inland salt meadows, soil salinity, vascular plants.*

INTRODUCTION

The Inland salt meadows are exclusively rare in Bulgaria. The habitat is included in: Red Data Book of Bulgaria in category Endangered (Tzonev and Gussev, 2011); Annex № 1 of the Biological Diversity Act (2007) and some of the localities are within sites of European Ecological Network NATURA 2000 in Bulgaria. One of the most representative localities of this habitat in the country is the Inland salt meadows near the town of Radnevo. An object of this study is the Inland salt meadow located north of the town of Radnevo near the village of Daskal Atanasovo between coordinates 42^{o}19.60 and 42^{o}19.185 N, 25^{o}53. 890 and 25^o 54.506 E and it occupies an area of 6.83 ha. According to the phytogeographical zoning adopted in the country their area is within the Thracian Lowland, at the border with Tundzha hilly country. The relief is plain, micro-depressions and surface waterlogging are available as a result of the high level of underground water and the low soil permeability.

Climatically the region is part of the transitional continental subregion of the European continental region. The average annual air temperature calculated for a period of many years is 12.3^{o}C. Winter is relatively mild. The average monthly temperature for January, the coldest month of the year, is 1^{o}C. Summer is relatively hot, with average monthly temperature in July – the hottest month of the year – of 23.4^{o}C. With prolonged anticyclonic episodes maximum air temperatures exceed 36°C. The annual amount of precipitation in the region is below the average for the country. Two precipitation maxima are typical: summer – in May and June and winter – in November and December. Droughts start as early as the second half of July and last for 90 – 100 days, almost till the end of October. All these climatic characteristics result in the establishment of an evaporation type of water regime.

Salinity of soils in the inland areas is a secondary process occurring on already set soils with increased level of underground water and their higher mineralization or with improper drainage and irrigation (Ganchev et al., 1971; Dimitrov, 1987; Raikov et al., 1989). The Inland salt meadows in the region of Radnevo municipality were developed on Gleyc Vertisols, surface water logging, slightly saline soil. They were formed in shallow underground water and meadow plantation on clayey silt. According to geobotanical data a considerable part of these territories in the past were occupied by oak and hornbeam forests alternating in places with peculiar shrub formations or leafless grass plants of the meadow type (Petkov and Pacharazov, 1988).

In the past decade the flora of the salt meadows near the town of Radnevo has not been a subject of a special study. We find data about their vegetation in some works on the halophylic vegetation in Bulgaria from the second half of the 20th century (Ganchev and Kochev, 1962, Ganchev et al., 1971) and the beginning of the 21st century (Tzonev et al., 2008).

The present investigation is part of a research project for studying the Inland salt meadows' flora near the town of Radnevo and the aim was to investigate the relationship between soil salinity and the vascular plants in the studied area.

MATERIALS AND METHODS

The survey was conducted in 2011 – 2012. The location map of the study area and sampling points are shown on Figure 1. A total of 60 soil samples were taken from a depth of 0-20 cm. In each sample taking point the vascular plants existing there were also collected. Soil samples were analyzed for Electrical conductivity (EC) and pH. Soil pH was determined on air-dry samples using 1:2.5 soil : water ratio. Electrical conductivity ($\mu S.cm^{-1}$) was measured using 1:5 soil:water ration and used as an indicator of salinity (Popandova, 1995, 2001).

The following were used as taxonomic basis for determining the species adherence of the collected plants: The Flora of PR Bulgaria (Jordanov, 1963–1979; Velčev, 1982, 1989; Kožuharov, 1995), Field Guide to the Vascular Plants in Bulgaria (Kozhuharov, 1992), Key to the Plants of Bulgaria (Delipavlov and Cheshmedzhiev, 2003).

Chemometrics was used to establish relations between the soil properties and distribution of the vascular plants in the the studied Inland salt meadows. Principal component analysis (PCA) was applied to the experimental data to assess relationship between values of EC and pH in soil samples and distribution of the samples in multimensional space. Cluster analysis (K-means methodology) was performed to understand the distribution of vascular plants with regard to values of EC and pH of soil samples. Chemometrics was carried out by Unscrambler X 10.2 (CAMO Software AS, Norway).

RESULTS AND DISCUSSIONS

The values of EC in the studied soil samples were characterized with wide range from 75.0 to 2057.0 $\mu S.cm^{-1}$, with SD = 366.0. According to the soil saltiness scale (Trendafilov and Popova, 2007) 85.0% of the samples were classified as not saline and 15.0 % were classified as saline. Most of them were light saline – 10.0% ($800 < EC < 1400$ $\mu S.cm^{-1}$) and only 5.0% of all samples were moderately salty soils ($EC > 1400$ $\mu S.cm^{-1}$), The distribution of values of EC and pH in studied soil samples are presented in Figure 2 and 3, respectively.

According to values of pH (H_2O) most of the samples – 91.7% were characterized with alkaline reaction and the remaining samples with neutral reaction. The mean value of pH was 7.5 and SD was 0.39. Alkaline reaction and high values of EC in saline soils were mainly due to the presence of sulfates. Carbonates were not established in the soil.

On the base of values of EC and pH for soil samples were performed Principal component analyses to investigate the soil samples distribution in multimensional space (Figure 4). In the score plots, the grouping of objects can be recognized (Simeonov et al., 2010).

Figure 1. Location map of the study area and sampling points

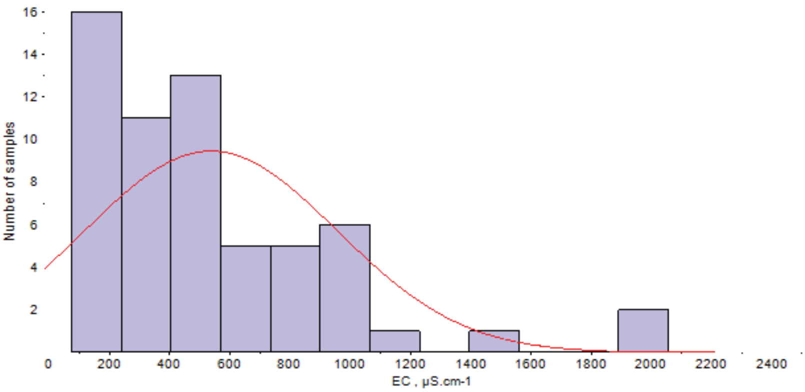

Figure 2. Histogram of EC values, µS.cm-1 in studied soil samples

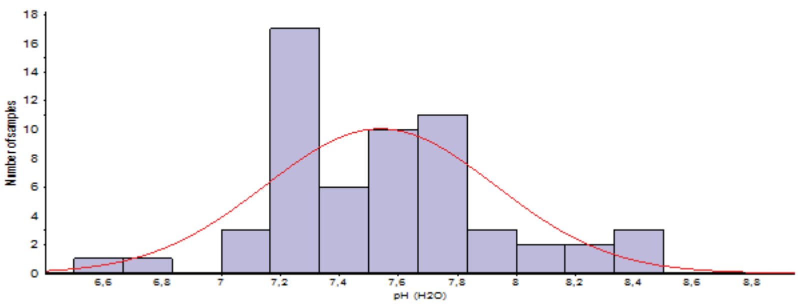

Figure 3. Histogram of pH values in studied soil samples

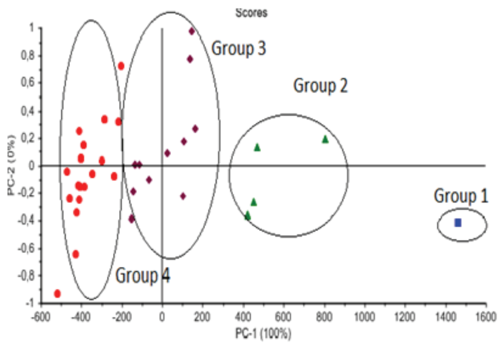

Figure 4. Scores plot of the soil samples

Factor 1 explained 100% of data variance, separated four groups of soil samples clearly. PC1 completely described variable – soil electrical conductivity, therefore EC is dominant soil parameter for groups formation than pH. Group 1 occupied distinctly different area in multimensional space far from others. The soil samples belongs to that were moderately salty with EC from 2050 to 2057 $\mu S.cm^{-1}$. Group 3 and Group 4 formed two groups at a short distance for each other. It is not surprising because samples of that two groups are non-saline with EC from 444 to 730 and from 123 to 356 $\mu S.cm^{-1}$, respectively. Group 2 occupied an area between Group 1 and the others. Soil samples belonging to that group were slighly saline with EC from 1014 to 1402 $\mu S.cm^{-1}$. On the basis of PC analysis result non-hierarchical clustering via K-means methodology was applied to group vascular plants based on their similarity with regard to the studied soil properties. Four clusters (groups) were specified in advance.

As a result of the conducted floristic studies during the vegetation period of 2011-2012 a total of 112 species of vascular plants have been found in the studied territory. The present analysis includes the 57 species registered during sample taking. The results about grouping of the studied vascular plants according to soil properties are presented in Table 1.

Predominant among them are the representatives of *Poaceae* and *Cyperaceae* families. Group 1 comprises 9 species occurring at EC from 2012 to 2057, $\mu S.cm^{-1}$ (Table 1). Five of these – *Carex distans* Host., *Elymus elongatus* (Host.) Runemark, *Hordeum hystrix* Roth and *Taeniatherum caput-medusae* (L.) Nevski are among the species registered with the most numerous populations in the studied territory and one – *Rorippa sylvestrys* (L.) Besser is of the species represented by the least numerous populations. Seven of the plant species included in group 1 incl. the five species represented by the most numerous populations and the two species of the genus *Trifolium -T. repens* L. and *T. resupinatum* L. are among the ones mentioned by Tzonev and Gussev (2011) as characterizing the inland salt meadows taxa. The other two species of Group 1– *Carex divisa* Huds and *Rorippa sylvestrys* are mentioned by Delipavlov and Cheshmedzhiev (2003) for saline locations in various parts of the country.

In Group 2 there are 17 species registered at EC from 695 to 1065, $\mu S.cm^{-1}$. The most numerous populations during the study have been found for six species – *Carex distans*, *Juncus gerardii* Loisel, *Elymus elongatus, Hordeum hystrix,Taeniatherum caput-medusae, Mentha pulegium* L. The first five species plus 4 more of the species included in that group-*Cynodon dactylon* (L.) Pers, *Dianthus campestris* Willd., *Trifolium repens* and *Trifolium resupinatum* are among the ones mentioned by Tzonev and Gussev (2011) as characterizing inland salt meadow taxa. The last species- *Mentha pulegium* is pointed out by Ganchev et al. (1971) as an accompanying species in grass communities formed in depression areas on medium and slightly saline soils. A part of the other representatives of group 2 such as *Alopecurus genuculatus* L., *Bromus commutatus* Guss. ex Steud, *Carex divisa,* etc. are hygrophytes tolerant to moderate soil salinity, another part such as *Pulicaria vulgaris* Gaertn and *Ranunculus constantinopolitanus* d' Urv are ruderal plants tolerant to slight soil salinity.

In group 3 there are a total of 30 species of vascular plants distributed at EC from 356 to 529, $\mu S.cm^{-1}$), and in Group 4 there are a total of 27 species distributed at EC from 75-307, $\mu S.cm^{-1}$) (Table 1). The most numerous populations of plants included in the two groups during the study have been registered for *Carex distans, Elymus elongatus, Hordeum hystrix, Bolboschoenus maritimus* Palla, *Ranunculus aquatilis* L., *Butomus umbellatus*

L. The first three species were mentioned by Tzonev and Gussev (2011) as characterizing inland salt meadows. The other three species- *Bolboschoenus maritimus, Butomus umbellatus* and *Ranunculus aquatilis,* as well as the greater part of vascular plant species included Group 3 and Group 4 such as *Alisma lanceolatum* With., *Leersia oryzoides* (L.) Sw., *Lemna minor* L., *Poa palustris* Vohlleb., *Rumex palustris* Sm., etc. are taxa typical of swampy and marshy areas. Their occurrence in the studied territory is accounted for by the considerable soil dampness during the greater part of the year since a salt meadow occurs together with a swamp. The other part of plants included in these two provisional groups are predominantly xerophytic and ruderal species. Their participation in the grass cover is due to the prolonged drought of part of the meadow during the hot months of the year.

Ten of the 57 vascular plant species included in the present study were registered in samples of varying EC range (Figure 5). Four of them – *Taeniatherum caput-medusae, Trifolium repens, Elymus elongatus, Cynodon dactylon* have been found at locations with varying salinity level from slight to medium. Six species – *Carex divisa, Hordeum hystrix, Alopecurus geniculatus, Bromus commutatus, Carex distans* and *Trifolium resupinatum* have been registered both on saline and non-saline soils.

CONCLUSIONS

The data in the present study show that in the inland salt meadow near the town of Radnevo there is different salinity level – from non-saline to medium saline. The salinity process results from the high level of underground water, the plain relief and the micro-depressions on its territory. The reaction of the studied soil samples is from neutral to medium alkaline, predominant are the samples with alkaline reaction.

A dominating factor for the grouping of the found 57 vascular plant species as a result of the applied cluster analysis is the electroconductivity of soil samples. Ten samples of the studied vascular plants- *Taeniatherum caput-medusae, Trifolium repens, Elymus elongatus, Cynodon dactylon, Carex divisa, Hordeum hystrix, Alopecurus geniculatus, Bromus commutatus, Carex distans* and *Trifolium resupinatum* have been registered in samples with different EC range, the last six species were found on non-saline and saline soils. Nine species – *Carex distans, Cynodon dactylon, Elymus elongatus, Hordeum hystrix, Taeniatherum caput-medusae, Trifolium repens, Trifolium resupinatum, Dianthus campestris* and *Juncus gerardii* are among the taxa mentioned as characterizing Inland salt meadows in Bulgaria.

The most numerous in the studied territory are the populations of *Carex distans, Elymus elongatus, Hordeum hystrix, Taeniatherum caput-medusae, Juncus gerardii*, *Bolboschoenus maritimus, Ranunculus aquatilis* and *Butomus umbellatus*.

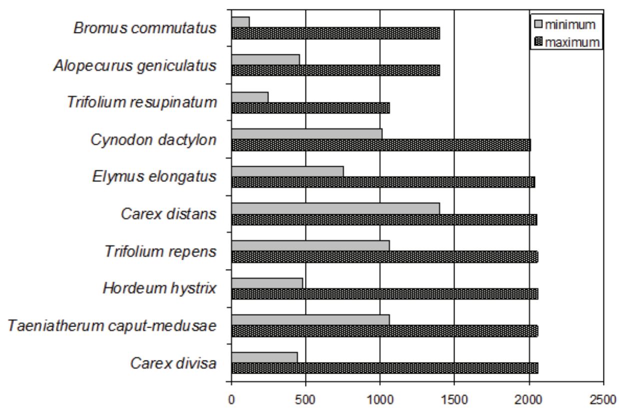

Figure 5. Vascular plant species found in samples of different salinity level

Table 1. Cluster analysis of the studied vascular plants based on values of EC and pH in the measured soil samples

Soil parameters	Group 1	Group 2	Group 3	Group 4
pH	7.3-7.5	7.2-7.8	7.4-8.5	6.5-8.2
EC, $\mu S.cm^{-1}$	2050-2057	1402-1014	756-444	356-123
	Carex distans Host.	*Alopecurus geniculatus* L.	*Carex divisa* Huds	*Alisma lanceolatum* With.
	Carex divisa Huds	*Bromus commutatus* Guss. Ex Stend	*Alisma lanceolatum* With	*Bolboschoenus maritimus* Palla
	Cynodon dactylon (L.) Pers.	*Carex distans* Host.	*Alopecurus geniculatus* L.	*Bromus arvensis* L.
	Elymus elongatus (Host) Runemark	*Carex divisa* Huds	*Alopecurus pratensis* L.	*Bromus commutatus* Guss. Ex Steud.
	Hordeum hystrix Roth	*Cynodon dactylon* (L.) Pers.	*Atriplex hastata* L.	*Bromus secalinus* L.
	Rorippa sylvestris (L.) Besser	*Dianthus campestris* Willd.	*Beckmannia eruciformis* Host	*Butomus umbellatus* L.
	Taeniatherum caput-medusae (L.) Nevski	*Elymus elongatus* (Host) Runemark	*Bolboschoenus maritimus* Palla	*Carex acutiformis* Ehrh.
	Trifolium repens L.	*Hordeum hystrix* Roth	*Bromus commutatus* Guss. ex Stend.	*Centaurea calcitrapa* L.
	Trifolium resupinatum L.	*Juncus gerardii* Loisel	*Carex distans* Host	*Dischanthium ischaemum* (L.) Roberty
		Lysimachia nummularia L.	*Carex hordeistichos* Vill.	*Eleocharis palustris* (L.) Roem. & Schult
		Mentha pulegium L.	*Carex vulpina* L.	*Festuca erundinacea* Vill.
		Persicaria mitis (Schrank.) Opiz	*Convolvulus arvensis* L.	*Juncus effuses* L.
		Pulicaria vulgaris Gaertn	*Coronopus procumbens* Gilib.	*Lemna minor* L.
		Ranunculus constantinopolitanus d Urv	*Datura stramonium* L.	*Lycopus exaltatus* L.
		Taeniatherum caput-medusae (L.) Nevski	*Elymus elongatus* (Host) Runemark	*Mentha longifolia* (L.) Huds.
		Trifolium repens L.	*Galium octonarium* (Klokov) Soó	*Oenanthe silaifolia* M. Bieb.
		Trifolium resupinatum L.	*Hordeum hystrix* Roth	*Persicaria mitis* (Schrank.) Opiz
			Leersia oryzoides (L.) Sw.	*Plantago major* L.
			Lolium perenne L.	*Poa bulbosa* L.
			Lysimachia nummularia L.	*Poa compressa* Schrenk ex Ledeb.
			Medicago arabica (L.) Huds.	*Poa palustris* Vohlleb.
			Mentha longifolia (L.) Huds.	*Pulicaria vulgaris* Gaertn.
			Oenanthe silaifolia M. Bieb.	*Ranunculus aquatilis* L.
			Poa bulbosa L.	*Ranunculus lanuginosus* L.
			Poa compressa Schrenk ex Lebed	*Ranunculus lateriflorus* DC.
			Poa palustris Wohlleb	*Ranunculus sardous* Crantz
			Poa pratensis L.	*Rumex palustris* Sm.
			Poa sylvicola Guss.	
			Rumex palustris Sm.	
			Veronica anagallis-aquatica L.	

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DIFFERENTIATION OF FERTILIZATION RATES WITH PHOSPHORUS AND POTASSIUM BASED ON GEOSPATIAL DATA FOR THEIR RESERVES IN SOIL

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Abstract

Generally the stockpiling fertilization with phosphorus and potassium is applied before planting of perennial crops and requires introducing of high fertilization rates, calculated on the basis of the soil reserves and forecasted balance of the element for a long period. Opportunities for correction of stockpile fertilizer rates after planting of perennials are very limited, taking into account the technological limitations of incorportation of fertilizers to the depth of active root layer.This requires precise calculation of fertilizer rates, depending on the heterogeneity of the soil even before planting.
Present work is an attempt for approximation of balanced stockpiling rates with phosphorus and potassium to the actual needs of plants of fertilization on the whole area of the plantation. It is used nearest neighbour method, combined with soil sampling in graticule conformed to the configuration of the area. The optimal density of the graticule is established experimentally by prior reconnaissance soil sampling and defining the function of the spatial heterogeneity expressed as variogram. Obtained on the first approximation results are generalized to the threshold of economically significant sensitivity to corresponding nutrient, and then are outlined sub-areas for differentiated fertilization.
The advantages of the nearest neighbour method in the proposed model for geospatialization is that, its application provides an outlining of sub-areas for diferentiated fertilization with proper configuration which is suitable for service by fertilizer technique.

Key words: *geospatialization, fertilization, phosphorus, potassium.*

INTRODUCTION

Compared with other perennial crops vine consumes relatively economical mineral forms of major nutrients in the soil and has well expressed adaptability to different levels of mineral nutrition (Enikov and Benevski, 1984). Some differentiation in terms of rate of nutrients absorption is established between the different varieties, cultivation directions, and variety-rootstock combinations (Delas, 1992; Lambert et. al., 2008).
By pre-planting fertilization with high doses of phosphorus and potassium fertilizers the soil is accumulated with major nutritional elements in quantities that are sufficient to ensure normal growth and development of perennial crops up to the third-fourth year (sometimes longer). From the potassium fertilizers most commonly used is potassium sulphate and from phosphorus-triple superphosphate. The use of more quick-acting fertilizer is not recommended because they can be leached easily into deeper soil layers. Due to the very low mobility of compounds in potassium sulphate and superphosphate, these fertilizers are retained in the zone of their introduction for a long period of time. On one hand, this feature may have a negative effect, because if these fertilizers are not incorporated in sufficient depth in soil, they can not be assimilated by the vine roots. From another hand, however their low mobility in soil, ensures their long-term action which is of great importance to all perennial crops (Valcheva et. al., 2012).
The doses used for stockpiling fertilization must be calculated the most precisely, because the opportunities for their correction after establishing the vineyard are very limited from a technological standpoint. Fertilizer rates must be calculated based on the soil reserves, the forecasted balance of the element for a long period, and according to the heterogeneity of the soil even before planting.
Present work is an attempt for approximation of balanced stockpiling rates with phosphorus and

potassium to the actual needs of plants of fertilization on the whole area of the plantation.

MATERIALS AND METHODS

During the current research we accepted a model for collecting of soil samples in which each sample is taken from the terrain with soil probe as the sampling points are situated in square grid, regardless of the borders of soil types and local terrain topography. We studied two sections-parcels 108 and 155 (Figure 1), which have complex topography and parcels 113, 157 and 158 (Figure 2), where the terrain is relatively leveled and with slightly rough and monotonous relief. Parcels 108 and 151, and parcels 113, 157 and 158 are adjacent and form two contoures. In both sites we take individual soil samples from three depths – 0-25, 25-50 and 50-75 cm for each point (position of sampling points is marked in Figure 1 and Figure 2). The location of points was previously mapped and coordinates were entered into the Global Positioning System-GARMIN, allowing to determine the location of each point to an accuracy of 1m.

After standard preparation of soil samples are established available forms of phosphorus and potassium in soil, according to GOST 26209-91.

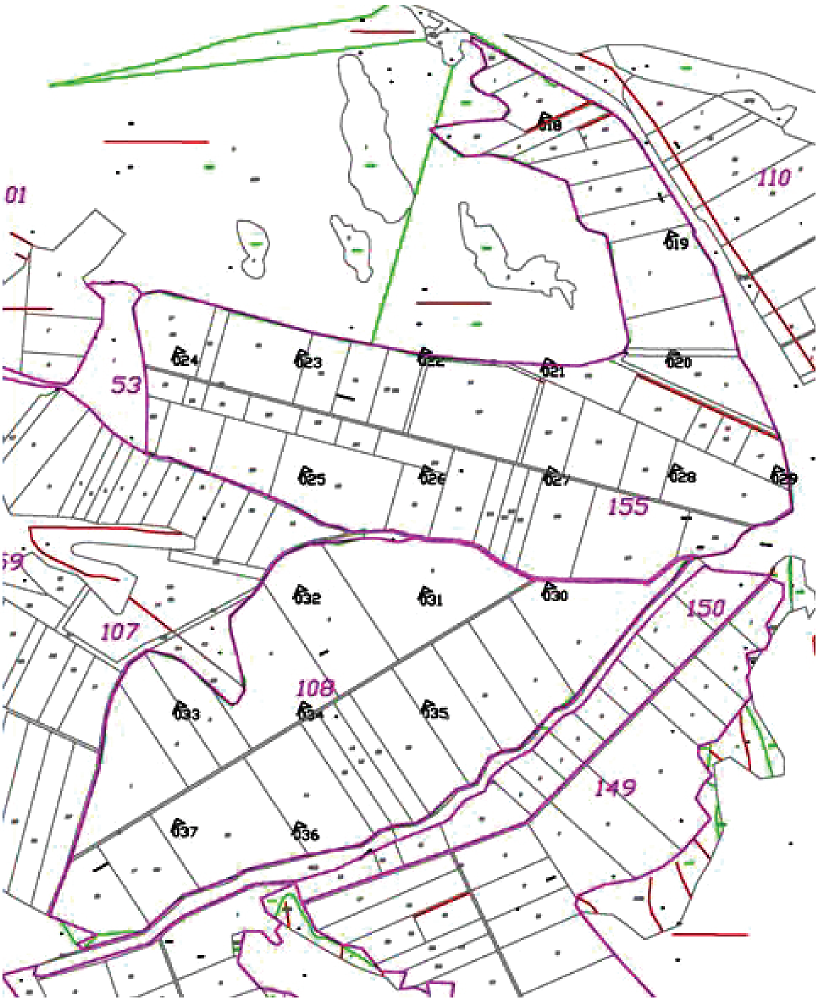

Figure 1. Situation and location of sampling points in parcels 108 and 155

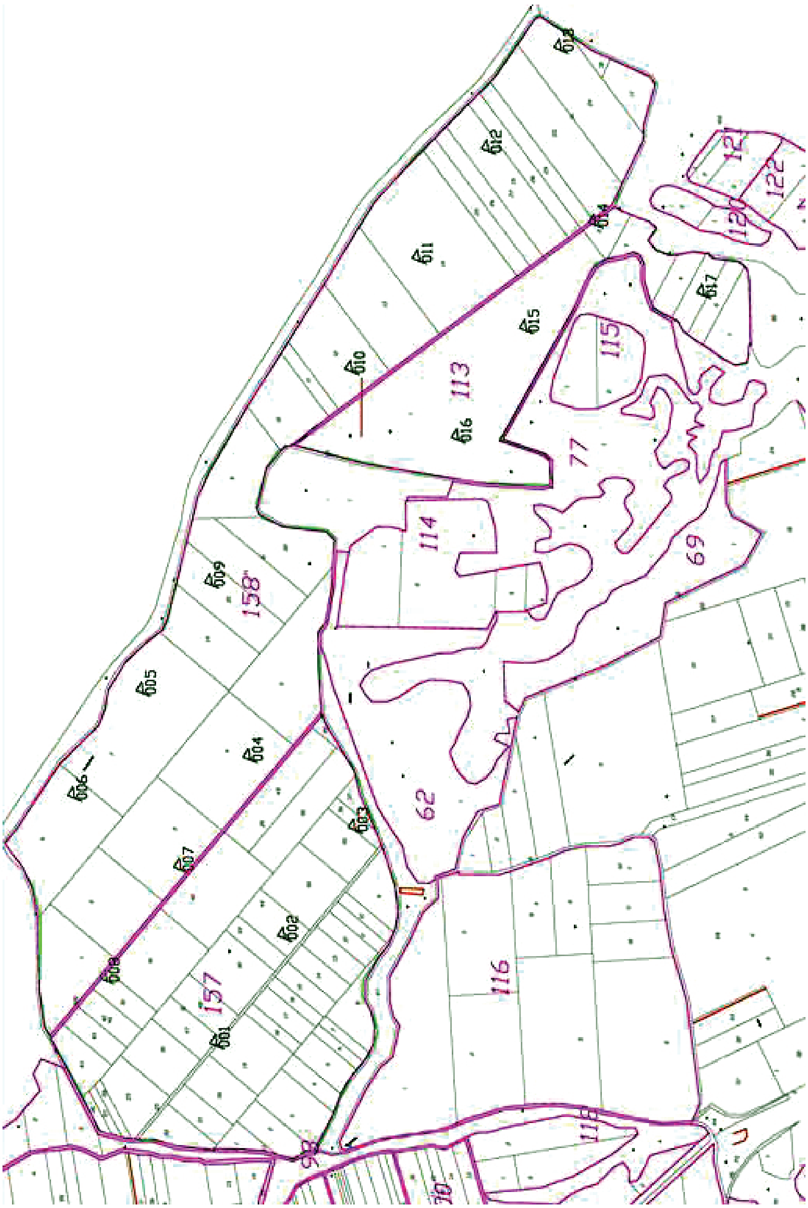

Figure 2. Situation and location of sampling points in parcels 157, 158 and 113

RESULTS AND DISCUSSIONS

Content of available phosphorus

Average content of assimilable phosphorus determined in acetate-lactate extract is low (4.03 mg P_2O_5/100g soil) and this is the overall conclusion which should be made for the whole investigated area. The lowest is phosphorus content within the boundaries of parcels 113, 155 and 158-under 4 mg P_2O_5/100g soil. As can be seen from Figure 3 and Figure 4 zones with relatively higher phosphorous content are established only in contour, delineated by the borders of parcels 108 and 155, while in the other content of this element is very low, according to standards for reserves of phosphorus in the classification tables for the method of 'Egner-Riem'.

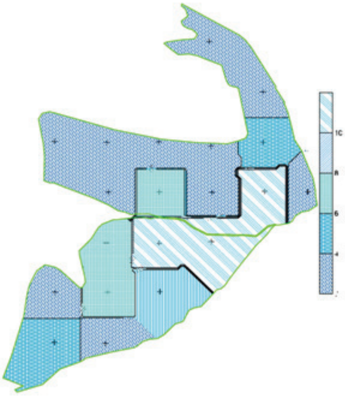

Figure 3. Spatial distribution of available phosphorus ($mg\ P_2O_5/100g$ soil) content in soil in parcels 108 and 155

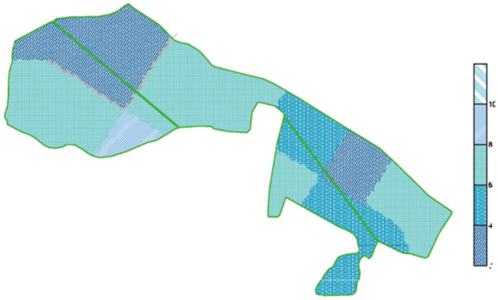

Figure 4. Spatial distribution of available phosphorus (mg P2O5/100g soil) content in soil in parcels 113, 157 and 158

Content of available potassium

Usually soils in Bulgaria are well stocked with potassium, but in this case studied areas are an exception. Average content of assimilable potassium, total for observed terrains is 13.79 $mg\ K_2O/100g$ soil, which is much below the standards for reserves of this nutrient. Obtained data require an application of stockpiling fertilization with potassium fertilizers. Stockpiling potassium fertilization will be differentiated by norms for some parts of the parcels.

The obtained results for reserves of phosphorus and potassium in soil give a reason to develop differentiated rates of stockpiling fertilization with these nutrients, which from agrochemical and economic viewpoint is appropriate for studied areas. For this purpose is used the method of Nearest neighbor, combined with soil sampling in graticule.

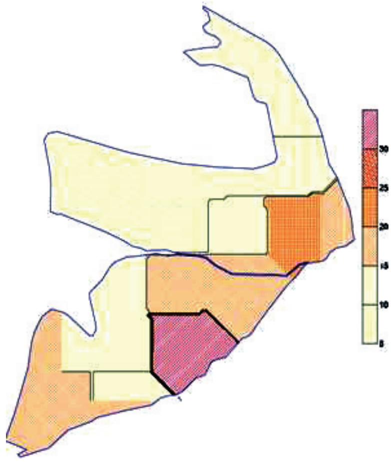

Figure 5. Spatial distribution of available potassium content ($mg\ K_2O/100g$ soil) in soil in parcels 108 and 155

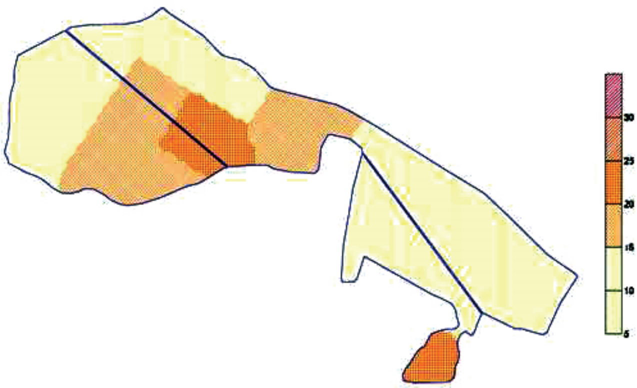

Figure 6. Spatial distribution of available potassium content ($mg\ K_2O/100g$ soil) in soil in parcels 113, 157 and 158

Statistical data processing

For the extrapolation of the data for reserves of nutrients on the principle from point to two dimensional space of field surface is used the method of Nearest Neighbor. Previously is randomized in space the position of points for investigation and is set the density of graticule corresponding with the technological significance of obtained thereby sub-parcels.

The randomized soil sampling formulated an algorithm in which areas have parallel sides. Sampling points are presented as three-dimensional vectors, the two of dimensions are meter coordinates x and y, and evaluated factors (in this case, stocks of the soil of phosphorus and potassium) play the role of vector on the axis 0z in three-dimensional space. Theoretically it is possible both parameters-reserves of phosphorus and reserves of potassium to be unite in a common algorithm with the coordinates of points, but then can not be achieved clear visualization and respectively mapping of the results.

In the accepted model the boundaries of representativeness of the sampling point forms a set of points with discrete distribution on axes 0x and 0y and with constant value on 0z. Extrapolation error is estimated by the method of fuzzy boundaries.

The presence of fuzzy boundaries obtained during the mapping of the algorithm generally should be an indicator for thickening of graticule of samples on the terrain. In this case it is avoided because by definition we have adopted the smallest technological size of areas.

Fertilization

Depending on the content of available phosphorus and potassium in the soil and after statistical analysis of data by the method of Nearest neighbor is developed a model for differentiated fertilization of investigated area. Obtained on the first approximation results are generalized to the threshold of economically significant sensitivity to corresponding nutrient, and then are outlined sub-parcels for differentiated fertilization.

For stockpiling phosphorus fertilization is used triple superphosphate and for potassium fertilization-potassium sulphate.

The area of sub-parcels for phosphorus fertilization, the rate of fertilization and the required amount of triple superphosphate are shown in Figure 7, Figure 8, and Table 1.

The area of sub-parcels for potassium fertilization, the rate of fertilization and the required amount of potassium sulphate are shown in Figure 9, Figure 10, and Table 2.

Phosphorus and potassium fertilizers are applied separately, after cleaning the weeds from the terrain. In order to achieve better homogenization of phosphate fertilizers with soil, it is recommended calculated in Table 1 fertilizer rates to be divided in two and to be applied twice. After fertilization, the area is ploughed at 15 cm in order to achieve better mixing of fertilizer with the soil. First three years after establishment of vineyard phosphorus and potassium fertilizers are not applied. During vegetation of vine is recommended to perform three or four times foliar fertilization with appropriate fertilizers, containing micronutrients and amino acids. Spraying of fertilizers can be combined with the performance of vineyard crop protection.

Table 1. Rate of fertilization (kgP_2O_5/ha) and required amount triple superphosphate (t)

Sub-parcel, №	Parcel, №	Area of subparcel (ha)	Rate of stockpiling fertilization with phosphorus (kg P_2O_5/ha)	Rate of TSP (t/ha)	Required amount TSP (t)
1	155	33.486	528.8	1.15	38.50
2	108 155	18.038	377.1	0.82	14.80
3	108	25.973	485.2	1050	27.30
4	157 158	13.688	548.0	1.19	16.30
5	157 158	27.913	477.8	1.04	29.00
6	113 158	20.237	521.1	1.13	22.90
7	158	6.741	485.6	1.05	7.10
Total:		146.075			155.90

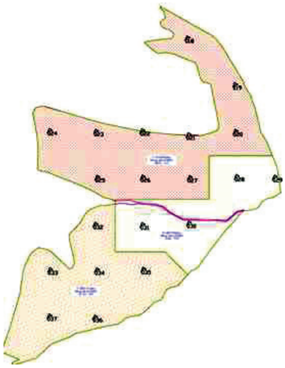

Figure 7. Distribution of area of parcels 108 and 155 into sub-parcels for phosphorus fertilization

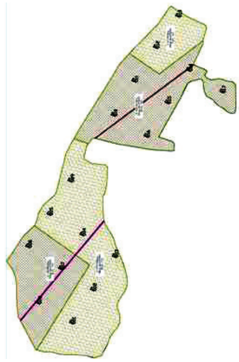

Figure 8. Distribution of area of parcels 113, 157 and 158 into sub-parcels for phosphorus fertilization

Table 2. Rate of fertilization (kgK_2O/ha) and required amount potassium sulphate (t)

Sub-parcel, №	Parcel, №	Area of subparcel (ha)	Rate of stockpiling fertilization with potassium (kg K_2O/ha)	Rate of Potassium sulfate (t/ha)	Required amount Potassium sulfate (t)
1	155	33.225	344.5	0.69	22.90
2	108 155	21.410	140.8	0.28	6.00
3	108	14.511	246.1	0.49	7.10
4	108	2.176	353.0	0.71	1.50
5	108	6.174	197.8	0.40	2.50
6	157 158	12.521	305.3	0.61	7.60
7	157	6.456	256.8	0.51	3.30
8	157 158	12.473	134.9	0.27	3.40
9	158	4.161	98.6	0.20	0.80
10	158	5.989	172.0	0.34	2.00
11	158	5.282	330.9	0.66	3.50
12	113 158	10.242	242.9	0.49	5.00
13	113 158	9.364	324.1	0.65	6.10
14	113	2.092	111.5	0.22	0.50
Total:		146.075			72.20

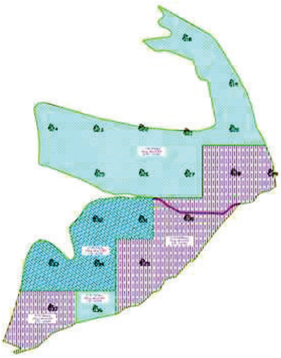

Figure 9. Distribution of area of parcels 108 and 155 into sub-parcels for potassium fertilization

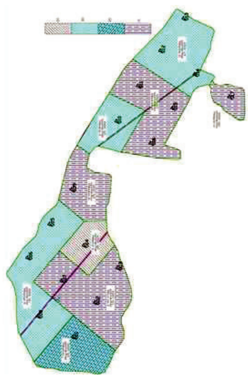

Figure 10. Distribution of area of parcels 113, 157 and 158 into sub-parcels for potassium fertilization

Phosphorus and potassium fertilizers are applied separately, after cleaning the weeds from the terrain. In order to achieve better homogenization of phosphate fertilizers with soil, it is recommended calculated in Table 1 fertilizer rates to be divided in two and to be applied twice. After fertilization, the area is ploughed at 15 cm in order to achieve better mixing of fertilizer with the soil. First three years after establishment of vineyard phosphorus and potassium fertilizers are not applied. During vegetation of vine is recommended to perform three or four times foliar fertilization with appropriate fertilizers, containing micronutrients and amino acids. Spraying of fertilizers can be combined with the performance of vineyard crop protection.

CONCLUSIONS

Advantages of this statistical method in the proposed model for geospatialization are that as a result of its application it is possible to outline sub-parcels for differentiated fertilization, with a proper from technological standpoint configuration.

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HYDROMELIORATIVE SOLUTIONS FOR IRRIGATION AND DRAINAGE OF VINEYARD IN NORTHWESTERN BULGARIA

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Abstract

The present work is a project for water supply and partial drainage of vineyard covering an area of 17.13 ha, located in the village Rayanovtsi, municipality Belogradchik in northwest Bulgaria. The aim is to provide the water quantities needed to supply drip irrigation system of the vineyard. It was designed and constructed a system for partial subsoil pipe drainage for discharging of excess groundwater, causing waterlogging of part of the terrain. Collected drainage water is important as an additional source, providing certain autonomy in the water supplying of the object. Performance of the tasks of this project is limited to applying a complex of technical-meliorative and hydromeliorative activities aiming to improve the drainage conditions in the non-drained part of the vineyard and to provide the necessary water amounts for the irrigation. In this paper are compared theoretical water balance calculations with the actual results from the first year of operation of the installation.

Key words: *drainage, irrigation, vineyard.*

INTRODUCTION

The following article represents a conceptual phase of a project for water supplement and partial drainage of vineyard with area of 17.13 ha, located in the northwestern part of Bulgaria – Rayanovtsi village, Municipality of Belogradchik. Project presents a bipartite acting ameliorative model in which with one technological solution is achieved solving two tasks:

- Drainage of a part of already established vineyard, where it is ascertained a periodic surface waterlogging.
- Independent emergency water supplement of vineyard as thus is provided the minimum required amount of water during the periods of extreme draught.

Dual-functioning drainage-irrigation system in this site is built after a preliminary hydro-geological observation in which is determined that the vineyard lies on a powerful granite, which is characterized limited drainage. The lack of alternative water sources and the low filtration capacity of the granite weathering materials, suggest us to the idea of building a drainage system, where the drained water is used for simultaneous emergency irrigation, while all elements of the system are assembled within the boundaries of the vineyard, without interfering with the common maintenance practices.

MATERIALS AND METHODS

Characteristic of the region

The vineyard is established in a region which geological structure is presented by a granite massif (Zagorchev et. al., 2009). The upper part of the massif at a depth up to 3.8m is highly weathered and gleyic (Figure 1). It is presented of sandy clays with single angular gravel, part of the primary rock. Under sandy clay elluvial material at depth up to 7-8m, is registered cracked and weatherd zone presented by angular gravel with sand filler. From 8 m to 38 m, during the drilling in the granite massif is separated zone of regional crack structure, characterized by sections of solid rock, alternating with cracked areas with thickness of about 0.5 m. At depth under 38 m, the massif is presented by dense and very solid granite, which strength increases in depth. Regional regularities of the section define it as part of the structure in which groundwater flows downward within a system of large and small cracks.

The relief of the region is slightly truncated. The main slope is east-southeast. Horizontal roughness of the relief within the whole site is

30 m. Regarding the formation and distribution of the flow the terrain is divided into two parts:

- Zone of a transit flow-mainly covers sites with a slope of more than 30. The soils in this area are well drained. Some of them are shallow and are formed on solid rock, forming water shields.
- Non-draining zone-covers enclosed shallow accumulative relief forms in the northwestern and central part of the terrain and routes of accumulation of groundwater flow, appearing to be stirred in east-west direction.

The groundwater flow cotters in described non-draining parts of the terrain. Poor natural drainage is naturally determined process. It is responsible for the formation of light grey forest soils with a strong contemporary hydromorfizm.

Described soil types have relatively heavy texture that determines the compaction of sobsoil. Waterlogging of surface horizons occurs periodically during the winter and spring.

From the surface downwards, the system could be considered as a hydraulically connected network of three zones.

Zone with thickness of 0.5-4 m composed of sandy clay. The zone has a low filtration features but not strong shielding role as regards to the infiltration of rain water. In sections where this zone is composed of more sandy varieties with small thickness, can be considered as a zone of aeration with juvenile waters, i.e. zone with periodic waters in which the water infiltrates vertically to the water table.

The gleyzation of feldspars acts as a water shield layer, creating pressure conditions for groundwaters. In clayey sections the zone is characterized by low water conductivity properties (k = 0.01-0.0001 m/d), while in areas with presence of more sand and gravel conductivity increase (respectively k = 0.5-0.01 m/d). By expertise for the intensity of infiltration recharge can be assumed value of 5.10^{-5}-$1,10^{-3}$ m/d.

Weathering crust from the zone of local cracks. Represents a dense network of micro and meso cracks. Its thickness is about 25-40 m, depending on the degree of weathering of the massif. During the hydrogeological observation of the massif in the middle of its body, was established a long watered zone. From the hydrodynamic point of view hydrogeological medium of this zone can be considered as heterogeneous and anisotropic hydraulic uninterrupted layer. The filtration ratio of the zone is about 1.10^{-4} to 5.10^{-5} m/d.

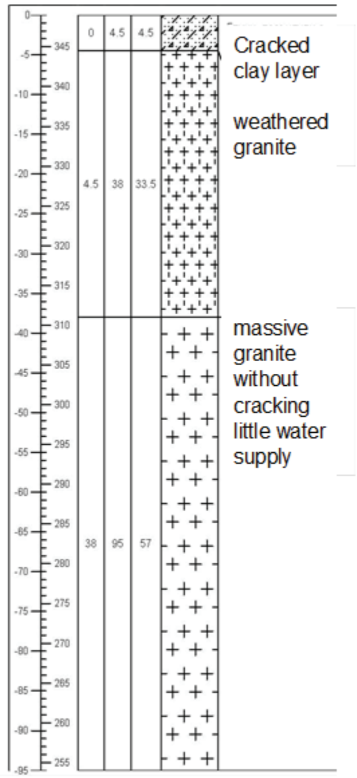

Figure 1. Research drilling column of the massif

Zone of deeper lying cracks. Water in them flows through cracked and weathered zones. Probably part of weathered cracks are affected by hydrothermal changes leading to gleyzation. Such zones have a barrage effect on the flow dynamics. Typical for the zone of regional cracks is the absence of one continuous piezometric surface. Therefore in hydrodynamic aspect the medium can not be considered as continuous. Approximation of the medium and solutions for the movement of water in it, can be searched solely by applying of numeric methods of analysis using the method of 'finite elements', and only in the cases when it is clear the geometry of the sections.

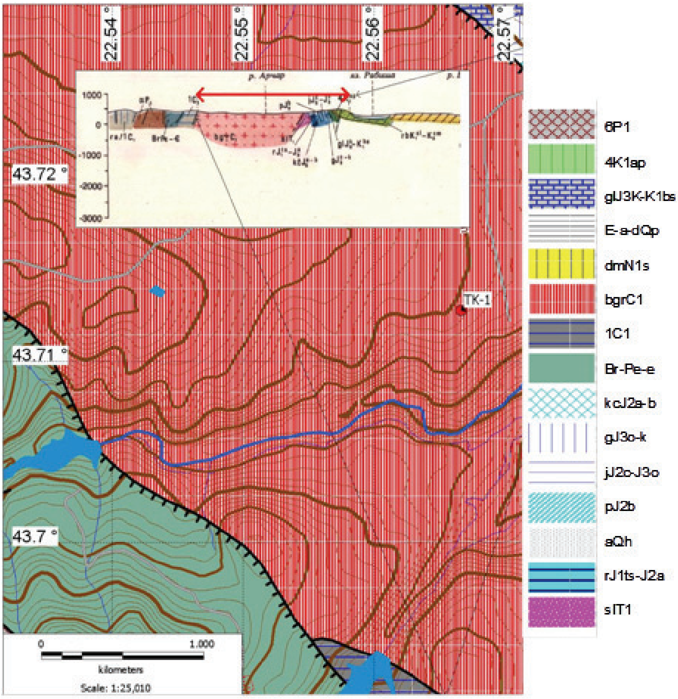

Figure 2. Geological map of the region. 6P1 – Volcanic rocks; 4K1ap-Urgonic limestone; glJ3K-K1bs-West Balcanic calcaric group; E-a-dQp-eolic alluvium and delluvium clay; dmN1s-sands, sandstones and detritussic limestones; bgrC1-Belogradtchik plutonite; 1C1; Br-Pe-e-gray and green shale; kcJ2a-b-diabases; gJ3o-sandstones; jJ2c-J3o-limestones; pJ2b;-sands and clays; rJ1ts-J2a-alluvium; slT1sandstones

Figure 1 shows geological column for the layout and depth of impermeable granite layers, and the Figure 2-sector of the geological map of Bulgaria showing the location of the terrain within the boundaries of granite plutonite.

RESULTS AND DISCUSSIONS

All research activities are focused on two general courses – first determining water supply capabilities of groundwaters, and second determining zones with water supply rates, sufficient for providing flow in the drainage canals.

The first task is solved through the implementation of exploratory drilling (Figure 3). To determine the hydrogeological properties of the medium, respectively, its filtration characteristics is carried out an experimental water extraction.

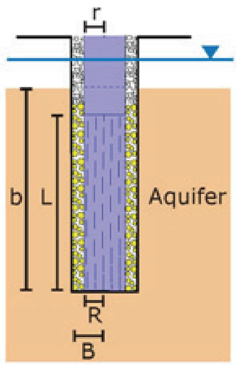

Figure 3. Scheme of exploratory column

In analyzing the results of the water extraction experiment the first eleven minutes from the start were ignored, due to low water extraction and conductivity of the medium. During the water extraction with flow rate of 0.7 l/s in the first eleven minutes the pump runs out the water from trunk, while the influx of water from the water supplying horizon is

considerably less. These facts are proven by the arrangement of the experimental results in this time interval in a straight line rather than in parabolic form, as would be normal.
Regarding the analysis of the results from the water level recovery, the first four minutes are disregarded, in order to remove the effect of the returned in the hose water in the drilling after stopping the pump.
The results of filtration experiments are shown on Figure 4. After summarizing it was concluded that in the medium around the two drillings, the conductivity is about 4.5×10^{-3}m/d. Water supply of the medium is about 1.3% (0.013). Its determination by the described manner we consider to be correct, since the experiment was conducted after dipping the pump directly into the drilling trunk – no filter zones were blocked. The drilling is regarded as ideal and that exploits the whole water supply zone, after it has considerably penetrated vastly into a solid massif. Data shows the average daily water capacity of the facility is 0.06 l/s.

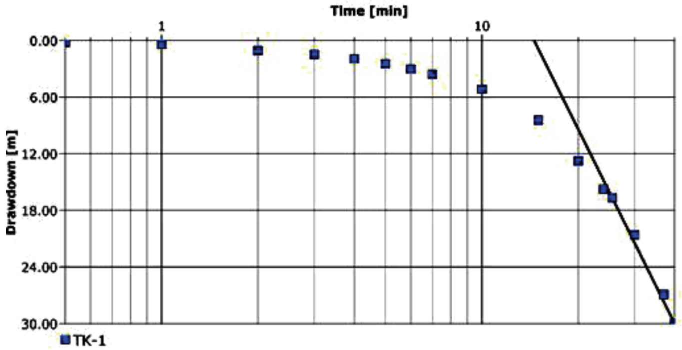

Figure 4. Results from a water extraction from drilling TK-1. Logarithmic time diagram

The main characteristics of the soil in the surface horizon are shown on Table 1. The presented data regards an average soil sample, representative for the layer in depth of 1m. The table shows that the soil is with heavy texture, where the clay and silt particles are dominant. Fine clay is about 25% from the contents of the physical clay. Water filtration ratio of the soil, measured in uninterrupted column at a pressure of 20 kPa, after reaching equliribrium water movement is low – 0.24 m/d. This limits the zone of action of the drainage pipes up to 12 m in both sides of the trace. In order to increase the radius of action we adopted height of the filtration bank to the level of the terrain. In destructed soil after reaching a bulk density of 1.4 g/cm3 the filtration ratio increases to 0.65 m/d.
Time for reducing of level to the set of drainage suction rate is 8 h. The height of reduced water level is estimated at 1.5 m, with a coefficient of water supply of 0.124.
The situation and the topography of studied terrain are shown in Figure 5. At the same scheme are given the traces of the drainage suction velves. They form a hydraulically connected network. Depending on the location of drainage canals, they function as canals for drainage of internal and external, regard to the limits of the terrain waters. Canals for the drainage of external waters are located at the borders of the terrain and cross the surface and shallow subsurface flow, as simultaneously they drain the adjacent zones of waterlogging. Canals located inside the terrain drain near lying groundwater in waterlogged zones. The direction and situation of drainage canals are in accordance simultaneously with the direction and position of the rows in the vineyard and with the local terrain topography.

Table 1. Soil characteristics

Parameter	Measure	Value
Physical clay (< 0.02mm)	%	56.6
Fine clay (< 0.002mm)	%	12.2
Arithmetic mean diameter of soil particles		17.10
Specific density in the level of drainage suckers, d	t/m^3	2.56
Bulk density in field capacity	t/m^3	1.37
Porosity	-	0.46
Filtration ratio before sub-soiling	m/d	0.24
Filtration ratio after sub-soiling	m/d	0.65
Average coefficient of filtration for the drainage layer	m/d	0.61
Time for reducing of water level	h	8.0
High of unreduced water level	m	1.5
High of reduced water level	m	0.6
Coefficient of water supplying	-	0.04
Depth of pipe laying	m	1.2

Figure 5. Situation and topographical plan of the drainnage canals

Table 2. Hydraulic dimensioning

Parameter	Volume	Dimension
Dimensioning module of drainage flow	0.83	$l/s/km^2$
Dimensioning the maximal area of drainage	21000	m^2
Dimensioning water quantity	17.43	l/s
Diameter of pipe	0.110	m
Wetted perimeter	0.35	m
Hydraulic radius	0.03	m
Roughness Y	0.02	
Speed coefficient, C	79.34	
Speed of open canal flow	0.211	m/s

The transverse profile of the drainage suckers is shown in Figure 6. Data from the hydraulic dimensioning of the drainage system are given in Table 2.

Canals are dug with a rotary trencher, at a depth that ranges between 0.70 and 1.50 m, depending on the longitudinal profile of the terrain. The depth of the trench along the whole trace exceeds projected depth in the corresponding section. Thus, the precise levelling of the bottom is achieved by filling of sand cushion. Sand layer is levelled manually and compacted to 14 KN,dm^{-3}. Precise levelling up to ± 0.01 m is completed in each 5.00 m along all traces. On the sand layer are laid corrugated drainage pipes with perforation at 270º of the transverse profile. The diameter of the pipes is accepted everywhere along the project traces at 100 mm. At this size and in set with the measurements of longitudinal profiles gradients is accepted a drainage capacity exceeding the designed hydraulic loadings. Additional capacity for increasing hydraulic radius of the drainage system is expected to be obtained from the sand-gravel filter backfill that fills the free volume of the transverse profile to the surface. By laying of the backfill the system drains both surface and near laying groundwater.

The application of the system over the water shield on the sand cushion produces imperfect work regime of the drainage system along the whole trace.

In this way is achieved an increase in the radius of drainage action if it is kept the condition for sufficiently low hydraulic resistance in the drainage canals. The calculation is made by Manning's formula for free-surface flow (Dooge, 1992). Water from drainage pipes is collected in a tank with a volume of 45 cm^3 cubic meters and from there are pumped under pressure and transferred to the main water reservoir with volume 987 cm^3. From this tank water is used for irrigation of vineyard during the periods of extreme drought with an automated drip irrigation system. Block scheme of the facility is shown in Figure 6.

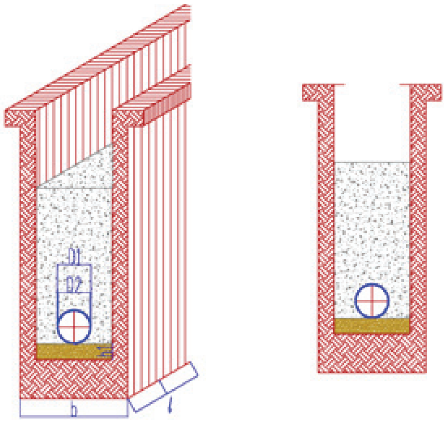

Figure 6. Transverse profile of the drainage sucker

The implementation of the projected ameliorative system begins with building of a discharge facility in the sedimentation pits. It is implemented from prefabricated elements. Drainage discharge includes manhole shown on the same drawing (Figure 7).

After the construction of the discharge installation is traced and excavated the route of the local collector in its part outside the existing vineyard. Hand trench of the rest of the collector is consistent hydraulically and is implemented after completion of excavation works. The final design and levelling of the trench is made after its full realization.

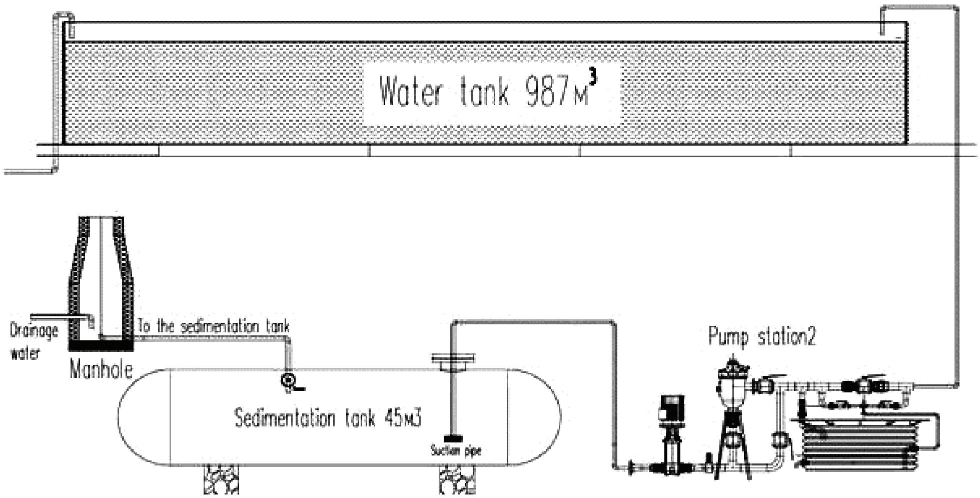

Figure 7. Block scheme of the system

CONCLUSIONS

The technological decision for construction of drainage system with possibilities for collecting water from the drain flow is a high tech meliorative solution that can be created in relatively rare cases when the high level of groundwaters during winter is combined with strong and extremely dry summer.

In its construction should be borne in mind that the collected water flows in all cases is insufficient to cover the requirements of plants and to ensure normal irrigation regime. In this case constructed meliorative bypass system can cover about 15% of the estimated quantities of water from which the plantation needs in extremely dry years.

In practice this means that in the course of vegetation can be realized one watering, with rate of about 15 dm^3 per vine. This amount of water should be applied within the period of growing of grapes, when there is maximum water need in conditions of the highest evapotranspiration of the plantation.

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SPATIAL VARIATION OF PHYSICAL CLAY AND ORGANIC CARBON IN THE COMPLEX OF CINNAMON FOREST SOILS (CHROMIC LUVISOLS) AND THEIR SUITABILITY FOR CULTIVATION OF VINES

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Abstract

Object of this study are lands in the village Balabanchevo, municipality Sungurlare, Bulgaria. The main soil type in the region is Chromic luvisols with soil profile differentiated to different degree. In the current work is studied the spatial variation of soil organic matter and physical clay content, depending on the topographical location and the degree of erosion.
Studied soils are characterized by two main processes that determine the their particle size distribution - lessivage, causing accumulation of clay in subsoil and surface erosion, which is responsible for removal of relatively sandy upper layers and remaining of clayey subsurface horizons on the top.
In this research is determined particle size distribution in three depths - 0-25, 25-50 and 50-75 cm and the content organic carbon in the surface horizons.
Differences in clay content determined in the three studied depths are substantial and statistically significant.
Differences between sampling points in respect toorganic matter content are insignificant. Relatively high levels of humus content is detected only in a small part of investigated area, where are distributed relatively dark colored soils with expressed meadow soil formation process, and in the northern and the southern parts, where to some extent more strongly is retained humus formation effect of the natural vegetation.

Key words: *Chromic luvisols, geospatialization, organic carbon, physical clay.*

INTRODUCTION

In topsoil, the ideal soil structure is formed by predominantly crub-like aggregates, best formed when organic matter is naturally high (> 2% organic carbon content) and well humified (Greenland et al. 1975). The role of organic matter is less significant in the subsoil where the soil texture and the exchangeable cations are more important (Bronick and Lal, 2005).
Soils rich in organic matter are generally high in available nutrients.
Soil texture is an important consideration in variety and rootstock selection due to its effect on vine growth and potential nematode and/ or phylloxera damage. Soil texture largely influences vine growth due to its effects on water holding capacity and nutrient availability. Generally, finer-textured soils have a higher water holding capacity and higher native fertility thereby producing vines of higher growth potential as compared to sandy soils (McKenry and Christensen, 1998). Clay soils can fix potassium in soil, thereby decreasing the availability of this nutrient to the plant. Particle size distribution however is an absolute limitation when the content of physical clay is less than 10% or more than 70%.
Present study is a part of soil amelioration survey of derelicted, because of their low natural fertility terrains in the hilly Central Eastern part of Bulgaria. The task we set ourselves is to be defined the boundaries of soil heterogeneity in relation to organic carbon content and particle size distribution of soil.

MATERIALS AND METHODS

During the current research we accepted a model for collecting of soil samples in which each sample is taken from the terrain with soil probe as the sampling points are situated in square grid, regardless of the borders of soil types and local terrain topography. We studied two sections-parcels 108 and 155 (Figure 1), which have complex topography and parcels 113, 157 and 158 (Figure 2), where the terrain is relatively leveled and with slightly rough and monotonous relief. Parcels 108 and 151, and parcels 113, 157 and 158 are adjacent and form two contoures. In both sites we take individual soil samples from three depths – 0-25, 25-50 and 50-75 cm for each point (position of sampling points is marked in Figure 1 and Figure 2). The location of points was previously mapped and coordinates were entered into the Global Positioning System-GARMIN, allowing to determine the location of each point to an accuracy of 1m.

After standard preparation of soil samples it is established particle size distribution in the three depths by pipette method (Trendafilov and Popova, 2007) and organic carbon content according to ISO 14235:1998.

Soil morphology. Within the boundaries of studied area are established two soil types:

Cinnamon forest soils (Chromic luvisols)

Chromic luvisols, within the terrain are shallow, moderate to severe eroded. Parent material is hard, silicate, presented of highly weathered granite, metamorphites of granite and paleovolcans. Weathering crust is shallow and most often its depth does not exceed 10-15cm. The morphology of soil profile is typical for the cinnamon forest soils (Chromic luvisols) in the region. The surface horizon is elluvial pale, highly washed in respect of bases. Its depth ranges from 0 to about 15-18 cm. Subsoil is represented by metamorphic illuvial yellow-reddish coloured horizon with depth up to 40-50 cm, with heavy texture and compacted significantly.

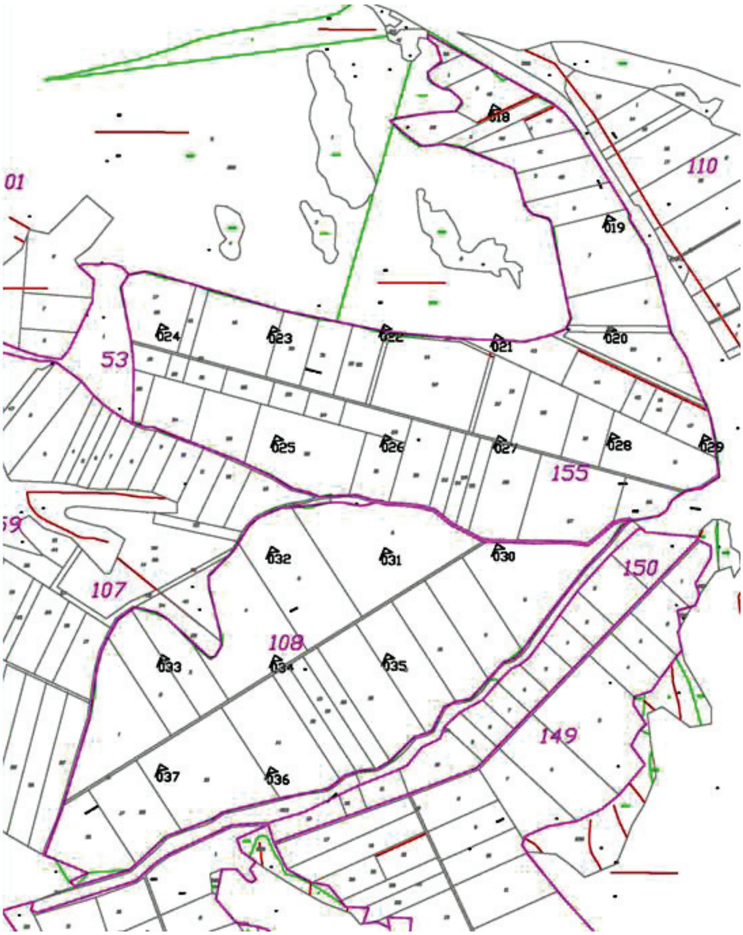

Figure 1. Situation and location of sampling points in parcels 108 and 155

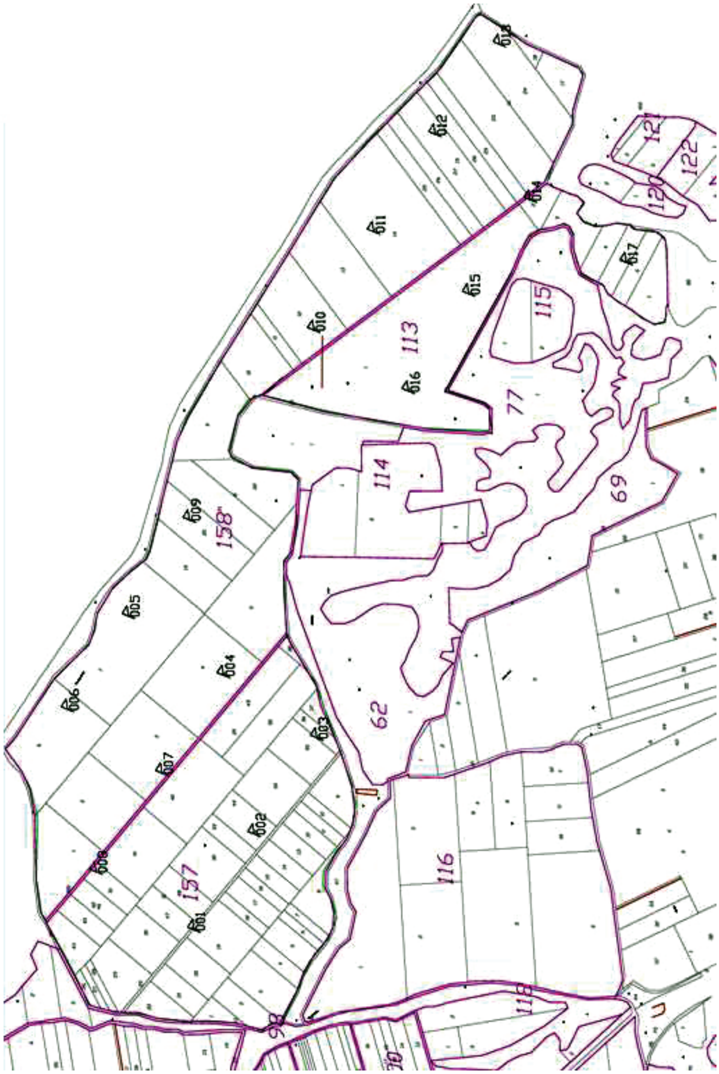

Figure 2. Situation and location of sampling points in parcels 157, 158 and 113

Most shallow profiles are established in the higher parts of the terrain where the soil is very severe eroded and on the surface is established the transitional, illuvial-metamorphic horizon. In some parts of the terrain with limited area on the surface is established the bottom 1/3 of the illuvial horizon which is skeleton with materials from the horizon C.

The structure of surface horizon is highly powdered and in the illuvial-metamorphic horizon-lumpy-prismatic, dappled with non-carbonate skeletal material whose granulometry is characterized by rock fragments with sizes in the range of 10 to 50 mm. In the zone of most active accumulation of clay in the illuvial horizon is established strong surface gleization, presented of stains, dots and concretions of manganese and iron oxides.

Severe eroded leached cinnamon forest soils, shallow

The depth of the humus horizon is between 10 and 20 cm. In some parts of the terrain which have limited area humus layer is completely reduced, as a result of sheet erosion. Total depth of the soil profile is 50-60 cm. The deeper layers of the soil profile are highly skeletal. The skeletal part turns into shallow weathering crust.

Shallow leached cinnamon forest soils have limited availability for cultivation of vines. These soils may be included within the vineyard with its peripheral parts of the distribution in order not to be disturbed the overall plan of the plantation.

RESULTS AND DISCUSSIONS

Soil texture

As stated above, mechanical structure is an important feature of the suitability of soil for wine growing and in a narrower meaning-for the choice of rootstock.

Studied soils are characterized by two main processes that determine the their particle size distribution-lessivage, causing an accumulation of clay in subsoil and surface erosion, which is responsible for removal of relatively sandy upper layers and remaining of clayey subsurface horizons on the top. In cases where the soil profile is relatively shallow and undeveloped in its lower part are established significant percentage of skeletal fractions-stone, sand and gravel.

The type, size and distribution of skeletal fractions within the soil profile are not significant limitation of the soil suitability for wine growing.

The overall impression given by the obtained results for particle size distribution is that soils are relatively clayey. Average content of physical clay is 55.5%, with no substantial differences in parcels. Relatively the lowest clay content is found in parcel 108-average 47.73%, while the highest – in parcels 157 (64.6%) and 113 (63.8%). Differences between the parcels, in terms of content of clay are insignificant.

From Figure 3 can be seen that the increase in content of physical clay, i.e. the presence of accumulated clay in subsoil is typical for parcels 155, 157 and 158, while in the other this trend is not clear. Differences in clay content for the three studied depths are substantial and statistically significant.

Interpretation of the data indicates that if during the preliminary preparation terrain the tillage is performed at a depth of 70-75 cm, the average content of clay in this layer will be less than 60%, which is generally favorable for the development of root system of all known and used in practice vine rootstocks. If the tillage in made at depth of 75 cm. with turning and homogenization of the layer, average content of clay over 60% will be established in 60% of the area of all terrains.

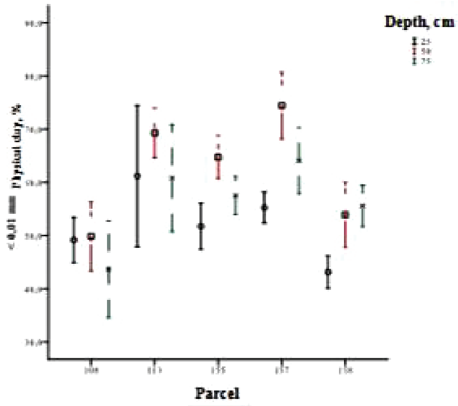

Figure 3. Changes in content of physical clay in parcels and depths, with intervals of variation

In cases when the ploughing is made in the upper 50 cm, the sections in which the plough layer will contain over 60% clay, will increase to 75% from the whole area.

The reason is that the soil composition in the deepest layer is very skeletal, which is a favorable opportunity to enrich the root active horizon with skeletal fractions.

Described average clay content, visible in raw form in Table 1 and displayed graphically in Figure 3 does not actually reveal that in this case, behind the averages is hidden a large variation of clay content in different samples from the field.

Data for the frequency distribution Figure 4 of the content of physical clay presented separately in depths of investigation (in the rows on the chart) and parcels (columns in the chart) shows that values of physical clay greater than 60% are highly unlikely in the surface horizons of parcels 108, 157 and 158, but in other parcels the variance of values higher than 60% physical clay is significant.

In deeper horizons up to 50 cm is more probably clay content to be established above 60% rather than below this value, while horizons with depth 50-75 cm take an intermediate position.

From the viewpoint of above analysis we can conclude that in the parcels 108 and 113 is necessary to use of rootstocks which are resistant to high clay content in the soil, such as SO4, or rootstock hybrids close to it. In other parcels this is not so decisive condition.

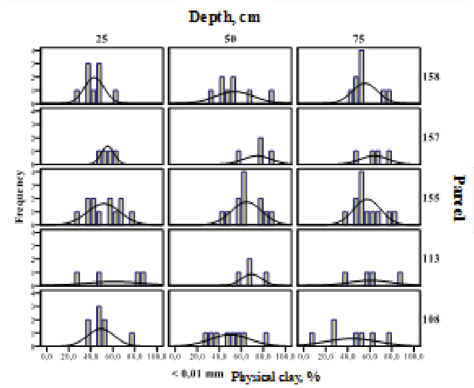

Figure 4. Frequency distribution of physical clay fraction in parcels and depths

According to particle size distribution the studied soils are classified [1] as follows:

In the surface horizons more common texture classes are heavy loam (35.1% of the total area), followed by medium loam (32.4%). In these sections physical clay content is up to 60% of the mass of soil and that is favorable for the development of vine roots, without significant limitations. Clayey variations at this depth are established in 13.5% of cases of investigation.

At a depth of 25-50 cm medium loam are established only in 16.7% of the cases of investigation, while heavy loam-in 36.1%. Clayey varieties are found in over 1/3 of the cases, i.e. in practice they are the most widespread in all study sites.

At a depth of 50-75 cm the most widespread are heavy loam soils with physical clay content from 45 to 60%, i.e. the clay content is in the range that is suitable for the vines grafted on appropriate rootstocks.

Shallow, leached cinnamon forest soils established within the terrain, can be used if the soil profile depth is more than 60 cm. It is appropriate in this area, soils not to be deep ploughed. As a primary tillage there can be applied meliorative deep loosening.

In the total sample, characterizing the whole surveyed area and through the whole depth of plough layer (unless it is more shallower than 75 cm) is more probably to be established clay content up to 60%, as the terrains in which it is higher will be an exception.

The spatial distribution ofphysical clay content in 0-75 cm layer in investigated parcels is presented in Figure 5 and Figure 6

Textural classes are defined according to classification developed by Kachinskii (1965).

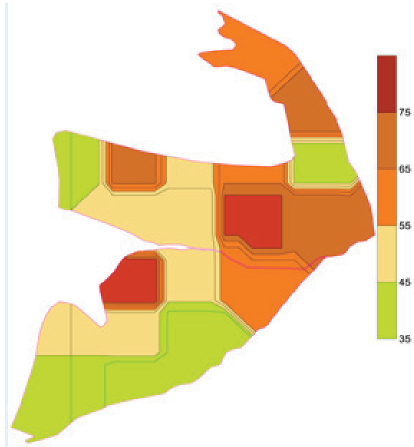

Figure 5. Spatial distribution of physical clay content in 0-75 cm layer in parcels 108 and 155

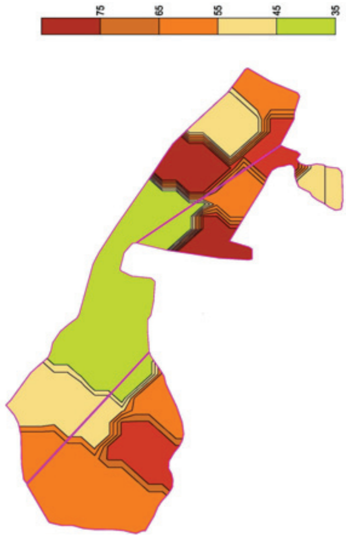

Figure 6. Spatial distribution of physical clay content in 0-75 cm layer on parcels 157, 158 and 113

During the survey there are established processes of present hydromorphism. This gives reason to predict unfavourable water and air regime in highly compressed subsoil horizons, which will occur after the entry of the vineyard into the fruit-bearing period (3-5 years after the pre-planting tillage).

This necessitates performing of periodic subsoiling of the soil with single ax subsoiler in period of 3-4 years. When performing this tillage, should be followed the technological requirements for optimum soil moisture at the time of subsoiling-moisture 50-65% of field capacity.

Soil organic matter content

Average humus content (Figure 7) expressed as organic carbon is low-1.22% for the whole area of investigation. The differences between parcels in terms of organic matter content are insignificant, except parcel 113 in which humus is only 0,85%-significantly lower than in the other investigated parcels and far below the average for the whole studied area.

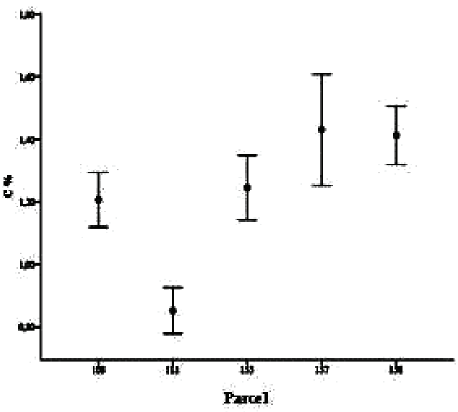

Figure 7. Average content and intervals of variation of organic carbon content in the surface horizon in the investigated parcels

Average content of humus in the parcel 108 is 1,22 ± 0,09%, and in 155-1,24 ± 0,1%. A higher content of humus in parcel 155 is due to the presence of soils with meadow process of soil formation in which humus is higher. Most frequently established humus content in both parcels in contour 1 is 1.2%, as in parcels 155 and 158 are determined values above 1.8%, but as an exception. (Figure 8).

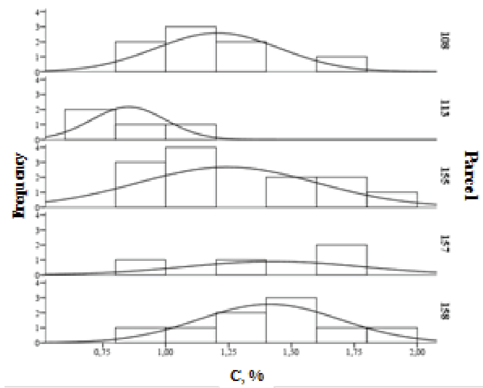

Figure 8. Frequency distribution of organic matter content

Figure 9 and Figure 10 shows the spatial distribution of humus content in the area of studied parcels. It is seen that relatively higher values of humus content are established only in a small part of parcel 155, where are distributed relatively dark colored soils with well expressed meadow soil formation, and in the northern and the southern parts of both parcels where to some extent more strongly is retained humus formation effect of the natural vegetation.

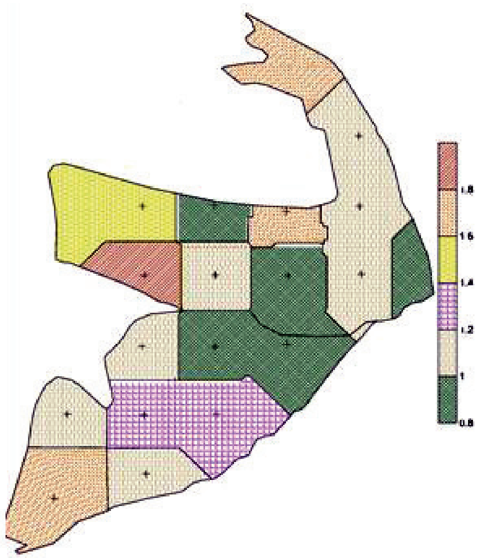

Figure 9. Spatial distribution of soil organic matter content in parcels 108 and 155

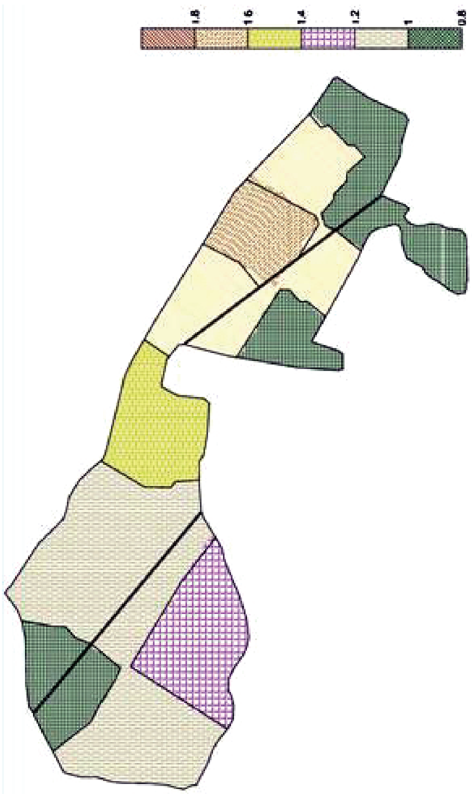

Figure 10. Spatial distribution of soil organic matter content in parcels 113, 157, 158

CONCLUSIONS

Described regularities in the distribution of physical clay and total data for particle size distribution of studied soils shows that, although values are very most favorable for the development of vine this indicator is not a significant limitation. Negative effects of high values of this parameter can be overcame by application of appropriate tillage and use of appropriate rootstocks.

Soil organic matter content, despite of its low levels is not a limitation for the suitability of land for vine growing, but it determines relatively weak vigor and requires application of less vigorous trainings.

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A SURVEY STUDY ON DETERMINATION OF FARMERS' OPINIONS ABOUT THE LAND CONSOLIDATION PROJECT IMPLEMENTED IN TURKEY, WITH SPECIAL REFERENCE TO BURDUR PROVINCE

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Abstract

Land consolidation is of special importance to the efficient use of land and water resources and sustainable agriculture in countries like Turkey where dense land degradation exists. The benefits expected from land consolidation projects depend on farmers' participation and the fulfilment of their expectations. Therefore, this study aims to investigate to what extent farmers' expectations were met and whether their satisfactions with the new parcel planning were fulfilled through the project implemented in some villages in the province of Burdur, Turkey.This study was conducted in 5 villages of Burdur located in the Mediterranean region. For this purpose, some 159 agricultural enterprises were selected using the stratified sampling method. The Likert-scale survey was used in this study; statistical data analyses were carried out; and some descriptive statistics were presented. It was found that 50.9% of the farmers indicated that their preferences were fulfilled; however, 34.6% of the farmers indicated that they were badly affected by the new parcel planning.

Key words: *land consolidation, survey, Likert scale, Burdur.*

INTRODUCTION

Land consolidation is mainly defined as bringing together those agricultural lands which prevent the formation of parcels convenient for management and which have been fragmented, scattered and deformed to the extent that will complicate the implementation of irrigation and agricultural production techniques and consolidating them in regular shapes (Kara, 1980). Today land consolidation is implemented in the form of projects in which many infrastructural services such as drainage, land levelling, land reclamation, road construction and the rearrangement of village settlement centres are carried out altogether, along with the merging of parcels and the correction of their shapes. In this sense, land consolidation projects can be regarded as one of the most important infrastructural services with respect to the rearrangement of the rural area. Besides many benefits such as cutting down on the cost of infrastructural projects, the facilitation of the implementation of modern agricultural techniques, saving of workforce and time, the increasing of arable agricultural lands, the irrigation of agricultural lands, saving of the materials used to protect parcels, the provision of assurance for land ownership, and the establishment of economic and social balance in the rural area (Arici, 1994; Yaganoglu et al., 2000), the land consolidation projects carried out in the modern sense positively contribute to the scheme performance indicators by enhancing the water use efficiency and the dependability of distribution of water in irrigation schemes (Uçar and Kara, 2006). Many researchers reported that average parcel size was increased but shapeless parcel was decrease with land consolidation projects (Uçar and Kara, 1997; Uçar et al., 2003).

It is reported that land consolidation can be implemented in 14 million ha of 28 million ha of agricultural lands in Turkey, and it is stated that land consolidation has been completed in 1,115,000 ha of this area (Manavbasi et al., 2012). In order for consolidation projects to become widespread and in order to easily get the approval required for the commencement of the projects from farmers, it is necessary to eliminate the hitches that might occur in the implementation of the projects. To determine what these hitches are, to propose solutions to them and to determine farmers' satisfaction with the project at the end of the project, it is necessary to eliminate the problems that might take place in the carrying out of consolidation projects and to determine farmers' satisfaction with these projects at the end of the project.

In Turkey, Burdur is one of the provinces where land consolidation has become widespread in the recent years. Totally 5 projects (Mürseller, Elmacik, Bademli, Akçaköy, and Kozluca) were completed in Burdur between 2002 and 2010. How satisfied the farmers in the areas where land consolidation had been carried out in Burdur were with the land consolidation projects was established with this planned study. For this purpose, the farmers were surveyed, and solutions were offered to the problems determined.

MATERIALS AND METHODS

The villages of Mürseller, Elmacik, Bademli, Akçaköy and Kozluca in Burdur, where land consolidation projects were carried out, were considered the material in the research. Some features of these projects are provided in Table no 1.

The questionnaire was used as the data collection tool in this study. The questionnaires were filled in through face-to-face interviews. The questionnaire form prepared using the five-point Likert scale consists of 20 questions in total. The hypotheses in the scale used in the research were measured with the 5-point Likert scale. In both ends of each item of the scale are the categories of 1 (strongly agree) and 5 (strongly disagree). Alternatives 1 and 2 that are marked for the hypotheses set forth denote a positive opinion, whereas alternatives 4 and 5 denote a negative opinion. Score 3 in the scale indicates that no opinions have been developed for the factor concerned. Considering this case, it was commented that the enterprise owners agreed with the hypotheses with an average below 2.5 but disagreed with the hypotheses with an average above 2.5.

In order to establish to which and how many of the existing agricultural enterprises that had benefited from the land consolidation project a questionnaire would be applied in the study, first of all, the number of enterprises that had benefited from the project in the project area was determined. After the determination of the total number of enterprises, the enterprises were arranged according to the land size and a population determination table was created. Since the farmlands owned by the enterprises that constituted the population according to the population determination table varied within extensive boundaries, the coefficient of variation was computed. The sum of lands of all agricultural enterprises constituting the population was computed in the process of stratification. The Quartile Calculation Method was used in the process of stratification. The sample volume was computed by the help of the following formula according to Neyman's Method and with Stratified Sampling from the Framework table (Yamane, 2001).

$$n = \frac{(\sum N_h S_h)^2}{N^2 D^2 + \sum N_h S_h^2}$$

n: Sample volume,
N: Number of enterprises in the population,
N_h: Number of enterprises in the *h*th stratum,
S_h: Standard deviation of the *h*th stratum,

$$D^2 = \frac{d^2}{Z^2}$$

d: Allowed deviation from the population average (amount of errors)
Z: The value of the allowed confidence limits in the distribution table,
The following equation was used to distribute the sample volume which was calculated by means of the above-mentioned equation into strata (Yamane, 2001).

$$n_h = \frac{N_h S_h}{\sum N_h S_h}$$

Table 1. Some land consolidation projects implemented in the province of Burdur and their features

Name of Village	Project Area (ha)	Year of Project	The project was carried out by
2nd part of Akçaköy	400	2008	TRGM (The Directorate General of Agricultural Reform)
Bademli	1,900	2008	TRGM (The Directorate General of Agricultural Reform)
Mürseller	425	2002	The Special Provincial Administration of Burdur
Elmacik	295	2005	The Special Provincial Administration of Burdur
Kozluca	597	2010	The Special Provincial Administration of Burdur

RESULTS AND DISCUSSIONS

At the end of stratified sampling, totally 159 farmers, 32 from Akçaköy, 24 from Bademli, 26 from Elmacik, 51 from Kozluca and 26 from Mürseller, participated in the questionnaire. Of the respondents, 3.77% were aged between 0 and 30 years, while 28.93% were aged between 30 and 50 years and 67.30% were aged over 50 years. The rate of the illiterate was 13.21%, whereas the rate of the literate was 86.79%. The rate of the enterprises with 0 to 3.99 da of land in the study area was 46.54%, while the rate of those with 4 to 7.99 da of land was 28.30% and the rate of those with more than 8 da of land was 25.16%. Of the farmers who participated in the questionnaire, the enterprises with 2 parcels had the highest rate (44.65%), followed by the enterprises with 3 parcels (24.53%), 5 parcels (11.32%), 4 parcels (10.06%), and 1 parcel (9.43%) (Table 2). The mean, standard deviation, chi-square and P values concerning the responses to the hypotheses used to measure farmers' satisfaction in the study area are seen in Table 3. When the means of the responses to the hypotheses in Table 3 are examined, it is seen that the farmers in the study area did not regard their lands as a property that could be bought and sold or as an economic area on which production was carried out, but they were emotionally bonded with their lands. From the responses to hypothesis H2 that determined enterprises' approaches to the project before the project, it was seen that the farmers had had no positive opinions before the project and that when deciding on the carrying out of the project, they had not been influenced by those projects which had been performed before. The farmers reported that it was failed to pay necessary attention to the production of the soil classification map, one of the important stages of land consolidation projects, and that the map produced did not reflect the real condition of the land and they consequently objected to the soil classification map. However, it was seen that the objections were not considered right by

Table 2. Some characteristics of the respondents

Characteristics	N	%	Characteristics	N	%
Age			**Gender**		
0-30	6	3.77	Female	0	0
30-50	46	28.93	Male	159	100
50+	107	67.30	**Number of parcels**		
Education			1	15	9.43
Illiterate	21	13.21	2	71	44.65
Elementary school	80	50.31	3	39	24.53
Secondary school	44	27.67	4	16	10.06
High school	14	8.81	5	18	11.32
University	0	0	**Village**		
Land assets of enterprises			Akçaköy	32	20.15
0-3.99	74	46.54	Bademli	24	15.08
4-7.99	45	28.30	Elmacık	26	16.35
8+	40	25.16	Kozluca	51	32.07
			Mürseller	26	16.35

Table 3. Results of the analysis of the scale items

Questions of the questionnaire	Means	Standard Deviation	Chi-Square	P Value
H1-I am emotionally bonded with my land (Bonded)	1.91	0.447	22.107*	0.036
H2-Our approach to land consolidation had been positive before beginning the project.	2.89	1.102	77.171**	0.000
H3-We had been influenced by the land consolidation projects carried out in other places when deciding on the carrying out of the project.	2.85	1.026	60.513**	0.000
H4-Necessary attention was paid when producing the soil classification map.	2.82	0.940	64.545**	0.000
H5-The soil classification map produced fully reflects the condition of the land.	2.87	0.982	57.200**	0.000
H6-Objections to the soil classification map were raised.	2.19	0.667	26.251*	0.010
H7-Your objections to the soil classification were corrected.	2.89	0.921	60.448	0.000
H8-Your preferences were (not) abided by when drawing up new parcellation plans.	2.79	0.949	61.747**	0.000
H9-The objections to the new parcellation plan were corrected.	2.86	0.913	58.749	0.000
H10-You suffered loss from the land consolidation project.	3.21	0.990	29.197**	0.004
H11-Your drainage problem was solved.	2.98	0.894	13.296	0.651
H12-Our irrigation system was completed with land consolidation.	2.45	0.816	19.221	0.083
H13-All procedures in the land consolidation project were carried out on time.	2.75	0.941	44.987**	0.000
H14-I was badly affected as the land consolidation project was not completed on time.	3.42	0.937	20.179	0.212
H15-The road quality improved following consolidation.	2.45	0.919	50.580**	0.000
H16-The use of workforce per unit area increased.	3.53	0.525	5.586	0.694
H17-The irrigation cost increased.	3.08	0.665	15.661*	0.047
H18-The product yield increased.	2.43	0.510	18.720*	0.016
H19-The number of parcels increased.	3.93	0.463	29.397**	0.003
H20-Producers' satisfaction increased.	2.45	0.761	43.088**	0.000

Note: Scale: 1: Strongly agree, 5: Strongly disagree.

the project administration and that the errors on the soil classification map were not corrected.

Prior to the project, farmers are interviewed and the requests by farmers are obtained during the planning of the new parcellation. This is crucial to the success of the project and to the acceptance of the new parcels. The farmers stated negative opinions for the question which was asked to determine whether the requests by the farmers had been fulfilled or not. In other words, it was substantially failed to fulfil the requests by the farmers. It is seen that the objections to the new parcellation plan which were submitted to the project administration for the fulfilment of the requests by the farmers were not corrected either. Although the objections to the new parcellation plan were not corrected by the project administration, the respondents reported that they had not been badly affected by the land consolidation project when the project was over. Likewise, it is seen that even though the procedures in the project were not completed on time in accord with the work plan, this delay was not reflected negatively in the farmers. While it was reported that no improvement was experienced regarding the problems about drainage – an infrastructural service – at the end of the consolidation project, it was seen that they remained undecided about the improvement in the road quality. It was reported that the use of workforce did not increase – in other words, decreased – in the study area, which is one of the essential outcomes of land consolidation projects. Likewise, it was established that there was no increase in the irrigation costs either. It might be stated that this result is in agreement with the decrease in the number of parcels in H18. It is seen that the farmers were undecided about the questions concerning the increase in the product yield and the determination of producers' satisfaction following the project.

In the chi-square independence tests, it is seen that the responses to hypotheses other than hypotheses H11, H12, H14 and H16 were independent of the villages (P=0.05), that is, there was no difference in the responses among the villages (Table 3). It is seen that the difference in the responses to hypotheses H11, H12, H14 and H16 among the villages was significant.

CONCLUSIONS

The obtaining of the benefit expected from land consolidation projects depends on the full reflection of the project area by the soil classification map, on making interviews with farmers in accord with the criteria, on drawing up the new parcellation plan in agreement with the interviews, and on completing other infrastructural services such as irrigation, drainage, road and land levelling on time. The non-occurrence of the parameters concerned will bring about the failure of farmers to adopt new projects besides the failure to obtain the benefit expected from the projects. It is seen that the soil classification map in the area where the questionnaire was carried out did not reflect the real condition of the land and that although it was stated that no correction was made despite the objections to both the soil classification map and the new parcellation map, the farmers were generally not badly affected by this case. It might be stated that the undecidedness of the enterprises about producers' satisfaction resulted from the failure to respond positively to the objections by the farmers in the carrying out of the project. The satisfaction at the end of the project can substantially increase provided that the reason why the objections by farmers have been negatively answered can be explained, even if they are not positively answered as required by the criteria for carrying out the project.

In conclusion, project employees should be equipped in terms of "public relations", besides their technical knowledge and skills, in land consolidation projects where the participation of farmers is extremely important for the success of the project. In this context, it is thought that the consideration of the results obtained from the research by decision-makers and project planners will contribute to the easy adoption of projects by farmers and to the enhancement of their satisfaction.

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COMPARISON OF SYSTEMS FOR TAXONOMY AND CLASSIFICATION OF SOILS FOR DESCRIPTION OF SOME DEGRADATION PROCESSES OCCURRING IN THEM

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Abstract

The aim of this work is based on data from large-scale soil survey, and on our own research to try to systematize and evaluate the main and economically significant factors for degradation of the complex of Cinnamon forest soils (Chromic luvisols) located near the town of Svilengrad, southeast Bulgaria. On the basis of data from large-scale soil survey, which is mainly based on genetic method for soil taxonomy is made generalization of soil map data, as are kept the requirements for conformity of soil types according to classification of FAO and the International soil database. Separate soil units are evaluated about: the degree of development of soil erosion, particle size distribution, degree of dehumification and soil acidity to a level harmful for the main agricultural crops. In the discussed in this study, complex of Cinnamon forest soils, was found that the differentiation of soil types on the basis of an improved system for taxonomy and classification, used in the FAO classification, better reflects the extent and direction of the degradation process. This is achieved without explicit mention of any of the degradation processes in the name of the soil units.

Key words: *Chromic luvisols, classification, degradation, taxonomy.*

INTRODUCTION

In modern interpretations of the problem soil and land degradation is a term which is interpreted very broadly according to the context of the study. The term 'degradation' generally means reducing of the effective soil fertility, which is associated simultaneously with alteration of the morphology and composition of the soil.

The main degradation processes of soil, including those in Bulgaria are the massive in recent years erosion of the lands, acidification, pollution with harmful to plants mineral and organic components, reduction of soil organic matter, loss of biodiversity, salinisation, compaction, mechanical excavation, and waterlogging. These processes are subject of extensive study both in specialized soil literature and in the broad researches examining the soil cover and its capacity as a link in the chain of agricultural production (Dregne, 1992; Eswaran and Dumanski 1994; Fahnestock et al., 1953).

During the continuing in recent years tendency for reducing of effectively used lands, first are eliminated soils with low natural productivity that simultaneously are located in problematic demographic areas. Most of them are genetically acid soils in low-forest zone mainly greyish brownish and light gray pseudopodzolic forest soils in the northern Bulgaria and cinnamon forest soil with differentiated to different degree profile - in the southern. The prospect of using these lands is different and is often dictated by the degradation processes in them.

This work aims, based both on data from large-scale soil survey, and on our own research to make an attempt to systematize and evaluate the main economically significant factors of degradation of the complex of cinnamon forest soils located in part of the territory of the town Svilengrad. This aim is discussed in genetics and meliorative-technological aspects, as the main task is the problem of land degradation.

MATERIALS AND METHODS

The object of present study is the complex of Cinnamon forest soils situated in southeastern part of the lands of the town Svilengrad. By itself this region is quite diverse in terms of its geology, geotectonics, relief, climate and soils. Erosion of cinnamon forest soils in this part of Bulgaria occurs to different degrees and in various forms and very often dictates the characteristics of microrelief, mechanical composition, reserves of soil organic matter, pH and other economically significant characteristics of the soil.

On the basis of data from large-scale soil survey and following the requirements for conformity of soil differences with improvements in FAO soil classification – World Reference Base for Soil Resources(WRBSR) is made generalization of data from large-scale soil map.

Differentiated and unified on this principle soil units are evaluated about the degree of development of soil erosion, degree of dehumification – soil organic carbon, according to ISO 14235:1998, particle size distribution - by pipette method (Trendafilov and Popova, 2007) and soil acidity (pH_{H2O} – Arinushkina, 1970) to a level harmful to major crops.

The degree of erosion within the boundaries of united soil differences is implemented in accordance with the data from large-scale soil mapping in which these data are defined by scales for assessment of water erosion using a mathematical model in Executive Environment Agency of Bulgaria (ExEA), based on Universal Soil Loss Equation (Hudson, 1993).

The other parameters for characterizing the degree of degradation within the united soil differences are established by analysis of soil samples situated in a reticule within the contours of the observed area Figure 1.

Table 1. Scale for estimation of predicted and actual risk of sheet water erosion

Predicted water erosion risk of soil		
Classes of predicted water erosion risk of soil		Predicted soil loss, t/ha/y
1	Very low	0 - 5
2	Low	5 - 10
3	Low to moderate	10 - 20
4	Moderate	20 - 40
5	Moderate to high	40 - 60
6	High	100 - 200
7	Very high	> 200
Actual water erosion risk of soil		
Classes of actual water erosion risk of soil		Actual soil loss, t/ha/y
1	Very low	< T *
2	Low	T - 3
3	Low to moderate	3 - 5
4	Moderate	5 - 10
5	Moderate to high	10 - 20
6	High	20 - 40
7	Very high	> 40
* Soil loss tolerance		

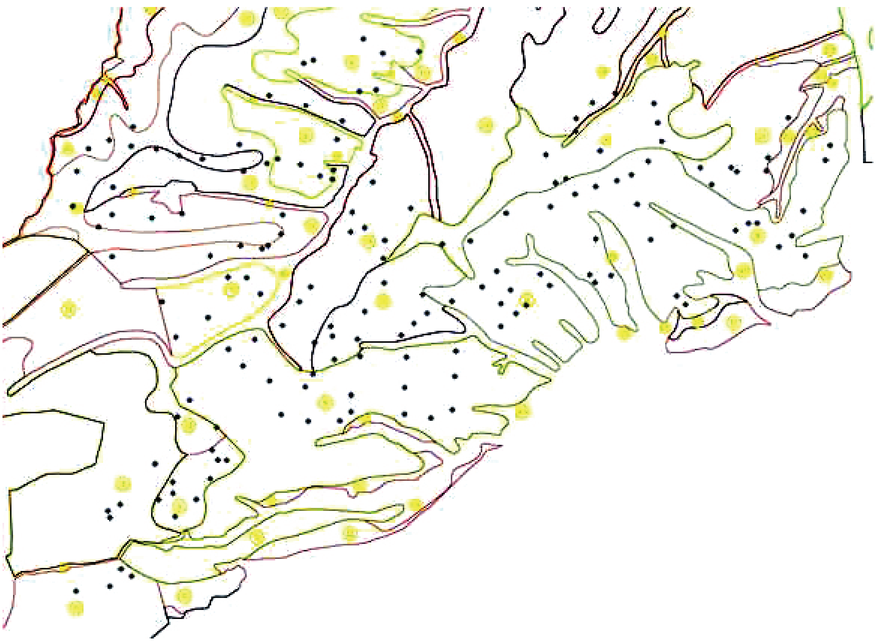

Figure 1. Situation of sampling points in the reticule

RESULTS AND DISCUSSIONS

Soil types

The officially accepted classification of soils in Bulgaria comprises soil differences, summarized in Table 2.

Classification of soils used in data from large-scale soil mapping is even more complicated and not always fully correspond to the taxonomy given in Table 2. The legend to the soil map (scale 1:25000 M) of studied area in Bulgaria, for example, is consist of 10 soil types, and its correlation with summarized taxonomic base (Table 2) is incomplete or is perceived default based on the genetic interpretation of the main taxa and sub-taxa. Because of these inconsistencies the classification systems do not gave an information about the presence of degradation processes and do not subordinated the factors and degradation processes, depending on their impact on the productivity and functionality of specific soil units.

Table 2. Part of the taxonomic list of soils in Bulgaria (Ninov, 2005)

Soil groups and sub-groups World reference base for soil resources (WRBSR)	Name according to "Improved classification system for soils in Bulgaria" 1992
Z O N A L S O I L S	
CHERNOZEMS	Chernozems
Calcic 35	*Calcareous and Typical*
Haplic 33	*Leached*
Luvic 34	*Degraded*
Gleyic 36	*Meadow*
PHAEOZEMS	Podzolized chernozems, Degraded chernozems, Dark-grey
	forest soils and Meadow chernozem-likes
Haplic 37	Podzolic chernozems
Calcic 38	*Meadow-chernozemics, calcareous*
Luvic 39	*Dark-grey forest*
Gleyic 40	*Meadow chernozem-likes*
VERTISOLS	Smolnitza Chernozem-smolnitza
	Leached
Eutric 18	*Calcareous*
Calcic 19	-
Gypsic 20	*Meadow*
Gleyic 21	
LUVISOLS	Gray forest, leached cinnamonic; cinnamon-likes
Haplic 41	*Brownish-gray (gray) forest*
Chromic 42	*Leached cinnamonic*
Calcic 43	*Gray forest, calcareous*
Vetric 44	*Cinnamonic-smolnitza-likes*
Albic 45	*Light-gray; highly leached to slightly podzolized*
Gleyic 47	*cinnamonic*
Rhodic 46	*Gray forest with gleyic B-horizon*
	Leached cinnamonic with red B-horizon
CAMBISOLS	
Chromic 25	Cinnamonic
Calcaric	*Typical*
	Calcareous
PLANOSOLS	
	Pseudopodzolic light-gray forest; Podzolic cinnamon
Eutric 48	forest; Cinnamon pseudopodzolic
Dystric 49	*Podzolic cinnamon or light-gray forest (pH > 5,2)*
	Light-gray forest, Cinnamon-podzolic, Podzolic-cinnamon
A Z O N A L S O I L S	*(pH < 5,2)*
LEPTOSOLS	
Lithic 13	
Umbric 14	Shallower than 50cm
	Lithosols
Rendzic 15	*Underdeveloped silicate soils (rankers); Shallow cinnamon*
	forest; Shallow gray forest
REGOSOLS	*Rendzinas (humic-calcareous)*
Eutric 10	
Dystric 11	Completely eroded soils
Calcaric 12	-
	-
	-

This requires the interpretation of factors and degradation processes to begin with a generalization of large-scale soil maps, based on accepted in our country table of correspondences of taxonomic units accepted in Bulgaria, with those adopted in FAO classification (WRBSR). The signs of degradation and the degree of development of the degradation process can be interpreted based on the already generalized map base that can be successfully used for monitoring of the degradation processes.

Soil units according to the large-scale soil survey, situated within the boundaries of studied region are:

- Moderately leached cinnamon forest soils, not eroded and slightly eroded, medium loam (5)[1]
- Moderately leached cinnamon forest soils, slightly eroded, medium loam (6);
- Highly leached to slightly podzolic cinnamon forest soils, not eroded and slightly eroded, medium loam (8);
- Highly leached to slightly podzolic cinnamon forest soils, slightly eroded, sandy loam, (9);
- Moderately leached cinnamon forest soils, moderately eroded, medium loam (11);
- Underdeveloped cinnamon forest soils, moderately eroded, sandy loam, slightly skeletal (14);
- Cinnamon forest soils, moderately and severely eroded, medium loam, slightly skeletal (17);
- Moderately leached cinnamon forest soils, moderately eroded, light clay (18);
- Moderately leached cinnamon forest soils, shallow, not eroded and slightly eroded, light loam, slightly skeletal (19);
- Moderately leached cinnamon forest soils, shallow, slightly eroded, light loam, slightly skeletal (20);

The situation of listed soil types on the area of the terrain is presented Figure 2.

On the basis of the morphological description, physico-chemical properties and brief characterization, and in view of the tasks of our investigation, the above described soil types, are summarized in accordance with the FAO international system for classification and taxonomy of soils - WRBSR (Table 2, first column).

As a result are separated four main soil differences, which situation on the terrain is presented in generalized soil map shown in Figure 3.

Degree of erosion

It is estimated the class of actual risk of sheet water erosion, regardless of the extent to which the erosion is already manifested within the boundaries of studied area.

Results are presented graphically in Figure 4. Between detached beforehand on the criteria of large scale soil survey data are established significant and statistically proven differences in the relation of soils into different erosion classes Table 1.

Erosion classes are coordinated well with the genetic origin of the soil to a certain part of the complex of cinnamon forest soils. With the highest grade of erosion and also homogeneous are undeveloped soil units, while the complex of shallow soils is relatively heterogeneous and generally less eroded.

In the generalized examination of the soil units according WRBSR (Figure 5), can be seen the following:

Relatively lowest degree of erosion is established for soils with a texture differentiated profile (Chromic luvisols). This coordinated with the concept of their formation. The difference between their degree of erosion with that of a well developed cinnamon soils with undifferentiated profile (Cambisols) is insignificant. The both groups have relatively degree of erosion in spite of soils with underdeveloped or shallow[3] profile.

Organic matter content

Differentiation of humus content in the surface horizons is proven influenced by soil type, both in soils, separated by genetic grounds, based on the classification in large-scale soil survey and in soil groups classified according to WRBSR.

From the genetically separated soils, the highest humus content is found in the deep moderate leached cinnamon forest soils. The original classification reflected in the legend of soil map the each soil detached in Figure 6 has different textural composition and different degree of erosion.

In a significant part of other genetically differentiated groups - for example between underdeveloped cinnamon forest soils and those with differentiated profile are not found differences in terms of humus content. A more detached humus distribution is observed in Figure 7, which shows the differentiation of humus in the cinnamon forest soil complex, where soils are divided into classes according to FAO.

Figure 2. Soil map of southeastern part of lands of Svilengrad (1:25000)

(5)[2] – Moderately leached cinnamon forest soils, not eroded and slightly eroded, medium loam; **(6)** – Moderately leached cinnamon forest soils, slightly eroded, medium loam; **(8)** – Highly leached to slightly podsolic cinnamon forest soils, not eroded and slightly eroded, medium loam; **(9)** – Highly leached to slightly podsolic cinnamon forest soils, slightly eroded, sandy loam; **(11)** – Moderately leached cinnamon forest soils, moderately eroded, medium loam; **(14)** – Underdeveloped cinnamon forest soils, moderately eroded, sandy loam, slightly skeletal; **(17)** – Cinnamon forest soils, moderately and severely eroded, medium loam, slightly skeletal; **(18)** – Moderately leached cinnamon forest soils, moderately eroded, light clay; **(19)** – Moderately leached cinnamon forest soils, shallow, not eroded and slightly eroded, light loam, slightly skeletal; **(20)** – Moderately leached cinnamon forest soils, shallow, slightly eroded, light loam, slightly skeletal.

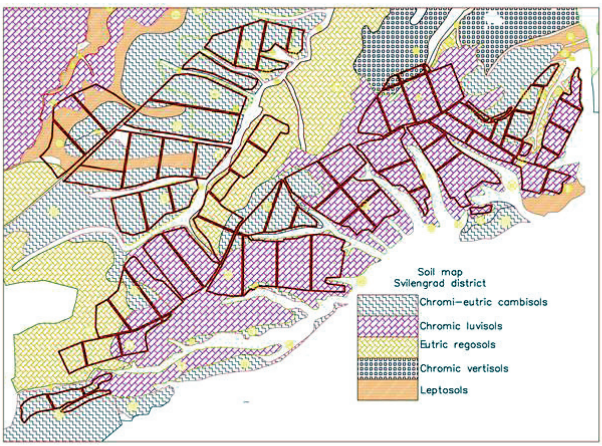

Figure 3. Generalized soil map of southeastern part of lands of Svilengrad

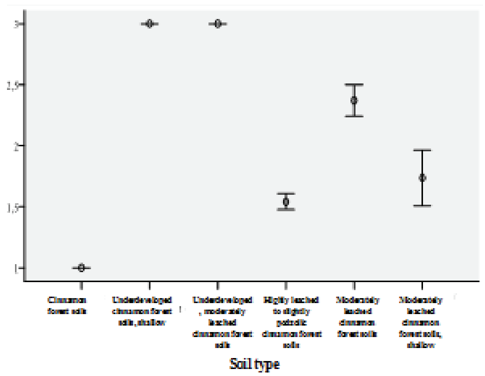

Figure 4. Class of actual risk of sheet water erosion of soil units detached according to the large-scale soil survey

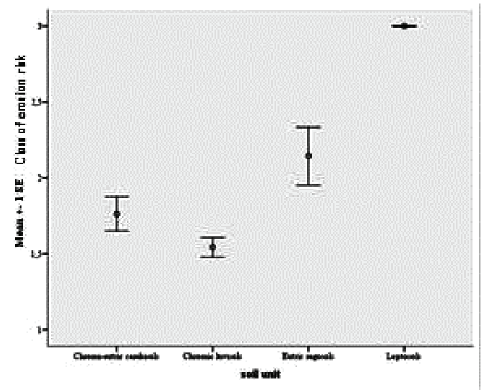

Figure 5. Class of actual risk of sheet water erosion of soil units detached according to FAO-WRBSR

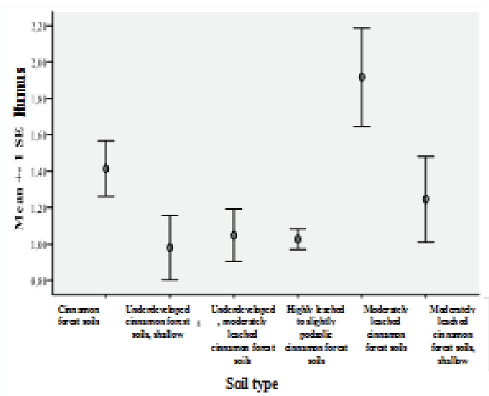

Figure 6. Humus content in surface horizon of soil units detached according to the large-scale soil survey

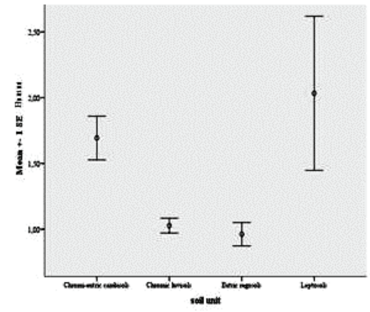

Figure 7. Humus content in surface horizon of soil units detached according to FAO-WRBSR

The change of the averages and the degree of variation very clear reflects the soil groups, differentiated according to FAO WRBSR. Figure 7 shows that relatively highest organic matter content, but in terms of highest degree of variation is established for the group of highly underdeveloped soils - Leptosols.
Obviously it comes to relatively young soils which in terms of their humus content are closest to their forest analogues. In the same interval changes the content organic matter in well developed cinnamon soils with undifferentiated profile - Chromi-eutric cambisols, while the humus content of texture differentiated Luvisols and Regosols is significantly and statistically proven lower.

Particle size distribution (soil texture)

Content of skeletal fraction

From genetically differentiated soils, the highest content of skeletal particles is determined for sub-taxa of underdeveloped soils, as the differences between them and other taxa are statistically proven (Figure 8). Certain gradation of skeleton content is established for soil classes detached according to FAO. In this classification system is determined very well expressed gradation from developed to underdeveloped soils in respect of the parameter 'skeletal content" (Figure 9).

Physical clay content

The content of clay is a key characteristic of textural composition of the soil. Changes in content of clay particles in the complex of cinnamon forest soils are shown in Figure 10 and Figure 11. The data show that soil affiliation to a particular taxon does not generate statistically proven differences in clay content.

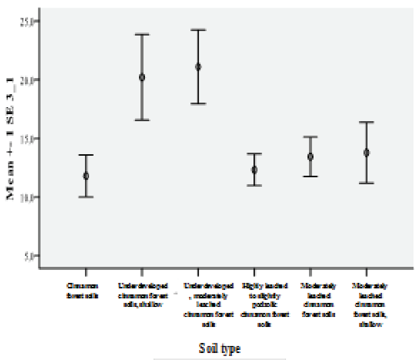

Figure 8. Content of skeletal fraction in soil units detached according to the large-scale soil survey

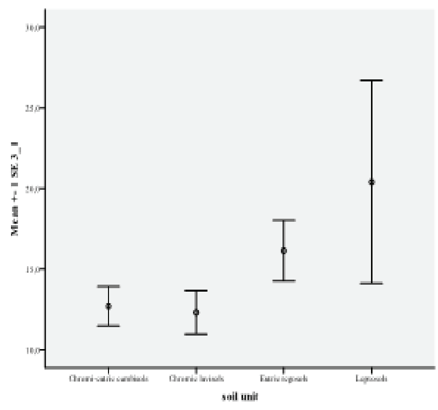

Figure 9. Content of skeletal fraction in soil units detached according to FAO-WRBSR

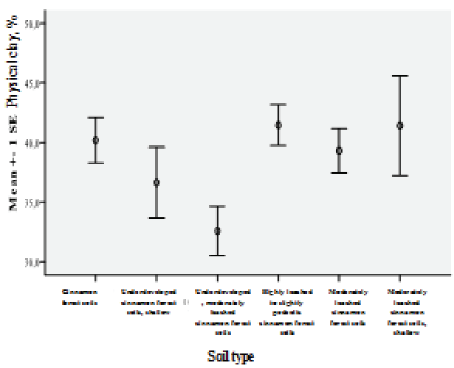

Figure 10. Content of physical clay in soil units detached according to the large-scale soil survey

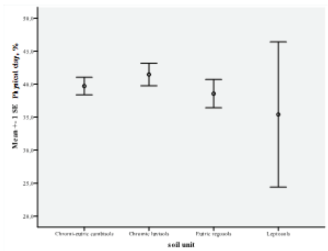

Figure 11. Content of physical clay in soil units detached according to FAO-WRBSR

Soil pH

The soil reaction (pH_{H2O}) is used as a criterion for soil acidity. The data are shown in Figure 12 and Figure 13.

The obtained results determine prevailing slightly acid reaction for most of the soil types. Between genetically detached soil units there are not determined significant differences in terms of soil pH.

For classes according to FAO significant differences are not determined only between underdeveloped and relatively young Leptisols and all other soil units. Probably this is due to relatively more preserved influence of the forest vegetation.

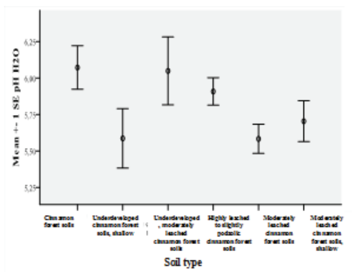

Figure 12. pH in soil units detached according to the large-scale soil survey

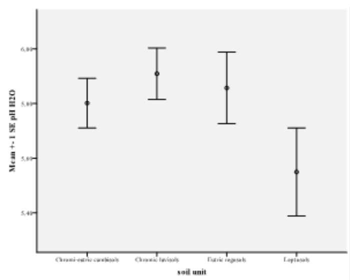

Figure 13. pH of soil units detached according to FAO-WRBSR

[1]Numbers in the legend of soil map scale M 1:25000
[2]Numbers in the legend of soil map M 1:25000
[3]Here can be understood also, secondary erosively shorten profiles.

CONCLUSIONS

The evaluation of parameters that characterize the degree of soil degradation, the trend of degradation processes and the degree of their development requires adequate differentiation of soil groups, with relatively uniform rate of development of the degradation process.

Differentiated with respect to degradation processes soil groups should be most relevant to the indications for differentiation of soil groups according to the accepted classification system.

At discussed in this study, complex of cinnamon forest soils, differentiation of soil units based on World reference base for soil resources of FAO better reflects the degree and the direction of the degradation processes.This is achieved without explicit reference to any of the degradation processes in the name of the soil units.

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MODEL FOR INVESTIGATION, AMELIORATION AND ORGANIZATION OF TERRAINS WITH COMPLEX TOPOLOGY FOR PLANTING OF VINEYARDS

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Abstract

On the basis of areas with complex topography and soil diversity is proposed a stepwise model for reclamation of lands for planting of vineyards. The model includes climate, soil and hydromeliorative conditions. Limiting components are presented as being localized in different parts of the area limitations of the suitability. The strength of the constraints is evaluated depending on the area of their occurrence, the extent to which they limit the suitability of the terrain and the opportunities for ameliorative correction.
Soil sampling and mapping of soil is performed by applying of GIS for characterization of the spatial diversity. Obtained results are analyzed based on the expectations for constraints and non-differentiability of the function characterizing the properties of the soil at each point within the field. Through this approach is considered the minimum number of points required for investigation and are localized the areas for correction of limitations arising from the properties of the soil and terrain.

Key words: *GIS, soil properties, spatial diversity, vineyards.*

INTRODUCTION

Preparation of lands for vineyards puts the condition for formation of terroir. The concept of terroirs in viticulture is increasingly relieved from the context of descriptive and analytical characteristics of the areas, which traditionally are identified as vineyard terroirs and is directed towards the development of predictive models for the potential of lands to be converted into terroirs. In terms of its characteristics, each particular terrain, included in an area with suitable climatic conditions is a potential vineyard terroir, having its advantages and disadvantages. Regarding the requirements of grape wine varieties, the question for 'the most suitable growing conditions' is always controversial, as controversial are requirements to terrain able to provide a high quality of the grape in terms of very limited yield potential and from the other hand-terrains with very high yield potential, giving a mediocre production. In the conditions of increasing scarcity of land resources, will increase the advisability of utilization for vineyards of areas with limited suitability for agriculture. Somewhat, the limited fertility of the soil, and terrain conditions is a desirable quality in terms of vineyards, as for them, unduly intensive growth is undesirable. On the other hand, the suitability of the terrain for agriculture, mustn`t make it completely non-functional. In this context the field restrictions are divided into those which can be improved by ameliorative activities, and other on which such an effect is impossible or impractical.
The present work is an attempt to systematize the complex study of the suitability of a very complicated in terms of its topography and erosion conditions terrain, in respect of its suitability for becoming a vineyard terroir.

MATERIALS AND METHODS

This study was carried out on terrain, covered with eroded to different degrees Cinnamon forest soils, which is located at the foothills of the lower Eastern part of the Balkan Mountains and belongs to the administrative region of Sungurlare, which has old traditions as a wine-growing region and especially, growing of white wine varieties. The current terrain has not been used previously for viticulture, mainly due to its topographic conditions and high degree of erosion in a significant part of the area. Solving the problem with the suitability of this terrain, includes development of steps of the study, characterization and mapping of constraints and determining the meliorative practices. Figure 1shows an air-photo of the situation of the terrain. The exposition is in the direction north-northwest - south-southeast. The total area is 33.2 ha and is divided from the existing topographical conditions into two parts - a relatively high North-Northwest and lower - South-Southeast part. The land is used for agriculture in the Northwest part and as unregulated grassland in the southern part. In Figure 2 is shown a volumetric, three-dimensional image of the terrain, by which are characterized the topographical conditions of the area.

During our research we collect 31 soil samples from three depths 0-25, 25-50 and 50-75 cm. Soil sampling is coordinated with the topologic conditions of the terrain. After standard preparation soil samples were analyzed to establish the pH, potentiometrically in water (Arinushkina, 1970); easily mobile and exchangeable Al^{3+} and H^{+}, titrimetric by Sokolov (Sokolov, 1939); easy mobile exchangeable Mn^{2+}, in extract with 1m KCl, as the preparation of the extract was carried out under the Laboratory system for liming of Palaveev and Totev (LSVPT-64) (Palaveev and Totev, 1970) and the determination of Mn^{2+} is by AAS (Ganev, 1990); easily mobile and exchangeable Ca^{2+} and Mg^{2+}, complexometric (Arinushkina, 1970), organic carbon - ISO 14235:1998, total carbonates (Arinushkina, 1970), content of active calcium according to Gruinnot-Gallet (Hartikainen H., 1986)

Figure 1. Air-photo of the situation of the investigated terrain

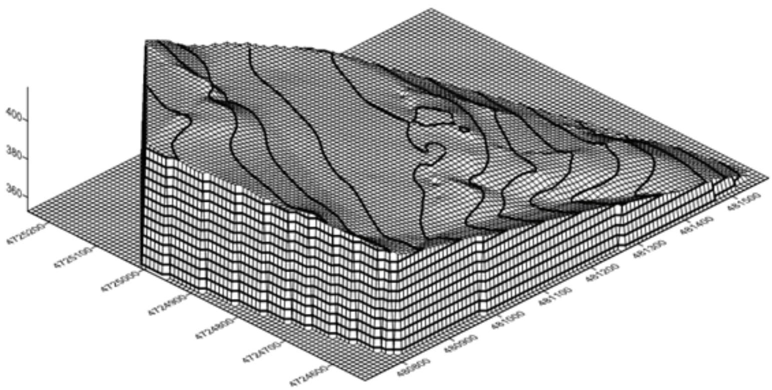

Figure 2. Volumetric topographic image of the terrain

RESULTS AND DISCUSSIONS

Characteristic of the topographic conditions

Topographical conditions are characterized by the altitude, gradient, exposure and the ruggedness of the terrain. Based on these features is formulated in a first approximation the separation of terrain into topographic areas. Reason for the topographic subdivision into individual sections is only the gradient magnitude. Altitude of the terrain changes monotone and the exhibition is uniform along the line of the main catena. Based on this are summarized three topographical areas: with gradient inclination 6-9^o (sections A and C) and with 3-6^o in section B. In section C are established active erosion forms, which are indicated in Figure 3.

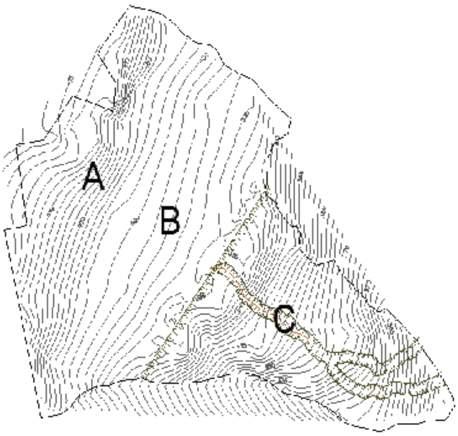

Figure 3. Topographic sketch of the terrain with separated topographical areas

Soil conditions

Taxonomic affiliation of soils and soil depth

Within the boundaries of terrain are established Cambisols, which in some parts passed into shallow Regosols, as a result of the erosion (it is used the Taxonomic list of soils in Bulgaria developed by Ninov in 2005).

There have been determined similar in origin but reduced to different degrees profiles, as a result of active contemporary erosion or by older erosion processes. Both deep and shallow soil profiles in terrain are formed on gneiss. Weathering crust is common for the whole area of our survey. In the southern parts of terrain is established contemporary process of waterlogging, which did not affect the morphology of the soil profile. Based on data from 11 exploration wells have been identified boundaries of the two main soil types. The distribution of soil differences within the terrain is shown in the soil map in Figure 4. The differentiation of soil profiles on deep Cambisols and shallow Regosols basically copies the data for gradient. This gives reason as a second approximation, the sections separating the terrain by topographic feature to be identified with the sections dividing the terrain in respect of profile depth. The parameter 'profile depth' may absolutely limit the suitability of soil for growing grapes, in cases where the depth of all soil horizons down to the weathering crust does not exceed 1m. In the researched field such limits have not been established and therefore the need for sufficient depth of soil is available.

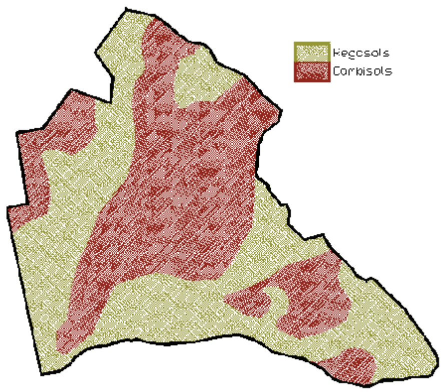

Figure 4. Soil map

Particle size distribution

Particle size distribution is an absolute limitation if the content of physical clay (particles < 0.01mm) is less than 10%, or more than 70%. Data from the field study showed that the probability to establishing such values is small, and actually they are not determined for any of the soil layers throughout the whole studied area.

Data for the physical clay can be approximated to the Gaussian frequency distribution and are suitable for further mathematical analysis. Mean content of physical clay distributed in soil depth – 0-25, 25-50 and 50-75 cm is shown in Table 1, and the distribution of the clay content between the soil types is shown in Table 2.

The data shows that the probability to establish clay content, higher than 60% is negligible. However, within the boundaries of the terrain is determined one of all 33 cases with clay content exceeding the critical value, but this result is not confirmed in any of the other samples.
Therefore, the accumulation of clay is possible to be identified in individual plots, which is not relevant to the suitability of the terrain. Therefore the particle size distribution, expressed by the physical clay content is not a restriction for vineyards. The most frequently observed value for the physical clay is about 36%, which is close to the optimal values of this parameter for vineyards.
In sections where it is established low clay content, naturally increases the skeletal fraction. The relationship between the skeletal and clay fraction in the observed terrain is shown in Figure 6. The power of the dependence is greater in shallow and relatively light Regosols.

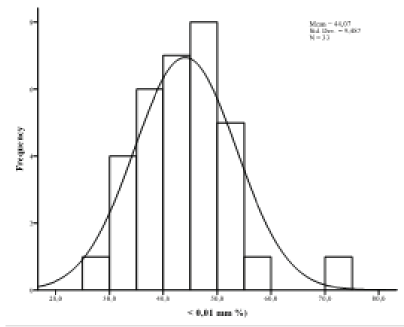

Figure 5. Histogram of the frequency distribution of physical clay content in the total sample

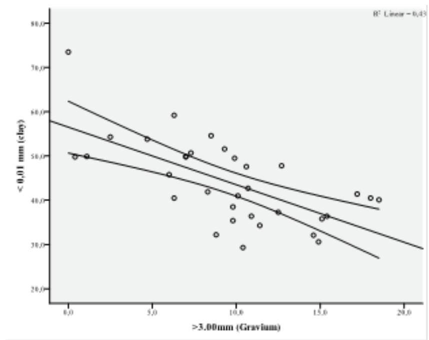

Figure 6. Relationship (correlation) between the content of gravel and physical clay in the observed terrain

Table 1. Distribution of physical clay content down to soil profile

Depth (cm)	Mean	N	Std. Error of Mean	Std. Deviation	Minimum	Maximum	Median
25	45.318	11	2.2504	7.4638	32.1	54.6	49.500
50	42.764	11	3.5464	11.7621	30.6	73.5	40.500
75	44.118	11	2.8661	9.5059	29.3	59.2	41.900
Total	44,067	33	1.6515	9.4870	29.3	73.5	41.900

Table 2. Distribution of physical clay content in different soil types

Soil type	Mean	N	Std. Error of Mean	Std. Deviation	Minimum	Maximum	Median
Cambisols	42.750	18	1.7677	7.4997	29.3	53.8	42.300
Regosols	45.647	15	2.9723	11.5117	32.1	73.5	40.500
Total	44.067	33	1.6515	9.4870	29.3	73.5	41.900

Soil chemical composition
In our study we determined the pH and content of the main macro and micronutrients in the soil, as the results are presented in Table 3. They show that studied soils are characterized by slight acid reaction, contain no carbonates, relatively poorly stocked with essential macronutrients and the content of micronutrients (Ca, Mg, Fe, Mn, Cu and Zn) is sufficient for normal mineral nutrition of plants but in non-toxic concentrations.

Analyzing the data, we do not find reason to formulate limitation of the suitability of soil for growing grapes, based on data on the soil chemical composition. The results, however, indicate a need for carefully considered and balanced mineral fertilization throughout the whole growing period of the vineyard.
The lack of carbonates down the profile and low content of Ca in all studied forms of this element may not be considered as a disadvantage in this object. That is because the

terrain is in the composition of a large area, proved as terroir based on non-carbonate soils, with a slightly acid reaction and pronounced deficiency of Ca, as we found in our study.

Model of differentiated fertilization

The rates for stockpiling fertilization with phosphorus and potassium, and rates for ammonium nitrate in the individual parcels are shown in Table 4. The borders of each outlined sub-parcel can be seen in Figure 8.

For stockpiling fertilization are used phosphorus and potassium fertilizers. It is recommended introduction of triple superphosphate (TPS) and potassium sulfate in rates listed in Table 4. Phosphorus and potassium fertilizers are applied separately, after cleaning the terrain from weeds. After the fertilization, the area is harrowed in 15 cm in order to achieve the best possible homogenization of fertilizers with the soil. During the first three years of the vegetation phosphorus and potassium fertilizers are not applied.

Nitrogen fertilizers are applied at the beginning of the vegetation in each growing season. It is proposed the use of ammonium nitrate in listed above rates. During the vegetation is recommended performing of three-four foliar application of suitable fertilizers containing micronutrients and amino acids. Application of fertilizers can be combined with the system for crop protection of the vineyard.

Table 3. Soil chemical composition

Sample	Depth (cm)	Soil type	pH (H_2O)	$CaCO_3$ (%)	Ca (%)	C (%)	N	P_2O_5	K_2O	Ca	Mg	Fe	Mn
				(%)			mg/100 g			mg/kg			
1	25	Regosols	5.62			1.18	0.98	13.00	24.49	455	819	2367	281
1	50	Regosols	5.77			0.71							
1	75	Regosols	6.82			0.19							
5	25	Regosols	6.50			1.31	0.87	12.50	19.75	594	1161	2813	
5	50	Regosols	6.78			0.77							
5	75	Regosols	6.90			0.25							
9	25	Cambisols	6.06			0.99	0.76	17.00	17.31	563	1335	2744	
9	50	Cambisols	6.92			0.59							
9	75	Cambisols	7.36		0.61	0.23							
10	25	Cambisols	6.03			0.98	0.53	15.00	17.31	531	1279	2744	
10	50	Cambisols	6.94			0.60							
10	75	Cambisols	6.62			0.33							
13	25	Cambisols	6.12			1.06	0.37	24.10	12.00	485	1301	4213	189
13	50	Cambisols	6.39			0.56							
13	75	Cambisols	6.79			0.27							
19	25	Cambisols	6.79			1.04	1.04	25.00	19.75	938	1526	2761	
19	50	Cambisols	7.60		0.50	0.69							
19	75	Cambisols	7.31			0.33							
22	25	Cambisols	6.84			0.99	1.04	34.00	19.94	1333	1400	2519	281
22	50	Cambisols	7.08		0.60	0.62							
22	75	Cambisols	7.18		0.43	0.31							
23	25	Regosols	6.31			1.56	0.29	18.00	16.54	667	1417	3149	174
23	50	Regosols	6.53			0.80							
23	75	Regosols	6.38			0.23							
27	25	Cambisols	6.06			1.69	0.31	26.00	21.37	483	943	1982	
27	50	Cambisols	6.25			0.96							
27	75	Cambisols	6.45			0.33							
30	25	Regosols	5.97			1.89	0.64	29.75	15.37	451	1032	1853	
30	50	Regosols	6.59			1.00							
30	75	Regosols	6.42			0.30							
31	25	Regosols	5.92			1.58	0.39	23.00	16.54	515	1240	2917	188
31	50	Regosols	6.18			0.96							
31	75	Regosols	6.70			0.42							

Table 4. Fertilization rates in parcels, kg/ha

Parcel №	Sub-parcel №	Sub-parcel area, ha	Stockpiling fertilization rate P_2O_5, kg/ha	Fertilizer rate, TPS, kg/ha	Stockpiling fertilization rate K_2O, kg/ha	Fertilizer rate Potassium sulfate, kg/ha	Fertilization rate, N, kg/ha	Fertilizer rate Ammonium nitrate, kg/ha
198	198-1	8.6318	566	1230	143	290	87	250
	198-2	11.746	406	880	220	440	93	270
199	199-1	0.9457	553	1200	240	480	106	310
	199-2	3.7758	353	770	250	500	94	270
	199-3	4.1389	558	1210	164	330	105	300
	199-4	0.6957	540	1170	240	480	103	300
	199-5	1.1433	540	1170	240	480	103	300

Erosion conditions

The studied area is with active erosion process. Topographical conditions described in previous section define an intensive surface runoff in conditions of low filtration capacity of the soil, especially in lower southeastern parts of the field. Erosion activity in them is the main reason they are not used for agriculture. Areas with relatively high potential concentration of the erosive flow are established also in the northern areas of terrain.

Figure 7 presents vector graphic of the intensity of runoff, where it is visible its predicted direction and intensity, with a leveling of surface resistance of water movement after preparation and use of land for vineyard.

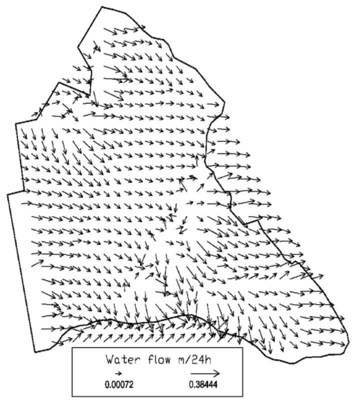

Figure 7. Direction and intensity of the surface runoff

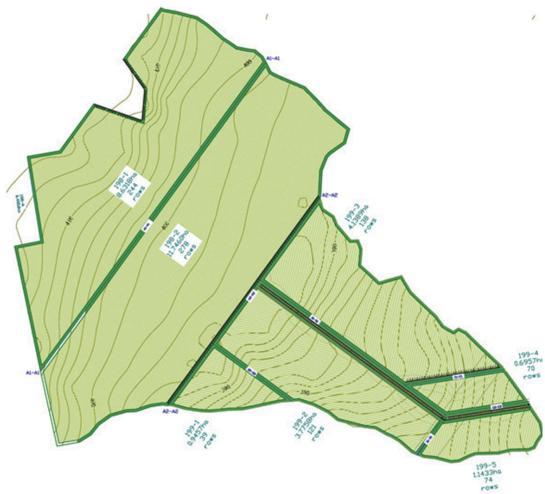

Figure 8. Plan of the vineyard in a conceptual stage

The vector diagram outlines two zones: a zone of potential waterlogging in areas of dispersion of erosion runoff and in areas where there is an abrupt change in its direction, and area with very active erosion runoff in parts where there are topographic conditions for its concentration in torrential beds.

Such characteristics require the need for catching of surface runoff in the direction coinciding with that of the main slope.

In the southern part of the field are formed active erosion gullies that are in an active phase of their development. Routes of erosion gullies are shown in Figure 3.

Plan of the vineyard

Described field conditions require the need vineyard plan to be complied with the described limitations. This can be achieved by the orientation of rows, density of planting, and mainly – by the direction, position and stabilization of the farm roads longitudinal and transverse to the flow and the direction of the rows. Plan of the terrain, accompanied by appropriate amelioration and communication infrastructure is presented in Figure 8.

The catchment of runoff is carried out approximately along the main erosion layout by building of anti-erosion canal that plays a role also in regulating of the subsurface flow in waterlogged areas of the terrain. This canal is discharged into the adjoining to the terrain natural gullies, as in the places of discharge banks are stabilized by building of a permanent barrage. The direction of rows in the southeastern erosively risky part of the terrain concludes a large angle with the vector of surface runoff. Anti-erosion and drainage canal crosses the flow and prevents its concentration in long layouts, especially in erosively risky areas and for that in southeastern parts are provided additional farm roads. General layout of the vineyard in conceptual stage is presented in Figure 8.

CONCLUSIONS

The described sequence of investigative and ameliorative works for creating of vineyards in the terrain, objected in this article represents a model for amelioration and utilization of complex in terms of topographic and soil conditions terrains for growing grapes. The experience from the work show us the relevance of implementation of terrain investigations and analyzes, which to a large extent can be considered as universally applicable for lands, with limited suitability for agriculture.

The main stages in our opinion, which are universally applicable to such kind of ameliorative surveys in order establishing vineyards, are:

1. Topographic conditions – exposure, slope and sections within the terrain, which can be differentiated based on these two main topographic features;
2. Soil cover – soil sampling and mapping of the representativeness of sampling points into uniform conditions within the terrain;
3. Erosion characteristics of the terrain;
4. Characterization of soil water regime.

The conclusions that are imposed by the analysis of the conditions stages 1 and 2 are not reason for ameliorative intervention in the terrain conditions, but they are limiting conditions in respect of its suitability for agriculture in the direction which it is being studied.

Conclusions from 3 and 4 have a meliorative importance. The analysis of the erosion conditions and conditions for waterlogging require construction of relevant to the degree of erosion risk, anti-erosion facilities and systems for regulation of water balance in the soil root zone. These events in the stage of design and construction of the plantation should be taken into account in the conceptual and technical design of vineyards.

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MICRO-NUTRIENT COMPOSITION OF SOME MEDICINAL AND AROMATIC PLANTS COMMONLY USED IN TURKEY

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Abstract

There has been a growing interest in monitoring nutrient composition and nutritional value of medicinal and aromatic plants in recent years. In this study, the levels of boron (B), copper (Cu), iron (Fe), zinc (Zn), manganese (Mn), and molybdenum (Mo) in selected medicinal and aromatic plants were monitored by inductively coupled plasma (ICP-OES). Samples of chamomile, nettle, rosemary, yarrow, bay leaf, St. John's wort, basil, lemon balm, linden, sage and thyme were subjected to chemical analysis. The contents of micronutrients in the plant samples were found in the ranges: 3.2-15.6 mg kg^{-1} for cupper, 93.0.1057.3 mg kg^{-1} for iron, 22.3-53.6 mg kg^{-1} for zinc, 28.3-148.3 mg kg^{-1} for manganese, 0.23-2.13 kg^{-1} for molybdenum and 15.0-64.3 mg kg^{-1} for boron. Results obtained are in agreement with data reported in the literature.

Key words: *herbal plants, nutrition, spices, trace elements.*

INTRODUCTION

The trace elements, in company with other essential nutrients, are required for growth, normal physiological functioning, and preserving of life; they must be provided by food, since the body cannot synthesis them. The scientific classification of trace side against macro minerals and trace elements are often considered as minerals required by the body in amounts less than 100 mg daily. While some of them are definitely important for health, the roles of others are unclear. Advised intakes have been set for some trace elements and their deficiency can lead to disease, but a lack of others does not cause any recognized problems. Trace elements have very important functions and it is believed that it has a variety of biochemical functions in all living organisms such as hemoprotein and hemoglobin even in low doses. However, the benefits of these micro-nutrients may be completely reversed if present at high concentrations (Bennett, 1993; Marschner, 1995). The micro elements copper, iron, manganese and zinc are not only constitutive elements with specific functions in plant growth, photosynthesis and respiration. However, in excess amounts, these elements are toxic to plants. Soil concentrations above 20 mg kg^{-1} Cu, 50 mg kg^{-1} Fe, 300 mg kg^{-1} Mn, 400 mg kg^{-1} Zn are toxic to plants (Bennett, 1993). On the other hand, Cu, Fe, Mn, Zn, B, Mo are trace elements that are significant for human physiology when they are captured in desired level (Arcasoy, 1998; Goldhaber, 2003). Plants have been used as source of food, animal feed, hiding place and medicines (Ghani et al., 2012). Many plants which are used in different traditional medicine systems of the world are determined as medicinal plants (Ishtiaq et al., 2007). These therapeutic plants have always been valued as a mode of treatment of variety of nuisances in folk cultures and have played a very important role in the discovering of the modern day medicines with newly-coined chemical constituents (Ishtiaq and Khan, 2008; Devi et al., 2008; Shirin et al., 2010).

The usefulness of medicinal plants for therapeutical objectives is in many instances accounted for in terms of their organic constituents like essential oils, vitamins, glycosides and other bio components. Now, it has been founded constituted fact that over dose or elongated taken down of medicinal plants may lead to chronic accumulation of different elements which cause various health problems (WHO, 1992; Sharma et al., 2009).

In this study, elemental contents of the medicinal plants and their proportion should be controlled in convenience with health safety measures and it is obligatory to screen for their quality check (Liang et al., 2004; Arceusz et al., 2010). In recent years, several authors across the world have reported in many studies, on the importance of elemental constituents of the herbal drugs which enhanced the awareness of trace elements in the plants (Basgel and Erdemoglu, 2006; Sharma et al., 2009; Koe and Sari, 2009). Trace elements have both a curative and a preventive role in combating diseases. It is very important to know the level of micro elements in medicinal plants and herbal medicaments and to estimate their role as sources of these components in the human diet because, at elevated levels, these metals can also be hazardous and poisonous. These precautions are indispensable when larger amounts of the products are consumed, when recommended dosages are followed and long term therapy is undertaken (Lesniewicz et al., 2005). Most of these studies elucidated that essential metals can also produce toxic (for example, Chen et al., 2003; Scarpa, 2004; Kumar et al., 2005) effects when the metal intake is in high concentrations, whereas non essential metals are toxic even in very low concentrations for human health. (Hayat et al., 2008; Ashraf et al., 2009). The present study was carried out in Black Sea Region which harbours quite rich medicinal plants. There is some information on trace element contents of spices and herbal plants grown and consumed in Turkey, the data available so far is not adequate or complete. The objective of the present study was to determine the concentrations of selected boron, copper, iron, zinc, manganese and molybdenum in some spices widely cultivated and traditionally consumed in Turkey.

MATERIALS AND METHODS

Plant materials of twelve species were gained in September 2012 from spice wholesalers and spice shop in the Black Sea Region (Samsun, Ordu and Giresun provinces) of Turkey. For chemical analysis, Table 1 shows the plant names and the part of the plant used. The samples (1000 g) in the plastic bags were kept at room temperature until to be analyzed. The samples were dried at 70ºC for 48 hours in an oven and ground for chemical analysis.

Table 1. Some characteristic of twelve selected medicinal plants

Plant scientific names	Common name	Turkish name	Part use
Matricaria chamomilla L.	chamomile	papatya	flowers
Thymus vulgaris L.	thyme	kekik	herb
Rosmarinus officinalis L.	rosemary	biberiye	leaves
Hypericum perforatum L.	St John's wort	kantaron	herb
Urtica dioica L.	nettle	isirgan	leaves
Lavandula stoechas	flos lavandulae	karabas	flowers
Salvia officinalis L.	sage	adaçayi	leaves, flowers
Ocimum basilicum L.	basil	feslegen	leaves, stem, seeds
Melissa officinalis	lemon balm	ogulotu	herb
Laurus nobilis L.	bay leaf	defne	leaves
Achillea millefolium	yarrow	civanperçemi	flowers
Tilia argentea Desf.	linden	ihlamur	flowers

In summary, 0.2 g of the sample was transferred into a burning cup and 5 ml of 65% HNO_3 and 2 ml of 30% H_2O_2 were added. The samples were incinerated in an HP-500 CEM MARS 5 microwave (Mathews, NC, USA) at 200°C and cooled at room temperature for 45 min. The extracts were passed through a Whatman 42 filter paper, and the filtrates were collected by high de-ionized water in 20 mL polyethylene bottles and kept at 4°C, in the laboratory, for inductively coupled plasma atomic emission spectrometry (ICP–OES) analysis. Each sample was analyzed in triplicate. Merck standards (R1 and R2 groups) were used as analytical reagent grade chemicals. Standard solutions of B, Cu, Fe, Zn, Mn and Mo were prepared in 1% HNO_3 immediately before the analysis by serial dilution of 1000 mg L^{-1} stock solution stored in polyethylene bottles. Peach leaves (Standard Reference Material, 1547) and corn bran (Standard Reference Material, 8433) was used as reference materials (N.I.S.T, 2004). Scanning ICP-OES (Varian Vista-Pro, Australia) with high resolution nitrogen purged with 1 m monochromator was used. B, Cu, Fe, Zn, Mn and Mo contents were ascertained using ICP-OES. In addition, to determine cadmium concentration in the extracts, inductively coupled argon plasma-optical emission spectrometry (ICP-OES; U 5000 AT + Ultrasonic Nebulizer; Cetac Technologies, Omaha, NE, USA) (214.438 nm/0.1 µgkg^{-1}) was also used.

RESULTS AND DISCUSSIONS

In this study twelve different plant samples collected in the Black Sea Region of Turkey (from Samsun, Ordu and Giresun provinces) were subjected to chemical analysis for their trace element contents. The mean values of boron (B), copper (Cu), iron (Fe), zinc (Zn), manganese (Mn), and molybdenum (Mo) concentrations in plant samples obtained from each sampling site are presented in Tables 1 and 2, respectively. The values, based on plant's dry weight, are the means of three replicates and given as mean ± SD. The correlation coefficients of the calibration curves were generally within the range of 0.996-0.999 and receivable recoveries (>95%) were procured for the analysis.

Table 2. Micronutrient concentrations of selected medicinal plants

Plant sample	Cu (mg kg^{-1})	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	B (mg kg^{-1})	Mo (mg kg^{-1})
Matricaria chamomilla L.	10.0±1.70	34.3±3.56	350.0±42.5	45.7±3.45	35.0±2.70	0.64±0.19
Thymus vulgaris L.	7.66±0.60	25.3±2.55	905.7±423	51.0±14.5	36.7±3.90	0.28±0.10
Rosmarinus officinalis L.	7.33±0.90	23.3±1.50	386.7±94.1	32.7±2.30	41.7±3.90	0.48±0.19
Hypericum perforatum L.	10.7±2.60	53.6±16.3	191.7±61.3	60.7±34.4	39.0±3.90	0.25±0.11
Urtica dioica L.	8.66±2.90	26.0±3.00	794.0±186	82.3±58.7	64.3±17.0	1.14±0.54
Lavandula stoechas	7.00±0.40	23.7±4.50	236.3±44.2	148.3±87.6	24.7±5.20	0.25±0.06
Salvia officinalis L.	7.66±1.10	47.3±17.6	739.0±283	55.3±15.1	33.7±3.00	0.35±0.05
Ocimum basilicum L.	15.6±3.90	36.0±9.50	1057.3±282	95.3±7.30	58.3±36.0	0.69±0.24
Melissa officinalis	11.7±3.50	30.7±3.45	319.7±70.4	50.7±45.3	47.3±9.60	2.13±1.54
Laurus nobilis L.	3.20±1.4	27.0±9.34	197.7±78.2	79.7±40.3	15.0±2.2	0.23±0.12
Achillea millefolium	10.7±0.8	22.3±6.86	93.0±45.4	28.3±7.23	37.3±12.0	1.13±0.23
Tilia argentea Desf.	10.3±4.1	24.0±2.68	220.7±90.8	32.7±10.5	32.7±3.9	0.46±0.43

The concentration of the monitored trace elements, the highest concentration found was that of iron followed by manganese and zinc. On the other hand, the lowest concentration found was that of molybdenum followed by boron and copper. Copper is essential micronutrient for living organisms due to a wide range of biological functions as component of redox and enzymatic systems, the latter of which is an important enzyme co-factor for human fatty acid (FA) metabolism (Deferne et al., 1996; Mclaughlin et al., 1999). Concentrations of copper in twelve spices were the ranges 3.20 mg kg^{-1}-15.6 mg kg^{-1}, the lowest in bay leaf (*Laurus nobilis* L.) and the highest in basil (*Ocimum basilicum* L.) samples (Table 2). The permissible limit set by WHO (1999) for edible plants was 3.00 mg kg^{-1}. After comparison of metal limit in the studied medicinal plants with those proposed by WHO (1999), it was found that all plants accumulated Cu above this limit. Reddy and Reddy (1997) reported that the range of Cu contents in the 50 medicinally important leafy material growing in India were 17.6 to 57.3 mg kg^{-1}. Zn is an essential micronutrient and is associated with a number of enzymes, especially those for synthesis of ribonucleic acids. Zinc deficiency resulted from inadequate dietary intake is of growing concern in the developing world. Zinc concentrations of the plant samples varied between 22.3-53.6 mg kg^{-1} with yarrow (*Achillea millefolium*) sample containing the lowest and in St John's wort. (*Hypericum perforatum* L.) sample having the highest, respectively. The permissible limit set by WHO (1999) for edible plants was 27.4 mg kg^{-1}. After comparison of metal limit in the studied medicinal plants with those proposed by WHO (1999), it was found that *Matricaria chamomilla* L., *Hypericum perforatum* L., *Salvia officinalis* L., *Ocimum basilicum* L. and *Melissa officinalis* are above this limit, while all others plants accumulated Zn within this limit. Fe is necessary for the formation of hemoglobin and also plays an important role in oxygen. The range of Fe in the studied plants was high with a minimum of 93.0 mg kg^{-1} in yarrow and maximum of 1057.3 mg kg^{-1} in basil. The permissible limit set by WHO (1999) in edible plants was 20 mg kg^{-1}. After comparison of metal limit in the studied medicinal plants with those proposed by WHO (1999), it was found that all plants accumulated Fe above this limit. Sheded et al., (2006) reported that the range of Fe in their study was between 261 and 1239 mg kg^{-1} in selective medicinal plants of Egypt. Manganese is an important element activating numerous essential enzymes. In the case of manganese, the flos lavandulae (*Lavandula stoechas*) samples occurred as the richest (148.3 mg kg^{-1}) whereby the lowest level (28.3 mg kg^{-1}) was recorded in yarrow (*Achillea millefolium*). The permissible limit set by WHO (1999) in edible plants was 2 mg kg^{-1}. After comparison of metal limit in the studied medicinal plants with those proposed by WHO (1999), it was found that all plants accumulated Mn above this limit. Sheded et al., (2006) reported that the range of Mn in their study was between 44.6 and 339 mg kg^{-1} in selective medicinal plants of Egypt. Concentrations of boron in twelve spices were the ranges 15.0 mg kg^{-1}-64.4 mg kg^{-1}, the lowest in bay leaf (*Laurus nobilis* L.) and the highest in nettle (*Urtica dioica* L.) samples. The range of Mo varied with values between 0.25 mg kg^{-1} in *Lavandula stoechas* and 2.13 mg kg^{-1} in *Melissa officinalis*. In trace amounts, may be beneficial in activating some enzyme systems, but its toxicity at higher levels is more prominent (Divrikli et al., 2006). Some of our results of mineral contents of medicinal and aromatic plants used in experiment show minor differences when compared with literature these differences might be due to growth conditions, genetic factors, geographical variations and analytical procedures (Özcan, 2004; Belaqziz, 2010).

CONCLUSIONS

This study indicates that some of these plants collect specific elements, and this property is dissolved by the use of these plants for medicinal objectives in addition to their bioactive secondary metabolites constituents. The total concentrations of micro elements were measured in herbal medicaments. Important numbers of herbal medicines, of various medical properties being used usually in long time therapy, were examined. Nutritive values of the examined herbal medicinal products were evaluated. Results proffered here clearly show that the analyzed herbal remedies play a meaningful role in human nutrition as micro-nutrients sources. Their recommended daily dose depletion is not healthful.

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EFFECTS OF HARVESTING STAGES ON FORAGE YIELD AND QUALITY OF CRIMSON CLOVER

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Abstract

The effects of three different harvesting stages (beginning of flowering, full flowering, and seed filling) on forage yield and quality of crimson clover (Trifolium incarnatum L.) were evaluated under the Mediterranean conditions of Turkey in 2011 and 2012 growing seasons. Dry matter (DM) yield, crude protein (CP), ADF, NDF, total digestible nutrients (TDN) and relative feed values (RFV) were determined in this research. Harvesting stages significantly affected most of the quality components determined in crimson clover. Harvesting at the late stages causes a reduction in forage quality. CP, TDN and RFV contents decreased with advancing stages while ADF and NDF contents increased.

Key words: *ADF, Crimson Clover, Crude Protein, Dry Matter, TDN.*

INTRODUCTION

Crimson clover (*Trifolium incarnatum* L.) is an erect annual legume. Its foliage is light-green and covered with soft hairs. It may be used as a cover crop, green manure, pasture or hay. It often is used as a winter annual cover crop in annual rotations (Sattell et al. 1998). The dry matter yields of 2.1 to 5.0 t ha^{-1} have been reported for crimson clover (Ross et al. 2001; Smith et al. 1992; Knight and Hollowell, 1973). One of the most important factor affecting the chemical composition and digestibility of forage is stage of grown. In general all forages are highly succulent and palatable in early growth. Most of the plants show a similarity in declining nutrient composition with advancing development towards maturation (Stubbendieck and Foster 1978; Rebole et al. 2004). The aim of this research was to determine the effects of harvesting stages on dry matter yield forage quality and nutritional value of crimson clover.

MATERIALS AND METHODS

This study was conducted at Isparta (37°45'N, 30°33'E, elevation 1035 m) located in the Mediterranean region of Turkey during 2011 and 2012. The monthly rainfall for March through June was 30.4, 52.3, 38.8 and 19.1 mm in 2011 (140.6 mm total) and 81.3, 48.7, 40.5 and 22.3 mm in 2012 (192.8 mm total), respectively. The 30-year mean for the same months is 219.9 mm.

The experiment was established in a randomized complete block design with three replicates. Three different harvesting stages (beginning of flowering at the end of April, full flowering at the end of the May and seed filling at the middle of the June) were used in this study.

Seeding rates were 20 kg ha^{-1}. Individual plot size was 2.1 × 10 m. Samples were taken from quadrats (1 m²). The experiment was repeated on an adjacent site in the second year.

After the harvest, samples were collected, dried at 70°C for 48 h, and weighed. The dried samples were reassembled and ground to pass through a 1-mm screen. The crude protein (CP) content was calculated by multiplying the Kjeldahl nitrogen concentration by 6.25 (Kacar and Inal 2008). The acid detergent fiber (ADF) and neutral detergent fiber (NDF) concentrations were measured according to methods from Ankom Technology. The total digestible nutrient (TDN) content and the relative feed value (RFV) were estimated according to the following equations adapted from Albayrak et al. (2011) :

TDN content= (-1.291 x ADF) + 101.35

$RFV = [120 / NDF] \times [88.9 – (0.779 \times ADF)] \times [0.775]$.

The statistical analysis of the yield and quality data was performed using the General Linear Model procedure of SAS (SAS Inst., 1998). The means were compared using the LSD test at the 0.05 probability level.

RESULTS AND DISCUSSIONS

Second and third harvest stage (3388 and 3921 kg ha^{-1}, respectively) had higher DM yields than the first harvest stage (2340 kg ha^{-1}). The DM yield increased after the first harvest stage. The third harvest stage exhibited lower CP values than the all other harvest stage. CP values decreased thought the vegetation period. The highest CP values obtained from the first harvest stage (221 g kg^{-1}). Sattell et al. (1998) reported that dry matter yield varied from 2200 to 11000 kg ha^{-1} in crimson clover. Ross et al. (2001) found that dry matter yield in crimson clover was varied from 2050 to 3950 kg ha^{-1}. Smith et al. (1992) found that dry matter yield in crimson clover was 4300 kg ha^{-1}. Knight and Hollowell (1973) obtained 2500-5000 kg ha^{-1} dry matter yield and 120-140 g kg^{-1} crude protein content in crimson clover. Albayrak et al. (2006) obtained 3200-4200 kg ha^{-1} dry matter yield and 171-174 g kg^{-1} crude protein content in crimson clover. Similar findings were found in present study.

Differences in NDF and ADF concentrations occurred between the harvest stage. The third harvest stage had higher NDF and ADF values than the first harvest stage. The NDF and ADF concentrations of forage are also important quality parameters (Caballero et al., 1995). At the early vegetative period legumes had lower NDF and ADF concentrations than at later vegetative period legumes. This situation can be explained by the fact that the amounts of cell wall constituents (NDF and ADF) in young legumes are not as large as those of old legumes (Buxton et al., 1991). The TDN refers to the nutrients that are available for livestock and are related to the ADF concentration of the forage. As ADF increases there is a decline in TDN which means that animal are not able to utilize the nutrients that are present in the forage (Aydin et al., 2010). In present study, the highest TDN value was obtained from the first and second harvest stage (723 and 695 gkg^{-1}), the third harvest stage had the least (664 g kg^{-1}). RFV was affected by harvest stage. The highest RFV determined on the first harvest stage (196). The first harvest stage displayed higher RFV, which may have been due to the decrease in the NDF and ADF concentrations in the crimson clover. Albayrak and Türk (2013) stated that forages with an RFV of over 151, 150–125, 124–103, 102–87, 86–75, and less than 75 are categorized as prime, premium, good, fair, poor, and rejected, respectively. Van Soest (1996) reported that the RFV is not a direct measure of the nutritional content of forage, but that it is important for estimating the value of the forage. Based on the average of the 2 years, at the different harvest stage crimson clover had relative feed values ranging from 162 to 196 and, thus, may be categorized as prime quality.

Table 1. Forage yield and quality parameters of crimson clover at different harvest stages (average of 2 years)

Harvest stage	DMY (kg ha^{-1})	CP (g kg^{-1})	ADF (g kg^{-1})	NDF (g kg^{-1})	TDN (g kg^{-1})	RFV
I	2340 b	221 a	225 b	338 b	723 a	196 a
II	3388 ab	192 ab	246 ab	365 ab	695 ab	177 ab
III	3921 a	169 b	270 a	389 a	664 b	162 b
CV (%)	15.49	9.85	10.36	5.78	4.75	5.07

Means in the same column were not significantly different at the 0.05 level in the Least Significant Difference (LSD) test.

CONCLUSIONS

Forage yield and quality changed by harvesting stages. Delaying harvest stage resulted in increased DM yield and decreased forage quality. At the end of the 2 year-research, full flowering harvesting stage could be recommended for high herbage quality growing crimson clover at similar soils and environments in Mediterranean conditions of Turkey.

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ABOVE-GROUND BIOMASS AT DIFFERENT HYBRIDS OF MAIZE (*ZEA MAYS* L.) CULTIVATED IN SOUTH ROMANIA IN DROUGHT CONDITIONS

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Abstract

Maize (Zea mays L.) is one of the most important crops for biomass production as source for producing biogas. The water stress affects significantly the maize biomass production. However, there is a wide response of maize plant to drought according to the cultivated hybrid. That is why the maize hybrids behaviour to specific climatic and soil conditions has to be well known in view to be cultivated the right hybrid for producing biomass for energetic purposes.
The aim of the paper was to present the results obtained at an assortment of maize hybrids regarding the above-ground biomass under the soil and climatic conditions from South Romania in the drought year 2012. Ten hybrids created in Romania were studied, respectively: CERA 270, CERA 290, CERA 370, CERA 390, CERA 6, CERA 420, CERA 2504, CERA 4505, Bărăgan 48, and CERA 10. The hybrids were studied in four different locations in South Romania, respectively: Fundulea – Călăraşi County; Vâlcelele – Călăraşi County; Vişani – Brăila County; Poşta Câlnău – Buzău County.
In the climatic conditions of 2012 in South Romania, five of the ten studied hybrids (CERA 2504, CERA 270, CERA 390, CERA 10, and CERA 420) registered values of the above-ground dry biomass production higher than 9 tons per hectare. Dry biomass production of stem and leaves that could present importance for different uses after harvesting ranged between 3.2 and 4.6 tons per hectare.

Key words: *maize, hybrids, biomass, drought.*

INTRODUCTION

Advanced development of human society was made possible by exploiting the huge stocks of energy deposited over millions of years in fossil biomass.
Biomass can be considered as a strategic resource because: it is renewable, it is accessible to any area, it provides products of vital interest (e.g. food, feed, raw materials for various industries, biofuels, and others), and it support the environmental and socio-economic development, providing jobs especially in rural areas (Epure, 2006).
Biomass presents an increasing importance as source of fuels (solid, liquid and gas). Traditionally, harvested and dry biomass can be used to produce heat through combustion. There are still zones, in which from different reasons the biomass represents for the inhabitants the main source of energy available; available because it exists at their own, and they can get it, transport and store with their means (Roman et al., 1996). Modern use of biomass consists in converting it into biofuel through different complex processes (gasification, pyrolysis, catalytic liquefaction).
Biogas production from agricultural biomass is of growing importance as it offers considerable environmental benefits (Chynoweth, 2004) and is an additional source of income for farmers (Amon et al., 2007).
Among the crops used for biogas production, maize is the most important crop (Amon et al., 2007; Balodis, 2011), which can produce between 205 and 450 m^3 of methane per tonne volatile solids (Murphy et al., 2011). The advantage of maize as C4 crop is less water requirement for plants dry matter production (Dubrovskis, 2010). However the water stress affects significantly the maize biomass production. There is a wide response of maize plant to drought according to the cultivated hybrid, respectively according to the capacity

of genotype to adapt to the environmental conditions and to tolerate water stress. Nevertheless the maize hybrids behaviour to specific climatic and soil conditions has to be well known in view to be cultivated the right hybrid and the farmers to take the appropriate technological decisions.
The aim of the present paper was to study an assortment of maize hybrids regarding above-ground biomass production in the specific soil and climatic conditions from South Romania. The study was realised under field conditions in year 2012, which is characterised as being a drought year.

MATERIALS AND METHODS

Researches were performed in the year 2012 on an assortment of ten hybrids of maize created in Romania for grain production, respectively: CERA 270 (FAO group 270), CERA 290 (FAO group 290), CERA 370 (FAO group 370), CERA 390 (FAO group 390), CERA 6 (FAO group 390), CERA 420 (FAO group 420), CERA 2504 (FAO group 440), CERA 4505 (FAO group 450), Bărăgan 48 (FAO group 480), and CERA 10 (FAO group 540).
The hybrids were studied in four different locations in South Romania, respectively:
- Fundulea – Călăraşi County (average multiannual temperature of 10.4°C; sum of precipitation of about 550 mm);
- Vâlcelele – Călăraşi County (average multiannual temperature of 11.2^{o}C; sum of precipitation of about 514 mm);
- Vişani – Brăila County (average multiannual temperature of 11.0^{o}C; sum of precipitation of about 460 mm);
- Poşta Câlnău – Buzău County (average multiannual temperature of 11.8^{o}C; sum of precipitation of about 410 mm).

The year 2012 can be characterized as been a warm and dry year in early spring, summer and autumn. With the exception of February, when temperatures were below the multiannual average, in all other months till November temperatures were higher than multiannual averages, especially in April and August.
March and April registered a rainfall deficit, while May was very wet with a rain rate of 160 mm, which means more than double compared to the normal value. After May month followed a dry period which has been extended until autumn, period that culminated in July with only 2 mm precipitation (about 70 mm deficit). The lack of water has affected the good plant growth and development, and as a result the biomass accumulation.
The average plant population for the ten studied hybrids was of 66.0 thousand plants per hectare in Fundulea location, 62.6 thousand plants per hectare in Vâlcelele location, 63.4 thousand plants per hectare in Visani location, 62.8 thousand plants per hectare in Poşta Câlnău location.
In each location and for each hybrid, two plants in four replications (in total eight plants per replication) were analysed at physiological maturity. The analysed plants were representative (average plants) for the plant population in the crop.
For each plant of maize, biometric determinations (plant height, number of leaves per plant, and stem diameter at base of the plant) were performed in view to better appreciate the fresh and dry biomass.
The fresh matter was determined by weighing the plants by components, respectively: stem; leaves; ear; husks, stalk and silk; panicle.
The dry matter was determined by oven drying the plant components 24 hours at a temperature of 80^{o}C.
Based on fresh and dry matter values, humidity content of the whole plant and plant components was calculated.
Based on plant population in each location and for each hybrid the biomass production was calculated.
The obtained data were statistically processed by analyses of variance (Anova-single factor).

RESULTS AND DISCUSSIONS

Average plant height at the studied maize hybrids ranged from 144.0 to 259.9 cm in South Romania and in 2012 climatic conditions (Table 1). As average value for all the four locations in which the hybrids were studied, the highest value was obtained at CERA 2504 hybrid (224.6 cm), while the smallest value was obtained at CERA 10 hybrid (189.8 cm).
The ten maize hybrids studied in different locations had a comparable height in three of the locations (220.5 cm in average at Vâlcelele – Călăraşi County, 217.1 cm in average at Fundulea – Călăraşi County, and 215.5 cm in

average at Vişani – Brăila County). Among the locations where maize hybrids were studied, stood out location Vâlcelele – Călăraşi County where the maize hybrids had the highest height. In the conditions from Poşta Câlnău – Buzău County, the height plant at the studied hybrids showed the lowest values (average value 172.8 cm), which means that studied maize hybrids here did not find very favourable growing conditions under specific climatic conditions of 2012 year.

Climatic and soil conditions influenced different the studied hybrids. However, it is noted that compared to average the CERA 2504 hybrid registered positive statistically differences in three locations (Vişani, Poşta Câlnău, and Vâlcelele), while the hybrids Bărăgan 48 and CERA 10 registered negative statistically differences assured in three locations (Fundulea, Poşta Câlnău, and Vâlcelele).

In average for all the hybrids and locations the height plant in the 2012 climatic conditions registered 206.5 cm.

Table 1. Plant height (cm) at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vişani	Poşta Câlnău	Vâlcelele	
CERA 270	228.0	223.1	187.4	228.5	*216.8*
CERA 290	212.6	190.3^{ooo}	156.5^{o}	202.5^{o}	*190.5*
CERA 370	237.1**	207.1	165.9	198.3^{o}	*202.1*
CERA 390	234.0**	216.9	182.3	236.9	*217.5*
CERA 6	212.9	202.4^{oo}	180.5	259.9***	*213.9*
CERA 420	211.0	217.3	165.8	216.9	*202.8*
CERA 2504	216.8	236.3***	199.9**	245.3**	*224.6*
CERA 4505	203.5^{o}	211.5	183.9	238.3	*209.3*
Bărăgan 48	201.4^{o}	225.6*	162.4	201.5^{o}	*197.7*
CERA 10	213.8	224.4	144.0^{ooo}	176.8^{ooo}	*189.8*
Average (Control)	*217.1*	*215.5*	*172.8*	*220.5*	*206.5*
LSD 5%	*12.5*	*20.2*	*15.5*	*17.8*	*20.9*
LSD 1%	*16.8*	*27.2*	*20.8*	*24.0*	*28.1*
LSD 0.1%	*22.3*	*36.1*	*27.7*	*31.8*	*37.3*

Number of leaves per plant is a hybrid-specific genetic characteristic, but it is still influenced by environmental conditions. In South Romania and in 2012 climatic conditions, the average number of leaves per plant ranged from 9.1 to 16.9 (Table 2).

The highest number of leaves per plant was recorded in Fundulea (Călăraşi County) climatic and soil conditions. The smallest number of leaves per plant was recorded in Vişani (Brăila County) climatic and soil conditions. It is also interesting to note that the number of leaves per plant did not correlate with plant size.

Table 2. No of leaves per plant at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vişani	Poşta Câlnău	Vâlcelele	
CERA 270	12.0^{ooo}	11.9*	11.8	13.3**	*12.3*
CERA 290	13.6^{o}	9.1^{ooo}	9.4^{oo}	12.3	*11.1*
CERA 370	14.4	10.3	10.0^{o}	11.1^{oo}	*11.5*
CERA 390	14.9	11.1	12.9**	12.8	*12.9*
CERA 6	15.0	10.4	9.4^{oo}	11.8	*11.7*
CERA 420	15.9*	12.0*	10.4	11.6	*12.5*
CERA 2504	14.5	11.1	12.3*	12.6	*12.6*
CERA 4505	15.6	10.8	10.6	13.0*	*12.5*
Bărăgan 48	15.8	11.1	11.3	12.0	*12.6*
CERA 10	16.9***	11.5	12.9**	12.3	*13.4*
Average (Control)	*14.9*	*10.9*	*11.1*	*12.3*	*12.3*
LSD 5%	*1.0*	*0.9*	*1.0*	*0.7*	*1.3*
LSD 1%	*1.3*	*1.3*	*1.4*	*0.9*	*1.8*
LSD 0.1%	*1.8*	*1.7*	*1.8*	*1.2*	*2.4*

At the studied maize hybrids, the stem diameter at base of the plant ranged from 10.5 to 20.1 mm in South Romania and in 2012 climatic conditions (Table 3). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 2504 hybrid (18.5 mm), while the smallest average value was obtained for Bărăgan 48 (14.7 mm). Among the areas where the hybrids were studied, the highest average value was obtained in Vişani area from Brăila County (18.2 mm), while the smallest value was obtained in Vâlcelele area from Călăraşi County (16.1 mm).

The above-ground dry biomass production at the studied maize hybrids ranged from 5 to 13 tons per hectare in South Romania and in 2012 climatic conditions (Table 4). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 2504 hybrid (9.8 tons per hectare), while the smallest average value was obtained for CERA 4505 (6.7 tons per hectare). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (10.3 tons per hectare), while the smallest value was obtained in Poşta Câlnău area from Buzău County (7.3 tons per hectare). The lowest above-ground dry biomass production registered at Poşta Câlnău from Buzău County correlates with the lower height plant and the small number of leaves per plant obtained under these conditions.

In average for all the hybrids and locations the above-ground dry biomass production in the 2012 climatic conditions registered 8.5 tons per hectare.

Table 3. Stem diameter (mm) at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vişani	Poşta Câlnău	Vâlcelele	
CERA 270	14.0	18.0	17.6	14.3	*16.0*
CERA 290	15.3	16.5	18.0	17.5	*16.8*
CERA 370	18.2	17.5	16.8	16.0	*17.1*
CERA 390	15.9	19.4	15.9	17.1	*17.1*
CERA 6	13.0^{o}	17.3	19.9	17.1	*16.8*
CERA 420	18.1	18.9	14.5	17.4	*17.2*
CERA 2504	16.9	18.6	19.9	18.4	*18.5*
CERA 4505	16.0	17.9	20.1	16.3	*17.6*
Bărăgan 48	15.6	18.0	14.8	10.5^{oo}	*14.7*
CERA 10	19.6	20.0	14.3	16.8	*17.7*
Average (Control)	*16.2*	*18.2*	*17.2*	*16.1*	*16.9*
LSD 5%	*3.2*	*3.0*	*3.6*	*3.4*	*2.7*
LSD 1%	*4.3*	*4.1*	*4.9*	*4.5*	*3.6*
LSD 0.1%	*5.7*	*5.4*	*6.5*	*6.0*	*4.8*

Table 4. Above-ground dry biomass production (kg/ha) at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vişani	Poşta Câlnău	Vâlcelele	
CERA 270	12,806*	8,847	10,021*	7,092	*9,692*
CERA 290	9,329	7,583	7,514	8,699	*8,281*
CERA 370	10,881	8,020	5,482	5,998	*7,595*
CERA 390	9,187	11,108*	8,604	8,970	*9,467*
CERA 6	8,761	8,407	5,017	9,288	*7,868*
CERA 420	12,414	9,649	6,768	7,912	*9,186*
CERA 2504	10,662	10,417	10,184*	7,987	*9,813*
CERA 4505	7,933	6,036^{oo}	6,932	5,860	*6,690*
Bărăgan 48	7,882	8,869	6,178	5,093^{o}	*7,006*
CERA 10	13,041*	9,418	6,331	8,240	*9,258*
Average (Control)	*10,298*	*8,862*	*7,259*	*7,494*	*8,478*
LSD 5%	*2,453*	*1,967*	*2,542*	*2,249*	*1,923*
LSD 1%	*3,307*	*2,651*	*3,427*	*3,032*	*2,593*
LSD 0.1%	*4,389*	*3,519*	*4,548*	*4,024*	*3,441*

The above-ground fresh biomass production registered a comparable situation for the studied maize hybrids and locations in South Romania with those of the above-ground dry biomass production.

The above-ground fresh biomass production at the studied maize hybrids ranged from 5.6 to 15 tons per hectare in South Romania and in 2012 climatic conditions (Table 5). In average for all the hybrids and locations the above-ground fresh biomass production in 2012 climatic conditions registered 9.7 tons per hectare.

Table 5. Above-ground fresh biomass production (kg/ha) at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vişani	Poşta Câlnău	Vâlcelele	
CERA 270	13,304	10,810	11,448*	9,632	*11,299*
CERA 290	10,340	8,166	9,320	10,031	*9,464*
CERA 370	14,796*	8,714	5,768^{oo}	6,858	*9,034*
CERA 390	10,030	12,679**	9,592	9,920	*10,555*
CERA 6	9,707	9,694	6,859	10,769	*9,257*
CERA 420	13,624	10,396	7,626	8,995	*10,160*
CERA 2504	11,819	11,568	11,784**	10,637	*11,452*
CERA 4505	8,636^{o}	6,516^{ooo}	7,674	7,292	*7,530*
Bărăgan 48	8,650^{o}	10,338	7,134	5,649^{o}	*7,943*
CERA 10	14,972*	10,617	6,850	9,333	*10,443*
Average (Control)	*11,588*	*9,950*	*8,406*	*8,912*	*9,714*
LSD 5%	*2,901*	*1,905*	*2,381*	*2,848*	*2,411*
LSD 1%	*3,911*	*2,568*	*3,209*	*3,839*	*3,250*
LSD 0.1%	*5,191*	*3,409*	*4,260*	*5,096*	*4,314*

In average for all the four locations from South Romania and in the climatic conditions of the year 2012, dry above-ground biomass production ranged between 6,690 kg per hectare at CERA 4505 hybrid and 9,813 at CERA 2504 hybrid (Figure 1). Five of the ten studied hybrids (CERA 2504, CERA 270, CERA 390, CERA 10, CERA 420) registered values of the above-ground dry biomass production higher than 9 tons per hectare.

Dry biomass production of stem and leaves that could present importance for different uses after harvesting (heat producing through combustion, biogas producing, and other purposes) ranged between 3,166 kg per hectare at CERA 290 hybrid and 4,655 kg per hectare at CERA 2504 (Figure 1).

Compared to the average of ten hybrids in Fundulea location, Călăraşi County, in drought year 2012, the above-ground dry biomass at plant maturity showed statistically positive difference for total plant biomass at the following hybrids: CERA 4505 (192.12 g), CERA 270 (191.76 g), and CERA 10 (191.23 g). Out of these three hybrids, only CERA 4505 and CERA 10 showed statistically positive difference for stem biomass and leaves biomass. In average for all the ten hybrids, the stem biomass represents 22% from total biomass of plant, and the leaves biomass represents 22.8% from total biomass of plant (Table 6).

The total plant above-ground dry biomass showed statistically negative difference at the hybrids CERA 6 and Bărăgan 48 (Table 6).

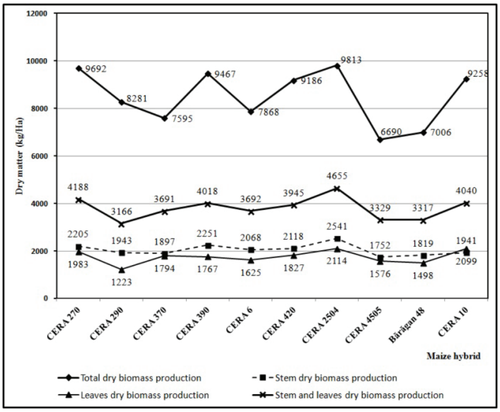

Figure 1. Dry above-ground biomass production (kg/ha) at plant maturity at an assortment of maize hybrids studied in four different locations (average values) in South Romania, in drought year 2012

Table 6. Plant above-ground dry biomass at plant maturity at an assortment of maize hybrids studied in Fundulea location, Călăraşi County, in drought year 2012

Maize hybrid	Total-plant (g)	Stem (g)	Leaves (g)	Ear (g)	Husks, stalks and silk (g)	Panicle (g)
CERA 270	191.76*	32.16	28.73	114.42**	14.82**	1.62
CERA 290	153.12	31.43	26.10^{o}	81.21	12.76 *	1.62
CERA 370	130.62	28.83	35.72	56.60	6.73	2.74 **
CERA 390	165.40	36.35	38.62	78.27	10.61	1.55
CERA 6	114.60^{o}	23.65^{oo}	27.34	55.88	6.22	1.51
CERA 420	158.70	40.48	36.42	71.07	8.98	1.76
CERA 2504	142.26	32.05	32.98	70.08	5.01^{o}	2.15
CERA 4505	192.12*	41.93*	46.86*	90.26	11.58	1.50
Bărăgan 48	119.31^{o}	33.92	33.04	45.38^{o}	4.94^{o}	2.04
CERA 10	191.23*	42.34*	49.53**	90.23	7.16	1.97
Average (Control	*155.91*	*34.31*	*35.53*	*75.34*	*8.88*	*1.85*
LSD 5%	*33.58*	*6.95*	*8.58*	*24.10*	*3.48*	*0.61*
LSD 1%	*45.27*	*9.37*	*11.57*	*32.49*	*4.69*	*0.82*
LSD 0.1%	*60.09*	*12.44*	*15.35*	*43.12*	*6.22*	*1.08*

Compared to the average of ten hybrids in Vişani location, Brăila County, in drought year 2012, the above-ground dry biomass at plant maturity showed no statistically positive differences for total plant biomass. Also, no statistically positive differences were registered for stem biomass and leaves biomass. In average for all the ten hybrids, the stem biomass represents 27% from total biomass of plant, and the leaves biomass represents 20.2% from total biomass of plant (Table 7).

The total plant above-ground dry biomass showed statistically negative difference at the hybrid CERA 6 (Table 7).

Table 7. Plant above-ground dry biomass at plant maturity at an assortment of maize hybrids studied in Vişani location, Brăila County, in drought year 2012

Maize hybrid	Total-plant (g)	Stem (g)	Leaves (g)	Ear (g)	Husks, stalks and silk (g)	Panicle (g)
CERA 270	141.71	41.18	32.46	58.80	7.81	1.47
CERA 290	111.86	26.41^{o}	15.44^{ooo}	60.28	8.33	1.40
CERA 370	136.19	40.78	24.05	62.97	7.52	0.88^{oo}
CERA 390	163.84	45.33	33.01	76.99	6.41	2.10
CERA 6	100.54^{o}	32.77	32.86	26.53^{ooo}	5.37	3.01*
CERA 420	120.65	32.08	25.43	54.31	7.55	1.28
CERA 2504	170.05	39.77	31.91	83.03*	12.20	3.15**
CERA 4505	166.79	47.07	32.55	70.89	14.73**	1.55
Bărăgan 48	128.36	35.43	29.87	51.39	9.24	2.44
CERA 10	158.01	37.23	25.08	82.39*	11.07	2.24
Average (Control	*139.80*	*37.80*	*28.27*	*62.76*	*9.02*	*1.95*
LSD 5%	*33.61*	*9.37*	*6.37*	*18.63*	*3.89*	*0.75*
LSD 1%	*45.31*	*12.63*	*8.58*	*25.12*	*5.24*	*1.01*
LSD 0.1%	*60.13*	*16.77*	*11.39*	*33.34*	*6.95*	*1.34*

Compared to the average of ten hybrids in Poşta Câlnău location, Buzău County, in drought year 2012, the above-ground dry biomass at plant maturity showed no statistically positive differences for total plant biomass. Statistically positive differences were registered for stem biomass and leaves biomass at the hybrid CERA 390, and only for leaves biomass at the hybrid CERA 270. In average for all the ten hybrids, the stem biomass represents 22.2% from total biomass of plant, and the leaves biomass represents 22% from total biomass of plant (Table 8).

Table 8. Plant above-ground dry biomass at plant maturity at an assortment of maize hybrids studied in Poşta Câlnău location, Buzău County, in drought year 2012

Maize hybrid	Total-plant (g)	Stem (g)	Leaves (g)	Ear (g)	Husks, stalks and silk (g)	Panicle (g)
CERA 270	148.79	29.37	36.77***	70.59	10.33	1.73
CERA 290	118.72	24.85	19.94^{o}	62.69	9.54	1.70
CERA 370	93.03	25.51	20.59^{o}	39.37	5.95	1.61
CERA 390	152.91	39.09**	33.90**	69.79	7.88	2.26
CERA 6	103.26	24.52	22.93	46.15	7.39	2.28
CERA 420	95.95	19.82	25.91	44.01	4.25^{oo}	1.96
CERA 2504	140.54	34.21	27.51	63.22	13.67**	1.93
CERA 4505	108.38	20.90	21.14	56.96	7.50	1.89
Bărăgan 48	99.23	21.92	17.38^{oo}	52.51	5.42	2.00
CERA 10	95.00	16.59^{o}	28.50	41.56	6.57	1.78
Average (Control	*115.58*	*25.68*	*25.46*	*54.68*	*7.85*	*1.91*
LSD 5%	*38.78*	*8.97*	*4.87*	*31.38*	*3.56*	*0.72*
LSD 1%	*52.28*	*12.09*	*6.56*	*42.30*	*4.80*	*0.97*
LSD 0.1%	*69.39*	*16.05*	*8.71*	*56.14*	*6.38*	*1.29*

Compared to the average of ten hybrids in Vâlcelele location, Călăraşi County, in drought year 2012, the above-ground dry biomass at plant maturity showed no statistically positive differences for total plant biomass. Statistically positive differences were registered only for leaves biomass at the hybrids CERA 420, CERA 270, and CERA 10. In average for all the ten hybrids, the stem biomass represents 25.8% from total biomass of plant, and the leaves biomass represents 16.8% from total biomass of plant (Table 9).

Table 9. Plant above-ground dry biomass at plant maturity at an assortment of maize hybrids studied in Vâlcelele location, Călăraşi County, in drought year 2012

Maize hybrid	Total-plant (g)	Stem (g)	Leaves (g)	Ear (g)	Husks, stalks and silk (g)	Panicle (g)
CERA 270	113.49	33.98	24.17*	41.13	12.62	1.59
CERA 290	132.20	37.92	15.08^{o}	67.14	10.40	1.66
CERA 370	145.48	38.27	23.61	69.87	11.60	2.14
CERA 390	115.83	33.88	23.36	51.74	4.96^{o}	1.88
CERA 6	95.67	28.72	14.69^{oo}	45.08	5.74	1.43
CERA 420	112.05	28.90	28.20***	42.27	10.47	2.20
CERA 2504	142.63	35.65	18.57	71.65	14.95*	1.81
CERA 4505	130.46	28.63	17.73	72.01	10.21	1.89
Bărăgan 48	83.03	19.91^{o}	10.81^{ooo}	45.59	5.30	1.42
CERA 10	126.85	23.91	24.97*	65.40	10.79	1.78
Average (Control	*119.77*	*30.98*	*20.12*	*57.19*	*9.70*	*1.78*
LSD 5%	*39.32*	*8.75*	*3.80*	*27.35*	*4.67*	*0.60*
LSD 1%	*53.01*	*11.79*	*5.12*	*36.87*	*6.29*	*0.81*
LSD 0.1%	*70.35*	*15.65*	*6.79*	*48.94*	*8.35*	*1.07*

In South Romania for the climatic conditions (drought) of the year 2012, the plant above-ground dry biomass ranged within the following limits (Tables 6, 7, 8 and 9):

- from 83.03 to 192.12 g for total plant dry biomass;
- from 16.59 to 47.07 g for stem dry biomass;
- from 10.81 to 49.53 g for leaves dry biomass;
- from 26.53 to 114.42 g for ear dry biomass;
- from 4.25 to 14.95 g for husks, stalks and silk dry biomass;
- from 0.88 to 3.15 g for panicle dry biomass.

In average for all the four locations from South Romania and in the climatic conditions of 2012, the total dry above-ground biomass of plant ranged between 103.52 g at CERA 4505 hybrid and 149.5 g at CERA 2504 hybrid (Figure 2). Five of ten hybrids (CERA 4505, CERA 420, CERA 270, CERA 390, and CERA 10) registered values for total above-ground dry biomass of plant higher than 140 g. In the total dry above-ground biomass of plant, the most important contribution is that of dry biomass of ears. After the ears biomass, the dry biomass of stems is the most important in the total plant biomass, except the CERA 10 hybrid for which the dry biomass of leaves is more important than the dry biomass of stems.

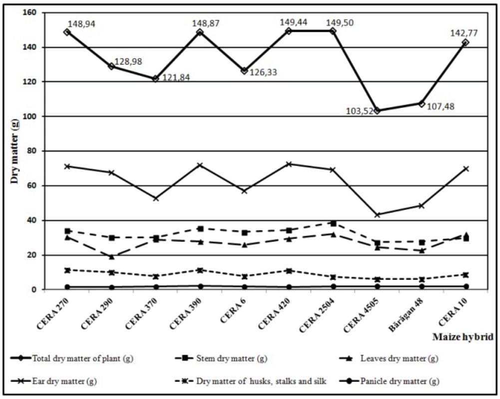

Figure 2. Dry above-ground biomass of plant (g) at plant maturity at an assortment of maize hybrids studied in four different locations (average values) in South Romania, in drought year 2012

Plant above-ground dry matter, in average for the ten studied maize hybrids and for the specific conditions from South Romania and under drought conditions of the year 2012, is composed of (Figure 3):

- 46.9% ear dry matter;
- 24.4% stem dry matter;
- 20.7% leaves dry matter;
- 6.6% husks, stalks and silk dry matter;
- 1.4% panicle dry matter.

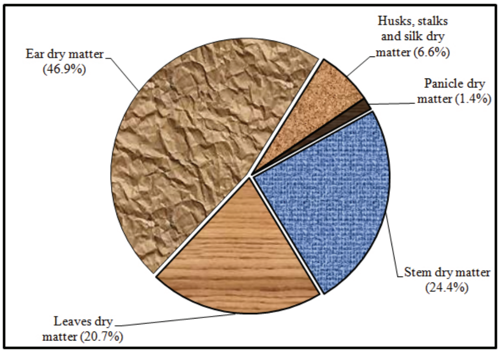

Figure 3. Plant components dry matter ratio (%) of total plant dry matter at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize plant is dry at physiological maturity and plant components have low humidity values, namely: stem humidity ranged between 6.29% (CERA 390 hybrid at Fundulea, Călăraşi

County) and 30.29% (CERA 270 hybrid at Vâlcelele, Călăraşi County) (Table 11); leaves humidity ranged between 5.6% (CERA 270 hybrid at Poşta Câlnău, Buzău County) and 29.1% (CERA hybrid 370 at Fundulea, Călăraşi County) (Table 12).

Table 10. Stem humidity (%) at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vişani	Poşta Câlnău	Vâlcelele	
CERA 270	9.53	23.20	8.13	30.29	*17.79*
CERA 290	11.43	10.40	7.65	12.84	*10.58*
CERA 6	7.18	23.95	10.27	18.82	*15.06*
CERA 2504	6.64	11.07	15.18	31.33	*16.06*
CERA 4505	10.30	16.85	7.32	23.62	*14.52*
CERA 370	22.52*	9.13	13.42	20.67	*16.44*
CERA 390	6.29	17.95	11.23	9.82	*11.32*
CERA 420	6.69	10.82	18.22	16.08	*12.95*
Bărăgan 48	8.85	8.66	23.52*	30.17	*17.80*
CERA 10	14.77	17.93	7.07	14.72	*13.62*
Average (Control)	*10.42*	*15.00*	*12.20*	*20.84*	*14.62*
LSD 5%	*10.11*	*14.65*	*8.90*	*20.52*	*8.76*
LSD 1%	*13.63*	*19.75*	*11.99*	*27.66*	*11.81*
LSD 0.1%	*18.09*	*26.22*	*15.92*	*36.71*	*15.67*

Table 11. Leaves humidity (%) at an assortment of maize hybrids studied in different locations in South Romania, in drought year 2012

Maize hybrid	Locations				*Average hybrid*
	Fundulea	Vişani	Poşta Câlnău	Vâlcelele	
CERA 270	7.36	15.56**	5.60	14.87	*10.85*
CERA 290	11.37	6.41	9.16	7.76	*8.68*
CERA 6	9.52	8.50	6.56	7.35	*7.98*
CERA 2504	11.21	9.01	15.70*	15.19	*12.78*
CERA 4505	6.03	7.56	8.06	17.72	*9.84*
CERA 370	29.10**	8.71	6.89	9.62	*13.58*
CERA 390	7.41	7.25	7.38	12.13	*8.54*
CERA 420	8.82	7.28	7.25	11.54	*8.72*
Bărăgan 48	10.76	7.32	9.09	16.70	*10.97*
CERA 10	17.98	9.15	7.98	11.00	*11.53*
Average (Control)	*11.96*	*8.67*	*8.37*	*12.39*	10.35
LSD 5%	*11.92*	*6.31*	*7.20*	*7.59*	6.13
LSD 1%	*16.07*	*8.50*	*9.71*	*10.24*	8.27
LSD 0.1%	*21.34*	*11.28*	*12.89*	*13.58*	10.97

CONCLUSIONS

In the drought conditions of the year 2012 in South Romania, the average plant height at the ten studied maize hybrids ranged from 144.0 to 259.9 cm, with an average value for all hybrids of 206.5 cm.

The average number of leaves per plant at the studied maize hybrids ranged from 9.1 to 16.9, with an average value for all hybrids of 12.3.

The stem diameter at base of the plant at the studied maize hybrids ranged from 10.5 to 20.1 mm, with an average value for all hybrids of 16.9 mm.

The above-ground dry biomass production at the studied maize hybrids at physiological maturity of plant ranged from 5 to 13 tons per hectare, with an average value for all the ten hybrids of 8.5 tons per hectare.

In the climatic conditions of 2012 in South Romania, five of the ten studied hybrids (CERA 2504, CERA 270, CERA 390, CERA 10, and CERA 420) registered values of the above-ground dry biomass production higher than 9 tons per hectare.

The above-ground fresh biomass production at the studied maize hybrids at physiological maturity of plant ranged from 5.6 to 15 tons per hectare, with an average value for all hybrids of 9.7 tons per hectare.

Dry biomass production of stem and leaves that could present importance for different uses after harvesting ranged between 3.2 and 4.6 tons per hectare.

Plant above-ground dry biomass ranged from 83.03 to 192.12 g.

Plant above-ground dry matter, in average for the ten studied maize hybrids and for the specific conditions from South Romania and under drought of the year 2012, is composed of: 46.9% ear dry matter; 24.4% stem dry matter; 20.7% leaves dry matter; 6.6% husks, stalks and silk dry matter; 1.4% panicle dry matter.

At physiological maturity of plant, stem humidity ranged between 6.3 and 30.2%, and leaves humidity ranged between 5.6 and 29.1%.

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VARIATION IN ESSENTIAL OIL CONTENT AND COMPOSITION OF SOME MEDICINAL AND AROMATIC PLANTS AVAILABLE ON TURKISH MARKET

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Abstract

Interest on medicinal and aromatic plants has increased during recent years as they are sources of many bioactive compounds, like essential oils, having versatile pharmacological and medicinal properties. Medicinal and aromatic plants are mostly collected from nature in Turkey and thus chemical composition of essential oils of herbal drugs available in markets is expected to be variable. In this study, variation in essential oil content and composition of eucalyptus, laurel, myrte and yarrow plant samples obtained from spice shops in Ordu province of Turkey were investigated. Essential oil contents of the plant samples were determined by water distillation and essential oil components were analyzed by GC/MS. Essential oil contents were within the ranges of 0.80-2.15% in eucalyptus, 1.55-2.85% in laurel, 0.65-1.40% in myrte and 0.25-0.45% in yarrow. A total of 26 components in eucalyptus and yarrow essential oils, 22 components in laurel and myrte essential oils were detected, representing 95.88-97.05% of the essential oils. Eucalyptol (61.53%), terpinyl acetate (7.90%) and sabinene (5.03%) in laurel; eucalyptol (48.06%), p-cymene (16.70%) and cyclopropeazulen (5.66%) in eucalyptus; eucalyptol (30.87%), a-pinene (28.23%) and linalol (8.27% in myrte, and eucalyptol (32.05%), camphor (11.09%) and carvacrol (9.27%) in yarrow were the major constituents of the essential oil. Eucalyptol was found to be the most common and the highest chemical constituent of the essential oils.

***Key words:** eucalyptus, laurel, myrte, secondary metabolite, volatile oil, yarrow.*

INTRODUCTION

Being a bridge between South Europe and Southeast Asia and located on the intercrossing point of three phyto-geographic regions, Anatolia is one of the richest regions of the world in terms of plant biodiversity. It has been stated that the flora of Anatolia includes almost 12 thousands plant species, and nearly one third of them are endemic (Kahraman et al., 2012).
Medicinal and aromatic plants are of significant importance in the plant diversity of Anatolia which has quite different climatic and ecological conditions. Turkey is among the richest countries especially in respect to medicinal and aromatic plants collected from nature as well (Baser, 2002).
The curative and aromatic properties of medicinal and aromatic plants are due to the presence of complex chemical substances, called secondary metabolites. Volatile oils, one the most important secondary metabolites found in medicinal and aromatic plants, are commonly used as a source of medicine, food, perfume and cosmetics. Recent researches revealed that volatile oils have a strong antioxidant and antimicrobial effect (Özcan and Erkmen, 2001; Bakkali et al., 2008).
Bioactive compounds synthesized in medicinal and aromatic plants may wary significantly according to used plant part, plant growth stage and harvest time etc. The highest essential oil present in leaves of certain plants, but in flowers of others. Growing period in which essential oils present at the maximum is full blooming in general. Ecological conditions, production technologies and postharvest operations play positive or negative effects on the amount and quality of bioactive compounds as well. The most important factor that determines the importance and economic value of essential oilsis the amount and variety of chemical constituents that forms essential oil. The amount and chemical composition of essential oils obtained from different plant parts, at different growth stages and at diverse ecologies may fluctuate greatly (Azizi and Kahrizi, 2008; Uyanik et al., 2010).

Although Turkey has a great potential for medicinal and aromatic plants, most of the plant drugs exported and used in traditional public health are composed of plants collected from natural habitat (Özek et al., 2000). The first hand source providing plant drugs are spice shops (Aktar in Turkish) which are of considerable importance in traditional folk medicine in Anatolia for ages. Since medicinal and aromatic plants are mostly collected from nature in Turkey, content and constituents of essential oils of herbal drugs sold in spice shops are likely to be considerable variable. This study was carried out to determine content and chemical composition of volatile oils of certain medicinal and aromatic plants obtained from spice shops in Ordu province of Turkey.

MATERIALS AND METHODS

Plant materials of four species were obtained in October 2009 from local spice shops in Ordu province in the Black Sea Region of Turkey. The plant species were: eucalyptus (*Eucalyptus globules*), laurel (*Laurus nobilis),* myrte *(Myrtus communis*) and yarrow (*Achillie millefolium*). For chemical analysis, four different samples of 100 g from each of the four species were obtained from local spice shops. The essential oil content was determined separately using a Clevenger-type apparatus. The samples were distilled for 3 h in 500 ml water. The essential oil was analyzed by GC-MS. The essential oil was analyzed using HP 6890 GC equipped with and FID detector and also oils were analyzed by GC-MS, using a Hewlett Packard system. HP-5 MS column (30 m x 0.25 mm i.d., film thickness 0.25 μm) was used with Helium as the carrier gas. Injector temperature was 250^{o}C, split flow was 1 ml / min. The GC oven temperature was kept at 70^{o}C for 2 min. and programmed to 150^{o}C at a rate of 10^{o}C / min and then kept constant at 150^{o}C for 15 min to 240^{o}C at a rate of 5^{o}C / min.

RESULTS AND DISCUSSIONS

Essential oils and the most important five constituents observed in the plant samples available on the markets of Ordu province are summarized in Table 1-5. Essential oil contents were within the ranges of 0.80-2.15% in eucalyptus, 1.55-2.85% in laurel, 0.65-1.40% in myrte and 0.25-0.45% in yarrow (Table 1). A total of 26 components in eucalyptus and yarrow essential oils and 22 components in laurel and myrte essential oils were detected by GC/MS analysis, representing 95.88-97.05% of the essential oils.

Table 1. Essential oil contents (%) of plant samples obtained from spice shops in Ordu province of Turkey

Plant name	Plant Samples				
	1	2	3	4	Mean%
Eucalyptus	0.85	0.80	2.15	1.75	1.38
Laurel	2.25	1.55	--	2.85	2.22
Myrte	1.40	0.65	1.20	0.95	0.78
Yarrow	0.40	0.40	0.25	0.45	0.37

Eucalyptol (48.06%), p-cymene (16.70%), cyclopropeazulen (5.66%), ß-phellandrene (5.13%) and cryptone 4.09%) were detected as the main components in eucalyptus samples, comprising the 79.64% essential oil (Table 2). In a previous study, 1, 8-eucalyptol (72.71%), a-pinene (9.22%) and a-terpineol (2.54%) were determined as the main components of eucalyptus essential oil (Song et al., 2009).

Table 2. Essential oil composition (%) of eucalyptus available in spice shops in Ordu province of Turkey

	Plant Samples			
Components	1	2	3	Mean%
Eucalyptol	30.74	52.99	49.65	58.86
p-cymene	20.52	28.4	5.44	12.46
Cyclopropeazulen	7.86		8.77	0.35
ß-phellandrene	5.30	3.38	5.62	6.23
Cryptone	9.05	3.18	2.54	1.62

In the essential oils of laurel, major compounds (Table 3) were found as eucalyptol (61.53%), terpinyl acetate (7.90%), sabinene (5.03%), a-pinene (3.76%) and 4-carvomenthenol (3.68%), comprising 81.90% of the essential oil.

Ozcan and Chalchat (2005) studied the essential oil components of *Laurus nobilis* gathered from seven different locations of Turkey. Among the major components were 1,8-cineole (51.73-68.48%), a-terpinyl acetate (4.04-9.87%), sabinene (4.44-7.75%), a-pinene (2.93-4.89%) and ß-pinene (2.58-3.91%). Minor qualitative and major quantitative variations of some compound, were determined with respect to localities.

In the study of Verdian-rizi (2009), the essential oilsobtained from the different phenological stages were found to have similar compositions. The main compounds were 1,8-cineole, sabinene, a-terpinylacetate, methyl eugenol, and a-Pinene. The time of harvesting did not show a major effect on the composition of essential oil. Flowering stage was the best time for harvest because at this time the plant contained the highest percent of essential oil.

Table 3. Essential oil composition (%) of laurel available in spice shops in Ordu province of Turkey

	Plant Samples			
Components	1	2	3	Mean%
Eucalyptol	66.89	67.63	50.07	61.53
Terpinyl acetate	6.45	4.91	12.35	7.90
Sabinene	3.68	3.41	8.00	5.03
a-pinene	3.08	3.43	4.79	3.76
4-carvomenthenol	4.50	3.25	3.30	3.68

The major constituents of myrte essential oil were eucalyptol (30.87%), a-pinene (28.23%), linalool (8.27%), limonene (6.43%) and a-terpineol (5.61%), as shown in Table 4. The first five components comprised the 79.41% of the essential oil of myrte.

Table 4. Essential oil composition (%) of myrte available in spice shops in Ordu province of Turkey

	Plant Samples				
Components	1	2	3	4	Mean%
Eucalyptol	43.94	26.29	22.52	30.74	30.87
a-pinene	24.31	21.03	33.81	33.77	28.23
Linalool	4.61	10.72	9.27	8.51	8.27
Limonene	5.54	9.64	2.92	7.62	6.43
a-terpineol	7.32	5.54	4.28	5.30	5.61

The composition of essential oils from leaves and leaves + branches (collected from Mugla and Balikesir provinces of Turkey) of Myrtus communis was examined by GC/MS (Özek et al., 2000). The main components were 1.8-cineole (eucalyptol) (18.2% and 10.5% in leaves and leaves + branches, respectively), linalool (16.3% and 18.6%) and myrtenyl acetate (14.5% and 10.8%). Wannes et al. (2009) found eucalyptol (7.31-40.99%), geranyl acetate (1.83-20.54%), linalool (0.74-18.92%) and a-pinene (1.24-12.64%) as the major compounds of essential oils of myrte.

Twenty-six compounds were identified in essential oil of yarrow and constituted 95.90-98.27% of the total oil. Eucalyptol (32.05%), camphor (11.09%), carvacrol (9.27%), eugenol (6.60%) and carvone (6.53%) were detected as the main components of eucalyptus essential oil (Table 5). Candan et al. (2003) reported that the essential oil of yarrow was characterized by a high number of monoterpenes. They found that eucalyptol (24.6%), camphor (16.7%), a-terpineol (10.2%), ß-pinene (4.2%), and borneol (4.0%) were the principal components comprising the 59.7% of the essential oil.

Table 5. Essential oil composition (%) of yarrow available in spice shops in Ordu province of Turkey

	Plant Samples				
Components	1	2	3	4	Mean%
Eucalyptol	35.99	24.45	34.44	33.32	32.05
Camphor	7.52	10.49	12.21	14.16	11.09
Carvacrol	5.36	17.9	13.0	0.82	9.27
Eugenol	3.04	15.9	5.45	2.26	6.66
Carvone	--	2.33	2.54	14.73	6.53

CONCLUSIONS

In the present work, the contents of essential oils ranged between 0.80 to 2.15% in eucalyptus, 1.55 to 2.85% in laurel, 0.65 to 1.40% in myrte and 0.25 to 0.45% in yarrow. A total of 22 constituents of theessential oil from laurel and myrte and 26 components of the essential oil from eucalyptus and yarrow were determined. The major constituents in the essential oils were similar to those reported in the literature, with some differences in the percentage composition. Eucalyptol was found to be the most common and the highest chemical constituent of the essential oils.

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STUDIES REGARDING THE INFLUENCE OF THERMIC AND HYDRIC STRESS ON PREMIUM WHEAT YIELD DURING 2006-2012 IN SOUTHERN, CENTRAL AND NORTHERN PARTS OF ROMANIA

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Abstract

The paper aims to present in detail the results of the researches performed in order to determine how weather conditions could affect winter wheat yields. To achieve this purpose we used several measurements and observations from our working points Modelu – Calarasi, Poroschia – Alexandria and also from various locations in Central and Northern Romania, data that were analyzed under different aspects. We took into account the quantity of rainfall during the flowering stage (in spring) and the temperature, expressed in °C, which exceeded the limit of 30°C in the same vegetative stage, being known that this is the maximum value supported for a normal behavior of premium wheat plants, of their production and of grain quality. Data obtained from our own experimental fields, as well as those collected from other sources, showed a negative correlation between the quantity of fallen rain and the high temperatures, but also two opposites correlations between precipitations and crops (positive links up to 350 mm and exponentially negative afterwards). Another negative correlation that we registered it is the one between the amount of degrees above 30°C recorded during flowering and the production level (which decreased, sometimes by up to 50%). The weakest results in the premium wheat production were obtained when soil drought, atmospheric drought and thermal stress correlative worked together, thing that began to happen more often in the last 10 years, especially in the Romanian Plain and in all the southern part of the country.

Key words: *premium wheat, drought, varieties, yield, genetics.*

INTRODUCTION

Climate changes are reflected by a significant modification of abiotic factors which acts on plants. Extremely important in this category are the temperature and the water (Berca, 2011). At the intersection between water and temperature is the humidity. Wheat crop begins to be under stress if soil moisture is approaching the withering coefficient, but also if the humidity goes below 30%, which is the minimum accepted (Meluca et al., 2011). It had been shown on correctly studied models (Brown and Rosenberg, 1999) that by simply increasing the area temperature with 1°C the production of wheat decreases by 18%, so that when it rises with +2.5°C it falls by 20% (temperature over 30°C). Starting from many factors solutions are seeked for taming the abiotic factors aggression on agriculture (INCDA Fundulea). Researchers calculate the climate impact on wheat yield beginning with the determination of evapotranspiration (Ehteramian, 2012), the losses of production caused by water / temperature stress exceeding 57%.

MATERIALS AND METHODS

In the research fields and lots in Southern Romania – Modelu, Alexandria County, in Center – Zagar area (Mures County) and in Northern part – Diosig (Bihor) was cultivated an extremely various range of varieties, out of which were selected 5 Premium varieties and „A" for the analysis of genetic composting plant (Capo, Josef, Fulvia, Balaton).

The following parameters were measured:

- total amount of temperature degrees that exceeded 30°C in May and June, which included 100% the flowering period;
- total amount of rainfall in the experimental year and area;
- in the South zones was also determinated the relative air humidity during flowering stage;
- productions level at 14% humidity, expressed in q/ha.

The data obtained were statistically processed through analysis (dispersion) and were presented as tables and graphs. Was studied the correlation between the amount of temperatures above 30^{o}C (ΣT>30^{o}C) and the crop yield, of precipitations on yields and of trifactorial correlation expressed in 3D between temperatures of over 30^{o}C, precipitations and crop yields.

Were also made directly observations into large farms, with high technologies, in order to check the results from experimental fields and verification lots.

A special accent was put on the agricultural year 2011-2012, which registered the highest scorching heat of the last 50 years. Where lacked the possibilities of climatic parameters measuring, the evaluations were made with marks from 1 to 9, namely:

- 1-2 = very resistant
- 3-4 = resistant
- 5-6 = medium resistant
- 7-8 = sensitive
- 9 = very sensitive.

RESULTS AND DISCUSSIONS

Was established that 2012 was a very suitable year for testing the varieties resistance not only in Romania, but also in the entire Europe. In April 2012 at Stockerau, in Austria, were communicated the wintering behavior results of main cereals. It turned out that especially barley varieties, as well as those of Durum wheat, weren't affected by the hardness of winter, with temperatures reaching –25^{o}C for more than 8 days in a row, as they were by the late and harsh frosts from early and mid April.

The results from Pannonian Plain, an area with a similar climate to that of Southern Romania, revealed average yieds, slightly over 3000 kg/ha, mainly because of the recorded thermic stress. The studies carried out during 2004-2010 by Boku University of Vienna on 55 researches (Grausgruber, 2012) show that, in such conditions, the average productions for 19 varieties is situated at 58 q/ha in dry areas and 53 q/ha in wet areas. No pesticides were applied. In Northern and Western regions the productions increased up to 65 q/ha, the summer thermic stress being greatly reduced.

The contribution of genetics remains decisive in the adjustement reports between wheat plants and the new stress conditions from soil and atmosphere. Investigations conducted during 1972-2008 in Pannonian Plain, using 473 researches and a number of almost 50 varieties (BauernZeitung, 2009), demonstrated that, despite the increasing of abiotic stress indicators, the varieties productivity for the studied period (36 years) grew with 30.5 kg/an (Figure 1). The effect of genetics wasn't equal every year, it ranged from 0.3 to 1.2%.

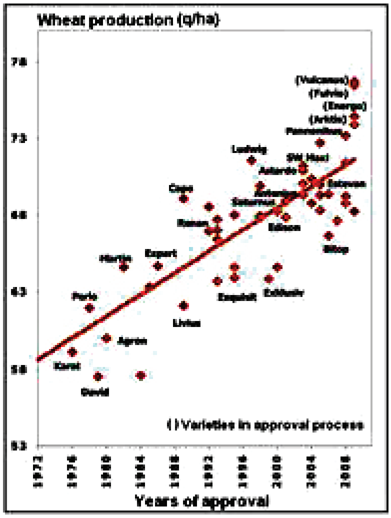

Figure 1. Certified varieties and some recently removed from culture – resu1ts 1972-2009, 473 researches

The analysis of wheat average yields in Romania between 2000-2012 (Figure 2), in spite of an advanced technology introduced in agriculture, reveals a slight increase from 2518 kg/ha in 2000 down to 2660 kg/ha in 2009, after which it remains relatively constant until 2012 (also see Figure 3).

The real values, included in Figure 2, demonstrate a very large variation on the country average yield from one year to another. If the arithmetic mean of the 12 analyzed years indicate a value of 2565 kg/ha, the variation coefficient is 28.39% (Table 1). It means that the average yield along the 15 years has been set in the confidence interval 2565 ± 28% = [2565 x 1.28 → 2565 x 0.72] = [1846 → 3283].

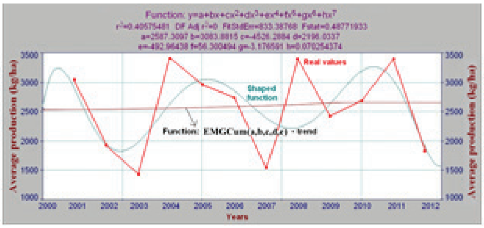

Figure 2. The dynamics of wheat average productions in Romania between 2000-2012 (original)

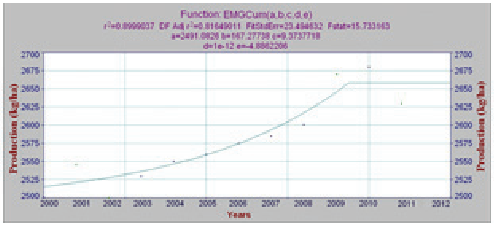

Figure 3. The corrected dynamics of wheat production during 2000-2011, in Romania (original)

Table 1. Variation in wheat production in Romania, 2001-2012 (national average)

No.	Inputs	Frequency	Amount
1	1,429.00	1	1,429.00
2	1,541.00	1	1,541.00
3	1,830.00	1	1,830.00
4	1,924.00	1	1,924.00
5	2,421.00	1	2,421.00
6	2,685.00	1	2,685.00
7	2,746.00	1	2,746.00
8	2,965.00	1	2,965.00
9	3,038.00	1	3,038.00
10	3,394.00	1	3,394.00
11	3,403.00	2	6,806.00
TOTAL		12	30,779.00
RESULTS			
ARITHMETIC MEAN =			2,564.91
MEAN DEVIATION =			613.26
SQUARE MEAN DEVIATION =			530,321.17
STANDARD DEVIATION =			728.23
VARIATION COEFFICIENT =			28.39 %

The exceptions encountered in 2003 and 2007 (Figure 2), which significantly fall under the calculated interval, are extremely important for our analysis because the reduction of production wasn't at all due to technological factors, but primarily to thermic and hydric tensions. Researches made in the years of study in 4 Romanian zones (Alexandria, Modelu – Calarasi, Zagar – Mures and Diosig – Bihor) show that both high temperatures and low rainfall were able to have a negative influence on wheat harvests.

When referring to the temperatures level, very harmful proved to be the quantities of heat, expressed in Σ°C, from May-June and particularly from flowering stage (Figure 4).

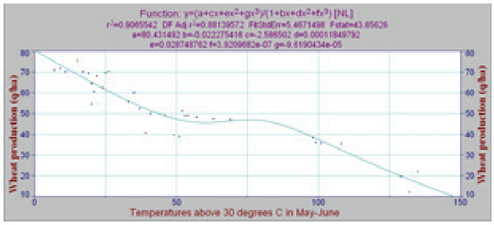

Figure 4. Influence of over 30 oC temperatures in May-June (blooming) on wheat yield (original)

Accumulating 50°C over the daily 30°C acceptated as maximum in wheat crop have led to a production decrease of 3 t/ha. Increasing with other 50°C above 30°C is reducing the yield level with another metric ton/ha, so that at >Σ150°C the harvest is almost compromised.

Usually the thermic stress complement the one caused by the lack of water. There is a negative correlation between the water scarcity and thermic stress, known and monitored by all agrometeorological stations and institutes.

Scientists from Fundulea (Petcu, 2007), talking about the term of „scorching heat", explain that at high values of it we are dealing with a mixed stress – hydric and thermic –, which leads, at cellular level, to an oxidative degradation.

The studies made in order to show wheat drought resistance demonstrate the induction, at cellular level, of protective enzymatic systems against oxidative stress. Oxidative stress reduces the FSI (foliar surface index), which is positively correlated with photosynthesis. FSI damage leads to the reduction of biomass and/or to the losses in plant productivity.

Although generally it is stated that the wheat is a high tolerance plant to hydric deficit, this applies for most of the autumn-winter season, all plants becoming susceptible in early spring, during the production parts differentiation, ie at flowering – grains filling, in May-June. These are, usually, rainy months, which should bring into soil the needed water for a constant yield. In fact, the annual rainfall variation has become extremely important, in some years (such as

2003, 2007, but also 2012) affecting the majority of wheat genotypes cultivated in Romania.

In Figure 5 is presented the relation between the level of rainfall in Romania and the wheat yield, figures obtained due to measurements and observations realised in our experimental and demonstrative fields.

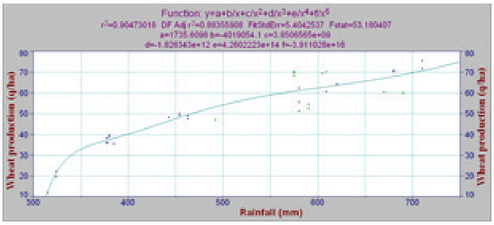

Figure 5. Correlation between precipitations (mm) and wheat production level in Romania (original)

The calculation shows that wheat production tends toward compromise in areas where annual rainfall drop below 300 mm, water stress not being well supported by wheat plants. Only from 360-380 mm we can say (especially if 70% of the precipitations fall during wheat vegetation period – in spring and early summer) that under high agrotechnics, with full water conservation, we can produce 3500-3800 kg/ha. In the same conditions, at 450 mm we can reach to about 5000 kg/ha, at 600 mm to 6200-6500 kg/ha and at 700 mm to 6800-7200 kg/ha.

The 3D analysis of the influence of rainfall and of the temperature amount over 30°C in May-June is the one presented in Figure 6.

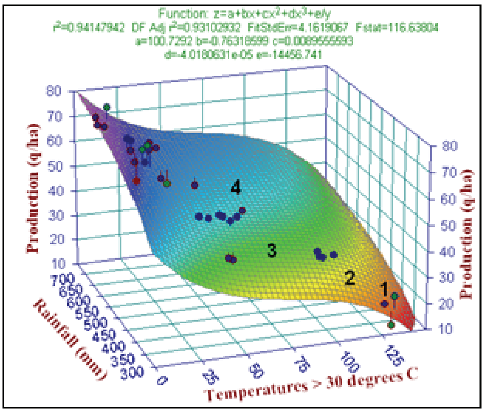

Figure 6. How is wheat production affected by high temperatures and rainfall level (original)

Depending on those 2 parameters we can distinguish 4 event areas of wheat:

- a critical area from Σ75°C more than 30°C during flowering period and rainfall between 300 and 450-550 mm (last ones at amounts above 125°C) - yields are around 2000-2500 kg/ha;
- a sub-critical area from Σ45-50°C to 75°C and annual rainfall of 450-500 mm - yields up to 4000 kg/ha;
- a favorable area from Σ25-45°C and rainfall not more than 650 mm - yields up to 5000 kg/ha;
- a very favorable area from Σ0-25°C and annual rainfall of about 650-700 mm - yields up to 8000 kg/ha.

This division of wheat production favorability areas by humidity and supra-temperatures needs revision according to the increase of research years. The pattern is valid for the average of at least 16 varieties of various origins (Romanian and foreign), with a high variability of production dictated by many other factors, but in which the genotype remains an important element.

2012 was a year characterized by low rainfall and extremely high temperatures all over Romania, but mainly in the South. The data provided by the Ministry of Agriculture show a reduction of 20% on wheat production, while farmer's organizations are declaring to the press that the losses caused by hydric and thermic stress are around 40%. Our observations indicate that the crop losses were closely correlated with the super-temperatures from flowering time, with the overlapping of both processes and with soil drought. The relative air humidity has also played an important role (Figure 7).

The number of days with air humidity below 30% ranged between 24-35 in 2007, 18-26 in 2008, 15-23 în 2009, 5-14 in 2010 and 39-44 in 2012, according to data collected from meteorological stations in Alexandria and Calarasi. Low humidity in the atmosphere, correlated with high temperatures and with a low water content of the soil, are working together to achieve maximum hydric stress – with extremely high destructive effect on yield, which in many cases, as it were 2007 and 2012, are going till the compromise of the harvest.

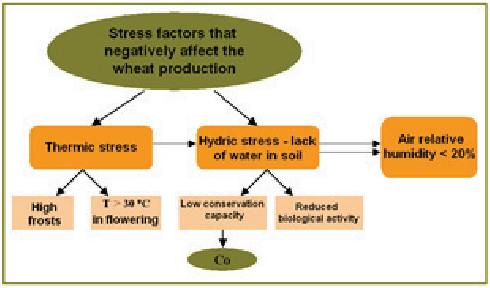

Figure 7. Thermo-hydric stress factors on winter wheat and other cereals (original)

Negative thermic stress from winter may largely affect the harvest, especially on barley.
In 2011-2012 winter, one of the harshest in the last 20 years, in Eastern part of Romania, especially in Braila, Galati, Vaslui counties, barley crops were over 50% destroyed. However, there were varieties that have resisted, but also of those that were completely destroyed by frosts.
Agronomically speaking, the studies (Oberforster, 2012) show that the damages occuring on cereals in winter come from two directions (Figure 8).

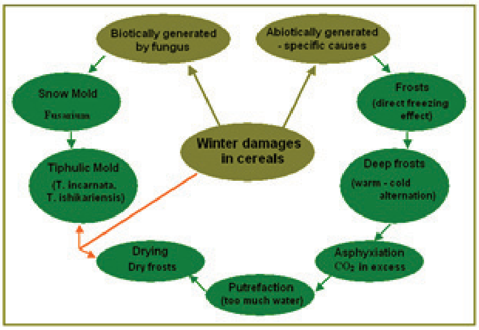

Figure 8. Causes of winter damages on grains – processed after Oberforster (2012)

The effect of the causes presented above is the level of productions that also include, in addition to their natural inputs and anomalies, a large amount of technological inputs.
At Modelu – Calarasi, in experimental plots in which the entire technology has been kept at maximum level, 15 Premium genotypes, which in normal years gave similar yields, in 2012 varied from 1 (Balaton variety) to 1.8 (Atrium variety) (Table 2).

Table 2. Thermic stress effect on Premium wheat yield (Modelu, 2012)

Variety	Production		Difference		Semnifi-cation
	kg/ha	%	kg/ha	%	
Balaton	4,886.00	71.25	-1,971.53	-28.75	000
Atrium	8,601.00	125.42	1,743.47	25.42	***
Arnold	7,447.00	108.60	589.47	8.60	**
Fabula	7,497.00	109.33	639.47	9.33	**
Fulvio	7,665.00	111.77	807.47	11.77	***
Josef	6,491.00	94.66	-366.53	-5.34	
Bitop	6,395.00	93.26	-462.53	-6.74	0
Midas	7,365.00	107.40	507.47	7.40	*
Peppino	7,210.00	105.14	352.47	5.14	
Pireneo	6,371.00	92.91	-486.53	-7.09	0
Capo	7,162.00	104.44	304.47	4.44	
Philipp	6,994.00	101.99	136.47	1.99	
Astardo	6,970.00	101.64	112.47	1,64	
Pedro	5,665.00	101.64	112.47	1.64	000
Ludwig	6,144.00	89.59	-713.53	-10.41	000
Average	6,857.53	100.00	0.00	0.00	CONTROL
DL 5% = 393.7472 DL 1% = 525.9086 DL 0.1% = 688.1778					

Balaton variety, with 8-10 days more untimely, normally obtains similar yields with Atrium. In 2012 its earliness was a disadvantage because all these days were during full flowering period, the effect on production being drastically negative.
Late flowering of Atrium variety and of others with similar genom came after a rain of 15 mm, which reduced the temperatures below 30°C for a period long enough, so the flowering and the process of grains formation and filling were held in normal conditions.
Components like in Atrium we also found in Fulvio, Fabula, Arnold and Midas.
In Central areas, such as Zagar – Mures, due to lower stress conditions, the output variation is lower, ie of 1–1.26, that is 3 times less that in South part of the country, at Modelu (Table 3).
Very good behavior have had, in this area, the varieties Pireneo, Astardo and Pedro, while Philipp, Josef and Fabula reacted weaker. All these happened in yields over 5200 kg/ha, on a low variation, so its difficult to draw a conclusion about the proper Premium genotyp for this region.
In Northern Romania, at Diosig – Bihor were performed researches with a number of over 20 varieties of different origins (Table 4).

Table 3. Thermic stress effect on Premium wheat yield (Zagar, 2012)

Variety	Production		Difference		Semnifi-cation
	kg/ha	%	kg/ha	%	
Balaton	5,720.00	96.42	-212.50	-3.58	
Arnold	5,810.00	97.94	-122.50	-2.06	
Fabula	5,440.00	91.70	-492.50	-8.30	0
Josef	5,250.00	88.50	-682.50	-11.50	00
Bitop	6,030.00	101.64	97.50	1.64	
Midas	6,160.00	103.83	227.50	3.83	
Peppino	6,020.00	101.47	87.50	1.47	
Pireneo	6,640.00	111.93	707.50	11.93	***
Capo	5,910.00	99.62	-22.50	-0.38	
Philipp	5,390.00	90.86	-542.50	-9.14	00
Astardo	6,480.00	109.23	547.50	9.23	**
Pedro	6,340.00	106.87	407.50	6.87	*
Average	5,932.50	100.00	0.00	0.00	CONTROL
	DL 5% = 326.0527				
	DL 1% = 391.6491				
	DL 0.1% = 525.5430				

Table 4. Wheat behavior in the North part of the country (Diosig Bihor, 2012)

Variety	Production		Difference		Semnifi-cation
	kg/ha	%	kg/ha	%	
Saggitario	4,399.00	75.50	-1,395.71	-24.50	000
Apache	5,481.00	96.23	-214.71	-3.77	
Arlequin	6,029.00	105.85	333.29	5.85	
Renan	5,821.00	102.20	125.29	2.20	
Jindra	5,575.00	97.88	-120.71	-2.12	00
Exotic	5,008.00	87.93	-687.71	-12.07	
Cubus	5,859.00	102.87	163.29	2.87	
Lupus	5,462.00	95.90	-233.71	-4.10	
Lukullus	5,575.00	97.88	-120.71	-2.12	
Gallus	5,991.00	105.18	295.29	5.18	
Pannonikus	6,067.00	106.52	371.29	6.52	
Vulcanus	6,067.00	106.52	371.29	6.52	
Amicus	5,940.00	104.29	244.29	4.29	
Sorrial	6,407.00	112.49	711.29	12.49	**
SO-207	5,934.00	104.18	238.29	4.18	
Element	5,934.00	104.18	238.29	4.18	
Bitop	5,273.00	92.58	-422.71	-7.42	0
Midas	6,161.00	108.17	465.29	8.17	*
Boema	5,594.00	98.21	-101.71	-1.79	
Glosa	5,821.00	102.20	125.29	2.20	
Crisana	5,311.00	93.25	-384.71	-6.75	
Average	5,695.71	100.00	0.00	0.00	CONTROL
	DL 5% = 413.8476				
	DL 1% = 550.4173				
	DL 0.1% = 715.9564				

The variation coefficient is higher than in Mures, but much smaller than at Modelu (1–1.45). Is also higher the genotypes variability because they come from very different sources, not having common genitors, except perhaps Midas and Bitop varieties. Thermic stress was higher in Bihor than in Mures.

An excellent behavior had the varieties Sorrial and Midas and a negative one was found in Saggitario, Exotic and Bitop. Phenomena is happening on an average of almost 5700 kg/ha. We need to mention that the average yields per areas were much lower thn those obtained in the experimental fields (Figure 9).

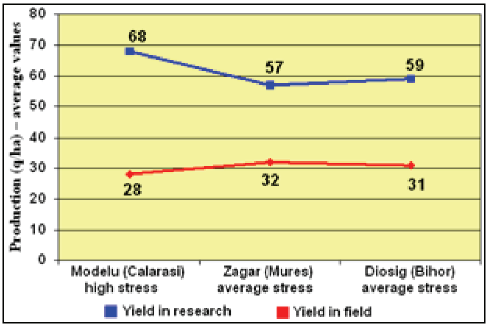

Figure 9. Wheat productions in 2012 in different parts of the country under stress influence (original)

In South Romania the level of average yields obtained from agricultural departments on normally kept surfaces is 2 times smaller than the one obtained in research, while for Mures and Bihor the differences are about 2500 kg/ha. The gap between research and production is not related only by abiotic stress, but also by technological level, with particular reference in crop rotation, soil tillage and fertilization.

CONCLUSIONS

XXIst century started with at least 4 years on which the thermo-hydric stress put its deeply negative mark on Romania's average productions, but also on them level and quality, even in units well-equiped technically and managerially.

Specialized research can make more resistant varieties to any kind of thermic and hydric stress (– or +), but can't be created varieties (genotypes) to completely resist to the total lack of water.

In Romania is grown a large assortment of variables genotypes as resistance. The research has the possibility to make a selection of the most effective ones for a fair and efficient promotion.

Extremely dangerous are the alternations between very high frosts and repeated warming periods, that are blocking the genetically defense sistem of the plant.

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THE DETERMINATION OF ANTIOXIDANT ACTIVITY OF SELENIUM-ENRICHED WHEAT AND PEA SPROUTS, AS WELL AS THEIR MICROBIOLOGICAL ANALYSIS

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Abstract

In this present study, we prepared selenium-enriched food sprouts, where the antioxidant capacity was analyzed, and we also determined their microbiological status. When we were about to decide which micronutrients to use during treatments, we took into account the fact that we can take in only a small amount of selenium by consuming food. During our research we wanted the following question to be answered: If sprouts are treated with increasing concentration of selenium, does it have any effect on the original antioxidant capacity of the sprouts, which is mainly due to high vitamin content of sprouts.
Furthermore, we think it is important to make microbiological analysis, because germination conditions, for example temperature, pH, all this will create an ideal environment for the growth of microorganisms. So our goal was to determine how the selenium concentration that affects the total plate count, coliform bacteria count and Staphylococcus aureus count of sprouts.
We determined the aboriginal antioxidant capacity of sprout with the PHOTOCHEM chemiluminometer and we applied pour plate technique for the mapping of the mycrobiological state of sprouts.
Experimental results are evaluated, that increasing concentrations of selenite or selenate treatment had an effect primarily on water-soluble antioxidant capacity of sprouts. The water-soluble antioxidant capacity of wheat sprout was much higher than the measured values in pea sprout, this may be linked to what we measured. That is much higher ascorbic acid content in the case of wheat sprout, which is well known as one of the most important compounds with antioxidant properties of wheat sprout. As a result of microbiological research we come to the conclusion, that the highest concentrations of selenite or selenate treatment have a relative significant anti-microbial effect in the case of wheat sprouts. Coliform and total plate count showed no clear decreasing tendency, although the values of treatments in both cases were below the control values.

Key words: *food sprouts, antioxidant capacity, selenium, microbiology.*

INTRODUCTION

The research of compounds with antioxidant properties has been the focus of medicine and food science in recent years (Veres et al., 2005). These are molecules based on specific definition, which are present in small concentration in the system compared to the oxidized substrate molecules and significantly slow down or completely inhibit their oxidation states (Stefanovits-Bányai, 2008; Halliwell and Gutteridge, 1984).
Biological importance of antioxidants lies in its ability to neutralize free radicals, which can arise as a result of variety of enzymatic reactions and adverse external influence. These reactive molecules are not only responsible for the ageing of our organism, but are responsible for various diseases, for example, immune system problems, cardiovascular diseases and cancer development (Veress and Fáry, 2004).
The most important components, which is in the human body's antioxidant defense system part, which can be according to records Cornetti (2009) lipophilic (vitamin E, ß-carotene, vitamin A), hydrophilic (Vitamin C, amino acids, polyphenols), cytosolic antioxidants (Coenzyme Q10) and structural antioxidants.
Several international literature data shows that the subject of our research in consumption of food sprouts play an important role in ensuring the body's antioxidant status, namely same sprouts contain the above-mentioned components in particularly high concentration.

Mainly vitamin C, E and polyphenols content give the significant part of antioxidants in sprouts, as Moriyama and Oba (2004) , Brajdes and Vizireanu (2012) and Yang et al. (2001) have shown during their research.
For example, Fernandez-Oroczo et al. (2006) reported that the germination of lupine seems to be a good way in aspect of increasing antioxidant capacity, because the vitamin C and polyphenols content was significantly increased during germination.
However some trace elements have vital role in the body's antioxidant defense, as component of enzyme which has important functions has in antioxidant'network (Prasad and Kucuk, 2002).
For example selenium, is the component of antioxidant effects glutathione peroxidase (GPx), which neutralize damaging free radicals and other reactive oxygen compounds with hydrogen peroxide and other harmful lipid and phospholipid hydroxides (Al-Kunania et al., 2001), as well as it inhibits DNA'impairment and formation of metabolically active carcinogens (Karag et al., 1998). However the presence of selenium is essential to the functioning of the enzyme, because the function of enzyme suffers disturbance in the absence of selenium (Meister and Anderson, 1983).
Since the above-mentioned fact points this out, that the selenium, than enzyme creator may contribute antioxidants'protection to our body, therefore our goal was to determine in our present experiment, if it is possible to enhance original antioxidant capacity of food sprouts, when the sprouts are grown on selenium solution.
Furthermore, we think it is important to make microbiological analysis, because germination conditions, for example temperature, pH, all this will create an ideal environment for the growth of microorganisms (Cobo Molinos et al., 2009; NACMCF, 1999). So we had the goal to determine, how the concentration of selenium affect the total plate count, coliform bacteria count and Staphylococcus aureus count of sprouts.

MATERIALS AND METHODS

Wheat sprout (*Triticum aestivum*) and green pea sprout (*Pisum sativum*) were used during our examination, which were germinated in selenium solution of increasing concentration**.** The selenium was used in the form of sodium selenite (Na_2SeO_3•$5H_2O$) (Fluka, Buchs, Switzerland) and sodium selenate (Na_2SeO_4) (Sigma-Aldrich, Steinheim, German) dissolved in deionized water. In case of solution, which contains 2 sort of selenium species, we calculated the proper trace element concentration referred to selenium. In the experiment, with regards to selenite and selenate 0.1; 1; 10 mg dm^{-3}, selenium concentrations was applied along with control treatment and distilled water. It took 5 days for wheat sprout to germinate while pea sprout took 4 days.

Determination of antioxidant activity of sprouts.
The sprouts were frozen, lyophilized, pulverized and then 25 mg cm^{-3} concentration solutions were prepared from the sample in Eppendorf tubes to order the investigation of antioxidant activity.
Distilled water was used to prepare the solution and the antioxidant capacity of water soluble (ACW) and methanol was used for the determination of antioxidant capacity of lipid soluble (ACL). In this way, the prepared sample was centrifuged 10 minutes, 2000 U min^{-1} rpm revs, in „2-16 Sartorius" (Sigma) laboratory centrifuge. By this method filtrate was used to obtain supernatant to take the measurement.
The antioxidant capacity was determined using a recently developed based research by Popov and Lewin (1999) using PHOTOCHEM equipment. The PHOTOCHEM applies the method of photochemiluminescencia, where the basic feature includes molecules, what are excited with UV light, which causes free radical reactions played out by a thousand times faster than in normal conditions. Superoxide anions are released from the test mixture, externally added photochemical sensitizers components as a result of excitation, which are eliminated in proportion of the antioxidant activity compounds of sample.
Then the rest of superoxide anions reacts with the specific superoxide anion of a

photochemical detector compound, which was added to the sample, as a result of this reaction the photons were emitted. The instrument measures this specific chemiluminescence issued by photochemical reactions, which in other words determines the antioxidant capacity of the sample indirect way.

Analysis of vitamin C and tocopherol content of sprouts.

The sample preparation to determine the vitamin C content of sprouts was made on the basis of Gyémánt and Kandra (2006). Vitamin C content was determined photometrically at 496 nm from the solution. The reducing property of vitamin C was used for the determination, where the equivalent amount of Fe (II) ions was generated from Fe (III) ions, which form a colored complex with the a,a-dipyridyl reagent.

The tocopherol content of sprouts was determined by high performance liquid chromatography (HPLC). Hexane was used for the extraction of the tocopherol, then one hour of stirring, and filtration, moreover evaporation was performed.

Microbiological analysis

Tryptone-glucose-yeast (TGY) agar medium was used to determine the total plate count of sprouts by MSZ EN ISO 4833:2003 standard. Plates were incubated for 72±3 hours, between aerobic conditions, at 30ºC. Colinstant medium was used to determine coliform count of sprouts by ISO 4832:2006 standard. Time of incubation was 24±2 hours, between aerobic conditions, at 30ºC.

The determination of *Staphylococcus aureus* count was made on the basis MSZ EN ISO 6888-1 (2000) international standard on Baird-Parker agar, supplemented with egg yolk and tellurite emulsion. Plates were incubated for 48±2 hours, between aerobic conditions, on 37ºC. Colonies grown on plates were counted after incubation period. Petri dishes were taken into consideration, were the number of colonies was between 15 and 300.

Statistical method

For the statistical analysis we used One-Way analysis of variance (ANOVA) and Tukey-test. The significance was evaluated at the $P< 0.05$ level. All statistical analyses were performed using SPSS v.13.0.

RESULTS AND DISCUSSIONS

Water-soluble and fat-soluble antioxidant activity of sprouts and their vitamin C, and tocopherol content

The water-soluble antioxidant activity was illustrated in Tables 1-2. This values show that selenite and selenate treatment resulted in similar concentration of antioxidant properties compounds of sprouts.

However, while the selenite treatment increased significantly the antioxidant capacity of both sprouts, then the selenate treatment increased the amount of antioxidants only to 1 mg dm^{-3} treatment and decreased in the case of largest applied treatment, but it was higher than of the control.

On the basis of Tables 1-2, the water-soluble antioxidant capacity of wheat sprouts was much greater than pea sprouts as a conclusion.

Table 1. The water-soluble antioxidant capacity of 4 days old pea sprouts grown on solution containing selenite or selenite, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (μg mg-1 dry mass), (n=3)

Treatments	Antioxidant capacity of pea sprouts (ACW)	
	Selenite treatment	Selenate treatment
control	$0.101^a±0.001$	$0.101^a±0.001$
0.1	$0.238^a±0.014$	$0.201^a±0.119$
1	$0.235^a±0.022$	$0.287^a±0.032$
10	$0.327^b±0.131$	$0.200^a±0.006$

Table 2. The water-soluble antioxidant capacity of 5 days old wheat sprouts grown on solution containing selenite or selenite, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (μg mg-1 dry mass), (n=3)

Treatments	Antioxidant capacity of wheat sprouts (ACW)	
	Selenite treatment	Selenate treatment
control	$6.42^a±0.08$	$6.42^a±0.08$
0.1	$6.24^a±0.60$	$7.32^a±0.61$
1	$7.05^a±0.28$	$9.83^b±1.99$
10	$7.23^a±0.63$	$9.30^a±0.61$

We assumed, that this difference in antioxidant capacity can be explained by examining the date of Tables 3-4, which shows that ascorbic acid content of wheat sprouts were lot more higher originally. In our opinion, probably due to the high water-soluble (antioxidant) ascorbic acid content, the antioxidant capacity of wheat sprouts was considerably greater than of pea sprouts.

Measuring fat-soluble antioxidant activity, neither selenite nor selenate treatments did not affect significantly the amount of the fat-soluble compounds with antioxidant properties in sprouts (Tables 5-6).

It can also be concluded from Tables 5-6, that the value of antioxidant activity of pea sprouts exceeded with few tenths the antioxidant activity of wheat sprouts. We supposed that this result is associated with different tocopherol isomers of sprouts.

Table 3. The ascorbic acid content of 4 days old pea sprouts grown on a solution containing selenite or selenite in the case of control; 0.1; 1; 10 mg dm-3 Se treatments, (mg/100 g), (n=3)

Treatments	Ascorbic acid content of pea sprouts	
	Selenite treatment	Selenate treatment
control	94.0^{a}±6.3	94.0^{a}±6.3
0.1	67.9^{a}±26.7	106^{a}±50
1	89.1^{a}±37.8	141^{a}±137
10	93.6^{a}±19.4	93.6^{a}±6.7

Table 4. The ascorbic acid content of 5 days old wheat sprouts grown on a solution containing selenite or selenite, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (mg/100 g), (n=3)

Treatments	Ascorbic acid content of wheat sprouts	
	Selenite treatment	Selenate treatment
control	251^{a}±27	251^{a}±27
0.1	451^{b}±87	534^{b}±36
1	572^{c}±50	312^{a}±116
10	259^{a}±64	530^{b}±2

It can also be established based on the tocopherol chromatograms of sprouts (Figures 1-2), that α-isomer was accumulated mainly in the wheat sprouts, beside this their structural analogue, the tocotrienol appeared also on the chromatogram, till γ-isomer dominated in the pea sprouts. Since γ-isomer had higher antioxidant activity because of their chemical structure (Dietrich et al., 2006), this is an explanation, why the measured antioxidant values of pea sprout exceeded with a few tenths the antioxidant activity of wheat sprout.

Table 5. The lipid-soluble antioxidant capacity of 4 days old pea sprouts grown on a solution containing selenite or selenite, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (µg mg-1 dry mass), (n=3)

Treatments	Antioxidant capacity of wheat sprouts (ACL)	
	Selenite treatment	Selenate treatment
control	1.75^{a}±0.14	1.75^{a}±0.14
0.1	1.53^{a}±0.13	1.43^{b}±0.13
1	1.45^{a}±0.07	1.68^{a}±0.23
10	1.47^{a}±0.28	1.15^{b}±0.17

Table 6. The lipid-soluble antioxidant capacity of 5 days old wheat sprouts grown on a solution containing selenite or selenite, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (µg mg-1 dry mass), (n=3)

Treatments	Antioxidant capacity of wheat sprouts (ACL)	
	Selenite treatment	Selenate treatment
control	1.03^{a}±0.08	1.03^{a}±0.08
0.1	1.22^{a}±0.09	1.01^{a}±0.18
1	1.16^{a}±0.04	1.23^{a}±0.03
10	1.03^{a}±0.11	1.18^{a}±0.09

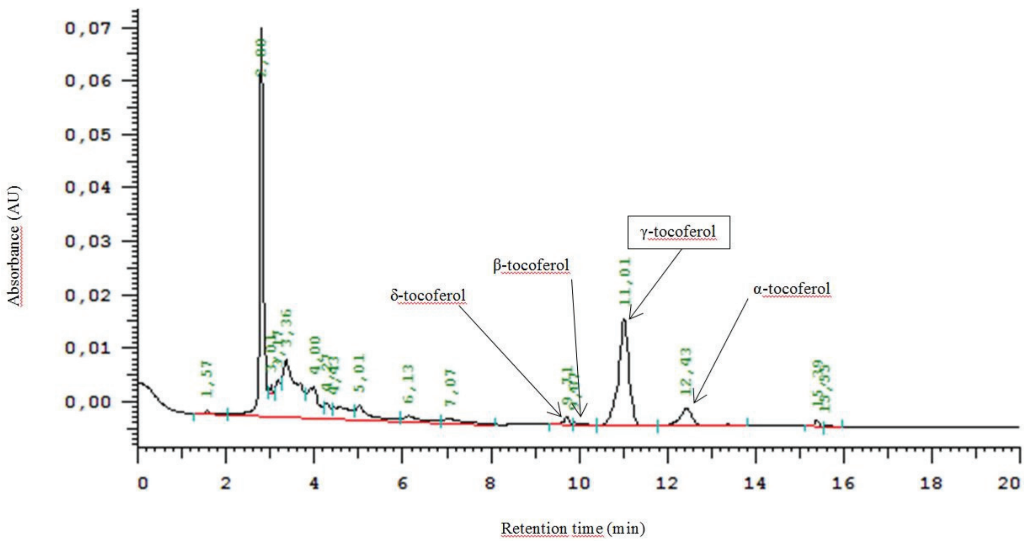

Figure 1. HPLC chromatogram of pea sprouts

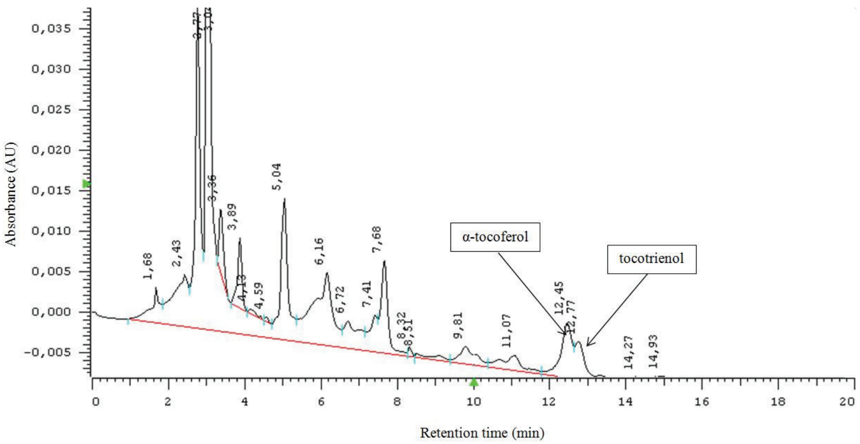

Figure 2. HPLC chromatogram of wheat sprouts

Results of our microbiological analysis.
On the basis of our microbiological analysis it is established that *Staphylococcus aureus* was not present either in control or treated samples. The results of our microbiological analysis of wheat sprouts are summarized in Tables 9-10. Based on these results, although there was some fluctuation in the coliform and total plate count because of effect of treatments, however there was some significant decrease only between the control and 10 mg dm^{-3} selenite treatments in the case of coliform count, and between the control and 0.1 mg dm^{-3} selenate treatments in the case of total plate count.
The results of our microbiological analyses in the case of wheat sprout are presented in Tables 9-10. The treatments were effective in the case of wheat sprout, namely the coliform count decreased owing to the treatments because the highest concentration of selenite treatment resulted nearly 50 % decreasing of coliform count, while the selenate treatment caused approximately 70 % decreasing of coliform count, compared to the control wheat sprout.

Table 7. Coliform count (103 CFU g-1) of 4 days old pea sprouts grown on a solution containing selenite or selenate, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (n=3)

Treatments	Coliform count	
	Selenite treatment	Selenate treatment
control	$9400^{a}\pm566$	$9400^{a}\pm566$
0.1	$4600^{a}\pm849$	$2900^{a}\pm1556$
1	$4700^{a}\pm1838$	$6850^{a}\pm3040$
10	$1450^{b}\pm636$	$4700^{a}\pm3253$

Table 8. Coliform count (103 CFU g-1) of 4 days old pea sprouts grown on a solution containing selenite or selenite, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (n=3)

Treatments	Ttotal plate count	
	Selenite treatment	Selenate treatment
control	$302^{a}\pm172$	$302^{a}\pm172$
0.1	$133^{a}\pm83$	$36^{b}\pm20$
1	$124^{a}\pm74$	$100^{a}\pm28$
10	$120^{a}\pm69$	$55^{a}\pm7$

Table 9. Coliform count (103 CFU g-1) of 5 days old wheat sprouts grown on a solution containing selenite or selenate, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments, (n=3)

Treatments	Coliform count	
	Selenite treatment	Selenate treatment
control	$42.3^{a}\pm28.8$	$42.3^{a}\pm28.8$
0.1	$37.7^{a}\pm15.4$	$98^{a}\pm41.6$
1	$38^{a}\pm14.6$	$58.7^{a}\pm26.9$
10	$23.2^{a}\pm14.6$	$13.9^{b}\pm5.9$

Table 10. Coliform count (103 CFU g-1) of 5 days old wheat sprouts grown on a solution containing selenite or selenate, in the case of control; 0.1; 1; 10 mg dm-3 Se treatments (n=3)

Treatments	Total plate count	
	Selenite treatment	Selenate treatment
control	$1653^{a}\pm145$	$1653^{a}\pm145$
0.1	$1913^{a}\pm1294$	$828^{a}\pm698$
1	$2443^{a}\pm929$	$1193^{a}\pm634$
10	$157^{b}\pm99$	$521^{a}\pm82$

CONCLUSIONS

Evaluating our experimental results, we concluded that the increasing concentrations of selenite or selenate treatments affected primarily the water-soluble antioxidant capacity of sprouts. The water-soluble antioxidant capacity of wheat sprout was much higher than the values measured in pea sprout, which can be associated with the fact, that we measured a lot more higher ascorbic acid content in the case of wheat sprout and it is well known that the ascorbic acid is one of the most important antioxidant compound in the wheat sprout. We concluded on the basis of our microbiological results, that the highest concentrations of selenite or selenate treatments had significantly anti-microbial effect in the case of wheat sprouts. However the coliform and total plate count showed no clear decreasing effect, although the values of treatments in both cases obtained were below the actual or control values.

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THE EFFECT OF DIFFERENT REGIONS AND NPK FERTILIZER ON PROTEIN AND SULPHUR CONTENT OF WINTER WHEAT (*TRITICUM AESTIVUM* L.) GRAINS

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Abstract

In this study the effect of different regions and different NPK treatments on the content of protein and S were investigated in the kernels of winter wheat (Triticum aestivum L.). Plant samples were collected from five experimental stations of the Hungarian National Long-term Fertilization trials. These stations are as follows: Bicsérd, Iregszemcse, Karcag, Nagyhörcsök and Putnok. These experimental fields have different types of soil and climatic conditions. The sulphur content of samples was measured using inductively coupled plasma optical emission spectrometer (ICP-OES) followed by digestion with HNO_3-H_2O_2 solution. The protein content was determined using Khjeldal method. Data analysis was done using SPSS for Windows 13.0 Software package. All data were subjected to ANOVA method, but after detection of significant differences ($P<0.05$) data were subjected to Duncan's test to allow separation of means. During our investigations it was proved that different growing places are having significant ($P<0.01$) difference in the S and protein content of samples. Sulphur and protein content of the treated samples were found higher than the element content of the untreated grains.

Key words: *sulphur, protein, winter wheat, NPK fertilizer, production area.*

INTRODUCTION

In this study the effect of different regions and different NPK treatments on the content of protein and S were investigated in winter wheat (*Triticum aestivum* L.) grains.

Sulphur is an important component of the sulphur-containing amino acids, peptides, proteins and lipids. It has a specific role in the enzymes and coenzymes which contains SH-groups (Loch and Nosticzius, 1992; Kalocsai et al., 2005).

Wheat grains are the richest in protein among cereals (Lásztity, 1981). High protein concentration of kernels is one of the most important baking quality requirements of winter wheat and it has great influence on the digestibility of bread too (Loch and Nosticzius, 1992; Loch, 1999).

According to Randall and Wrigley (1986) sulphur defficiency in wheat grains may cause poor baking quality through the reduced essential amino acids content.

Nutrition and fertilization is one of the most important factors during the cultivation of winter wheat (Pepó, 2004).

Based on results of previous researchers N fertilization enhanced the protein concentration in plant organs and raised the quality of proteins too (Dubetz et al., 1979; Hegedus et al., 2002; DuPont and Altenbach, 2003; Labuschagne et al., 2006; Kindred et al.; 2008). Other researchers found that the increase of sulphur content had been correlated with N and NP fertilization (Lásztity, 1992; Lásztity, 1997; Kádár, 2004).

Wheat production is determined by the ecological factors of the growing area (Tolner, 1999). In the experiment of Destain et al. (1991) there were less influence of different N doses on the N intake of wheat but the effect of different production areas caused significant differences. According to Škribic and Onjia (2002) element content of winter wheat grains harvested from different regions also showed significantly difference.

MATERIALS AND METHODS

The Hungarian National Long-term Fertilization trials were set up to study the effect of different NPK levels. The experiment has a split-split-plot design with 40 treatments in 4 replications. Samples of winter wheat were collected from Bicsérd, Iregszemcse, Nagyhörcsök, Karcag and Putnok experimental stations. Plant samples were harvested in 2004 when the weather conditions were humid.

Bicsérd is a township located in Baranya Hills, in Hungary. The soil is chernozem brown forest soil formed on loamy loess soils. The cultivated layer has moderate soil moisture management. The characteristics of the cultivated layer is the following: pH (KCl): 5.45; $CaCO_3$: 0%; humus: 1.93%.

Iregszemcse is located in Transdanubian Hills. The production area has typical chernozem soil formed on slightly having clay loess sediments. The soil moisture is balanced. The characteristics of the cultivated layer is the following: pH (KCl): 7.49; $CaCO_3$: 10.69%; humus: 2.69.

Nagyhörcsök is located in the Transdanubian region of Hungary. The experimental station has calcareous chernozem soil formed on loess. The soil has excellent soil moisture management. The characteristics of the cultivated layer is the following: pH (KCl): 7.3; $CaCO_3$: 4.27%; humus: 3.45%.

Karcag is located in the Tisza floodplain in the Great Hungarian Plain. The experimental field has non-carbonated meadow chernozem soil formed on infusion loess and the soil moisture is very favorable. The characteristics of the cultivated layer is the following: pH (KCl): 5.45; $CaCO_3$: 0%; humus: 3.09%.

Putnok is located in North Hungarian Mountains. The soil is non-podzolic forest infiltration clay soil. The cultivated layer has heavy water retention and low drainage, permeability and available water resources. The characteristics of the cultivated layer is the following: pH (KCl): 5.00; $CaCO_3$: 0%; humus: 2.29% (Debreczeni and Németh, 2009).

The sulphur content of samples was measured using inductively coupled plasma optical emission spectrometer (ICP-OES) followed by digestion with HNO_3-H_2O_2 solution (Kovács et al., 1996). The protein content was determined using Khjeldal method (MSZ 6830-4:1981). Data analysis was done using SPSS for Windows 13.0 Software package. All data were subjected to ANOVA method, but after detection of significant differences (P< 0,05) data were subjected to Duncan's test to allow separation of means.

RESULTS AND DISCUSSIONS

Table 1 shows the effect of different N, P_2O_5 and K_2O levels on the protein and sulphur content of winter wheat grains from the experimental station of Bicsérd. According to our experimental results the protein content were higher in every NPK treatments than the control but there were no significant effect of the different NPK doses on the sulphur content of kernels.

Table 1. Effect of N, P_2O_5 and K_2O levels on the protein and sulphur content of wheat grains (Bicsérd)

	Protein content		Sulphur content	
N treatment (kg/ha)	Mean (%)	$SD_{5\%}$	Mean (mg/kg)	$SD_{5\%}$
0	12.55	a	1436	a
150	15.75	b	1417	a
200	16.05	b, c	1440	a
250	16.56	c	1444	
P_2O_5 treatment (kg/ha)		c		
0	15.01	a	1436	a
50	16.40	b	1421	a
100	15.94	b	1418	a
150	15.96	b	1420	a
200	16.28	b	1458	a
K_2O treatment (kg/ha)				
0	15.01	a	1436	a
100	15.95	b	1418	a
200	15.93	b	1447	a

Our results proved that different production areas caused significant (P<0.01) difference in the protein and sulphur content of winter wheat grains. Table 2 shows the protein content of wheat samples from five different experimental stations.

Samples, which were collected from Karcag, have the highest protein contents. Lowest protein contents were measured in samples from Iregszemcse. The protein content sequence of samples was the following: Iregszemcse < Nagyhörcsök < Putnok < Bicsérd < Karcag.

We compared our results with previous ones. During our investigation protein concentration was found similar to the literature value which was 12-15% (Lásztity, 1981).

Table 2. Protein content of winter wheat grains from different regions

Protein content		
Production area	Mean (%)	$SD_{5\%}$
Iregszemcse	13.94	a
Nagyhörcsök	14.34	a, b
Putnok	14.68	b
Bicsérd	15.69	c
Karcag	15.85	c

Table 3. Sulphur content of winter wheat grains from different regions

Sulphur content		
Production area	Mean (mg/kg)	$SD_{5\%}$
Bicsérd	1430	a
Putnok	1439	a
Nagyhörcsök	1512	b
Iregszemcse	1665	c
Karcag	2032	d

Table 3 shows the sulphur content of wheat grains from different production areas. The sulphur content sequence of wheat grains was different from previous one: Bicsérd < Putnok < Nagyhörcsök < Iregszemcse < Karcag.

In our study the measured values were analogous with published ones, which were 1211-1960 mg/kg (Dániel et al., 1998). The only exception was Karcag.

CONCLUSIONS

During our investigations it was proved that different areas having significant (P<0.01) difference in the protein and sulphur content of winter wheat samples and they were mostly determined by the production areas.

Protein content were found higher in the treated samples than in that samples which were harvested from the control plots and the N fertilizer enhanced the protein concentration of kernels but there were no significant effect of the different NPK levels on the sulphur concentrations of wheat grains.

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ANTIFUNGAL ACTIVITY OF PLANT EXTRACTS AGAINST PRE AND POSTHARVEST PATHOGENS

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Abstract

The bio pesticide market is currently expanding in Western Europe and North America. The European market represents a 45% of the total demand, and its importance is shown by the priority given by the Seventh Framework Programme (FP7) of the European Union. Due to environmental side effects and health concerns, many synthetic pesticides have been banned (Council Directive 91/414 EC) or are being under evaluation (Regulation 2009/1107/E and Directive 2009/128/EC). Regarding plant protection, natural extracts represent one of the greatest perspectives. Their impact is efficient, the extraction procedures are not complicated, are safe for environment and people and the degrading process is fast. Therefore, there are already on the market natural fungicides like thyme oil, Thymus zygis (Bio 75®), cinnamon oil (Cinnacoda®), extract of citric seeds (Zytroseed®), extract of Reynoutria sachalinensis, the giant knotweed (Milsana®). An interesting way of searching for bio pesticides, including fungicides is screening naturally occurring compounds in plants. In our study, the antifungal potential of 16 extracts (essential oil, hidrolate, dry ethanolic extract) from various species of Artemisia, Laurus, Argyranthemum, Persea, Euphorbia was investigated in vitro against important pre-and postharvest pathogens: Fusarium oxysporum, F. moniliforme, F. solani, Alternaria alternata, Botrytis cinerea, and Penicillium expansum. The activity of Artemisiaabsinthium essential oil (from stem and leaves) was assesed in vivo on artificially inoculated apple fruits with P. expansum. Our results indicated that the extracts have a variable degree of antifungal activity, depending on plant species, type of extract, fungal isolate and concentration. The present study highlights the fungicidal potential of various extracts from Artemisia species and Argyranthemum frutescens. Extracts from Laurus azorica, Persea indica and Euphorbia azorica did not inhibit mycelial growth. The in vivo test confirmed the high efficacy showed in vitro by Artemisia absinthium essential oil, which was verry effective in controlling disease severity of infected apple fruits by P. expansum. Further studies are in progress to confirm the in vivo efficacy of extracts on different fruits and vegetables.

Key words: *antifungal activity, plant extracts, plant pathogens.*

INTRODUCTION

From the beginning of the 60s, agriculture surface has grown with 11%, from 4.5 billion to 5 billion and the arable land from 1.27 to 1.4 billion has. Directly proportional, the production has increased as well. Being an extensive system, the pesticides consume has also had an ascendant line (Hazell and Wood, 2008). Along with globalization, the consumers preferences have migrated to quality products, healthy, authentic and obtained in hygienic conditions accepted by the society and the environment. The consumer is more and more conscious of the toxic substances present in aliments. Even when the synthetic pesticides are correctly applied, the residues are maintained in aliments, soil and water, by this entering the alimentary chain. Scientific literature abounds in information regarding negative effects versus benefits of these products (Gupta and Dikshit, 2010; Damalas and Eleftherohorinos, 2011).

Necessity of ‘cleaner’ and without residues products opens new perspectives in bio pesticides use. Unlike synthetic pesticides, bio pesticides have an inexistent risk or a minimum one on environment, accelerated decomposition and they are efficient at low concentrations. Literature studies emphasize the fact that plant extracts represent one of the greatest frames in terms of plant protection: good results, facile extraction procedures, safe to environment and people and their use usually

pays off (Mares et al., 2004; González-Coloma et al., 2009; Al-Samarrai, 2012).
Of more than 500.000 secondary metabolites of plants, only 18.000 have been characterized until 2008 (Ntalli and Menkissoglu-Spiroudi 2011). Principal groups are: phenylpropanoids, phenols, terpenes, steroids, alkaloids and nitrogen compounds (Gonzalez-Coloma et al., 2009). The problems concerning pest resistance, public health risks and environmental damages, have promoted the investigation of natural products with pesticide effects. Thereby are already commercialized natural fungicides like thyme oil, *Thymus zygis* (Bio 75®), cinnamon oil (Cinnacoda®), extract of citric seeds (Zytroseed®), extract of *Reynoutria sachalinensis*, extract of the giant knotweed (Milsana®), natural nematocides like Neem extract (Neemate®), mustard extract (Nemitol®), sesame seeds extract (Dragonfire CCP®).
The genus *Artemisia* is one of the largest (over 400 species) and widely distributed genera of the family *Asteraceae*. The most common species in the world are: *Artemisia absinthium* L., *A. vulgaris* L., *A. maritime* L., *A. dracunculus* L., *A. abrotanum* L., *A. annua* L., *A. pontica* L., *A. cina* O. Berg & C.F. Schmidt.. In Romania there are known 15 species: *Artemisia annua* L., *A. pontica* L., *A. dracunculus* L., *A. vulgaris* L., *A. austriaca* Jacq., *A. lerchiana* Weber, *A. pontica* L., *A. abrotanum* L., *A. santonicum* L., *A. eriantha* Ten., *A. absinthium* L., *A. tschernieviana* Besser., *A. alba* Turra, *A. campestris* L., *A. scoparia* Waldst. & Kit. (Badea, 2011). *Artemisia dracunculus* is a well-known spice and *A. absinthium* is extremely cultivated for the preparation of absinth and vermouth, as for medical purposes also (antidote for opium, tonic and antifebrile) or for its insecticidal properties against aphids, mites and caterpillars (Chiasson et al., 2001; Brudea 2008; Dancewicz and Gabrys 2008). In the Canary Islands, an endemic species, *Artemisia thuscula* Cav., is traditionally used in medicine and in plant protection as repellent for insects. Other genera of plants which have been found as bioactive are: *Argyranthemum, Persea* (Gonzalez-Coloma et al., 1993), *Laurus* (Rodilla et al., 2008) and *Euphorbia* (Kamba and Hassan 2010). The objectives of our study were to investigate, *in vitro,* the fungicidal potential of 16 extracts (as essential oils, hydrolates and ethanol dry extracts) from 3 species of *Artemisia*, *Laurus novocanariensis* Rivas Mart., *Argyranthemum frutescens* (L.) Sch.Bip., *Persea indica* (L.) Spreng. and *Euphorbia azorica* Hochst. Nine fungal isolates, from important pre and postharvest pathogens as *Fusarium oxysporum fs. Lycopersici* Scheldt,*Fusarium moniliforme* Sheldon, *Fusarium solani* Mart), *Alternaria alternata* Keissl, *Botrytis cinerea Pers.: Fr*and *Penicillium expansum* Link were tested. Further, the activity of *Artemisia* absinthium essential oil was assesed *in vivo* on artificially inoculated apple fruits with *P. expansum*.

MATERIALS AND METHODS

Preparation of plant extracts

Recollection of samples of *Artemisia thuscula*, *Artemisia spp.*, *Laurus azorica*, *Argyranthemum frutescens*, *Persea indica*, *Euphorbia azorica* took place in different locations (Table 1). The plant samples (root, stem, leaves and seeds) were air dried at room temperature in order to prepare the extracts. Plants vouchers were carried out to authentication and conservation. Extracts in liquid and solid form were used. In the case of solid extracts, after 48 hours of maceration in ethanol, the solvent was removed by low-pressure distillation on a rotary vacuum evaporator. Ultimately the extracts were introduced in the stove to be dried. As for the liquid extracts distillation process has been used to obtain essential oils and hydrolates.

Fungal isolates

The fungal isolates used in this study are listed in Table 2. All the isolates were purified by monospores isolation and maintained in tubes of malt agar medium (malt extract 20 g, agar 20 g in 1 L distilled water) at 4^0C. Fresh subcultures were made by transferring hyphae plugs to Petri dishes containing potato dextrose agar (PDA Sigma®) medium to obtain inoculum for sensitivity tests.

Table 1. Plant species and type of extract

Species	Extract code [EC]	Plant organ	Date and place of recollection	Extract type [ET]
Artemisia absinthium	718	Stems and leaves	Loc1, 2010	Essential oil
	720	Stems and leaves	Loc2, 2010	Hydrolate
	749	Stems and leaves	Loc 1, 2009	Essential oil
Artemisia absinthium	759	Leaves	Cape Verde; 2011	Dry EtOH extract
	760	Leaves	Cape Verde; 2011	Dry EtOH extract
Laurus azorica	766	Leaves	Terceira, Azore; 2011	Dry EtOH extract
Artemisia thuscula	775	Leaves	Las Aguas, Tenerife; 2012	Dry EtOH extract
	776	Seeds	Las Aguas, Tenerife; 2012	Dry EtOH extract
	777	Leaves	Taganana, Tenerife; 2012	Dry EtOH extract
	778	Stems	Las Aguas, Tenerife; 2012	Dry EtOH extract
	181	Roots	La Matanza, Tenerife; 2000	Dry EtOH extract
	182	Stems	La Matanza, Tenerife; 2000	Dry EtOH extract
	183	Leaves	La Matanza, Tenerife; 2000	Dry EtOH extract
Argyranthemum frutescens	359	Stems	La Matanza, 2011 Tenerife; 2002	Dry EtOH extract
Persea indica	406	Leaves	Mercedes, Tenerife; 2002	Dry EtOH extract
Euphorbia azorica	444	Stems and leaves	Azore; Terceira; 2011	Dry EtOH extract

Table 2. Fungal isolates used

Fungal species	Isolate code	Provenience	Origin
Alternaria alternata	Aa 2207	Pepper	Bulgaria
Alternaria alternata	Aa 100	Unknown	Tenerife
Botrytis cinerea	Bc 2107	Grapes	Romania
Botrytis cinerea	Bc 0510	Grapes	Tenerife
Penicillium expansum	Pe 2712	Apple	Romania
Fusarium oxysporum	Fo 809	Cucumber	Romania
Fusarium solani	Fs 810	Cucumber	Romania
F. o. f. sp. lycopersici	CECT 2715	-	Valencia
Fusarium moniliforme	CECT 2152	-	Valencia

***In vitro* tests-assay on mycelium**

Tests were carried out to determine the biological activity of extracts using biometric agar dilution method. The extracts were incorporated into the culture media (PDA) as follows: 0.1-0.5 – 1 mg/ml for solid extracts and 0.1 – 0.5 – 1% for hydrolytes and essential oils. For a better solubility of the essential oils, Tween 20 (polyoxyethylene derivative of sorbitol fatty acid ester) was used in ethanol solution (40% Tween 20 and 60% ethanol). The final percentage of ethanol in the media was adjusted to a concentration of 2% (v/v). Plates containing the solvent (ethanol) were used as negative control.

Each pathogen was spot-inoculated at 8 equidistant points to PDA media amended with the plant extracts at tested concentrations. Three replicates were used per treatment. For each extract and concentration, inhibition of radial growth compared with the untreated control was calculated after 48 hours of incubation at 27^0C, in the dark. The radial growth was measured with an image-processing program ImageJ-Wayne Rasband (NIH).

Results were expressed as effective concentration EC50 (the concentration which reduced mycelial growth by 50%) determined by regressing the inhibition of radial growth values (%) against the log 10 values of the fungicide concentrations (GraphPad Software).

***In vivo* tests on apple fruits**

Based on the *in vitro* tests, *Penicilium expansum* isolate was selected for the *in vivo* study conducted on apple fruits, variety 'Idared'. *Artemisia absinthium* essential oil (from stems and leaves, code 749) was tested at the concentration of 1%. Apples were superficially surface disinfected by soaking in 80% ethanol for 3 minutes, rinsed with distilled water and left to dry. Then, they were wounded to 2 mm depth with a needle (4 wounds per each apple, equidistant at 2 mm, on the side of the apple half way between stem and calyx). All wounds were artificial inoculated by pipetting 7 µl *P. expansum* spore suspension (10^4 spores/ml). Apples were divided into five lots/variants (Table 3).

Lot no. 1 (V1) was considered as inoculated and non treated control. Fruits of lot no. 2 and no. 3 (V2 and V3) considered as controls, also, were artificially inoculated and then treated (V2), respectively treated and artificially inoculated (V3) with a solution of Tween 20 and ethanol.

Table 3. Tested variants

V1	Control	Contamination	Sterile water
V2	Control PT	Ethanol + Tween 20	Contamination
V3	Control CT	contamination	Ethanol + Tween 20
V4	Treatment PT	*Artemisia absinthium* extract	Contamination
V5	Treatment CT	contamination	*Artemisia absinthium* extract

Treatment with *A. absinthium* extract has been applied with a micro pulverization dispenser, forming an uniform layer on apples, before artificial contamination, as preventive treatment (PT) in variant V4 and after, as curative treatment (CT), in variant V5. Time between spore inoculation and treatment was 10 minutes to avoid simultaneous contact. Ten apples and three repetitions were used for each variant. The apples were placed in sterile plastic boxes and incubated at 25^0C and 78,8% RH. To maintain the air condition in the container while the apples respire, the containers were opened during 5 minutes in a sterile environment (biosafety cabinet) every day. Subsequently diameters of lesions were monitored and recorded. The efficacy [%] of the treatment to reduce disease severity was calculated using Abbot Formula (Efficacy = (lesion size control – lesion size test) /lesion size control x 100).

RESULTS AND DISCUSSIONS

In vitro tests – effects on mycelial growth

The effect of essential oil, hidrolate or dry ethanolic extracts from species of *Artemisia, Laurus, Argyranthemum, Persea, Euphorbia* has been variable, depending on plant species, type of extract, fungal isolate and concentration. Some of the tested extracts were highly effective. In the presence of the essential oil (718 and 749) and hydrolate (720) from *A. absinthium*, all the tested isolates were sensitive (EC50 by 0.3%). Dry ethanolic extracts from leaves and seeds of *Artemisia thuscula* (775, 776, 777) were very effective against *Fusarium oxysporum* isolate (EC50 between 0.06-0.15%). Also, dry ethanolic extract from leaves of *A. absinthium* (760) showed fungicidal activity against *A. alternata* isolate (EC50 = 0.9%).

The ethanolic extracts from *Argyranthemum frutescens* (359) inhibated the mycelial growth of all tested isolates (Table 4).

Table 4. In vitro sensitivity of fungal pathogens to plant extracts

Extract code	Isolate code	Concentration (%)			EC50
		0.1	0.5	1	
718	*Bc 0510*	81.8	100	100	0,08 (0.03 – 0.14)
	Aa 100	5322	100	100	0.07 (0.03 – 0.1)
	Fo 2715	100	100	100	< 0.1
720	*Bc 0510*	90.4	100	100	< 0.1
749	*Bc 0510*	38.8			0.04 (0 – 0.6)
	Aa100	41.9	89.2		0.02 (0 – 2.9)
	Bc 2107	60	100	100	
	Pe 2712	0	100	100	0.3 (0.3-0.3)
ExtractCode	Fungal species	Concentration (mg/ml)			EC50
		0.1	0.5	1	
760	*Aa 2207*	40	30	40	0.9
	Fs 810	15	20	20	2.9 (2-2)
775	*Fo 2715*	18. 7	36.1	51.4	0.09 (0-0.11)
776	*Fo 2715*	19.9	31.3	38.6	0.15 (0-0.21)
777	*Fo 2715*	23.5	47.5	63.9	0.06 (0-0.21)

The fungicidal activity of the extracts from *Artemisia* species and *Argyranthemum frutescens* could be attributed to different compounds as the main active encountered are essential oils and polyphenols (Gonzalez et al., 1997; Soylu et al., 2005; Ahameethunisa and Hopper, 2010; Umpierrez et al., 2012;). Recent studies provided data on antibacterial, antifungal and antioxidant activities of the essential oil of *A. annua* and the chemical composition of this essential oil was also described (Cavar et al., 2012).

A series of extracts did not present activity against tested isolates (Table 5). No antifungal activity on mycelial growth has been observed for *Laurus azorica*, *Persea indica* and *Euphorbia azorica* extracts.

Table 5. Extracts without bioactivity on tested isolates

Isolate code	Extract code
Bc 2107	182, 183, 406, 444, 759, 760, 766, 775, 776, 777, 778
Bc 0510	181, 183, 775, 776
Aa 100	181, 182, 183, 444, 406, 766, 775, 776, 777, 778
Aa 2207	182, 183, 775, 776
Fs 810	182, 183, 444, 406, 759, 766, 810, 777, 778
Pe 2712	182, 183, 444, 406, 759, 760, 766, 775, 776, 777, 778

'In vivo' tests

After 7 days, lesion size of apples inoculated and non treated (V1 control) was 1.3 cm. For the apples treated with the solvent used in preparation of the extract (ethanol + Tween) and inoculated (V2, PT) the size of the lesions was 0.63 cm. The differences between the variant where the solvent was applied after inoculation (V3) and the control (V1) were almost inexistent (lesion size 1.27 cm, respectively 1.3 cm). We have observed that when the solvent was applied before artificial contamination (V2) it has determined a slower growth of the pathogen by 50% compared to control in sterile water (V1), the lesions size measured being 0.63 cm, respectively 1.30 cm. One of the probabilities we may consider is that Tween 20 is forming a layer which may act as a barrier against spores germination.

After 17 days, we have noticed an evolution of lesions size, in control, where symptomatic areas were developed on 3.58 cm. For the variants where apples were treated with the solvent and inoculated (V2) or inoculated and treated (V3), the size of the lesions was 1.75 cm, respectively 3.0 cm (Table 6).

The efficacy of *Artemisia* extract treatment was confirmed by very small symptomatic lesions with a diameter of only 0.3 cm (V4, preventive treatment) and 0.08 cm (V5, curative treatment). An inhibition (or efficacy) of this treatment was recorded, at 7 days: 76.9% (V4) and 93.8 (V5) compared to control (Figure 1).

After 17 days, we have noticed an efficacy of 76.8% (V4) and 88.5% (V5); evolutions of the symptomatic areas were only 0.33 cm and 0.53 cm.

Table 6. Lesion size evolution in time (days after inoculation and treatment)

Variants		Lesion size [cm]	
		7 days	17 days
V1	Control	1.30	3.58
V2	Control (solvent) PT	0.63	1.75
V3	Control (solvent) CT	1.27	3.00
V4	Treatment *A. Absinthium* PT	0.30	0.83
V5	Treatment *A. Absinthium* CT	0.08	0.41

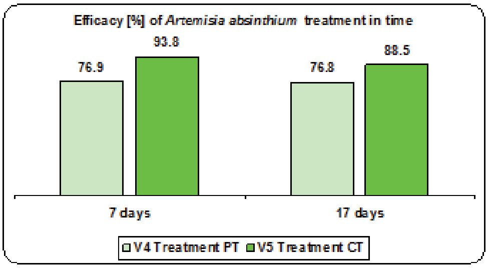

Figure 1. Efficacy of *Artemisia absinthium* extracts treatment on apples

CONCLUSIONS

The present study concludes that some essential oils, hydrolates or dry ethanolic extracts from various species of *Artemisia* and *Argyranthemum frutescens* showed antifungal activity against important plant pathogens. Our results indicated that the extracts have a variable degree of antifungal activity, depending on plant species, type of extract, fungal isolate and concentration.

No antifungal activity on mycelial growth was been noticed for *Laurus azorica*, *Persea indica* and *Euphorbia azorica* extracts.

The *in vivo* test confirmed the high efficacy showed *in vitro* by *Artemisia absinthium* essential oil, which was very effective in controlling disease severity of infected apple fruits by *P. expansum*, applied as curative treatment. Further studies are in progress to confirm the *in vivo* efficacy of extracts on different fruits and vegetables.

Exploring new plant species for their antifungal activity would bring more resource base for use in eco-friendly and sustainable agriculture, especially in organic farms.

To summarize, it is our strong belief that the study of plants with traditional uses as 'plant protectors' is essential for understand more about the inner value of flora. Therefore, different kinds of studies should be followed as metabolic interactions, physiological reactions and biochemical profile which may lead to the real understanding of fungicide mechanisms.

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RESEARCH REGARDING THE VARIETY IN OBTAINING HIGHER QUALITY WHEAT PRODUCTION, ON SANDY SOILS IN SOUTHERN OLTENIA, IN THE CONTEXT OF CLIMATE CHANGE

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Abstract

Wheat has a great importance as a food product, providing a large portion of carbohydrates and proteins necessary for man and more than half the calories consumed by humans.
Given the economic importance and special role it holds in human nutrition, basic trend now and in the future is to increase global production. In addition to this direction is emerging ever stronger and other trends, such as the introduction in production of varieties with a high content of protein with increased nutritional value and superior cultivation with baking qualities. Climate change last period of time with pronounced drought and even climate aridisation trend in southern Romania, led to increased frequency of drought years.
At CCDCPN Dabuleni in 2010-2012 were studied in terms of quality of grain, several varieties of winter wheat. Productivity and product quality are strongly influenced by abiotic limiting conditions (thermic and hydric stress) exhibited during the experiment.
The best production results were obtained in the climatic conditions of 2010, the varieties: Albota 69 (4133 kg/ha), Delabrad (4267 kg/ha), Glosa (4233 kg/ha) and Ciprian (4356 kg/ha) the production increases achieved statistically very significant.
Negative and significant correlation between wheat production and the number of days to gray, in conditions of droughty year, shows that precocity variety can be a measure that can contribute to mitigate effect drought and heat.
Protein content and wet gluten resulted in wheat grains gives a good quality of production: Delabrad (15.2% protein, 33.2% wet gluten), Boema (14.8% protein, 33.8% wet gluten), Glosa (14.9% protein, 31.4% wet gluten), etc..

Key words: *climate change, quality, variety, wheat.*

INTRODUCTION

Wheat is the most important cultivated plants, with great food weight. Having regard to the economic importance and special role it holds in human nutrition, the basic trend of now and in the future is of increasing global production. In addition to this direction is emerging increasingly stronger and other trends, such as the introduction in production of varieties with a high content of protein with enhanced nutritional value and superior cultivation of varieties with of bakery qualities.

Climate change in last period of time, with pronounced drought and even climate aridisation trend in southern Romania have led to increased frequency of drought years.

Variety represents an essential factor in the wheat culture technology in order to obtain constant and superior production quality, and this fact is even more evident during drought conditions.

Choosing varieties resistant to thermic and hydric stress conditions (drought, drought accompanied by heat) plays an important role in the fight against this phenomenon, in recent years more and more. Numerous studies highlights the differences between variety on the response to water shortage, as well as the difficulty of the merge a high production potential and features higher quality with good tolerance to drought (Blum, 1996; Mustatea et al., 2003; Olteanu and Tabara, 2008; Andronache, 2009; Idikut et al., 2009; Pasha et al., 2009; Voichita et al., 2010; Hrušková et al., 2012).

The present paper aims at behaviour some varieties of winter wheat in during 2010-2012 under the aspect of adaptability to climatic conditions, specific to areas of sandy soils of southern Oltenia manifested in the period the production test capacity and quality.

MATERIALS AND METHODS

Biological material studied consisted of 15 varieties of winter wheat: Flmura 85, Lovrin 34, Alex, Simnic, Albota, Boema, Crina, Delabrad, Dor, Faur, Glosa, Ciprian, Briana, Exotic, Capo.

The research was place in CCDCPN Dabuleni, during 2010-2012. Were made following observations and measurements:

- determined of protein: Perten method;
- determined of moisture-Perten method;
- determined of wet gluten-Perten method;
- determined of sedimentation Zeleny index Perten method;
- determined the MMB;
- determined MH;
- production (kg/ha).

The experimental results were processed by variance analysis and calculation of correlation coefficients (Saulescu, 1967).

RESULTS AND DISCUSSIONS

A complex area, in which we must improve the knowledge and understanding in order to take immediate and correct view to ensuring to obtain agricultural productions high performance it represents major climate change of our century.

Drought remains still an important abiotic stress factor that threatens agricultural production in many parts of the country, particularly in the south, the water becoming a scarce resource which requires economic and environmental management, conducted with great care. Climate change in recent years, have highlighted the clear trend of global warming and the intensification and expansion of droughts, with negative implications for crop plants. During the experiment included three different years in terms of water and temperature regime: 2010-rainy year, 2011-dry year and 2012 -very dry year (Table 1).

Table 1. Abiotic stress factors manifested in the vegetation period of winter wheat CCDCPN Dabuleni (2010-2012)

Stress factors	2010	2011	2012
Number of days with maximum temperature> 30 C^0 during May-June	13	11	25
Number of days with atmospheric humidity < 30% during May-June	3	17	20
S temperatures (C^0)	4048	3942	4612
The normal (C^0)	4099	4088	4136
Differences ± the normal (C^0)	-51	-146	+ 476
S rainfall (mm)	710	376	383.51
The normal (mm)	548	545	542.9
Differences ± the normal (mm)	+162	-169	-159.4
Characterization years	Rainy	Dry	Very dry

Table 2. The influence of variety on the nutritional quality of the grain of wheat production (2010-2012)

Variety	Moisture (%)	Proteine (%)	Index Zeleny (ml)	Gluten (%)	Hectoliter weight (kg/hl)	Weight of 1000 seeds (g)	Production	
							kg/ha	Significance
Flmura 85	12.8	16.5	68	38.2	74	44	2553	Mt.
Lovrin 34	12.7	15	63	35.4	72	43	3099	*
Alex	13.1	15.1	55	31.6	74	44	2905	-
Simnic	13.3	14.6	46	29.1	72	45	3026	-
Albota	12.5	15.3	57	33.8	73	43	3309	**
Boema	12	14.7	65	34.1	75	44	3308	**
Crina	12.7	15.3	53	31.7	75	45	3226	**
Delabrad	12.5	15.7	60	33.2	76	47	3586	***
Dor	13	15.8	58	33.5	76	42	2969	-
Faur	12.1	15.2	52	31.3	76	42	3422	**
Glosa	12.3	15.4	54	30.9	75	44	3692	***
Ciprian	12.7	15.5	60	33.1	73	46	3675	***
Briana	12.9	15.6	64	34.4	73	44	3442	**
Exotic	12.9	14.5	63	35.9	75	43	3501	**
Capo	12.6	17.7	72	39.3	74	41	3496	**
The average varieties	12.7	15.6	59	33.7	74	44	3280	*

LSD 5% = 544 kg/ha; LSD 1% = 733 kg/ha; LSD 0.1%=974 kg/ha

The year 2010 was characterized as a wet year, marking a higher amount of rainfall, with 162 mm of multiannual amount and frequency of days with temperatures >30^{o}C and atmospheric humidity <30% are smaller, 13 days with hot temperatures and 3 days of heat.
The year 2011 can be characterized as a dry year due to higher frequency of days with temperatures >30^{o}C(11 days), relative humidity <30% (17 days) and the total rainfall was 169 mm in multiannual rainfall amount. Drought was accompanied by heat, suffering a strong wheat plants water and temperature stress.
The year 2012 was a very dry year with 25 days with maximum temperature >30^{o}C and 20 days with relative humidity <30%. Amount average temperature was above 476^{o}C annual average and rainfall was 159 mm in the amount of multiannual.
The meteorological conditions during the experiment manifested reflected in production levels and quality of its stress factors (drought and heat) with different degrees of manifestation. The results on grain quality traits of wheat variety highlight influence on product quality in climatic conditions during the experiment. The amount of protein in grain presented different values depending on the varieties studied, and the climatic conditions in the area of culture. In wheat grains was determined average protein content of between 14.5% to Exotic variety and 17.7% at Capo variety, with an average of 15.6% (Table 2).
For bread wheat flour is preferred, with a minimum of 11% protein content. To obtain this flour, wheat must be at least 12% protein content, between 1-1.5% of wheat protein is lost in the transformation of its flour. All varieties studied showed a protein content greater than 12%. Varieties were observed: Capo variety (17.7%), Flamura 85 variety (16.5%), Delabrad variety (15.7%), Dor (15.8%), Briana variety (15.6%).
Grain moisture is also an important indicator of quality assessment. At harvest, the moisture should not exceed 15%, while maintaining optimal conditions is not performed until a moisture content below 14%. Studied varieties, grain moisture ranged from 12% to Boema variety and 13.3% to Simnic variety.

Wet gluten content in grain and sedimentation index Zeleny are very important quality indicators for the process, contributing to the characterization of dough, especially processing capacity and the potential for its baking. Values for these indicators fall wheat production obtained as very good. Varieties were observed: Flamura, Lovrin and Capo varieties gluten containing greater than 35%. Between gluten and Zeleny index was set a positive linear correlation with a highly significant correlation coefficient (r = 0.94 ***) (Figure 1).
Protein quality is given by sedimentation index. Sedimentation index Zeleny association with protein content is described by a regression of the rise, which shows that the sedimentation rate is proportional to the protein content. Also, the correlation between the amount of gluten and wheat grain protein is described by a regression, showing that gluten is directly proportional to the amount of protein in grain (Figure 2).
Averaged over the three years of experience in the production of wheat varieties studied ranged between 2558 and 3731 kg/ha (Table 2). The best behavior was variety Ciprian variety, who achieved 3731 kg/ha, exceeding the reference variety Flamura 85 variety distinct production with a significant increase of 1173 kg/ha. Also, good adaptability to the climatic conditions of the years of experimentation at CCDCPN Dabuleni and variety manifested Delabrad, Glossa, Briana, Exotic varieties, which exceeded the reference variety Flamura 85 variety with significant production increases from 963 to 1134 kg/ha.

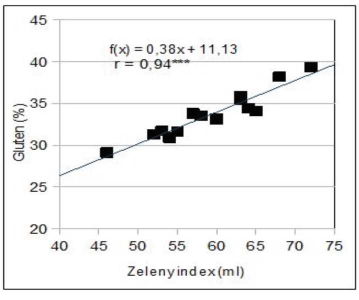

Figure 1. The correlation between the Zeleny index and gluten content of wheat grains

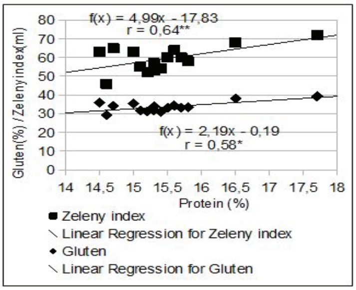

Figure 2. Correlation between protein content, Zelleny index and gluten content of wheat grains

Productivity elements that characterize the varieties studied are presented in Table 2. Wheat varieties tested showed MMB value of 41-49 g and MH values of 72-76 kg/hl. The meteorological conditions during the experiment manifested reflected in production levels and the nutritional quality of the grain, stress factors (drought and heat) with different degrees of manifestation in the three years of study. The experimental results obtained in 2010-2012 are presented in Table 3.

Table 3. Influence of years of study over production and nutritional quality of wheat grain

Year	Moisture (%)	Protein (%)	Index Zeleny (ml)	Gluten (%)	Hectoliter weight (kg/hl)	Weight of 1000 seeds (g)	Production (kg/ha)
2010	13	16.73	-	-	75	48	3628
2011	12.53	14.3	34	60	74	41	3034
2012	11.3	14.56	33.4	61	75	41	3179
The average	12.28	15.2	33.7	61	75	43	3280

In the conditions a rich hydric and thermal regime, in which the phenomenon of heat was almost absent, which characterized 2010 on sandy soils in southern Oltenia production levels was higher compared to the years 2011 and 2012. Also, grain protein content was higher percentage (12.93%). The precipitations was quantitatively significant in May and June, but there have been after a relatively dry sandy soil area of southern Oltenia and wheat productivity elements were already formed. The temperature higher and lower precipitations, hurry completion phase formation straw, although stem length may remain lower than optimal temperature and humidity conditions. Stage in the formation of straw is accompanied by complex physiological processes, because at this time there is differentiation of the reproductive organs.

In the years 2011 and 2012 production levels was influenced by water stress and temperature registered in May-June when droughts and heat had a negative influence on training elements productivity of wheat plants.

Decreased grain moisture percentage in the three years of study, and the highest values were determined in 2010, a year rich in precipitation during May-June and the lowest was determined in 2012, characterized as the most dry year. The protein content of wheat grains presented the highest values in 2010 (16.76%) and in years with thermo-hydric stress in wheat grains was determined a lower protein content.

The relationship between production and quantity of protein in grains in the three-year study is represented by a positive linear correlation with a correlation factor very significantly (Figure 3). The relationship between quality indices: index Zeleny, gluten and protein is more intense the climatic conditions specific to each year compared with the average for the three years of study. The correlation coefficients are highly significant (Figure 4).

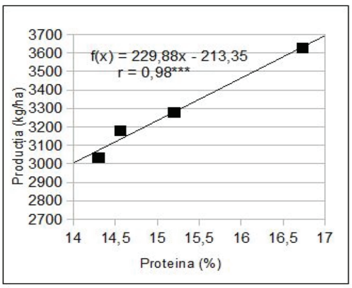

Figure 3. Correlation between production and quantity of protein in grains

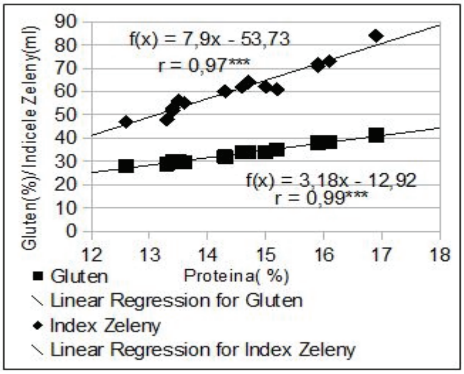

Figure 4. Correlation between protein the content, Zelleny index and gluten content of wheat grains (2012)

Evolution of maximum temperatures >30°C (25 days), relative humidity < 30% (20 days) in May and June 2012 and the amount higher average temperatures from 476°C annual average, allowed the determination of the relationship between production and the number of days from 1 May to gray phase. Thus, significant negative correlation coefficient (r =-0.66 **) suggest that precocity of wheat represents one of physiological mechanisms that determine mitigate drought (Figure 7). In terms of precipitation a year (2010) and a relatively dry year (2011), the correlation between production and the number of days until the gray is insignificant (Figures 5 and 6).

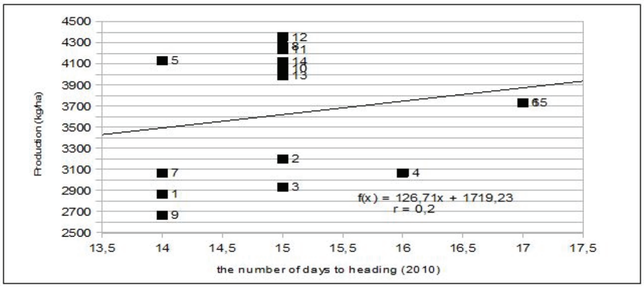

Figure 5. The correlation between production and the number of until the exit ear from 1 May 2010

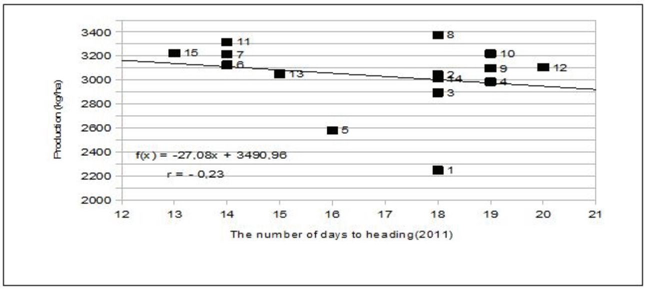

Figure 6. The correlation between production and the number of until the exit ear from 1 May 2011

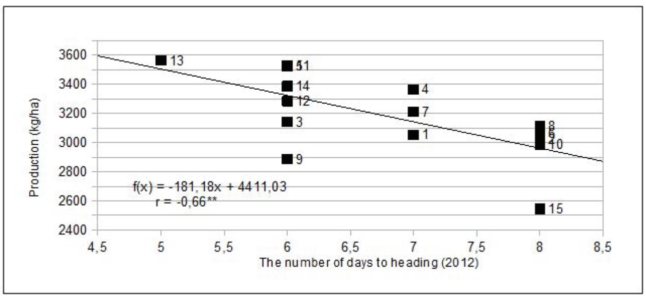

Figure 7. The correlation between production and the number of until the exit ear from 1 May 2012

CONCLUSIONS

Production and quality of production are strongly influenced by extreme climatic conditions (thermic and hydric stress) manifested during the experiment.

The level of production on three years have highlighted varieties, Delabrad (3586 kg/ha), Glossa, Ciprian, Boema (3692 kg/ha, 3675 kg/ha and 3308 kg/ha) results as very significant statistically ensured.

Protein content and wet gluten resulted in wheat grains gives a good quality production and best varieties were: Flacara, Delabrad, Capo, Lovrin

Between quality indicators studied were significant positive correlations determined. Thus the association of sedimentation index Zeleny and quantity of gluten with the content of protein is described by regression with a slope ascendant, that shows that these indices are directly proportional to the protein content of grains.

Negative and significant correlation between wheat production and the number of days until the exit ear from 1 May, under the conditions a dry year, shows that precocity variety can be a measure that can contribute to mitigate drought and heat.

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OPTIMIZATION OF SEVERAL WEED CONTROL TECHNOLOGICAL MEASURES BASED ON MODERATE INPUTS IN MAIZE CROP

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Abstract

The alternative weed control of maize crop, based on absent chemical products, consists in mechanical and manual hoeing weed control and is an ecological alternative. This alternative could be easily adopted in an integrated weed management system owing to the regional traditions and success all over the world. We studied a very importantcrop – maize, in 11 types: mechanical hoeing, manual hoeing and a combination of both. The results collected from 2009 to 2011, showed the best solution which has to be adopted in order to obtain a good yield both quantitatively and qualitatively. We measured the weed number between rows and the plant rows. The decrease in the weeding level resulted in an increased average grain yield, from 4410 kg/ha to 8775 kg/ha.

Key words: *maize, mechanical and manual practices, weed number, grain yield.*

INTRODUCTION

The application of effective crop technologies for the maximum use of the high productive potential resulting from the new cultivars is a basic element of agricultural production. The literature shows average production losses between 50 and 80%, sometimes even 100%, between the maize crop where high-quality hoeing was applied and the unhoed crops (Aldrich, 1984; Berca, 1996; Beraru, 1997).
Non-polluting modern crop technologies give consideration to weed identification and control in order to limit the damage. Maize, like other row crops, is highly affected by weeds, irrespective of the growing area (Berca, Ciorlaus, 1994). Sometimes, the high density of certain weeds, such as *Sorghum halepense*, can damage the maize grain yield up to 91.3% (Sarpe, 1987). Using environmentally friendly practices, i.e. mechanical and manual weeding, is an alternative for the ecological crop system (Ionescu et. al., 1996).
As known, the concept of integrated control appeared at the beginning of the 1970s, entailing the development of technologies that reunite all the prevention and control means whose application helps to achieve the best economic results (Berca, 2004).

The analysis of the research results on weed control shows that Romania mainly favours herbicides (Sarpe,1981; Budoi, 1994), compared to other measures. A brief summary of the weed control measures, other than the chemical ones, also refers to manual and mechanical hoeing (Ionescu, 2010). The concept of ecological agriculture excludes the use of chemicals, replacing them on several technological sequences with other methods, at least equally efficient in weed control.

MATERIALS AND METHODS

Research was carried out at SCDA Caracal and was focused on important issues related to the selection of the best agrotechnical methods, i.e. combinations between mechanical and manual hoeing that provide one of the ecological alternatives for weeding decrease in the maize crop.
To achieve this goal, between 2009 and 2011 we performed a complex experiment based on grain maize cultivation and a combination of hoeing practices for weed control, as presented in Table 1.
The experiments were based on the randomized block method applied in three replications.

The following presents several technological issues resulted from the three years of experimentation.

Thus, deep ploughing in autumn was followed by two disking in spring and complex fertilization in doses of 80kg/haN and 30kg/haP. Seeding was conducted at the beginning of May, using the maize hybrid LG 3330 at a density of 5.5pl/m^2. Weed sampling was performed in three phenophases, as follows:

- 20 days after emergence (20 ZDR);
- 40 days after emergence (40 ZDR);
- 60 days after emergence (60 ZDR).

Numerical and gravimetric analysis was performed on the space between the rows and on the rows, results being related to one linear metre (1m).

On-row analysis included 6 cm on both sides of the row, over a 1m distance. The six centimetres represent the plant protection area during mechanical hoeing.

The analysis on the space between rows included a distance of 58 cm, i.e. 70 cm (the technological distance between the rows) minus the protection area (6 cm on each side of the row), over a 1m distance.

Table 1. Experimental variants analyzed during the experiments carried out at SCDA Caracal

No. var	Treatments	Mechanical-ZDR days			Manual-ZDR days		
		20	40	60	20	40	60
1.	2Mec (I,II) Control	yes	yes				
2.	2man (I,II)				yes	yes	
3.	2Mec (I,II) +1man (II)	yes	yes			yes	
4.	1Mec (II) +2man (I,II)		yes		yes	yes	
5.	2Mec (I,II) +1man (I)	yes	yes		yes		
6.	1Mec (I) +2man (I,II)	yes			yes	yes	
7.	*2Mec (1,2) +2man (1,2)*	*yes*	*yes*		*yes*	*yes*	
8.	2Mec (I,II) +2man (I,II)	yes	yes		yes	yes	
9.	3Mec +2man (I,II)	yes	yes	yes	yes	yes	
10.	*3Mec +3man (1,2,3)*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
11.	3Mec + 3 man (I,II,III)	yes	yes	yes	yes	yes	yes

RESULTS AND DISCUSSIONS

The research performed at SCDA Caracal between 2009 and 2011 resulted in a wide range of resultson the influence of the manual and mechanical hoeing on weeding in the maize crop, partly presented in this paper.

1. Weed evolution on maize row depending on the mechanical and manual works applied.

The analysis of the data presented in Table 2 shows the evolution of weed density on the maize rows, prior to the three hoeing epochs (20 ZDR, 40 ZDR si 60 ZDR).

At 20 ZDR (days after emergence), the weed number varied between 19.9 plt./ml in variant V_7-2Mec (1,2) +2 man (1,2) and 25.2 in V_9-3Mec (I, II, III) +2 man (I, II), while the control 2 Mec I, II recorded 22.8 plt./m. Compared with the control, there were no significant differences between the experimental variants.

Before the second-epoch works (40 ZDR), the degree of weed infestation on the maize row ranged between 7.1 plt./ml in V_{11}-2Mec + 3 man (I, II, III) and 21.9 plt./ml la V_3-2Mec (I,II) +1 man (II). Except for variant V_3, all other variants showed a decrease in the degree of infestation, compared with the control.

At 60 ZDR, the weed number decreased to 4.8 plt./m in V_{11}-3Mec+3 man (I, II, III), recording significant differences for all combinations of mechanical and manual hoeing, compared with the control.

The analysis of the weed number as the mean for the three epochs of observation also showed the favourable effect of combining mechanical with manual works, the degree of infestation ranging between 49% and 76%, compared with the control.

For the mean values, it should be noted that weeding had a certain dynamics. The mean values included the dynamics, particularly due to reinfestation which is a natural phenomenon, given the biological characteristics of the plant species.

Table 2. Weed evolution in maize rows, 2009-2011

No.	*Variants* / Treatments	20 ZDR	40 ZDR	60 ZDR	Mean	
		No. plt./m	No. plt./m	No. plt./m	No. weeds	%
1.	**2Mec (I,II) Control**	22.8	20.4	27.1	23.4	100
2.	2man (I,II)	209	14.5^{00}	8.0^{000}	14.5^{000}	62
3.	2Mec (I,II) +1man (II)	20.4	21.9	11.1^{000}	17.8^{00}	76
4.	1Mec (II) +2man (I,II)	20.8	10.7^{000}	7.0^{000}	12.8^{000}	55
5.	2Mec (I,II) +1man (I)	23.8	10.7^{000}	13.4^{000}	16.0^{000}	68
6.	1Mec (I) +2man (I,II)	21.3	8.5^{00}	6.5^{000}	12.1^{000}	52
7.	*2Mec (1,2) +2man (1,2)*	19.9	13.4^{00}	6.0^{000}	13.1^{000}	56
8.	2Mec (I,II) +2man (I,II)	24.9	9.2^{000}	5.6^{000}	13.2^{000}	56
9.	3Mec +2man (I,II)	25.2	9.0^{000}	4.9^{000}	13.0^{000}	56
10.	*3Mec +3man (1,2,3)*	21.4	8.3^{000}	5.2^{000}	11.6^{000}	50
11.	3Mec + 3 man (I,II,III)	22.2	7.1^{000}	4.8^{000}	11.4^{000}	49
	DL 5%	3.4	3.9	2.4	3.23	
	DL 1%	4.8	5.5	3.2	4.50	
	DL 0,1%	6.7	7.7	4.1	6.17	

2. Effect of mechanical and manual works on the dynamics of weed number on the distance between the rows, mean 2009-2011

The analysis of the data presented in Table 3 shows the evolution of weed density on the spaces between the maize rows before the three-epoch hoeing (20 ZDR, 40 ZDR si 60 ZDR). At 20 ZDR the weed number varied between 37.3 plt./m in variant V_7- 2 Mec (1,2) + 2man (1,2) and 29.2 in V_6- 2 Mec (I, II) +2man (I, II), while the 2 Mec I, II control infestation recorded 30.7 plt./m. Compared with the control, there were significant differences between the experimental variants $V_{3,7,8,9}$.

Before the second-epoch works (40 ZDR), weed infestation of maize crop varied between 18.7 plt./ml in V_5- 2 Mec (I, II) +1 man (I) and 33.4 plt./m in V_2- 2 man (I, II). Except for variants $V_{3,4}$, all the other variants showed reduced infestation, compared with the control.

At 60 ZDR, weed number decreased to 10.4 plt./m in V_{11}- 3 Mec + 3 man (I, II, III), with highly significant differences from the control, in all combinations of mechanical and manual hoeing.

The analysis of weed number as mean for the three epochs also shows the favourable effect of combining mechanical with manual works, reducing infestation to 85%, compared with the mechanically weeded control.

Table 3. Weed evolution on maize interval between rows

No.	Variants / treatments	20 ZDR	40 ZDR	60 ZDR	Mean	
		No. plt./m	No. plt./m	No. plt./m	No. Weeds	%
1.	**2Mec (I,II) Martor**	30.7	29.1	16.1	25.3	100
2.	2man (I,II)	31.8	33.4*	42.5***	35.9***	142
3.	2Mec (I,II) +1man (II)	34.5*	26.7	13.3^{0}	24.8	98
4.	1Mec (II) +2man (I, II)	29.3	32.1	16.3	25.3	100
5.	2Mec (I,II) +1man (I)	33.4	18.7^{000}	12.9^{0}	21.7^{0}	86
6.	1Mec (I) +2man (I, II)	29.2	19.0^{000}	27.0***	25.1	99
7.	*2Mec (1,2) +2man (1, 2)*	37.3*	18.7^{000}	10.5^{000}	22.2	88
8.	2Mec (I,II) +2man (I, II)	33.7*	20.2^{000}	11.1^{000}	21.7^{0}	86
9.	3Mec +2man (I, II)	34.8*	20.7^{000}	10.8^{000}	22.1	87
10.	*3Mec +3man (1, 2, 3)*	32.6	20.4^{000}	11.7^{00}	21.6^{0}	85
11.	3Mec + 3 man (I, II, III)	34.6	19.6^{000}	10.4^{000}	21.5^{0}	85
	DL 5%	3.0	4.2	2.7	3.30	
	DL 1%	4.1	5.8	3.5	4.47	
	DL 0.1%	5.8	8.2	4.9	6.30	

3. Evolution of total weed number in maize crop, depending on manual and mechanical hoeing, mean 2009-2011

The analysis of the results presented in Table 4 shows the evolution of weed density on the entier maize-grown area before the three-epoch hoeing (20 ZDR, 40 ZDR and 60 ZDR). At 20 ZDR, weed number renaged between 50.1 plt./m in varianti V_4- 1 Mec (2) +2 man (1,2) and 60.0 plt./m in V_9- 3 Mec (I, II, III) + 2 man (I, II), with a degree of infestation of 53.5 plt./m in the control 2 Mec (I, II). Compared with the control, significant differences were recorded in the experimental variants $V_{8,9,11}$.

Before the second-epoch hoeing (40 ZDR), weed infestation of maize crop on the entire area varied between 26.7 plt./m in V_{11}- 3 Mec (I, II, III) +3 man (I, II, III) and 49.5 plt./m in V_1- 2 Mec (I, II). Except for variants $V_{2,3}$, all other variants recorded decreased infestation, compared with the control.

At 60 ZDR, weed number decreased to 15.2 plt./m in V_{11}- 3 Mec + 3 man (I, II, III), with highly significant differences compared with the control, for all combinations of mechanical and manual hoeing.

The analysis of weed number as mean for the three epochs of observation also shows the favourable effects of combining mechanical with manual works-V_3-V_{11}, infestation ranging between 68% and 87%, compared with the manually hoed control (I, II).

Table 4. Evolution of weed total number in maize crop

No.	Variants / treatments	20 ZDR	40 ZDR	60 ZDR	Mean	
		No. plt./m	No. plt./m	No. plt./m	No. weeds	%
1.	**2Mec (I, II) Control**	53.5	49.5	43.2	48.7	100
2.	2man (I, II)	52.7	47.9	50.5***	50.4	103
3.	2Mec (I,II) +1man (II)	54.9	48.6	24.4^{000}	42.6^{00}	87
4.	1Mec (II) +2man (I, II)	50.1	42.8^{00}	23.3^{000}	38.7^{000}	79
5.	2Mec (I,II) +1man (I)	57.2	29.4^{000}	26.3^{000}	37.6^{000}	77
6.	1Mec (I) +2man (I, II)	50.5	27.5^{000}	33.5^{000}	37.2^{000}	76
7.	*2Mec (1,2) +2man (1, 2)*	57.2	32.1^{000}	16.5^{000}	35.3^{000}	72
8.	2Mec (I,II) +2man (I, II)	58.6**	29.4^{000}	16.7^{000}	34.9^{000}	72
9.	3Mec +2man (I, II)	60.0***	29.7^{000}	15.7^{000}	35.1^{000}	72
10.	*3Mec +3man (1, 2, 3)*	54.0	28.7^{000}	16.9^{000}	33.2^{000}	68
11.	3Mec + 3 man (I, II, III)	56.8*	26.7^{000}	15.2^{000}	32.9^{000}	68
	DL 5%	3.2	4.1	2.6	3.30	
	DL 1%	4.5	5.7	3.4	4.53	
	DL 0.1%	6.3	8.0	4.5	6.27	

4. Maize grain yield, depending on manual and mechanical hoeing applied to the crop grown at SCDA Caracal

Table 5 presents the production data resulted from research. Data analysis shows that, in 2009, maize grain yield was 5219 kg in the control, and varied between 5957 kg/ha in V_2 and 9134 kg/ha in V_{11}. The yield increase, achieved by applying weed control measures in the experimental variants V_2-V_{11}, varied between 14 and 75% (highly significant).

In 2010, the yield increase recorded in variants V_2-V_4 was statistically assured as well (distinctly significant in V_2 and highly significant in V_3-V_{11}).

Yields varied between 3684 kg/ha in V_1 (control) and 8823 kg/ha in V_{11}.

In 2011, the control achieved a yield of 4326 kg/ha; compared with variants V_2 and V_3, production increases were recorded, although not statistically assured while variants V_4-V_{11} recorded statistically assured productiion increases.

Variant V_{11} recorded the highest production level in 2011 (8369 kg/ha).

The application of two-three mechanical hoeing works, together with two-three manual works, proves the most effective for obtaining high yields of maize.

Concerning the production data expressed as the mean for the three experimental years, the differences were singificant, compared with the control, the grain yields varying between 4410 kg/ha in variant V_1 (control) and 8775 kg/ha in variant V_{11}. The yield increase resulting from manual and mechanical hoeing ranged between 11 and 99%, depending on the number of works applied for weed control purposes.

Table 5. Results on grain maize yield obtained at SCDA Caracal depending on mechanical and manual hoeing, 2009-2011

No.	Variants/ treatments	Year 2009		Year 2010		Year 2011		Mean 2009-2011	
		$kg.ha^{-1}$	%	$Kg.ha^{-1}$	%	$Kg.ha^{-1}$	%	$Kg.ha^{-1}$	%
1	**2Mec (I,II) Control**	5219	100	3684	100	4326	100	4410	100
2	2man (I, II)	5957^{xxx}	114	4185^{xx}	114	4520	104	4887^{xx}	111
3	2Mec (I,II) +1man (II)	6433^{xxx}	123	4602^{xxx}	125	4634	107	5223^{xxx}	118
4	1Mec (II) +2man (I, II)	6889^{xxx}	132	5163^{xxx}	140	4893^{xx}	113	5648^{xxx}	128
5	2Mec (I,II) +1man (I)	7347^{xxx}	141	5723^{xxx}	155	5271^{xxx}	122	6114^{xxx}	139
6	1Mec (I) +2man (I, II)	7728^{xxx}	148	6179^{xxx}	168	5784^{xxx}	134	6564^{xxx}	149
7	*2Mec (1,2) +2man (1, 2)*	8244^{xxx}	158	7493^{xxx}	203	6720^{xxx}	155	7486^{xxx}	170
8	2Mec (I,II) +2man (I, II)	8630^{xxx}	165	7779^{xxx}	211	7224^{xxx}	167	7878^{xxx}	178
9	3Mec +2man (I, II)	8885^{xxx}	170	7899^{xxx}	214	7458^{xxx}	172	8081^{xxx}	183
10	*3Mec +3man (1, 2, 3)*	8950^{xxx}	171	8433^{xxx}	229	7892^{xxx}	182	8425^{xxx}	191
11	3Mec + 3 man I, II, III	9134^{xxx}	175	8823^{xxx}	239	8369^{xxx}	193	8775^{xxx}	199
	*DL 5%	285.5	12	343.6	9	345.8	8	324.9	9.76
	DL 1%	389.8	16	468.6	13	471.2	12	443.2	13.62
	DL 0.1%	528.4	23	634.1	17	641.7	19	601.4	19.62

CONCLUSIONS

Developing ecological weed control strategies is also based on substantiating efficient agrotechnical measures that can be applied for maintaining a low level of damage.

Our research shows that, given an above-average weeding (as was the case of the experimental area), combining mechanical and manual hoeing is the best weed control solution in the ecological agriculture system.

Variant $V_{11,}$ (3 Mec + 3 man I, II, III) was the most favourable technological sequence by its increased maize grain yield.

In 2009, the yield varied between 3684 kg in the control and 9134 kg/ha in variant V_{11}, resulting from the application of thrree mechanical and three manual hoeing works.

Research results can be used by the farmers located in the area of SCDE Caracal, particularly by those who turn to ecological agriculture, in order to select the technological variant that will provide weed control of the maize crop.

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RESEARCH ON APPLICATION OF NPK FERTILIZERS IN PEANUTS GROWN ON SANDY SOILS

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Abstract

Sandy soils by texture provides good conditions for bringing peanuts, so there is the possibility of their cultivation on these lands.
A rational fertilization, besides covering the necessary nutrients for plants involves ensuring at the same time maintaining a certain proportion between soil nutrients.
One of the ways in which it can act to reduce nitrogen loss through leaching is split application of nitrogen on two occasions.
Nitrogen fertilizers affect productivity elements and foundations achieve increased production of pods.
Applying nitrogen fertilizer dose of N90 on two occasions, the first at sowing, the second in vegetation led to obtaining a very significant increase of production 1321 kg/ha.

Key words: *fertilization, peanut, sandy soils.*

INTRODUCTION

For ecopedological sands and sandy soil conditions allow cultivation of a wide range of plant species including peanuts.
Sandy soils by texture provides good conditions for bringing peanuts, so there is the possibility of their cultivation on these lands.
Global results show that fertilization contributes about 40% to increase yields per unit area and yields obtained in different countries are linked to the quantities of fertilizers (Hera et al., 1984; Hera et al., 1980).
A rational fertilization, besides covering the necessary nutrients for plants involves ensuring at the same time maintaining a certain proportion between soil nutrients (Caramete et al., 1973).
Macro and microelements effect on plants is very complex and dependent on the absolute amount and the ratio between them.
In case of dry periods is recommended fertilizer in small doses, but in a balanced ratio of NPK and traces of micronutrients.

MATERIALS AND METHODS

The research was conducted under irrigation, the three-year rotation of wheat-corn-peanut.
The experiment was located in the field, by the method of randomized blocks including 13 variants was applied nitrogen dose divided into three rounds: full dose at sowing, 1/3 at planting + 2/3 vegetation, vegetation full dose.
Observed in experience growing technology peanuts on sandy soils under irrigation.
Vegetation biometric measurements were made on waist plant, number of tillers per plant, and the harvest were determined number of pods per plant, number of grains per pod, pod production.
Laboratory to determine grain protein content based on nitrogen dose applied.
Peanut production was brought to the humidity of 9%.
Interpretation of research results was performed by analysis of variance method and correlation method.

RESULTS AND DISCUSSIONS

It is known that nitrogen peanuts secures the most about symbiotic. But symbiotic nitrogen not fully meet the needs of plants, requiring supply of nitrogen through fertilizers (Pop et al., 1986).
Results of Dima (2006), under the experimental culture peanut Dabuleni CCDCPN

demonstrates the need for nitrogen fertilizers, which have had a significant influence by applying the first phase of vegetation, size and elements influencing productivity, leading to achieving increased production of pods.

Biometric determinations made discloses a class of plants that can reach up to 47 cm in the variant fertilized with dose $N_{90}P_{60}K_{60}$ where nitrogen was divided doses (1/3 at sowing +2/3 vegetation). Compared to the control unfertilized the plant size was 30.2 cm was recorded size of 46 cm in the variant fertilized with $N_{60}P_{60}K_{60}$ the full dose was administered in vegetation nitrogen. In the first part of the growing season peanut plants have slow growth, followed by a period of rapid growth both in height and weight, which continues almost to harvest.

Table 1. Influence of nitrogen management on determinations made during the growing season (2011-2012)

Experimental variant		Plant height (cm)	Number of stems/plant	Number of pods/plant	Number of grains/pod
NPK	The time of application of nitrogen				
N0P0K0		30.2	4	20.6	1.8
N0P60K0		31.4	5	23	2
N0P0K60		32	5	21.6	2
N0P60K60		37	5	21.4	2
N30P60K60	at sowing	36.8	5	22.4	2.1
	1/3 at sowing+2/3 in vegetation	37	5	23	2
	In vegetation	37.8	5	21.2	2.2
N60P60K60	at sowing	39.8	5	25.6	2
	1/3 at sowing+2/3 in vegetation	36.6	5	28	2.2
	In vegetation	46	5	24.2	2
N90P60K60	at sowing	34.6	4	32.4	2.3
	1/3 at sowing+2/3 in vegetation	47	5	33.2	2.8
	In vegetation	38.8	5	28.6	2.6

Observations on productivity elements show that production increased more or less in all areas that received nitrogen.

In terms of productivity, represented by the number of mature pods formed per plant was observed with the highest production of 2359 kg of pods/ha variant in which the dose of $N_{90}P_{60}K_{60}$ where nitrogen was split 1/3 at sowing + 2/3 in vegetation resulting in a production increase very significantly.

Table 2. Influence of nitrogen management on groundnut production and protein content of grain

Experimental variant		Production		Difference		The protein content of grain
NPK	The time of application of nitrogen	Kg/ha	%	Kg/ha	Significance	%
N0P0K0		1038	100	Mt.	Mt.	21.3
N0P60K0		1190	114.6	152	-	21.7
N0P0K60		1211	116.6	173	-	22.1
N0P60K60		1212	116.7	174		22.7
N30P60K60	At sowing	1579	152.1	541	-	22.2
	1/3 at sowing+2/3 in vegetation	1817	175	779	*	23.2
	In vegetation	2034	195.9	996	**	22.9
N60P60K60	At sowing	1969	189.6	931	*	23.2
	1/3 at sowing+2/3 in vegetation	2099	202.2	1061	**	23.9
	In vegetation	1882	181.3	844	*	23.2
N90P60K60	At sowing	2185	210.5	1147	**	21.8
	1/3 at sowing+2/3 in vegetation	2359	227.2	1321	***	23.8
	In vegetation	2250	216.7	1212	**	22.6

Also increase production significantly distinct variant was obtained when nitrogen was applied at a dose of N_{90} kg/ha vegetation. production obtained in this way is of 2250 kg/ha.

Apply nitrogen after flowering is uneconomic and prolongs vegetation cluster.

The chemical composition of peanut seeds are characterized by a content of 20-30% protein and 45-60% fat (Rehm and Espig, 1976).

Results on peanut production quality culture, shows a protein content ranging from 21.3% in the control variant unfertilized and 23.9% in the variant fertilized with $N_{60}P_{60}K_{60}$ and nitrogen was given 1/3 at sowing + 2/3 in vegetation. If we compare the amount of protein in grain production from, it increases with increasing production (Figure 1).

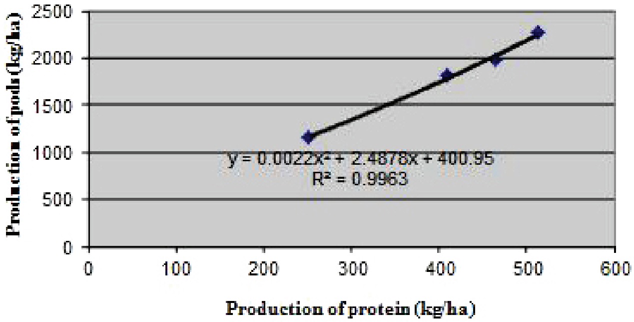

Figure 1. Correlation between the pods yield and the quantity of protein depending on the dos eof nitrogen applied

CONCLUSIONS

One of the ways in which it can act to reduce nitrogen loss through leaching is split application of nitrogen on two occasions.

Nitrogen fertilizers affect productivity elements and foundations achieve increased production of pods.

Applying nitrogen fertilizer dose of N_{90} on two occasions, the first at sowing, the second in vegetation led to obtaining a very significant increase of production 1321 kg/ha.

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THE INFLUENCE OF NEW HERBICIDES ON THE GROWTH AND THE SOME STRUCTURAL ELEMENTS OF THE YIELD OF FODDER MAIZE

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Abstract

Within the period 2011-2012 in the experimental field of the Agricultural University, Plovdiv, we conducted field experiments using new herbicides on fodder maize. The experiments were based on the block method over an area of 21 m^2 in four repetitions. It has been established that they demonstrate excellent selectivity for this crop and by eliminating the competition of the weeds, they increase the components of the yield and have a positive effect on the growth and the development of maize. The obtained data has been statistically processed based on the ANOVA method.

Key words: *zea mays, herbicides, structural elements, growth.*

INTRODUCTION

In order to obtain high and sustainable yield of maize (*Zea mays* L.), it is necessary to grow it applying irrigation and at the same time fight the weeds by using the most appropriate herbicides (Zhelyazkov, 2007; Tonev et al., 2010; Mahmood and Swenton, 2005; Stoimenova et. al., 2004). The production capacity of the mid-early maize hybrids are determined to a large extent by the quantity and the distribution of the rainfall during the vegetation period. New maize hybrids are constantly being used in practice, testing their productivity in the different agroecological regions around the country (Ilchovska, 2008; Delibaltova and Ivanova, 2009) and determined the impact of pests on crop (Dimitrov et al., 2012).

The strong negative influence of weeds on the growth and the yield of maize as well as the need to use new herbicides on this crop set the objective of this survey, namely, to study the influence of new soil and leaf herbicides on the growth and some structural elements of the yield of fodder maize.

MATERIALS AND METHODS

Within the period 2011-2012 in the experimental field of the Agricultural University, Plovdiv, we made field experiments using new herbicides applied into the soil after sowing and before the germination of the crop and also applied to the leaves during the vegetation period of the maize – a hybrid of Pioner company: Kolomba (450 FAO). The sowing during the two years of the experiment was performed on 21.04.2011 and 23.04.2012. The experiments were made using the block method over an area of 21 m^2 in four repetitions (Table 1).

The agrotechnical activities were conducted in accordance with the commonly used technology for growing maize (processing of the soil, fertilization, sowing, rolling). The soil and leaf herbicides were applied using a knapsack sprayer and a solution of 30-40 l/dka. The efficiency of the herbicides was registered in sample areas (2 for each repetition) i.e. 8 per variant:

- For the soil herbicides – on the 28^{th}, 40^{th} and 56^{th} days after spraying.
- For the leaf herbicides – on the 20^{th} and 40^{th} days after spraying.

The year 2011 was characterized by moderately warm and dry spring considering the small quantity of the rainfall during the winter period (in January the rainfall was far below the norm – it barely reached 24,6 l/m^2 compared with the year 2012 when the quantity of the rainfall was 120,2 l/m^2). The summer of 2011 was very hot and the quantity of the rainfall was close to the norm.

In April 2012, the pre-sowing processing of the soil had already been performed in the conditions of extreme drought (the total quantity of the rainfall for the region in March and April barely reached 27,1 l/m^2), which did not allow the growth of separate groups of weeds typical for that period. However, in May there were heavy precipitations (160,8 l/m^2). This provided conditions for secondary weeding in the experimental areas and contributed to the good efficiency of the soil herbicides.

Table 1. The field experiments performed

Variants	Active substans	Dose
1. Control (K_1)-untreated and not trenced area		
2. Industrial control (K_2) – untreated with 2-3 hoeing		
3. Laudis OD	*44 g/l tembotrion*	200 cm^3/dka (folair application)
4. Lumux 538 SK	*375 g/l s-metolaxlor 125 g/l terbutilazin 37.5 g/l mezotrion*	400 cm^3/dka (soil application)
5. Elumis	*30 g/l nikosulfuron 75 g/l mezotrion*	200 cm^3/dka (folair application)
6. Gardoprim plus gold 500 SK	*312.5 g/l s-metolahlor 187.5 g/l terbutilazin*	450 cm^3/dka (soil application)
7. Wing	*212.5 g/l dimetenamid-P 250 g/l pendimetalin*	400 cm^3/dka (soil application)
8. Stelar	*50 g/l topramezon 160 g/l dikamba*	100 cm^3/dka (folair application)
9. Kaspar 55 WG	*50 g/kg prosulfuron 500 g/kg dikamba*	30 g/dka (folair application)
10. Merlin flex	*240 g/l izoxaflutol*	42 cm^3/dka (soil application)

RESULTS AND DISCUSSIONS

The data on the elements determining the yield has been processed mathematically based on the ANOVA method.

We estimated the degree of provedness of the differences between the indicators regarding the zero control sample (No. 1) and the hoed control sample (No. 2).

Tables 2 and 3 show the height of the plants in the different variants of the treatment registered during the stage of full maturity of the crop within the period of the survey. The smallest height of the maize plants was registered in the zero control sample – 120.7 cm and 154.6 cm, respectively. In variants No. 5, 8 and 9, the values of this indicator reach 139.32 cm but the differences with the zero control sample have not been proven (Table 2). The tallest maize plants were registered in variants No. 4, 6, 7 and No. 3, which is statistically significant compared with the zero control sample. The differences between the treated variants and the hoed control sample are statistically doubtful, which means that the registered heights in all variants are at the level of the hoed control sample.

Table 2. Degree of provedness of the differences with the control sample regarding the height of the plants measured in cm during the experiment with maize plants in their full maturity stage, 2011.

Variants	Average	D ± var. 1	Significance	D ± var. 2	Significance
4	185.47	30.82	+++	9.95	ns
6	179.97	25.36	++	4.45	ns
3	177.25	22.63	++	1.73	ns
2	175.52	20.90	+		
7	174.82	20.20	+	-0.7	ns
8	174.62	20.00	+	-0.9	ns
10	167.87	13.25	Ns	-7.65	ns
9	162.60	7.98	Ns	-12.9	ns
5	159.97	5.35	Ns	-15.5	ns
1	154.62			-20.9	-

$GD_{p5\%} = 18.47$; $GD_{p1\%} = 21.50$; $GD_{p\,0.1\%} = 27.30$

In 2012, the plants of all variants were taller compared with the previous year 2011, when the height varied from 223.3 to 247.05 cm. The lowest value of this indicator was registered among the plants of the zero control sample – 154.62 cm for the year 2011 and 223.3 cm for the year 2012 (Table 3). The biggest proven height compared with the zero control sample in the tasseling stage of the maize was registered for variants No. 3 (226.0 cm), 4 (216.9 cm) and 8 (215.2 cm) and during the full maturity stage also for variant No. 10 (237.7 cm). For all other variants, these differences compared with the zero control sample are insignificant although higher values were registered during both stages of this crop.

The differences in the height between the variants treated with herbicides and the hoed control sample have not been proven, which puts then into the same category.

As regards the length of the corncob (Table 4), the influence of the examined variants is similar to that registered for the width of the corncob. Only the leaf treatment with Kasper 55 VG-30 g/dka (var. 9) did not have a substantial influence on the length of the corncob and it is at the same level as that of the zero control sample.

Table 3. Degree of provedness of the differences with the control sample regarding the height of the plants measured in cm during the experiment with maize plants in their full maturity stage, 2012.

Variants	Average	D ± var. 1	Significance	D ± var. 2	Significance
3	247.05	23.75	+++	11.82	ns
8	246.66	23.23	+++	11.32	ns
4	238.35	15.05	+	3.12	ns
10	237.73	14.43	+	2.50	ns
6	236.95	13.65	ns	1.72	ns
7	236.87	13.57	ns	1.64	ns
2	235.23	11.93	ns		
5	232.10	8.80	ns	-3.13	ns
9	227.98	4.68	ns	-7.25	ns
1	223.30			-11.9	

$GDp_{5\%} = 13.95$; $GDp_{1\%} = 17.58$; $GDp_{0.1\%} = 21.33$

Table 4. Degree of provedness of the differences with the control samples regarding the length of the corncob measured in cm during the experiment with maize, 2011.

Variants	Average	D ± var. 1	Significance	D ± var 2	Significance
4	17.4	2.23	+++	0.86	+
6	17.0	1.83	+++	0.46	ns
7	16.9	1.73	+++	0.36	ns
3	16.68	1.51	+++	0.14	ns
8	16.58	1.41	+++	0.04	ns
2	16.54	1.37	+++		
5	16.50	1.33	+++	-0.04	ns
10	16.29	1.12	++	-0.25	ns
9	16.01	0.84	ns	-0.53	ns
1	15.17			-1.37	---

$GD_{p5\%} = 0.86$; $GD_{p1\%} = 0.94$; $GD_{p\,0.1\%} = 1.16$

The highest degree of provedness for this indicator compared with the zero control sample was registered for variant No. 6 – Gardoprim plus Gold 500 SK – 450 cm^3 /da where the length of the corncob was 17.85 cm for the year 2012 and 17.00 cm for the year 2011 and variant No. 4 – Lumax 538 SK-400 cm^3 /da -17.76 cm in the year 2011 and 17.4 cm in 2012 (Tables 4 and 5).

Table 5. Degree of provedness of the differences with the control samples regarding the length of the corncob measured in cm during the experiment with maize, 2012.

Variants	Average	D ± var. 1	Significance	D ± var. 2	Significance
6	17.85	2.56	+++	0.40	ns
4	17.76	2.47	+++	0.31	ns
7	17.46	2.17	++	0.01	ns
2	17.45	2.16	++		
3	17.42	2.13	++	-0.03	ns
5	17.10	1.81	+	-0.35	ns
8	16.48	1.19	ns	-0.97	ns
10	15.55	0.26	ns	-1.90	-
9	15.30	0.01	ns	-2.15	--
1	15.29			-2.16	--

CONCLUSIONS

On average, during the period of the survey in the variants treated with the herbicides Laudis OD applied during the vegetation period of the crop in a dose of 200 m^3/da, Lumax 538 SK-400 cm^3/da and Gardoprim plus Gold 500 SK-450 cm^3/da, applied to the soil, the plants reach the biggest proven height compared with the zero control sample during the full maturity stage of the maize. The differences between all treated variants in the experiment and the hoed control sample have not been statistically proven.

When using the herbicides Gardoprim plus Gold 500 SK, Lumax 538 SK, Wing P-400 cm^3/da and Laudis OD-200 cm^3/dka, we registered higher values for the length of the corncob compared with the zero control sample and regarding the hoed control sample, the differences are not significant for any of the variants with the exception of variant No. 4 in 2011.

In 2011, variants No. 4, 6, 7, 3 and 8 had bigger values of the indicator related to the number of lines on a corncob compared with the two control samples and in 2012 only variant No. 6 showed a value higher than the one of the zero control sample. Such a difference between the variants treated with herbicides and the hoed control sample in 2012 was not registered.

The application of Gardoprim plus Gold (variant 6), Lumax 538 SK (variant 4) and Wing P (variant 7) during the two years of the experiment contributed to the increase of the values of the weight of the grains of one corncob, which has been statistically proven compared with the zero control sample and the difference with the hoed control sample is insignificant.

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VARIETAL SUSCEPTIBILITY OF WINTER FODDER PEAS TO HERBICIDES

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Abstract

Within the period 2005-2008, in the municipality of Radnevo, village of Lyubenova mahala, we made a three-factor field experiment with fodder peas based on the method of fractional plots in four repetitions in order to establish the varietal susceptibility of the crop to the herbicides imazetapir, 2,4D, propizachlor, bentazon and metribuzin. The obtained results regarding the separate indications have been processed as a two-factor complex based on the analysis of variance. It has been proven that the herbicide 2,4-D has a negative effect on the growth and the development of all three types of winter peas.

Key words: *winter fodder peas, herbicides, varietal susceptibility.*

INTRODUCTION

Peas (*Pisum sativum* L.) is one of the oldest and most significant frumentatious-leguminous plants, widely grown around the world at different ecological conditions. Despite its advantages, the average crops of the culture are blow their biological potential and the main reason for this are the weeds. According to the data from some authors, weeds have an adverse effect on the reproductive capability of the spring fodder peas and the decrease in the crop harvest is up to 53% (Mishra, J.S., Bhan, V.M., 1997; Khan, M. H. et al., 2003; Dimitrova, C., 2000). During the first days after its germination the peas develop very slowly and it is easily overgrown by the weeds. The usage of numerous herbicide preparations with multiform chemical ingredients, mechanism and sphere of activity, the changes in weed associations due to different factors, as well as the continuous selection of new varieties, necessitate the constant research on the issue connected with the susceptibility of the varieties to them. The application of suitable herbicides and herbicide mixtures in the fight with the weeds at the peas growing is a prerequisite for optimizing the biological potential of the harvest, which in combination with the proper agricultural machinery can prove to be a highly efficient and environmental activity.

MATERIALS AND METHODS

The field research wad conducted in the village of Lyubenova mahala as two three-factor trials under the method of fractional parcels with 4 repetitions and crop parcel area of 10 m². Factor A includes the peas varieties, factor B – the variants with herbicides and factor C – herbicide doses (Table 1). The variants of the factors tested are applied on one another which provides the opportunity to judge the action both of each separate factor and the interaction between them. The herbicides were dispersed by a dorsal sprayer with tank consumption of the work solution-40 l/dka. The research was done on an area without any weeds in order to avoid their influence.

Table 1. Experimental factors

Factor A *Variety*	Factor B *Herbicide*	Factor C *Doze*
A1: Vesela **A2**: No 11 **A3**: Mir	**B$_1$**- Pivot 100 SL *(100g/limasetapir)*, 80 ml/da, soil treatment **B$_2$**- Basagran forte (*480 g/lbentazon + lutensol*)leaf of the weed and the culture **B$_3$**- Zenkor 70 VG - (*700g / kgmetribusin*), 50 g/da, 3 three-leaf of the culture (10-15 cm high) **B$_4$**- Pivot 100 SL (*100 g/лимазетапир*), 40 ml/da, foliar treatment **B$_5$**– 2,4D (*600 g/l 2,4 D–amen salt*), 67 ml/da, foliar treatment	**C1** - optimal doze **C2** - double doze

RESULTS AND DISCUSSIONS

Data about the height of the plants measured at the end of the vegetation of the winter peas were handled like two-factor complex under the method of disperse analysis. The three tested varieties are the first factor A, and the second factor B are the herbicides studied.

In Table 2 the average values of the three tested varieties are presented with regard to the height of the plant regardless of the five types of herbicides applied at single treatment doses. Based on all possible differences observed, it becomes clear that Mir variety has the biggest height and is proved to be ($P_{0.1\%}$) higher than the other two varieties. This is variety ability and the variety is suitable for foliage. The shortest plants are those of variety No 11, followed by Vesela variety which is suitable for peas.

With regard to the herbicide influence, regardless the variety studied (Table 3), the highest plants are those treated with herbicide Basagran forte (B_2). The differences between B_2 and the herbicide influence of B_1 (Pivot – 80 ml/da, in the soil), B_3 (Zenkor – 50 ml/da) and B_4 (Pivot – 40 ml/da, in the leaves) are insignificant. The only statistically significant difference is the extent of influence of the type with 2,4D (B_5). It is the same situation further to the other three herbicides.

Table 2. Proved difference between the varieties with regard to the plant height, treated with single dose

Variety	ẋ	Different with		
		a_1	a_3	a_2
a_1	115	-	+++	+++
a_3	89.20		-	+++
a_2	78.13			-

$gDp_{5\%} = 4.41$; $gDp_{1\%} = 5.94$; $gDp_{0.1\%} = 7.87$

Table 3. Proved difference between the herbicides with regard to the plant height, treated with single dose

Herbicides	ẋ	Different with				
		B_2	B_1	B_3	B_4	B_5
B_2	95.889	-	ns	ns	ns	+
B_1	95.778		-	ns	ns	+
B_3	94.778			-	ns	+
B_4	94.000				-	ns
B_5	90.111					-

$gDp_{5\%} = 4.41$; $gDp_{1\%} = 5.94$; $gDp_{0.1\%} = 7.87$

Comparative analysis between the combinations of the two factors is presented in Table 4. Following the logic of the two previous tables, the combination of Mir variety treated with Basagran (a_1B_2) has the highest average value – 116.33 cm, followed by the same variety treated with Zenkor, Pivot and 2,4D respectively. The values of these variants (combination variety – herbicide) are proved to be higher than the others. However, there is not any significant difference between them, which means that the herbicides do not have a negative influence on the growth of the peas.

In the hierarchical order with regard to the average values, the variants of combinations between Vesela variety treated with the respective herbicides follow in approximately same order. The proven difference is defined at Vesela variety treated with Pivot, Basagran, Zenkor and the herbicide 2,4D respectively. Similar dependency is detected with the other combinations between variety No 11 and the herbicides studied.

The combination between variety No 11 and B_5 (herbicides 2,4-D, at dose 67 ml/da) is distinguished by the lowest value of the indication studied.

It was proved that the combination between the three varieties with herbicide B_5, i.e. 2,4-D at double dose led to withering of the plants. Therefore, the values are 0.

The average values with regard to the number of the peas on one plant of the three varieties winter peas tested with the five herbicides applied at single treatment dose are presented in the next three tables.

Table 5 shows that there are no proved differences between the varieties tested with regard to the indicator number of peas. The values of this indication are within the limits between the average 12,667 for Mir variety (a_1) and 12,133 for variety No 11 (a_2).

With regard to the herbicide influence, regardless of the variety tested (Table 6), the number of the peas per plant is the biggest for the plants treated with herbicide 2,4D (B_5) – 13,222. This indicator is proved to be larger than the number of peas detected after treatment with herbicides Pivot (B_1) and Zenkor (B_3). On the second place with regard to the number of peas is the variant treated with Pivot (B_4) – 13,000. They have proved bigger value than the variant with $в_3$ (Zenkor). For it, the number of peas detected was the smallest - 11,333.

Table 4. Proved difference between the varieties with regard to the indicator number of peas per plant, treated with single dose

Variety	ẋ	Different with		
		a_1	a_3	a_2
a_1	12.667	-	ns	ns
a_3	12.200		-	ns
a_2	12.133			-

$gDp_{5\%} = 1.16$; $gDp_{1\%} = 2.64$; $gDp_{0.1\%} = 3.50$

Table 5. Proved difference between the herbicides with regard to the indicator number of peas per plant, treated with single dose

herbicides	ẋ	Different with				
		$в_5$	$в_4$	$в_2$	$в_1$	$в_3$
$в_5$	13.222	-	ns	ns	+	+
$в_4$	13.000		-	ns	ns	+
$в_2$	12.111			-	ns	ns
$в_1$	12.000				-	ns
$в_3$	11.333					-

$gDp_{5\%} = 1.16$; $gDp_{1\%} = 2.64$; $gDp_{0.1\%} = 3.50$

Table 6. Proved difference between the varieties with regard to the indicator weight of the seeds per plant, treated with single dose

Variety	ẋ	Different with		
		a_1	a_3	a_2
a_1	12.733	-	ns	ns
a_3	12.600		-	ns
a_2	12.267			-

$gDp_{5\%} = 1.03$; $gDp_{1\%} = 1.72$; $gDp_{0.1\%} = 2.61$
$gDp_{5\%} = 1.03$; $gDp_{1\%} = 1.72$; $gDp_{0.1\%} = 2.61$

The competitive analysis between the combinations of the two factors – variety-herbicide is presented in Table 7. The plants of variety No 11, treated with herbicide Pivot ($в_4$) – 14,330 have the highest average value of this indicator. For the three varieties combined with herbicides $в_4$ and $в_5$ the values were close to each other and vary from 14,330 to 13,333 pcs.
Variety No 11, treated with $в_4$ herbicide (Pivot, veget.) has proved higher value than the other 12 combinations.
The lowest value of the indicator was detected for Vesela variety treated with herbicide Zenkor ($в_3$) – 11,000, that proved to have the weakest influence as shown in Table 7. For the three varieties combined with herbicide 2,4D at double dose, all the plants withered.

Table 7 proved difference between the combinations variety – herbicide with regard to the indicator number of peas per plant, treated with single dose

The average values with regard to the indicator weight of the seeds per plant for the three varieties of winter peas tested regardless of the five herbicides applied at single dose are shown in Tables 8, 9 and 10.
Table 8 shows that there are not any differences between the varieties tested with regard to the indicator observed – weight of the seeds per plant. The values of this indicator are between the limits of the average 12,733 for Mir variety (a_1) and 12,267 for variety No 11 (a_2).
Further to the influence of the herbicides, with no regard to the variety tested (Table 9) the weight of the seeds per plant is the heaviest for the plants treated with herbicide Basagran ($в_2$) – 13,22, followed by the variant treated with Zenkor ($в_3$) – 12,89. The lowest weight proved to be for the variant with herbicide $в_5$ (2,4D) – 11.33.
The competitive analysis between the combinations of the two factors – variety-herbicide is shown in Table 10. The highest equal average value of this indicator have the plants of variety No 11 and Vesela variety treated with herbicide Basagran ($в_2$) – 13.33. The indicator weight of the seeds for the three varieties treated with herbicide Zenkor and Pivot respectively, has the same values – 13.00. The lowest value of the indicator weight of the seeds per plant was detected for the variety No11, treated with 2,4D ($в_5$) – 10.33. All the other combinations between the varieties and herbicides tested proved higher values compared to those of variety No 11 and herbicide 2,4D.
The combination with 2,4D at double dose had a lethal effect on the plants.
All the other varieties have proved, though at different grade, heavier weight of the seeds compared to those treated with 2,4D at single dose for varieties No 11 and Vesela.
Table 10. Proved difference between the combinations variety – herbicide with regard to the indicator weight of the seeds per plant, treated with single dose.

Table 7. Proved difference between the combinations variety – herbicide with regard to the plant height, treated with single dose

Combination	ẋ	Different with														
		a_1B_2	a_1B_3	a_1B_1	a_1B_4	a_1B_5	a_3B_1	a_3B_2	a_3B_4	a_3B_3	a_3B_5	a_2B_1	a_2B_2	a_2B_3	a_2B_4	a_2B_5
a_1B_2	116.33	-	ns	ns	ns	ns	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
a_1B_3	116.00		-	ns	ns	ns	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
a_1B_1	115.33			-	ns	ns	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
a_1B_4	114.67				-	ns	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
a_1B_5	112.67					-	++	+++	+++	+++	+++	+++	+++	+++	+++	+++
a_3B_1	91.33						-	ns	ns	ns	+	+++	+++	+++	+++	+++
a_3B_2	90.67							-	ns	ns	+	+++	+++	+++	+++	+++
a_3B_4	89.33								-	ns	+	+++	+++	+++	+++	+++
a_3B_3	89.00									-	ns	+++	+++	+++	+++	+++
a_3B_5	85.67										-	+	+	++	++	+++
a_2B_1	80.67											-	ns	ns	ns	+++
a_2B_2	80.67												-	ns	ns	+++
a_2B_3	79.33													-	ns	++
a_2B_4	78.00														-	++
a_2B_5	72.00															-

$gDp_{5\%} = 4.41$; $gDp_{1\%} = 5.94$; $gDp_{0.1\%} = 7.87$

Table 8. Proved difference between the combinations variety – herbicide with regard to the indicator number of peas per plant, treated with single dose

Combination	ẋ	Different with														
		a_2B_4	a_3B_5	a_1B_5	a_3B_4	a_2B_5	a_2B_2	a_1B_1	a_2B_1	a_3B_2	a_1B_2	a_2B_3	a_1B_4	a_1B_3	a_3B_1	a_3B_3
a_2B_4	14.330	-	ns	ns	+	+	+	+	+	+	++	++	++	++	++	++
a_3B_5	13.667		-	ns	ns	ns	ns	ns	+	+	+	+	+	+	+	++
a_1B_5	13.333			-	ns	ns	ns	ns	+	+	+	+	+	+	+	+
a_3B_4	13.000				-	ns	ns	ns	ns	ns	+	+	+	+	+	+
a_2B_5	12.667					-	ns	ns	ns	ns	ns	ns	ns	+	+	+
a_2B_2	12.667						-	ns	ns	ns	ns	ns	ns	+	+	+
a_1B_1	12.667							-	ns	ns	ns	ns	ns	+	+	+
a_2B_1	12.000								-	ns	ns	ns	ns	ns	ns	ns
a_3B_2	12.000									-	ns	ns	ns	ns	ns	ns
a_1B_2	11.667										-	ns	ns	ns	ns	ns
a_2B_3	11.667											-	ns	ns	ns	ns
a_1B_4	11.667												-	ns	ns	ns
a_1B_3	11.333													-	ns	ns
a_3B_1	11.333														-	ns
a_3B_3	11.000															-

$gDp_{5\%} = 1.16$; $gDp_{1\%} = 2.64$; $gDp_{0.1\%} = 3.50$

Table 9. Proved difference between the combinations variety – herbicide with regard to the indicator weight of the seeds per plant, treated with single dose

Combination	ẋ	Different with														
		a_2B_2	a_3B_2	a_1B_2	a_1B_3	a_3B_3	a_3B_4	a_1B_4	a_2B_3	a_2B_4	a_3B_1	a_1B_1	a_2B_1	a_1B_5	a_3B_5	a_2B_5
a_2B_2	13.33	-	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	+	+	+++
a_3B_2	13.33		-	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	+	+++	+++
a_1B_2	13.00			-	0	0	0	ns	ns	ns	ns	ns	ns	ns	+	+++
a_1B_3	13.00				-	0	0	ns	ns	ns	ns	ns	ns	ns	+	+++
a_3B_3	13.00					-	0	ns	ns	ns	ns	ns	ns	ns	+	+++
a_3B_4	13.00						-	ns	ns	ns	ns	ns	ns	ns	+	+++
a_1B_4	12.67							-	ns	ns	ns	ns	ns	ns	ns	++
a_2B_3	12.66								-	ns	ns	ns	ns	ns	ns	++
a_2B_4	12.65									-	ns	ns	ns	ns	ns	++
a_3B_1	12,64										-	ns	ns	ns	ns	++
a_1B_1	12.33											-	ns	ns	ns	++
a_2B_1	12.32												-	ns	ns	++
a_1B_5	12.00													-	ns	+
a_3B_5	11.66														-	+
a_2B_5	10.33															-

$GDP_{5\%} = 1.03$; $GDP_{1\%} = 1.72$; $GDP_{0.1\%} = 2.61$

CONCLUSIONS

Out of the varieties tested, Mir is the highest. This is variety ability and the variety is suitable for foliage. The shortest plants are those of variety No 11, followed by Vesela variety which is suitable for peas.

Further to the influence of the herbicides, with no regard to the variety tested, the plants treated with herbicide Basagran forte - 150 ml/da are the highest, and the shortest are the plants at the variant with 2,4-D - 67 ml/da.

The highest average value under the indicator weight of the seeds have the plants of variety № 11 and variety Vesela, treated with herbicide Basagran forte – 13.33 g, and the lowest value was measured for variety No 11, treated with 2,4D (B_5) - 67 ml/da.

There are no differences proved between the varieties tested with regard to the indicator weight of the seeds of 1 plant and number of peas per 1 plant.

The combination between the varieties and herbicide 2,4D – 133 ml/da (double dose) has a lethal effect on the pea's plants.

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INFLUENCE OF DIFFERENT LEVELS OF WATER SUPPLY ON PRODUCTION CAPACITY AND QUALITY OF CORN GROWN IN DOBROGEA CLIMATIC CONDITIONS

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Abstract

This work presents results on an experience from 2010 and 2011, which was organized by randomized block method in three repetitions, in a field planted with corn hybrids from different germoplasm source and from another FAO group, carried out under irrigation, with irrigation (700 mc/ha) and with 50% reduced irrigation level (350 mc/ha) in Dobrogea area at SCDA Valul lui Traian.
Throughout Romania, Dobrogea by geographic location, in terms of weather conditions, has the most diverse range of climate risks. Dobrogea is located in the interference of polar air masses with the tropical area where very cold air masses and dry arctic or polar origin, causes temperature decreases, the winds that sweep the snow in winter and summer masses entering hot air tropical climate that favors summer climate risks (massive heating, prolonged droughts and heat, aridity, etc.).
Although the thermal potential of the area allows corn hybrids from very late group growing, prolonged drought and heat of summer limited their cultivation.
Correlation was established between different levels of water supply and production capacity in the three groups of precocity to identify most adapted hybrids to adverse conditions (drought and heat) in the area where experience has been mounted.
Early hybrids, due to short growing season, have used more water reserve in winter, while medium and especially late hybrids reacted positively with increasing water applied.
Analysis of quality components showed an increase in fat content and a decrease in protein and starch to increase soil moisture levels.
A longer growing season is accompanied by an increase starch content and a decrease in fat content and crude protein.

Key words: *hybrid, corn, irrigation, drought, tolerance, fat, protein.*

INTRODUCTION

The corn production capacity is a complex issue, a resulting effect of the action of genetic, ecological and technological factors (Muresan et al., 1972). For this reason, any alteration results in obtaining low, non-economic productions.
For the success of a corn crop, an enhanced dilligence is needed when choosing the hybrid.
One of the main objectives of the improvement programs is the selection of the best genotypes for drought stress conditions (Richards et al., 2002).
The adaption of the corn hybrids to the climatic variations is actively contributing to the production increase and its stability, by capitalizing even better the natural resources and diminishing the damages caused by the stress factors (Sarca Vasilichia, 2004).
An important production increase was registered by introducing large scale irrigation (Botzan, 1972; Luca et Nagy, 1999; Luca et al., 2008).
The present work aims at identifying some hybrids showing a high production stability and quality, under contrasting climatic conditions, in Dobrogea, using three water supply levels.

MATERIALS AND METHODS

Research has been made in SCDA Valu lui Traian conditions, Constanta, on a vermic chernozem soil, by the method of subdivided parcels with two factors:
- Factor A – irrigation system with the following graduations: a1- non irrigated; a2-

irigated with 50% reduced time (350 m^3/ha); a3- full time irrigation (700 m^3/ha).

- Factor B – used germplasma: b1- Turda 145; b2- Severo; b3- PR37D25; b4- Oituz; b5- Kamelias; b6- PR36D79; b7- Rapsodia; b8- KWS 1394; b9- PR35F38.

Experience has been placed in plots subdivided in three repetitions, with buffer zones 24 m wide between treatment options. Water management has been made by sprinklers.

Measuring the quantity of water was performed using rainfall sprinklers placed on the column of sprinklers.

The testing hybrids are from three precocity groups (early, medium and late).

The technology applied in these experiments with corn hybrids was the best, recommended for the area of corn cultivation, corresponding to the climatic conditions of Dobrogea area, place of experiments

The obtained results have been statistically calculated using the analysis of variation for bi-factorial experiments and the correlation between different characters and water supply (Saulescu N.A., Saulescu N.N., 1967).

RESULTS AND DISCUSSIONS

1.Climate conditions

The test was carried on over the course of three years (2010 – 2012). The year 2010 was an extremely rainy year, registering 662.8 mm of rainfall, 230.7 mm more than the multi-annual average on 71 years (Figure 1).

In 2011, 368.9 mm of rainfall were registered, 62.7 mm less than normal. As compared to the previous year, 2011 was extremely droughty. 2012 was the most droughty, even more droughty than 2007, a representative year for the severe drought in the last decade, especially in Dobrogea.

In the month of June-July, period in which the corn crop registers the highest water consumption, the following values of rainfall have been registered: 251.3 mm in 2010, 88.1 mm in 2011 and only 6.9 mm in 2012.

The rainfall registered in the three years of testing confirm the fact that these are, generally, insufficient for corn cultivation, that they fluctuate form one year to another and are not uniformly distributed over one calendar year.

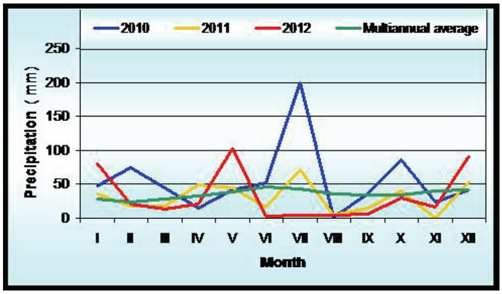

Figure 1. Rainfall registered in SCDA Valu lui Traian in 2010-2012

The average temperature of the year 2010 was of 12.30°C, with 1.3°C above the normal of 71 years (Figure 2). The average temperature of 2011 was of 11.19°C, with 0.19°C above the normal. 2012 was the hottest year of the testing, registering an annual average temperature of 13.37°C, with 2.4°C more that the multi-annual means.

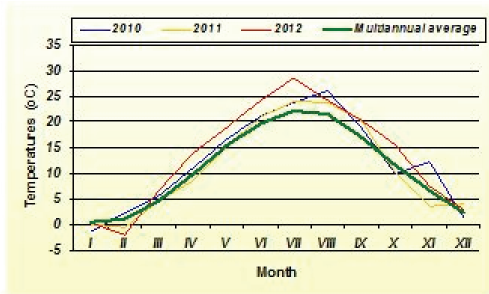

Figure 2. Temeperatures registered in Dobrogea in 2010-2012

The dynamics of these climate factors led to the induction of the hydric stress and emphasizes the aridization tendency of Romania, in general, and of Dobrogea, in particular.

2.The study of the production capacity

The analysis of the significances show the presence of some distinctly significant differences regarding the production capacity, as a result of the variability of water supply level, of the testing years and of the diversity of the analyzed hybrids (Table 1). The smallest productions of the testing were obtained under non irrigation conditions (8620 kg/ha) (Table 2).

At this level of water supply, the average crop of corn hybrids was situated 2030 kg/ha under the test average values (nine hybrids x three levels of water supply x three years of testing) a very significant negative difference.

Table 1. Variance analysis experience with nine hybrids and three water levels insurance at SCDA Valu lui Traian 2010-2012

Variability cause	SP	GL	s^2	Sample F	
				Against error	Against interaction
Years	48371.11	2			
Blocks	1238.16	6			
Agrofunds (Water supply levels)	53117.58	2	26558.79	140.49^{xx} (6,93)	37.07^{xx} (18,0)
Agrofunds (Water supply levels)x years	2859.73	4	714.94	3.79 (3,26)	
Error (a)	2268.5	12	189.05		
Hybrids	22155.96	8	2769.50	48.59^{xx} (2,53)	22.03^{xx} (3,89)
Hybrids x years	2011.68	16	125.73	2.21^{xx} (2,12)	
Hybrids x Agrofunds (Water supply levels)	1591.35	16	99.46	1.75 (1,71)	1.45 (1,99)
Hybrids x Agrofunds (Water supply levels)x years	2198.16	32	68.7	1.21 (1,83)	
Eroare (b)	8206.86	144	57.0		

Table 2. Influence of different levels of water supply on the yield obtained at SCDA Valu lui Traian in 2010 - 2012

No. crt	Irrigation regime	Production(kg/ha)				Difference from mt		Significance
		2010	2011	2012	Average	kg/ha	%	
1	Not irrigated	9940	9040	6870	8620	-2030	81	000
2	Irrigated with 350 m^3/ha	12230	12080	9070	11130	480	104	*
3	Irrigated with 700 m^3/ha	13390	13170	10080	12210	1560	115	***
Average		11850	11430	8670	10650	Mt	100	
DL 5% = 470 kg/ha DL 1% = 660 kg/ha DL 0.1% = 930 kg/ha								

Table 3. Production results obtained from nine maize hybrids at three levels of water supply in SCDA Valu lui Traian 2010 to 2012

No. crt.	Hybrid	Production(kg/ha)				Difference from mt		Significance
		Not irrigated	Irrigated with 350 m^3/ha	Irrigated with 700 m^3/ha	Average	kg/ha	%	
Early hybrids								
1	Turda 145	7110	10050	9750	8970	-1680	84	000
2	Severo	7420	10270	11310	9670	-980	91	000
3	PR37D25	8840	11670	12780	11100	450	104	*
Medium hybrids								
4	Oituz	7850	9980	11640	9820	-830	92	000
5	Kamelias	8720	11340	12560	10870	220	102	
6	PR36D79	9260	11770	12970	11330	680	106	**
Late hybrids								
7	Rapsodia	9520	10880	13180	11420	770	107	***
8	KWS 1394	8570	7290	11830	10420	-230	98	
9	PR35F38	10270	12650	13960	12270	1620	115	***
Exp. average		8620	11130	12210	10650	mt	100	
Dl 5% = 410 kg/ha Dl 1% = 540 kg/ha Dl 0.1% = 690 kg/ha								

The best results regarding the behaviour of corn hybrids involved in the testing, at different levels of water stress induction, averaged over three years of testing, were obtained by the Pioneer hybrids (Table 3):

- on the early precocity group, the PR37D25 hybrid makes a significant production gain of 450 kg/ha;
- on the medium precocity group, the PR36D79 hybrid makes a significantly different production gain of 680 kg/ha;

- on the late group, the PR35F38 hybrid makes a very significant production gain of 1620 kg/ha. Also, in the same group, the Romanian hybrid Rapsodia is noticed, for its performance of a very significant production gain, of 770 kg/ha. The hybrids: Oituz, Severo and Turda 145 have placed themselves, with 830 kg/ha; 980 kg/ha, and 1680 kg/ha respectively, under the average for testing, with verry significantly negative differences.

The results regarding the behaviour of the corn hybrids on different irrigation regimes, averaged over three years of testing, have emphasized the PR35F38 hybrid, which showed significant production increase under all water supply conditions (Table 4).

The smallest productions were shown by:
- under non-irrigated conditions, the Turda 145 hybrid (7110 kg/ha), 1510 kg/ha below the average, a difference ensured for P=5%;
- irrigated with 350 m^3/ha, the KWS 1394 hybrid (7290 kg/ha), showed 3840 kg/ha below the average, a difference ensured for P=0.1%;
- for full-time irrigation (700 m^3/ha), the Turda 145 hybrid obtained a production of 9750 kg/ha, with 2460 kg/ha below the average of the testing, a difference ensured for P=1%.

Regarding the specific reaction of each corn hybrid on irrigation, it was found that the KWS 1394 hybrid is the only one that, when a 350 mc/ha irrigation was applied, obtained a lower gain, 1280 kg/ha lower, a significantly negative difference (Table 5). For the same irrigation level, the Rapsodia hybrid offers a production increase of 1360 kg/ha, a significantly distinct gain. The increase of 850 kg/ha obtained by the Severo hybrid was within the testing error limits. The other hybrids showed very significant production increases when the reduced time irrigation of 50% was applied.When using a 700 c.m./ha water supply, all thehybrids showed very significant production increases.

The best reaction on irrigations was of the hybrids: Oituz, with an increase of 148%, PR37D25 with an increase of 145% and Kamelias, with an increase of 144%.

3.Production quality

The corn production quality is estimated by the contents of protein, gross fat, starch and their quality.

For these reasons, any alteration of any of the constituting components is mirrored in the obtainment of low quality crops.

During the last decade, Dobrogea faces extreme climatic changes (excessively rainy years, with over 200 mm above thove normal values – such as 2010, years when rainfall is 60-70 mm below the regular values, such as 2011 and years with higher temperatures that average – such as 2012: 2.4°C), years with very harsh winters, as well as years with very bland winters.

These contrasting conditions provoke significant fluctuations of the crop sizes and of the crop quality.

The starch content is high and oscilates within tight limits on the three irrigation levels.

For non irrigation, the average contents for the tested hybrids was of 72.65%, for 350 mc/ha irrigation it was reduced with 0.13% and for 700 mc/ha irrigation it was reduced with 0.16% (Figure 3).

There are higher differences among the precocity groups. Thus, the early hybrid Turda 145 has the lower starch content in all of the irrigation

regims, while the more late hybrids PR36D79, KWS 1394 and PR35F38 show, under the same water supply conditions, the highest values.

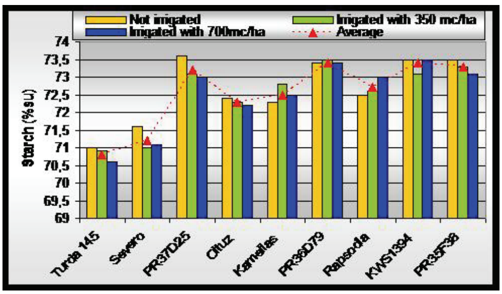

Figure 3. Starch content

The fat content showed amplitudes comprised between 3.84% for KWS1394 and 5.14% for Turda 145 (Figure 4). The following intermediate values were registered: 3.84% for the KWS1394 hybrid; 3.87% for the PR35F38 hybrid.

Amongst the three precocity groups, the highest fat content was shown by the early group (4.62%), for the medium group it deacreased to 4.07% and reached the value of 4.0% for the late group.

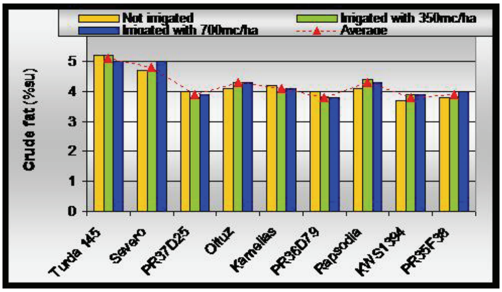

Figure 4. Fat content

The gross protein content had relatively reduced average values, their amplitude ranging from 8.64% for PR36D79 to 10.54% for Turda 145 (Figure 5). The highest average values of the protein content in the corn seeds was present in the early hybrids (9.89%) and medium hybrids (9.72%), as compared to the late hybrids, which registered the value of 8.84%.

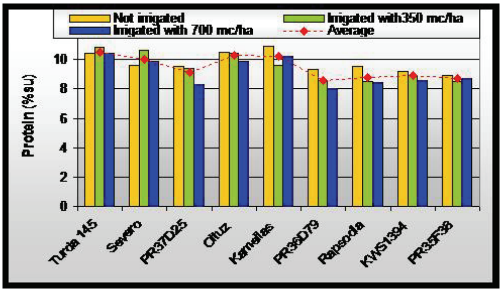

Figure 5. Protein content

Table 4. The behavior of nine corn hybrids at different irrigation regimes at SCDAValu lui Traian

No crt.	Hybrids	Production (kg/ha)	Difference from mt		Significance
			(kg/ha)	(%)	
Not irrigated					
1	Turda 145	7110	-1510	82	00
2	Severo	7420	-1200	86	
3	PR37D25	8840	220	102	
4	Oituz	7850	-770	91	
5	Kamelias	8720	100	101	
6	PR36D79	9260	1000	107	
7	Rapsodia	9520	900	110	
8	KWS 1394	8570	-50	99	
9	PR35F38	10270	1650	119	*
Average		8620	mt	100	
Irrigated with 350 m^3/ha					
1	Turda 145	10050	-1080	90	
2	Severo	10270	-860	92	
3	PR37D25	11670	540	105	
4	Oituz	9980	-1150	90	
5	Kamelias	11340	210	102	
6	PR36D79	11770	640	106	
7	Rapsodia	10880	-250	98	
8	KWS 1394	7290	-3840	65	000
9	PR35F38	12650	1520	114	*
Average		11130	mt	100	
Irrigated with 700 m^3/ha					
1	Turda 145	9750	-2460	80	00
2	Severo	11310	-900	93	
3	PR37D25	12780	570	105	
4	Oituz	11640	-570	95	
5	Kamelias	12560	350	103	
6	PR36D79	12970	760	106	
7	Rapsodia	13180	970	108	
8	KWS 1394	11830	-380	97	
9	PR35F38	13960	1750	114	*
Average		12210	mt	100	

Dl 5% = 1220 kg/ha
Dl 1% = 1770 kg/ha
Dl 0.1% = 2660 kg/ha

CONCLUSIONS

During the testing period, having a critical pluviometric regime, temperatures above the multi-annual average values were registered. The dynamics of these two climatic factors, as well as the relatively low humidity and a higher sunshine duration, show an aridization tendency of Dobrogea.

For non-irrigation regime, the hybrids of the testing were placed 2030 kg/ha below the average of the three water supply levels. The irrigation with 350 mc/ha of water brings an increase of 2510 kg/ha, while the irrigation of 700 mc/ha of water brings an increase of 3590 kg/ha.

The early hybrids, averaged on the three water supply levels, showed 820 kg/ha, below the average production of the medium hybrids and 2360 kg/ha below the average production of late hybrids.

The late hybrid PR35F38 showed the highest productions for the three water supply levels and a good tolerance to the pedological drought, best capitalizing the irrigation water, both for the 50% irrigation regime and for the full time irrigation regime.

The Romanian hybrid Rapdsodia shows a production stability under all testing conditions and effectively capitalizes the limited water resources, out of rainfall.

For the 350 mc/ha irrigation regime, the hybrid KWS 1394 was the only one diminishing the usual production, 3840 kg/ha below the average for the said water supply.

The maximum production potential of the Turda 145 hybrid was shown when the 350 mc/ha water supply regime was applied.

The 700 m/ha water supply regime did not lead to increase of production, the water excedent from irrigation not being capitalized by this hybrid.

Related to the water supply level, a tendency of increase of the average fat content and a tendency of deacrease of the

starch and protein content are noticed, when a 700 m.c./ha water supply regime is applied (+0.6% fat and 0.16% starch and 0.60% protein, respectively), as compared to non irrigation.

Related to the period of vegetation, a tendency of increase of the average starch content and a tendency of decrease of fat and protein are noticed, for the more late hybrids (+1.4% starch, and respectively 0.62% fat and 1.06% protein) as compared to early hybrids.

Table 5. The individual behavior of nine corn hybrids at different irrigation regimes at SCDA Valu lui Traian

Precocity	Hybrids	Agrofunds	Production (Kg/ha)	Difference from mt		Significance
				kg/ha	%	
Early hybrids	Turda 145	a1	7110	Mt	100	
		a2	10050	2940	141	***
		a3	9750	2640	137	***
	Severo	a1	9420	Mt	100	
		a2	10270	850	109	
		a3	11310	1890	120	***
	PR37D25	a1	8840	Mt	100	
		a2	11670	2830	132	***
		a3	12780	3940	145	***
Medium hybrids	Oituz	a1	7850	Mt	100	
		a2	9980	2130	127	***
		a3	11640	3790	148	***
	Kamelias	a1	8720	Mt	100	
		a2	11340	2620	130	***
		a3	12560	3840	144	***
	PR36D79	a1	9260	Mt	100	
		a2	11770	2510	127	***
		a3	12970	3710	140	***
Late hybrids	Rapsodia	a1	9520	Mt	100	
		a2	10880	1360	114	**
		a3	13180	3660	138	***
	KWS 1394	a1	8570	Mt	100	
		a2	7290	-1280	85	0
		a3	11830	3260	138	***
	PR35F38	a1	10270	Mt	100	
		a2	12650	2380	123	***
		a3	13960	3690	136	***

Dl 5% = 930 kg/ha
Dl 1% = 1240 kg/ha
Dl 0.1% = 1600 kg/ha

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RESEARCH ON GENETIC AND BREEDING SUNFLOWER FOR RESISTANCE TO BROOMRAPE PARASITE (*Orobanche cumana*) IN ROMANIA

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Abstract

Theparasitic angiosperm broomrape (Orobanche cumana Wallr.) is currently regarded as one of the most important constraints in sunflower (Helianthus annuus L.) production Romania, but especially with highest frequency and intensity of the attack is found in the central and southern part of Moldova, Dobrogea and eastern Plain Baraganu. In the last 40 years, efforts to introduce genetic resistance to this parasite in sunflower hybrids were followed by the occurence of new virulent races that promptly overcame all known resistance genes. Due to this situation, most of the research efforts have focused on the development and characterization of new sources of genetic resistance to the most virulent races and also, on the genetic variability of Orobanche cumana populations. Different tests for sunflower resistance to the new races of the parasite, have showed that they are present now in different regions in Romania. Recommendations for reducing sunflower yield caused by broomrape are given.

Key words: *sunflower, Orobanche cumana, broomrape races, genetic resistance.*

INTRODUCTION

Broomrape (*Orobanche cumana* Wallr.) has more than forty years of parasitism on sunflower in Romania. For this period the malicious obligate parasite caused production losses of sunflower crop areas of central and southern part of Moldova, the eastern part of the Plain Baraganului and Dobrogea. The joint evolution of a broomrape and the host led to appearance of new races of the parasite, capable to overcome immunity of resistant varieties and hybrids. Last epiphytic conditions developed in the Romania at the beginning seventies when the biotype of broomrape which appeared for the first time in Moldova, named the Moldavian race, started to affect sunflower varieties and this new broomrape population seems to have spread and south-eastern Romania, the Big Island Braila and in Dobrogea, and the Eastern Bulgaria.

Research conducted in Romania by Pacureanu et al. (2009), identified as G race from experiences located in the south-east of the country using an assortment differentiator consists of inbred lines and commercial hybrids available on the market in Romania and presented resistant to Orobanche more aggressive races than race E.

Vrânceanu and Pacureanu (1995) studied a set of 84 hybrids international sunflower, noting that only 12% of them showed good resistance genetic attack *Orobanche cumana*, rest very sensitive. In the European countries cultivating sunflower new broomrape races, overcoming resistance of gene Or5 have appeared and have quickly extended much earlier on an extent 90th (Melero-Vara, et al., 2000; Molinero-Ruiz, Melero-Vara, 2004; Fernandez-Escobar et al, 2008). Resistance to them of sunflower wild species has been studied and resistant genotypes have been found out, lines and the hybrids resistant against race F, differentials for races have been developed (Dominguez, 1996; Fernandez-Martinez et al, 2000; Perez-Vich et al., 2002; Pãcureanu-Joita et al., 2004, 2008). Nevertheless Orobanche cumana is currently regarded as one of the most important constraints for sunflower production in Southern Europe, the Black Sea region, Ukraine and China (Parker, 1994). For the last fifteen years of effort of scientists and breeders to present genetic sources of resistance to this parasite in sunflower hybrids were accomplished by occurrence of new virulent races which quickly have overcome all known genes of resistance (Fernandez-Martinez et al., 2008).

The purpose of our researches was to determine broomrape virulence from different locations of the east part area in Romania, with application of known sunflower differentials.

MATERIALS AND METHODS

Broomrape seeds were collected from four fields with natural broomrape infestation from four counties (Tulcea, Constanta, Ialomita and Calarasi) in the east part of Romania with one year before. The hybrids used in the natural infestation fields for isolation and collecting broomrape seeds were following: Performar, Sambro, Favorit, Sanluca, Sanay and ES Etnic.

Sunflower differentials (corresponding genes of resistance in brackets): lines AD 66 (susceptible), LC1002A (Or4), LC 1003A (Or5), LC1093A (Or6), KuglikA/41 (Or1), Jdanov 8281 (Or2), variety Record (Or3) and LG 5580 (Or7), have been used for studying broomrape virulence.

For differentiation of broomrape races seeds of sunflower differentials were sown in plastic boxes with the size 20:20:20 cm, filled with a soil-sandy mix (3:1), mixed with seeds of a parasite. Seeds of each broomrape population added in box from calculation of 200 mg on 1 kg of a soil mix. Plants were grown up in the natural condition and having watered carried out at drying of the top layer of soil. Through 30 days after seedlings appearance plants were dug out and roots were washed with water. Quantity of broomrape individuals (healthy tubercles and stems) were counted up. Average broomrape individuals on one affected plant were calculated on five plants of everyone differentials.

RESULTS AND DISCUSSIONS

In Romania, more than 60% of the sunflower cultivated area is infested with broomrape. There are four important areas, as the presence of the broomrape races and infestation degree, situated in Tulcea, Constanta, Ialomita and Calarasi locations.

The sunflower differentiators have been performed in these areas to have the information about the parasite races spreading.

In the Table 1, it can be observed that in Tulcea area all differentiators are attack with a very high degree of infestation, so even the differentiator for race G is hybrid and the biological purity is not like for the lines, this present high level of infestation. In this area were identification races A,B,C,D,E,F and G.

Table 1. Affection degree of sunflower differentials by broomrape from different populations, 2011 in Tulcea location

No	Hybrid, variety, on which broomrape was collected	AD 66	KuglikA/41	Jdanov 8281	Record	LC1002A	LC1003A	LC1093A	LG 5580
1	Performar	83	72	64	41	27	10	9	14
2	Sambro	16	10	12	8	14	17	7	12
3	Favorit	12	8	14	18	13	14	6	10
4	Sanluca	24	18	15	11	13	12	8	10
5	Sanay	7	5	4	6	10	16	4	8
6	ES Ethic	4	3	4	6	5	17	3	6

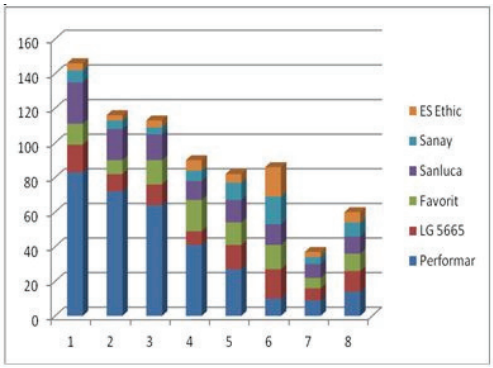

Figure 1. Chart data Tulcea

All differentiators which have been infested in Tulcea are infested in Constanta area too,but the infestation degree being smaller comparing with the results obtained in Tulcea (Tables 2); degree of infestation is high on inferior races, and decrease to the superior races. The same like in Tulcea, in this area were identification races A, B, C, D, E, F and G, but the level of infestation is different.

Table 2. Affection degree of sunflower differentials by broomrape from different populations, 2011 in Constanta location

No	Hybrid, variety, on which broomrape was collected	AD 66	KuglikA / 41	Jdanov 8281	Record	LC1002A	LC1003A	LC1093A	LG 5580
1	Performar	94	85	77	64	50	36	8	16
2	Sambro	84	80	76	36	24	8	4	14
3	Favorit	78	72	71	33	22	8	3	10
4	Sanluca	87	73	64	32	23	6	3	12
5	Sanay	72	68	58	38	26	7	5	8
6	ES Ethic	67	60	47	41	29	5	4	5

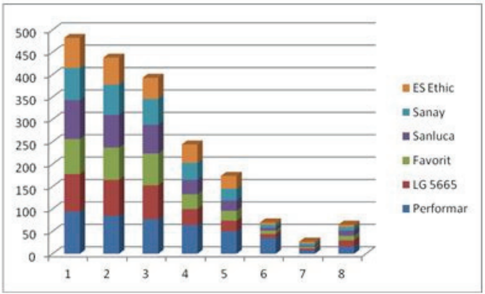

Figure 2. Chart data Constanta

In Ialomita aria (Table 3) are affected differentiator for race A,B,C,D,E and F so this means that race F was spread in this area. Degree of infestation is high on inferior races, and decrease to the superior races.

In Calarasi aria (Table 4) are affected differentiator for race A,B,C,D and E so this means that race E was spread in this area. Degree of infestation is high on inferior races, and decrease to the superior races, so in this area means that the race F is superior race for this area.

Table 3. Affection degree of sunflower differentials by broomrape from different populations, 2011 in Ialomita location

No	Hybrid, variety, on which broomrape was collected	AD 66	Kuglik A / 41	Jdanov 8281	Record	LC1002 A	LC1003 A	LC1093 A	LG 5580
1	Performar	114	92	44	32	27	6	8	0
2	Sambro	84	64	38	27	18	5	4	0
3	Favorit	71	60	34	24	14	8	3	0
4	Sanluca	82	61	33	22	20	11	5	0
5	Sanay	0	0	0	0	0	0	0	0
6	ES Ethic	0	0	0	0	0	0	0	0

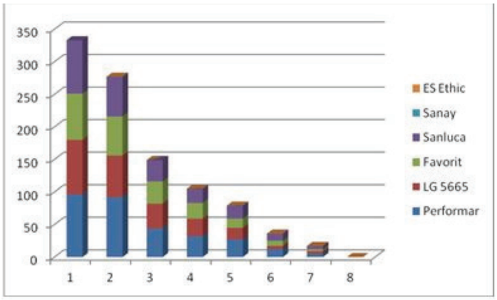

Figure 3. Chart data Ialomita

Table 4. Affection degree of sunflower differentials by broomrape from different populations, 2011 in Calarasi location

No	Hybrid, variety, on which broomrape was collected	AD 66	Kuglik A / 41	Jdanov 8281	Record	LC1002 A	LC1003 A	LC1093 A	LG 5580
1	Performar	114	92	44	32	27	6	8	0
2	Sambro	84	64	38	27	18	5	4	0
3	Favorit	71	60	34	24	14	8	3	0
4	Sanluca	82	61	33	22	20	11	5	0
5	Sanay	0	0	0	0	0	0	0	0
6	ES Ethic	0	0	0	0	0	0	0	0

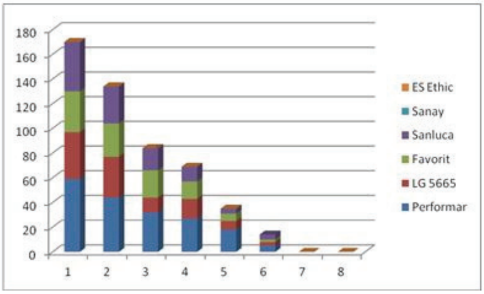

Figure 4. Chart data Calarasi

CONCLUSIONS

Parasite *Orobanche cumana* Wallr. evolved in the virulence of populations in recent two decades in southeastern Romania with especially in Tulcea and Constanta.

To achieve the research is essential establish a differentiator assortment created of inbred lines and hybrids with reaction known to the pathogen, with the participation of private companies and research institutes.

Expanding research in all areas with *Orobanche cumana* and monitoring these areas.

Zoning sunflower hybrids depending on the resistance and tolerance to *Orobanche cumana*.

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RESEARCH ON GENETICS AND BREEDING FOR SUNFLOWER RESISTANCE TO *PLASMOPARA HALSTEDII*

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Abstract

Sunflower is attacked by more than 40 different diseases of which only a certain number causes serious reduction of seed yield. One of the most damaging diseases is downy mildew which is caused by Plasmopara halstedii fungus (Farl.) Berl.et de Toni (syn. Plasmopara helianthi Novit.). Sunflower downy mildew has a great economic importance in all countries where sunflower is grown. When the meteorological conditions during the vegetation period of sunflower become favorable for disease development, the damages produce considerable reducing of the seed yield and the oil content.
The best way of controlling the fungus is to grow resistant cultivates and because that the major objective of this study was to developed sunflower genotypes genetically resistant to dominant races of downy mildew in Romania. During this work two co-dominant markers for Pl-6 and Pl-8 gene. For introduction of these genes in breeding program marker assisted selection (MAS) was used. Developed commercial sunflower inbred lines exhibit resistance to all known races of downy mildew in Romania indicated incorporation of resistance to downy mildew in well-known and widely produced hybrids. Except that, Pl-genes were introduced to large number of new inbred lines and new downy mildew resistant hybrids.

Key words: *downy mildew, hybrid, inbred line, race, sunflower.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important source of vegetable oils and it keeps gaining popularity because of its high oil percentage and quality, short duration and thermophotinsensitiveness.
More than 30 diseases have been identified on sunflower (Gulya et al., 1994). Among these, downy mildew caused by *Plasmopara halstedii* (Farl.) Berl. and de Toni is the most destructive one (Kolte, 1985). Existence of physiologic races in *Plasmopara halstedii* is evident from reports of several workers from different parts of the world (Abdullah, 1983; Patil and Mayee, 1990). Sunflower downy mildew is caused by the fungus *Plasmopara halstedii* Farl.Berl. & de Toni, an obligate parasite which infects seedlings during the early stages of development, usually from sowing to two leaves. Systemic infection is characterized by symptoms of chlorotic mosaic bordering the veins of the leaves as well as stunting of the plants. Optimum conditions for the disease, such as high inoculums concentrations, abundant rain and temperatures of 15-18°C can cause preemergence or postemergence damping off of the young plants.
The incorporation of genes of resistance to *Plasmopara halstedii* is a common way to control the disease. These genes are effective against one or more races of the fungus, but they are overcome by more virulent races of the fungus after continuous crop of resistant hybrids.
Over the last 20 years there have been great changes in the pathogen population in almost all sunflower growing countries in the world, except Australia. In Europe, there was an increase in the number of path types of pathogens, each with a distinct virulence structure. In Romania have been identified five path types of the pathogen, until 2006 (Pacureanu et al., 2006) and in the last 3 years are still identified another two path types. For the vast diversity in the pathogen influence both disease epidemic and improve the sunflower resistance to the *Plasmopara*

Halstedii is necessary to identify local populations and monitor their changes over time.

MATERIALS AND METHODS

To achieve experiments on identifying pathogen races present in sunflower crop in Romania was used following set of differentiators: HAR-304 who is sensitive for all downy mildew races; RHA-265 and RHA-266 who are resistant for race 100 and sensitive for races 300, 310, 330, 700, 710 and 730 downy mildew races; RHA-274 who is resident for races 100, 300, 330, undefined for 310 race and sensitive for races 700, 710, 730 downy mildew races; PMI 3 who is resistant for races100, 300, 330,700, undefined for 310 races and sensitive for 330, 710 and 730 races; PM 17 who is resistant for races 100, 300, 700, 710, undefined for 310 races and sensitive for 330 and 730 races; 803-1, RHA-340 and HAR-4 who are resistant for all downy mildew races; HA-335 who is resistant for races 100, 300, 330, 700, 710, 730, undefined for races 310 and sensitive for 304 races; DM-2 who is resistant for races 100, 300, 304, 700 and sensitive for races 330, 710 and 730. To identify the spectrum of races of the pathogen were collected sunflower plants attacked by mildew from following areas cultivated sunflower in the country: Movilita – Ialomita, Tamadau – Calarasi, Peciu Nou – Timis, Farcasele – Olt, Perieti – Ialomita, Mihail Kogalniceanu – Constanta, Ianca – Braila, Dor Marunt – Calarasi. These samples were kept in the freezer and multiplied on the susceptible cultivar "Peredovic" using the radicle inoculation method and then subsequently used to obtain suspensions of zoospores for making artificial infection. Identify races of *Plasmopara halstedii* study was done in the laboratory, in 2012.

RESULTS AND DISCUSSIONS

In Romania, the pathogen *Plasmopara halstedii* evolved in increasing virulence, especially in recent years, during which identified five new races of it. If a very long time, about thirty five years ago, there were only two races of the pathogen in the sunflower crop in Romania, but the pathogen has developed new races.

The results obtained (Table 1 and Table 2) show that in Movilita were infected the differentiators HAR-304, RHA-266 and RHA-266, in Tamadau were infected the differentiators HAR-304, RHA-266, RHA-274, PMI 3, PM 17, DM-2 and DHA-265, in Ianca were infected HAR-304, RHA-266, RHA-274, PMI 3, DM-2 and DHA-265, in Dor Marunt were infected HAR-304, RHA-266, RHA-274, PMI 3, PM 17, DM-2 and DHA-265.

Table 1. Results of testing of the sunflower differentials set, for resistance to the pathogen first four location

Differentiators	Izolate			
	Movilita	Tamadau	Ianca	Dor Marunt
	Degree of infection (%)			
HAR-304	78.1	80.4	71.4	79.2
RHA-266	53.5	61.2	55.8	57.1
RHA-274	0.0	52.2	54.5	51.1
PMI 3	0.0	61.5	51.9	64.4
PM 17	0.0	59.3	0.0	52.0
803-1	0.0	0.0	0.0	0.0
RHA-340	0.0	0.0	0.0	0.0
HA-335	0.0	0.0	0.0	0.0
DM-2	4.1	57.4	59.1	62.4
HAR-4	0.0	0.0	0.0	0.0
RHA-265	54.4	56.3	57.2	51.2

Table no. 2 shows that in Peciu Nou were infected differentiators HAR-304, RHA-266, RHA-274, PMI 3, PM 17, DM-2 and DHA-265, in Farcasele were infected differentiators HAR-304, RHA-266, RHA-274, PMI 3, DM-2 and DHA-265, in Perieti were infected differentiators HAR-304, RHA-266, RHA-274, PMI 3, PM 17, DM-2 and DHA-265, and in Mihail Kogalniceanu were infected differentiators HAR-304, RHA-266, RHA-274, PMI 3, PM 17, DM-2 and DHA-265.

The results show that in Romania races 100 and 300 are prezent in all studied locations, race 700 is prezent in Movilita and Tamadau locations, race 730 is prezent in Peciu Nou, Perieti, Mihail Kogalniceanu and Dor Marunt locations, race 310 is prezent in Tamadau, Peciu Nou, Perieti, Ianca and Dor Marunt locations, race 330 is prezent in Tamadau, Perieti and Dor Marunt locations, race 710 is prezent in Tamadau, Peciu Nou, Farcasele and Ianca locations.

The sunflower crop in Romania have been identified in recent years several new races of the pathogen *Plasmopara halstedii*, it developing in a relatively short period about ten years, five new races. New races are present in different areas of southern, western and eastern countries.

Table 2. Results of testing of the sunflower differentials set, for resistance to the pathogen last four location

Differentiators	Izolate			
	Peciu Nou	Farcasele	Perieti	Mihail Kogalniceanu
	Degree of infection (%)			
HAR-304	58.2	64.5	52.7	72.2
RHA-266	52.3	58.8	54.9	52.1
RHA-274	56.9	63.1	24.2	54.2
PMI 3	57.1	56.6	67.6	51.8
PM 17	59.8	0.0	55.8	62.0
803-1	0.0	0.0	0.0	0.0
RHA-340	0.0	0.0	0.0	0.0
HA-335	0.0	0.0	0.0	0.0
DM-2	59.1	52.8	54.0	61.2
HAR-4	0.0	0.0	0.0	0.0
RHA-265	55.1	67.2	61.8	56.2

Table 3. The patotypes of the pathogen *Plasmopara halstedii*, identified in the sunflower crop, in seven locations

Location	1	2	3	4	5	6	7
Downy mildew race	100	300	700	730	310	330	710
Movilita	x	x	x				
Tamadau	x	x	x		x	x	x
Peciu Nou	x	x		x	x		x
Farcasele	x	x					x
Perieti	x	x		x	x	x	
Mihail Kogalniceanu	x	x		x			
Ianca	x	x			x		x
Dor Marunt	x	x		x	x	x	

CONCLUSIONS

The use of hybrids with genetic resistance to new races of *Plasmopara halstedii* developed in Romania.

Using the seed treatment with chemicals (fungicides) that can prevent infection by the fungus *Plasmopara halstedii* developed.

Identifying new sources of resistance and their use in creating new hybrizi resistant to fungus infections.

Monitoring the evolution in time and space developed by fungus *Plasmopara halstedii* races.

To achieve the research is essential establish a differentiator assortment created of inbred lines and hybrids with reaction known to the pathogen, with the participation of private companies and research institutes.

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EFFICIENCY OF UTILIZATION OF ASELECTION INDEX IN ASSESSMENT OF DRYDOWN OF CORN GENOTYPES (*Zea mays* L.)

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Abstract

Utilization of a reliable, large scale, fast, non-destructive methods for assessing the speed of corn grain dry-down rate (DDR) (speed of loosing water from grain between physiological maturity and harvest) in early stages of the breeding program, to identify real differences among genotypes, is proposed. Non-destructive determinations of the grain moisture of individual plants with a wooden moisture (Voltcraft FM-200 Humidity meter) were performed for a large number of genotypes, hybrids and inbred lines from Romanian Pioneer corn breeding program, during 2010-2012. Calibration curves (issued on the basis of successive determinations of the grain moisture by using in parallel the wooden moisture and standard gravimetric method) were used to transform the wooden moisture readings in estimated% grain moistures (EPGM). A synthetic selection index (DDIND), represented by the slopes of the linear regression line between EPGM and measurement timing were computed. DDIND computed as describe above was used to compute ANOVA analysis. Preliminary results showed that DDIND had a large degree of precision; a significant part of the DDIND variation was due to genotypic variations in all analyzed experiments, suggesting that real differences in genotype with regard to DDIND could be detected by this method. Additional studies are necessary to determine if selection on the basis of DDIND would results in releasing of superior commercial hybrids with fast DDR.

Key words: *corn, dry-down, selection index, Zea mays L.*

INTRODUCTION

Corn dry-down rate (DDR) (speed of loosing water from grain between physiological maturity and harvest) has become an important trait in the last several decades. Farmers appreciate hybrids with fast DDR from economical reasons: saving of drying costs and fossil fuel consumption, preventing mold deterioration during the storage as well as earlier harvest with fewer losses (Boute et al., 2002; Cross, 1985; Eckert, 1978; Hellevang and Reef, 1987; Hellevang, 2004; Lackey, 2008; Ragai and Loomis, 1954; Stere et al., 1995). Numerous studies revealed that corn genotypes differed in DDR and that the differences are heritable (Crane et al. 1959; Cross, 1985; Cross and Kabir, 1989; De-Jager et al., 2004; Hallauer and Russsell, 1961, 1962; Hillson and Penny, 1965; Kondapi et al., 1993; Nass and Crane, 1970; Newton and Eagles, 1991; Purdy and Crane, 1967a; Stere et al., 1995; Troyer and Ambrose, 1971; Zhang et al., 1996). DDR is a physical-biological process, influenced by the weather conditions and genotype. Relationship of DDR with other plant, kernel and husk traits have been reported (Baron and Daynard, 1984; Cavalieri and Smith, 1985; Crane et al., 1959; Hiks et al., 1976; Kang et al., 1975; Nass and Crane, 1970; Purdy and Crane, 1967; Stere et al., 1995; Sweeney et al., 1994; Tollenar and Daynard, 1978; Troyer and Ambrose, 1971) as well as meteorological data (Aldrich et al., 1975; Kang et al., 1983, 1986; Schmidt and Hallauer, 1966). Thus, improving of this trait has become an essential objective of any modern corn breeding program. One difficulty of the breeding programs is the lack of a reliable, large scale, fast, non-destructive methods to asses DDR speed. Such a method would allow breeders to asses DDR in early stages of the breeding program, to identify real differences among genotypes.

Kang et al., 1978 proposed utilization of an electronic device, DC-10 moisture meter, measuring moistures between 6 and 70%, for non-destructive trough husks assessment of kernel moisture content of corn plants grown in the field. A similar approach using an adapted version of an Electrophysics moisture meter (model MT 808 produced by Electrophysics, London, ON, Canada) was proposed by Reid et al., 2010. Khang and Zuber, 1987, 1989 and Kondapi et al., 1993 reported positive results of the utilization of such electronic probes in non-destructive field grain moisture measuring. Data of grain moisture were used by breeders for selection of genotypes with fast DDR. Area under the dry down curve (AUDDC), an index representing the dynamic progress of field dry down, was proposed by Yang et al., 2010 with the objective to test the efficiency of a simple and reliable procedure to select genotypes with fast DDR in corn. Stere et al., 1995 proposed for the first time a DDR selection index based on the slope of linear regression line between successive measurements of the moisture and dates of measurements, but using a destructive electronic probe methods to determine the grain moisture. The present study proposes a similar synthetic selection index (DDIND) for DDR, represented by the slope of the linear regression line between successive grain moisture measurements and timing. Non-destructive determinations of the grain moisture of individual plants with an wooden moisture (Voltcraft FM-200 Humidity meter) were used to estimate of DDR (DDIND).

MATERIALS AND METHODS

Non-destructive successive grain moisture measurements were made with a wood moisture meter (Voltcraft FM-200 Humidity meter) in Pioneer yield trials with hybrids (2 and 4 rows plots) and inbred lines (1 row plots), in 1-2 locations, during 2010-2012, with the purpose of DDR estimation. Same tagged contiguous competitive 5-10 plants were used for successive measurements in each plot (Table 1). Measurements started at physiological maturity (about 30-35% grain moisture), estimated when completely yellowish husks of 50% of the plants from a plot occurred.

Voltcraft FM-200 Humidity meter is a robust and precise measuring device for determining the moisture in wood and construction material like plaster, floor etc. (Pictures 1 and 2) Technical Details & Specifications of the device are presented in Table 2.

Table 1. Experimental parameters of the trials used for DDIND estimation, 2010-2012

Year	Exp.	Loc.	Type of entries	No. of entries	Type of plot	No. of plants per plot
2010	10R3H	1	Hybrids	36	4 rows/plot	6
2010	10DPI	2	Inbreds	185	1 row/plot	5
2011	11TCNSH	2	Hybrids	197	2 rows/plot	6
2011	11TCSSH	2	Hybrids	250	2 rows/plot	6
2011	11R3H	2	Hybrids	121	4 rows/plot	10
2011	11DPI	2	Inbreds	467	1 row/plot	5
2012	12R3H	1	Hybrids	94	4 rows/plot	6
2012	12R1H	1	Hybrids	416	2 rows/plot	6
2012	12DPI	1	Inbreds	530	1 row/plot	5

Table 2. Specifications of the device

Calibration possible to	ISO / DKD
Measurement type	Invasive, two pins
Measurement accuracy wood moisture	± 1%
Measurement range-wood moisture	6-44
Dimensions	47 x 139 x 25 mm
Power supply	3 batteries CR2032
Measurement range-temperature	-
Weight	100 g

In a separate experiment, successive determinations of the grain moisture were performed by using in parallel the wood moisture meter and standard gravimetric method (recommended by seed quality laboratories), averaged over 3 plants for each measurement, were collected and used to compute calibration curves (for each of the three utilized devices) for transforming the wood moisture meter readings in estimated% grain moistures (EPGM). A synthetic selection index (DDIND), represented by the slope of the linear regression line between successive grain moisture measurements and dates of measurements, was computed from EPGM to estimate the DDR expressed as lost% of moisture/day. ANOVA analysis was computed to separate the effects of genotype, environment and genotype x environment on DDR.

Figure 1. Voltcraft FM-200 Humidity meter, produced by Volcraft, UK

Figure 2. Measuring grain moisture with Voltcraft FM-200 Humidity meter, trough the husks

RESULTS AND DISCUSSIONS

Means, amplitudes of variation and coefficients of variation (CV) of DDIND, obtained in all experiments during 2010-2012 are shown in Table 3. Relative large amplitudes of variation were registered, roughly indicating the existence of significant differences among tested genotypes. Relative low values of the coefficients of variation presented in Table 3 suggest a good quality and uniformity of the data used. In Table 4, p main variance components and their F values and probabilities of DDIND are presented. Data showed that DDIND computed with EPGM had a large degree of precision and that a significant part of the DDIND variation was due to genotypic variations in all analyzed experiments, suggesting that real differences in genotype could be detected by utilization of DDIND to estimate the DDR. The differences in DDR expressed as DDIND were used for a better characterization and selection of the experimental genotypes.

Table 3. Means, amplitudes of variation and coefficients of variation (CV) of DDIND, 2010-2012

Exp.	Mean	Amplitude	CV %
10R3H	-1.049	-0.2208 _-1.5529	17.50
10DPI	-1.105	-0.4324 _-1.6044	12.20
11TCNSH	-1.182	-0.7427 _-2.0457	4.37
11TCSSH	-1.149	-0.736 _-2.0808	5.70
11R3H	-1.066	-0.4917 _-2.2612	5.41
11DPI	-1.852	-0.9019 _-2.7486	6.27
12R3H	-1.215	-0.7401 _-1.6126	5.60
12R1H	-1.189	-0.4877 _-1.9199	6.12
12DPI	-1.215	-0.7401 _-1.6126	9.6

Table 4. ANOVA results: main variance components and their F values and probabilities of DDIND, 2010-2012

Exp.	Location			Genotype			Loc X Genotype			Error
	Mean Sq.	*F Value*	*Prob*	*Mean Sq.*	*F Value*	*Prob*	*Mean Sq.*	*F Value*	*Prob*	*Mean Sq.*
10R3H				0.234	6.956	0.000				0.034
10DPI	5.854	31.679	0.001	0.144	7.958	0.000	0.071	3.895	0.000	0.018
11TCNSH	7.013	871.930	0.000	0.145	54.406	0.000	0.106	39.723	0.000	0.003
11TCSSH	21.340	1583.654	0.000	0.395	91.827	0.000	0.349	81.209	0.000	0.004
11R3H	0.237	69.73	0.000	0.794	326.999	0.000	0.541	161.667	0.000	0.003
11DPI	51.014	3605.133	0.000	0.022	16.600	0.000	0.158	11.707	0.000	0.013
12R3H				0.142	30.564	0.000				0.005
12R1H				0.171	32.176	0.000				0.005
12DPI				0.299	118.617	0.000				0.003

CONCLUSIONS

Utilization of Voltcraft FM-200 Humidity meter and of the calibration curves represented a reliable and efficient method to assess non-destructively the grain moisture on field corn plants.

DDIND, the selection index for measuring DDR was efficient in detecting significant real differences among genotypes.

A strong interaction genotype x environment has been estimate, as expected.

Addition future studies are necessary to to see the extend in which DDIND is efficient in selecting hybrids with early generation superior commercial hybrids, with a fast DDR.

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INFLUENCE OF THE CLIMATIC CONDITIONS CONCERNING MAIZE LEAF WEEVIL (*Tanymecus dilaticollis* GYLL) ATTACK ON SUNFLOWER CROPS AT NARDI FUNDULEA

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Abstract

The climatic conditions of the year 2012 were favorable for the maize leaf weevil attack (Tanymecus dilaticollis Gyll) on sunflower crops in south and south-east of the Romania. At NARDI Fundulea, the attack intensity of this pest at untreated plants, on a scale from 1 (not attacked) to 9 (plant complete destroyed) was of 4.09 in 2012, 3.54 in 2011 and 2.99 in 2010. Saved plants percent at untreated plants was of 80.75% in 2012, 87.75% in 2011 and 92.5% in 2010. In case of treated seed with thiametoxan, clotianidin or two active ingredients combination (clotianidin+betaciflutrin), the saved plants percent was higher then 98,25% in all of the three years taken in study. Seed treatment is the most effective method to protect sunflower crop in first vegetation stages against maize leaf weevil attack.

Key words: *climatic conditions, sunflower, pest, seed treatment.*

INTRODUCTION

The climatic conditions of the year 2012 were favorable for the maize leaf weevil attack (*Tanymecus dilaticollis* Gyll) on sunflower crops in south and south-east of the Romania. At NARDI Fundulea, the attack intensity of this pest at untreated plants, on a scale from 1 (not attacked) to 9 (plant complete destroyed) was of 4.09 in 2012, 3.54 in 2011 and 2.99 in 2010. Saved plants percent at untreated plants was of 80.75% in 2012, 87.75% in 2011 and 92.5% in 2010. In case of treated seed with thiametoxan, clotianidin or two active ingredients combination (clotianidin + betaciflutrin), the saved plants percent was higher then 98.25% in all of the three years taken in study. Seed treatment is the most effective method to protect sunflower crop in first vegetation stages against maize leaf weevil attack.

MATERIALS AND METHODS

The experiments were carried at NARDI Fundulea, Calarasi County between 2010 and 2012. Every year the sunflower crop was sowing at third decade of the April. For favoring the attack of *Tanymecus dilaticollis*, the experimental plots were sowing after three consecutive years of maize monoculture. The experiments were arranged according randomized block design, with plots length of 10 m and plot width of 4.2 m, equivalent of the 6 rows of sunflower. The distance between rows is 70 cm. The sunflower seeds were sowed manually with planter, at 35 cm distance between seeds on row. This low density have purpose to concentrate maize leaf weevil on the emerged sunflower plants. To avoid migration of *Tanymecus dilaticollis* adults from one plot to another, the experimental plots were laterally isolated with a 2 m wide strip sown with pea, a plant repellent to this insect. Seed treatment was effectuated two days before sowing with seed treating machine, HEGE 11. Attack intensity was evaluated when sunflower plants are in BBCH stage 14 (four leaf stage). From each plot will be assessed 20 plants, from four rows. The plants from marginal rows of the plot weren't assessed. Five plants per each row will be marked with stakes. On the four rows assessed, marked plants will be in "stairs" system. Attacked plants will be rated by a scale from 1 to 9, similar with scale used at maize (note 1, plant not attacked-note 4, plants with leafs chafed in proportion of 25%-note 9, plants destroyed). After 30 days from plant emergence it has evaluated saved plants percent by counting the all emerged plants from a plot and comparing with sowing seeds number/plot. After 50 days from plant emergence, on the same 20 plants that we assessed before attack intensity, it has measuring plants height. The data were statistical analyzed through variance analyze method by using of the Microsoft Excel 2003 and ARM 8 programs.

RESULTS AND DISCUSSIONS

Temperatures and precipitations from April and May, varied between 2010 and 2012. As result the attack of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) at untreated sunflower plants have oscillations from one spring to another.

In 2010, at NARDI Fundulea, the mean air temperature was higher than the multi-year average, especially for the last 10-day period of April and all May (Table 1). Low values of the average air temperatures registered on 9th and 17th May while higher value of the temperatures registered on 27th May (Figure 2). The precipitations from April and May 2010 were lower comparative with the multiyear average. Data from figure 1 show that, at NARDI Fundulea, in the last 10-day period of April 2010, only 4.4 mm of rain occurred, while in the first 10-day period of May only 2.6 mm. Total amount of precipitation from this two months in 2010 was of 73 mm, comparative with the multiyear average (144.5 mm). The attack intensity in untreated plants, on a scale from 1 to 9 was 2.99; that means the young plants were damaged in proportion between 10 and 25%. In conditions of the lower attack intensity values at untreated plants, saved plants percent was of 92.50%.

Table 1. Influence of air temperatures from April and May (10-day periods) concerning the attack of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) at NARDI Fundulea (2010-2012)

Year	Attack inten-sity	Saved plants (%)	Temperature (°C)						Ave-rage Temp.	Multiyear average Temp.	De-viation (°C)
			April			May					
			I	II	III	I	II	III			
2010	2.99	92.50	11.2	11.2	13.4	15.9	16.4	19.7	14.63	14.00	-0.63
2011	3.54	87.75	9.7	9.0	12.2	11.8	17.1	19.8	13.27	14.00	+0.73
2012	4.08	80.75	11.6	13.6	17.4	20.8	16.6	16.7	16.12	14.00	+2.12

In 2011, at NARDI Fundulea, average temperatures recorded in first two 10-day periods of April were 9.7 and 9.0°C, lower then multiyear average Table 1). Average air temperature recorded in first 10-day period of May were lower then average temperature for last 10-day period of April. The values of the temperature recorded in the second and third 10-day periods of May were higher versus the values recorded in 2010 (Figure 3). The precipitation in last 10-day period of April was of 2.1 mm and in first 10-day period of May this was 48.4 mm. Data from figure 4 show that in first 10-day period of May, more of the half precipitations from this period was registered only in two days, on the 8th and 9th. Temperatures recorded in last two 10-day period of May and low precipitations favored attack, especially in the second 10-day period of May when plants get to the BBCH 14 stage. Meteorological data from table 1 show that in the second 10-day period of May, the average air temperature was 17.1°C and in third 10-day period of May, average air temperature was 19.8°C. Precipitations from the second and third 10-day periods of May, 2011, were lower comparative the first 10-day period of May (Table 2). Data from figure 2 show that in the first three days from the second 10-day period of May, temperatures had a lower level, then temperature increasing by more than 16.2°C, reaching 19.4°C in the 15th of May and 19.3°C on May 16. In last 10-day period of May 2011, daily average temperatures were higher than 19°C and even 21°C in the 25th of May, while precipitation was lower versus the multi-year average. In this conditions, the attack of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) at untreated sunflower plants were higher then year 2010, with an attack intensity of 3,54 on a scale from 1 to 9 and saved plants percent was of 87.75%.

In 2012, at NARDI Fundulea, data from table 1 show that the average air temperature recorded in April and May were higher than the multi-year average by +2.12°C. In the last 10-day period of April, the average air temperature was 17.4°C, the highest level of this parameter from all of the three years taken in study (Figure 1).

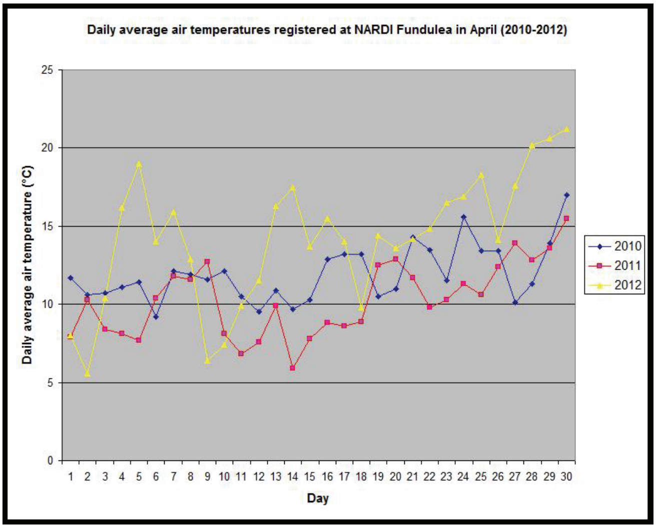

Figure 1. Daily average air temperatures registered at NARDI Fundulea in April (2010-2012)

Table 2. Influence of rainfall from April and May (10-day periods) concerning the attack of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) at NARDI Fundulea (2010-2012)

Year	Attack intensity	Saved plants (%)	Precipitations (mm)						Total Prep. (mm)	Multiyear average (mm)	De-viation (mm)
			April			May					
			I	II	III	I	II	III			
2010	2.99	92.50	22.6	14.8	4.4	2.6	13.3	15.3	73.0	144.5	+71.5
2011	3.54	87.75	3.2	23.6	2.1	48.4	23.0	5.6	105.9	144.5	+38.6
2012	4.08	80.75	4.0	29.3	1.8	14.2	87.8	57.5	194.6	144.5	-50.1

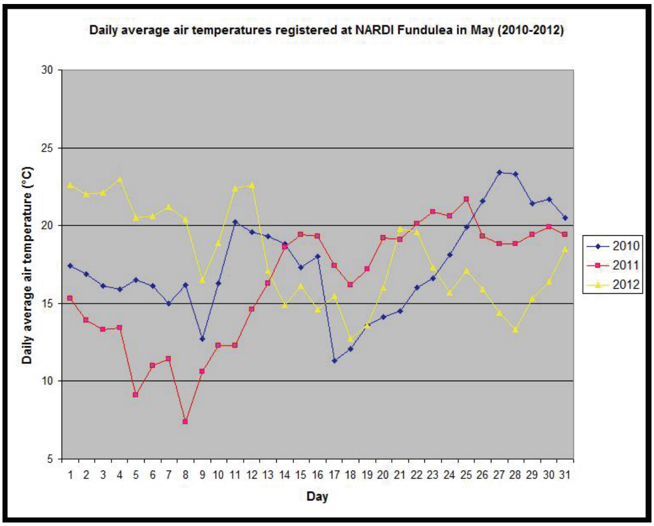

Figure 2. Daily average air temperatures registered at NARDI Fundulea in May (2010-2012)

Similarly, in the first 10-day period of May there were higher temperature values from all of the similar periods between 2010 and 2012 (T=20.8°C, Figure 2). The daily average temperature was below 14°C only in 20 April, while on April 25, the average temperature was of 18.3°C and more than 20°C in the 28th and 29th of April, values higher than the multi-year average (Figure 1). Maximum temperatures, higher than 30°C, were recorded in the 25th, 29th April and from 1th to 3th May. Regard precipitation level, data from table 2 shows that average values of this parameter were lower then multiyear average in April and higher then multiyear average in May. In fact, 2012 have some particularities regard as daily distribution of the precipitations. In most of the time, in April and May it has drought. For example, in last 10-day period of April and the first 10-day period of May the precipitation level was lower, while in the second 10-day period of May it was 87.8 mm and in the last 10-day period of this month there were 57.5 mm of rain. Data from figure 4 show that most of the precipitation from the second 10-day period of May occurred only in one day, on the 19th of May (52.7 mm of rain). As a result, the attack of maize leaf weevil (*Tanymecus dilaticollis* Gyll) at untreated plants were higher comparative with 2010 and 2011, with an intensity of 4.08 on a scale from 1 to 9, that means that most of the plants were with leafs damaged in proportion of 25% (tables 1 and 2). Saved plants percent at sunflower untreated plants was of 80.75%, that means almost 20% of the plants were damaged as result of the pest attack.

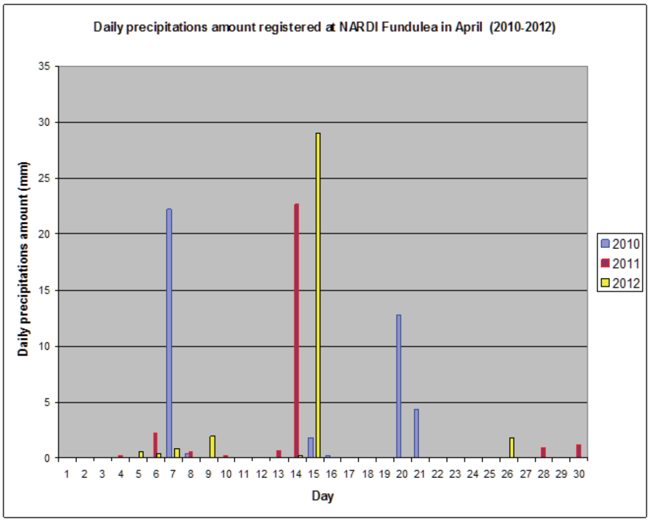

Figure 3. Daily precipitations amount registered at NARDI Fundulea in April (2010-2012)

Every year, in experimental field of the Plant Protection Laboratory from NARDI Fundulea it has tested insecticides used like seed treatment at sunflower crop against maize leaf weevil (*Tanymecus dilaticollis* Gyll) attack. The tested insecticides, between 2010 and 2012 were based on thiametoxan (Cruiser 350 FS), clothianidin (Poncho 600 FS) and the two active ingredients combination: clothianidin+betaciflutrin (Modesto 480 FS). Data from table 3 show that attack intensity at plants treated with Cruiser 350 FS was low, of 1.79 on a scale from 1 to 9. Plants treated with Modesto 510 FS have an attack intensity of 2.16 while plants treated with Poncho 600 FS have higher values of this parameter form treated plants variants (I=2.33). The untreated plants present lower attack intensity values (I=2.99). Regard plants height, at 50 days from plant emergence, in 2010, untreated sunflower plants measured 109.44 cm while plants height at variant treated with Poncho 600 FS was of 118.84 cm, plants height at variant treated with Modesto 480 FS was of 119.81 cm while plants height at variant treated with Cruiser 350 FS was of 121.56 cm, the highest value of this parameter from the treated variants. There are not high differences between treated plants variants regard as plant height or saved plant percent in climatic conditions of the year. Differences between untreated and treated plants are statistically assigned (Table 3).

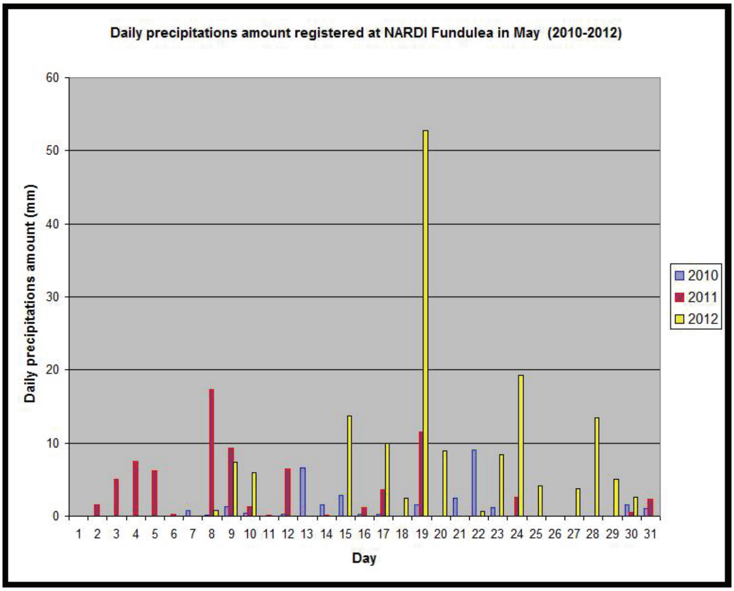

Figure 4. Daily precipitations amount registered at NARDI Fundulea in May (2010-2012)

Table 3. The effectiveness of some products used for seed treatment in sunflower crops against *Tanymecus dilaticollis* Gyll, at NARDI Fundulea, year 2010

Nr. crt.	Variant	Rate (l/t)	Attack intensity (1-9)	Plants height (cm)	Saved plants percent (%)
1	Control (untreated)	—	2.99	109.44	92.50
2	Cruiser 350 FS (std)	10.0	2.33**	121.56**	99.25***
3	Poncho 600 FS (std)	9.0	1.79***	118.84**	99.25***
4	Modesto 480 FS	4.5	2.16***	119.81**	98.50***
			DL5%=0.37	DL5%=6.28	DL5%=1.86
			DL1%=0.52	DL1%=8.81	DL1%=2.62
			DL0.1%=0.75	DL0.1%=12.75	DL0.1%=3.79

In climatic conditions of the year 2011, the attack intensity at untreated plants was higher then year 2010 (I=3.54). Also, the attack intensity at treated variants was slightly higher in 2011 comparative with 2010. However there are not high differences between treated variants, in 2011. Attack intensity at variants treated with Poncho 600 FS and Modesto 480 FS was basically, equal (Table 4) while variant treated with Cruiser 350 FS present the highest value of this parameter (I=2.48). Regard as plants height at 50 days from plant emergence, at untreated sunflower plants this parameter were below 100 cm. At variants treated with Cruiser 350 FS and Modesto 480 FS this parameter were, basically, equal (109.06 cm and 108,93 cm). Plants height at variant treated with Poncho 600 FS was of 105.79 cm, the lowest value of this parameter from the treated variants. Saved plant percent was of 87.75% at untreated plants and higher then 98% at all treated variants. The differences between treated and untreated variants are statistically assigned.

Table 4. The effectiveness of some products used for seed treatment in sunflower crops against *Tanymecus dilaticollis* Gyll, at NARDI Fundulea, year 2011

Nr. crt.	Variant	Rate (l/t)	Attack intensity (1-9)	Plants height (cm)	Saved plants percent (%)
1	Control (untreated)	—	3.54	99.91	87.75
2	Cruiser 350 FS (std)	10.0	2.48***	109.06**	98.75***
3	Poncho 600 FS (std)	9.0	2.23***	105.79*	98.50***
4	Modesto 480 FS	4.5	2.24***	108.93**	98.25***
			DL5%=0.28	DL5%=4.78	DL5%=2.03
			DL1%=0.40	DL1%=6.71	DL1%=2.85
			DL0.1%=0.57	DL0.1%=9.71	DL0.1%=4.13

Climatic conditions of the year 2012 (April and May) were the most favorable for the maize leaf weevil *Tanymecus dilaticollis* Gyll) attack on sunflower plants, especially in first phases of the vegetation (BBCH 10-BBCH 12). At untreated plants, attack intensity have the highest value from the all three year taken in study (I=4.08). However, data from table 5 show that, at treated variants there are not correlations between climatic conditions and attack intensity. This value is equal for all of the three variant treated with Cruiser 350 FS, Poncho 600 FS and Modesto 480 FS (I=1.79). Regard at plants height at 50 days after plant emergence, at untreated plants it has registered the lowest value of this parameter from all of the three study years. There are not high differences between plants height at treated variants. Plants height at variant treated with Cruiser 250 FS was of 100.06 cm, plants height at variant treated with Poncho 600 FS was of 101.98 cm while plants height at variant treated with Modesto 480 FS was of 121.56 cm, the highest value of this parameter from the treated variants. Regard as saved plants percent, at untreated plants was the lowest value of this parameter from period 2010-2012. Data from table 5 show that at treated variants, saved plant percent is higher then 98%. At variant treated with Cruiser 350 FS, saved plants percent was of 98.75% while at variants treated with Poncho 600 FS and Modesto 510, saved plant percent was of 98.50%.

Table 5. The effectiveness of some products used for seed treatment in sunflower crops against *Tanymecus dilaticollis* Gyll, at NARDI Fundulea, year 2012

Nr. crt.	Variant	Rate (l/t)	Attack intensity (1-9)	Plants height (cm)	Saved plants percent (%)
1	Control (untreated)	—	4.08	93.19	80.75
2	Cruiser 350 FS (std)	10.0	1.79***	100.06*	98.75***
3	Poncho 600 FS (std)	9.0	1.79***	101.98**	98.50***
4	Modesto 480 FS	4.5	1.79***	101.30**	98.50***
			DL5%=0.26	DL5%=5.20	DL5%=3.05
			DL1%=0.36	DL1%=7.29	DL1%=4.28
			DL0.1%=0.52	DL0.1%=10.56	DL0.1%=6.19

In three years with different climatic conditions, at NARDI Fundulea, products on base of thiametoxan (Cruiser 350 FS), clothianidin (Poncho 600 FS) and the two active ingredients combination: clothianidin+betaciflutrin (Modesto 480 FS) has offered satisfactory protection for sunflower plants against maize leaf weevil (*Tanymecus dilaticollis* Gyll) attack. Average attack intensity value at sunflower plants, in period taken in study was of 3.53 (Table 6). In all three years, attack intensity of this pest has lowest values at plants emerged from seeds treated with Poncho 600 FS (I=1.93). Promising results has product Modesto 480 FS (two active ingredients combinations), with average attack intensity, of 2.06 (Figure 5). Average attack intensity of this pest at plants treated with Cruiser 350 FS was of 2.20. There are not significantly differences between treated variants, in period 2010-2012, but all products was effective in control of this pest comparative with control variant. Saved plant percent at treated variants are higher then 98% in all years, at all variants (Figure 6).

Table 6. The effectiveness of some products used for seed treatment in sunflower crops against *Tanymecus dilaticollis* Gyll, at NARDI Fundulea (average values of the years 2010-2012)

Nr. crt.	Variant	Rate (l/t)	Attack intensity (1-9)	Plants height (cm)	Saved plants percent (%)
1	Control (untreated)	—	3.53	100.85	87.00
2	Cruiser 350 FS (std)	10.0	2.20***	110.23***	98.92***
3	Poncho 600 FS (std)	9.0	1.93***	108.87***	98.75***
4	Modesto 480 FS	4.5	2.06***	110.01***	98.42***
			DL5%=0.23	DL5%=3.11	DL5%=1.58
			DL1%=0.32	DL1%=4.37	DL1%=2.21
			DL0.1%=0.47	DL0.1%=6.33	DL0.1%=3.21

These results are similar with those obtained by Barbulescu et al. (2000, 2001). Further studies are necessary; both in field and laboratory conditions for evaluation of the climatic changes impact on the maize leaf weevil evolution and seed treatment effectiveness. Even the climatic conditions from spring period (April and May) are variable from one year to another; the seeds treatment is the most effective method to control the attack of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) at sunflower crops.

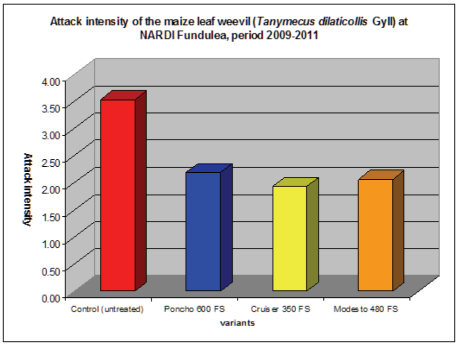

Figure 5. Attack intensity of the maize leaf weevil on sunflower plants at NARDI Fundulea, period 2010-2012

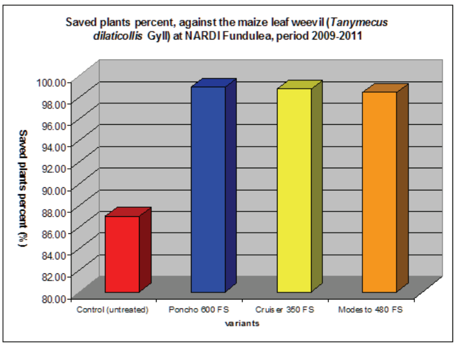

Figure 6. Saved plants percent, against the maize leaf weevil on sunflower plants at NARDI Fundulea, period 2010-2012

Figure 7. Sunflower plant attacked by the *Tanymecus dilaticollis* Gyll (INCDA Fundulea)

Figure 8. Adult of *Tanymecus dilaticollis* died after he feed with sunflower plant emerged from a treated seed (NARDI Fundulea)

CONCLUSIONS

Even if the attack is not with same intensity like maize, *Tanymecus dilaticollis* Gyll is the main pest of the sunflower plants in south and southeast areas from Romania.

The weather conditions from the spring period are different from one year to another, and in some years the amplitude of temperatures are higher from one 10-day period to another or from one day to another. High temperature and drought favored the maize leaf weevil attack on sunflower plants, in first phases of vegetation (BBCH 10-14).

Climatic conditions registered in 2012 at NARDI Fundulea were the most favorable for maize leaf weevil attack. There were days with extreme drought and high temperatures and days with high precipitation amount. As result, the attack of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) at sunflower crops was higher in 2012 versus 2010 and 2011, even if the precipitation amount was higher than the multi-annual average.

Seed treatment is the best method for controlling *Tanymecus dilaticollis* attack, when sunflower plants are in the first phases of vegetation (BBCH 10-14).

Products based on clothianidin (Poncho 600 FS in dose of 9 l/tone seeds) and thiametoxan (Cruiser 350 FS in dose of 10 l/tone seeds) provide better effectiveness for controlling of this pest. Promising results has product with two active ingredients combination clothianidin+betaciflutrin (Modesto 480 FS in dose of 4.5 l/tone seeds).

Further studies are necessary; both in field and laboratory conditions for evaluation of the climatic changes impact on the maize leaf weevil evolution and seed treatment effectiveness.

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DISTRIBUTION OF SOIL MOISTURE IN THE PROFILE OF TYPICAL CHERNOZEMS UNDER WIDE-SPACE IRRIGATION AND IMPACT ON THE YIELD OF MAIZE (*Zea mays* L.)

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Abstract

Irrigation in Bulgaria is a common agricultural practice for improving and stabilizing crop yields. Recently, the socio-economic conditions and climate peculiarities set the pattern for practicing water saving irrigation technologies. Irrigation in ever-other-furrow on capillary soils is a way to save water amounts, to improve water use efficiency and to protect soil structure. The goal of the paper is to present the seasonal water depletion in soil profile of chernozems under maize at different intra-furrow spaces and different application depths. The relation of yield to soil moisture unevenness and water deficit is discussed. A two-year experiment in 2009 and 2010 was conducted in Central North Bulgaria, in the experimental field of Maize Research Institute Knezha. The following variants were tested: rainfed (RF) (control), full irrigation at a refill point (RP) 80% of field capacity (FC), 50% deficit irrigation (DI), and 67% DI. The water was distributed as follows: in every furrow (EF), in every-other furrow (EOF) and in ever-third furrow (ETF). Considering the rainfall totals, both years were medium wet, while considering air humidity they were very dry. The yields under rain-fed conditions were high – average 7.01 Mg/ha, while the yields under full irrigation – comparatively low-9.39 Mg/ha. The additional yield under full irrigation in both years was 1.98 and 2.79 Mg/ha respectively, under 50% DI –8.54 and 8.75 Mg/ha, and under 67% DI-8.09 and 8.24 Mg/ha. Yield losses caused by DI relate nonlinearly to the application depth reduction. A 50% reduction of the application depth caused 5.8-6.8% yield losses in 2009 and 8.0-17.7% in 2010. A 67% reduction of the application depth caused 7.0-9.8% yield losses in 2009 and 17.3-18.1% in 2010. Greatest yield losses occurred at 67% DI in ETF, but the smallest ones – at 50% DI in EOF. EOF irrigation technology proved to be water-accumulating. The lower layers of chernozems tended to accumulate available water through all the vegetation season long in a continuous zone. Therefore the space between furrowsdidn't impact significantly the yield even under deficit irrigation.

Key words: *maize, chernozems, every-other furrow irrigation, available water, yield.*

INTRODUCTION

The atmospheric water supply in the semi-humid climate of Bulgaria is unsecured and irrigation is a good practice for stabilizing the yields of the agricultural crops. At the same time, irrigation in the country is disabled by the poor economic situation and the irrigation systems being out of condition. In the last years, crop water needs are hardly met, because of warming and drought atmospheric processes, settling in the region. Saving water, a simple design and low prices are the desirable features of the contemporary irrigation equipment and technologies. These factors are hardly met all together, because water-saving technologies require great investments in compound equipment. Therefore they are applied to intensive crops over small areas, but not to large-field crops. There are a lot of attempts to reduce the water losses in surface irrigation and to turn this easily applicable and mostly used irrigation technology into a water-saving one. Since last decades some investigations abroad and in our country have proved that furrow irrigation in some particular accomplishment can be likely for obtaining high water use efficiency (WUE), that it can save water under some particular conditions, system design and irrigation schedule. An optimized combination of soil properties, intra-furrow space and application depth, including some water deficit can be successful in terms of obtaining profitable yields. The results from the experiments show that high yields close to the maximum ones can be obtained by applying 80-50% of the biologically optimal irrigational water quantity (Stone et al., 1982; Stone Crabtree et al., 1985; Hodges et al., 1989; Kang et al., 2000). Suitable for that are soils of good water capacity and good capillarity. Technologically, water can be given in every-other furrow (EOF) or every-third furrow (ETF) with reduced application depths, fixed-furrow (FF) or alternate-furrow (AF) irrigation, by constant or variable flow rate. These technologies avoid water losses from evaporation and deep percolation, protect soil structure, contribute for relatively uniform watering, enable high water use and labor efficiency, etc. Evidence for the higher absorption of the irrigational water by wide-spaced irrigation is the results of Sepaskhah and Afshar-Chamanabad (2002). They have established that the infiltration parameters of the every-other furrow irrigation (EOF) are higher than those of the ordinary every furrow irrigation (EF). Hodges et al. (1989) have obtained 0.68 to 0.81-time smaller rate of the advance of water down the furrow at the EOF vs. EF irrigation, depending on soil type and slope. High yields can be obtained by wide-spaced irrigation with small irrigation depths – this is the standpoint of Stone et al. (1982). They have established that maize and soybean produce yields like the maximum ones under 20-50% irrigation deficit. The 73% irrigation depth distributed in EOF provided for 16% higher yield vs. EF distribution (Sepaskhah, Kamgar-Haghighi, 1997). There are experimental results for wide-spaced irrigation on chromic luvisols, smolnitsa and alluvial-meadow soil that correspond to the results from abroad (Moteva, Stoyanova, Matev, 2009).

MATERIALS AND METHODS

A furrow irrigation experiment with "Knezha 511" maize variety (FAO 500) has been conducted in Knezha Region (Central North Bulgaria) in 2009 and 2010. It was put in a randomized complete block design in four replications. The variants consisted of three soil moisture regimes: rain-fed (RF), full irrigation at a refill point (RP) of 80% of FC; 50% deficit irrigation (DI); 67% DI. Each application depth was distributed as follows: in every furrow (EF); in every other furrow (EOF); and in every third furrow (ETF). The harvested plots were 42 m^2. The furrow length of the experimental plots was 18 m. The application depth at *RP* was calculated as: $m=10 \times H \times \alpha(\beta_{FC}-\beta_{RP})$, where β is the moisture percentage by weight; a – bulk density, g/cm^3; H – depth of the root zone, m (Kostyakov, 1951). Grain yield was estimated at 14% standard humidity of the grains. Land preparation, fertilizers and weed control were applied according to the standard agricultural practices of the region.

The experimental field of Maize Research Institute Knezha is situated to 43.46^o N, and asl 117 m. The climate is moderate continental. The high July-August air temperatures together with very low relative air humidity – down to 30-35% are peculiar for the region. The period July-August is also very dry with average rainfall total 105.0 mm and longer than 10-day drought periods. The water content in the top 25-cm soil layer at sowing, as established in a long-term statistical investigation, is readily available (RAW) (Georgieva et al., 2010). Irrigation of maize is practiced within the period 3rd decade of June-2nd of August (Slavov et al., 2000; Georgieva et al., 2011). Soil is a typical chernozem – loamy, fertile and capillary with good water holding capacity. The total water content at FC is TWC=335.9 mm, available water content AWC=152.3 mm, bulk density average for 0-100-cm soil layer is *a*=1.31 g/cm^3. The hydrological properties of the soil can be seen on Figure 1.

A soil moisture grid 10/35 across the furrows was compounded for every variant, 48 hours after an application was given, by the gravimetric method.

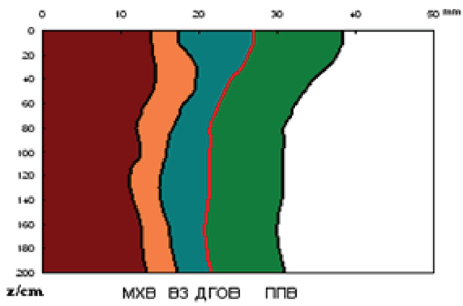

Figure 1. Hydrological constants in soil profile 0-200 cm of typical chernozems (Georgieva et al., 2010)

Table 1. Probability of the meteorological factors

Period	Rainfalls				Air temperature				Vapour pressure deficit			
	April-Sept.		July-Aug.		April-Sept.		July-Aug.		April-Sept.		July-Aug.	
Years	∑*R* mm	Proba-bility (%)	∑*R* mm	Proba-bility (%)	Σ°C	Proba-bility (%)	Σ°C	Proba-bility (%)	∑D hPa	Proba-bility (%)	∑D hPa	Proba-bility (%)
2009	309.0	55.0	124.8	23.2	3497.1	25.2	1426.2	29.2	1598.7	49.0	699.9	47.0
2010	306.5	58.9	61.6	78.8	3555.4	17.3	1479.7	11.3	1916.7	17.3	878.0	17.3

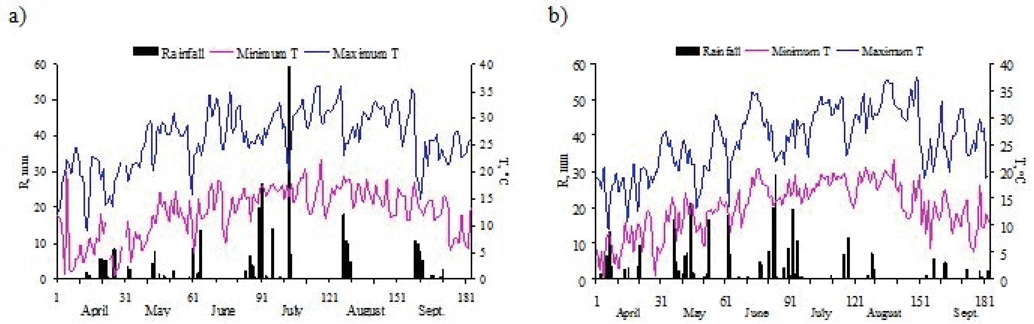

Figure 2. Daily rainfalls, minimum and maximum air temperature: a) 2009; b) 2010

A variance analysis was applied to establish the significance of irrigation impact.

The years of the experiment were of medium conditions as to the probability of exceedance of April-September rainfall totals; very hot as to air temperature totals; and 2009 was medium as to the vapor pressure deficit totals, but 2010 was very dry

(Table 1). The daily distribution of the rainfalls during the vegetation period can be seen on Figure 2. Long drought periods are observed in June, July and August in both years.

RESULTS AND DISCUSSIONS

Soil moisture is one of the main factors for yield formation. Its availability predisposes the rate of the physiological processes and dry matter accumulation. Lack of water works for slowing down plant development and obstructs formation of the reproductive organs.

Full irrigation in EF ensured high moisture-around 90% of FC through the soil profile (Figure 3). Deficit irrigation in EF ensured around 85% of FC in 20-50-cm soil layer. The top 0-20 cm of the soil could not be enough moisturized. Applying 67% DI in EF caused insufficient moisturizing of the 60-100-cm layer. Moisture in this layer did not raise up to RP.

Distribution of soil moisture after the 1st application when irrigating in EOF is similar to that in EF. The 50% and 67% DI keeps moisture of the 40-100-cm layer around RP, the top 20 cm-s quickly dries up down to 70% of FC. Full irrigation in EOF ensured readily available water (RAW) through the whole soil profile, but moisturizing is lower than that in EF, probably due to percolation losses, because of high water quality delivered to the irrigated furrows. This is the reason for the water losses occuring at full irrigation in ETF.

Full irrigation after the 2nd application at the three ways of distribution of the water refilled soil moisture up to 90% of FC. Irrigation in EF and EOF did it for the layer 40-100 cm, but irrigation in ETF – for the lower 50-100-cm layer. The top 0-30 cm remained dry (Figure 3).

Soil water depletion mostly depends on evapotranspiration. Soil reservoir is refilled only by the atmospheric rainfalls in the rain-fed variants. The insufficiency and intermittence of rainfalls hinder crop productivity. It is seen on Figures 4 and 5 that depending on the distribution of the rainfalls and on the evapotranspiration increase, soil moisture depleted to RP at mid June, 48 DAS in the vegetative stage in 2009 and mid July, 83 DAS, during silking in 2010.

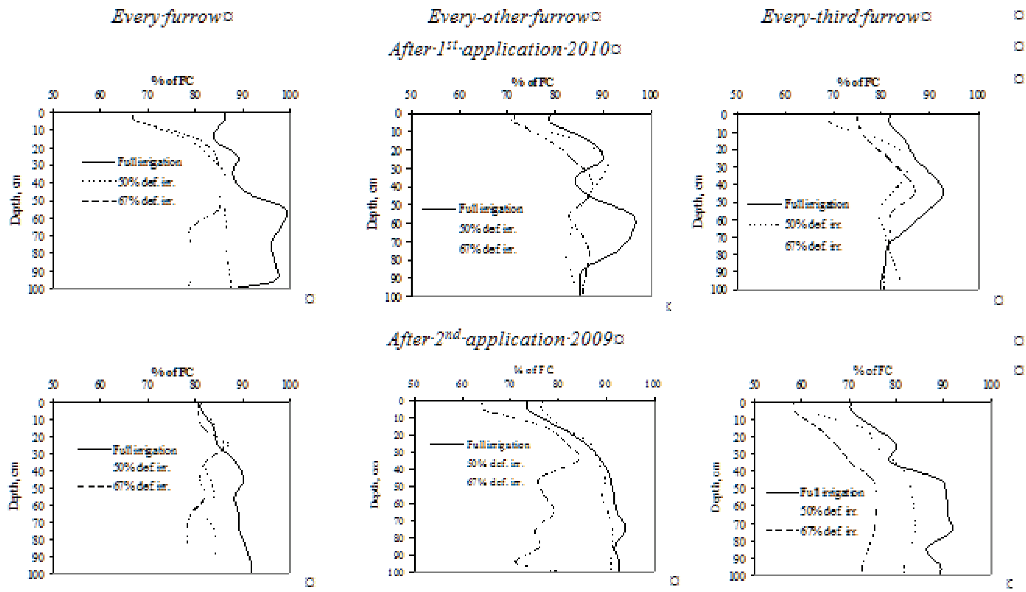

Figure 3. Distribution of soil moisture in the soil profile

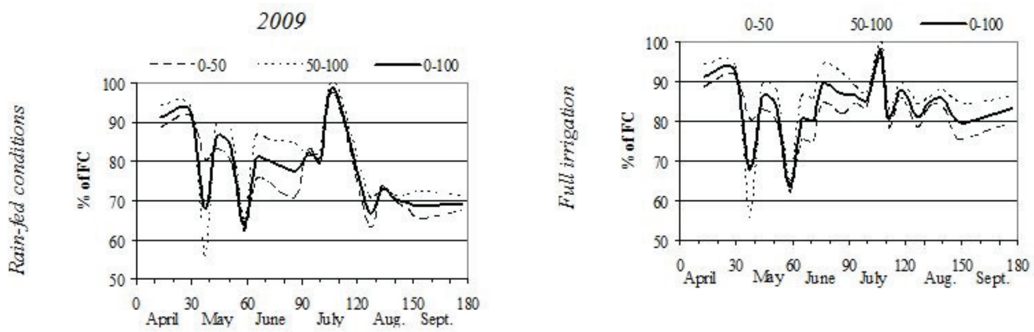

Figure 4. Dynamics of soil moisture through the vegetation period in 2009

Considering the same dates of sowing in both years, the great time range of soil water depletion is evidence for the significance of the meteorological factors especially rainfall distribution, for soil moisture depletion. Since thexperimental years were medium related to rainfalls, soil moisture depleted beneath 70% of FC lately. That happened in wax maturity when availability of soil water was not important.

We assume that distribution of soil moisture in soil profile at EF is uniform, while the distribution in EOF and ETF should vary across and along the furrow direction even at full irrigation. At full irrigation in EOF, the top 15-cm soil layer under the dry furrows remained dry. The remaining part of the soil profile was wet in the range 70–95% of FC (Figure 6). At full irrigation in ETF – part of the soil profile under the dry furrows and the adjacent rows also remained dry. Moisture under the wetted furrow increased up to 92-98% of FC at a depth of 40-100 cm. It was around 90% of FC in the layer 50-100 cm under the adjacent row. Moisture decreased gradually in depth and perpendicularly away from the wetted row. Apparently, full irrigation in wide-spaced furrows is the reason for deep percolation losses of water, resulting in uneven distribution of soil moisture through the soil profile.

At 50% DI in EOF, only a small part of the profile did not get RAW. Soil moisture was higher than 70% of FC in the 30-100-cm layer, mostly in the range 81-86% of FC. After the 2nd application the top 30-cm layer remained dry. At 50% DI in ETF, RAW in the range 70-86% of FC was established generally in the layer 40-100 cm (Figure 6). At 67% DI in EOF, the root zone 1-m in depth × 35 cm radially was moisturized in the range 70-89% of FC. The driest parts were located under the dry furrow and the adjacent row in the top 0-20 cm. At 67% DI in ETF, RAW after the 1st application was established in the lower 50-100-cm soil layer and after the 2nd one – under the wetted and furrow mainly (Figure 6).
Longitudinal mosturizing (along the furrows) in wide-spaced irrigation was uneven (Figure 7 and 8). At full irrigation in EOF – soil moisture was high and uniformly distributed only under the wetted furrow. Under the row and the dry furrow RAW was discovered in the right part of the profile.
At 50% DI the available water in soil profile was below 50 cm. At 67% DI in EOF the top 20 cm under the wetted were dry 48 h after the application was given. The remaining part of the profile was evenly moisturized in the range 70-93% of FC. Plants could take water from beneath 40 and 60 cm under the row and the dry furrow. The moisture in the layer 40-80 cm was between 70 and 80% of FC, and in the 80-100-cm layer – more than of 80% of FC.
At full irrigation in ETF, moisture under the wetted furrow was readily available through the whole profile, but with higher values at the end of the furrows. This was the tendency under the whole plot, the dry furrow and the adjacent rows inclusive. No tendency of moisture distribution was noticed at DI in ETF, due probably to the small amount of the given water (Figure 8).
Irrigation impact was significant in all variants of irrigation and water deficit applied (Table 2 and 3), except for 67% DI in EF and in ETF in 2010. The yield under rain-fed conditions in both years was 6.92 and 7.09 Mg/ha respectively. Relative yield varied from 126.6% to 140.3% in 2009 and from 104.7 to 127.9% in 2010. Yield increase was considerably small due to the mid and mid-moist conditions considering rainfalls and air humidity, which favored the yield accumulation under RF (col. 7 and 8 of Table 2 and 3).

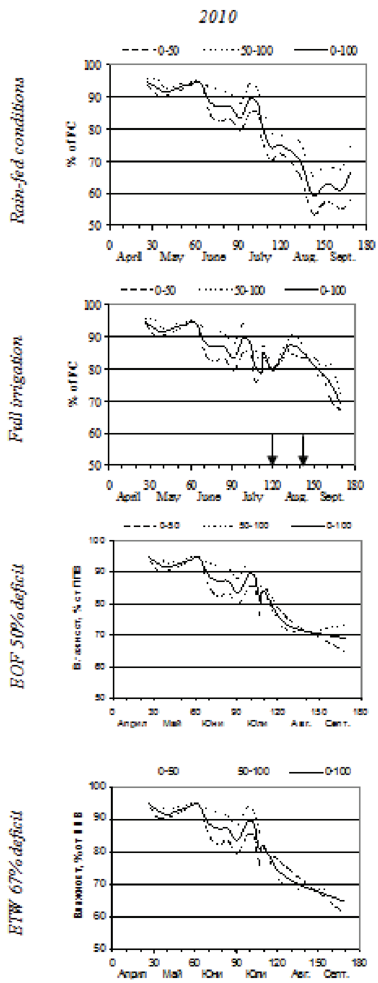

Figure 5. Dynamics of soil moisture through the vegetation period in 2010

Water deficit had significant effect in all studied cases, except for 50% DI in EOF in 2009. The latter proved to be efficient. Like yields were obtained by 50% of the needed irrigational water distributed in EOF and by the full needed amount. The relative yield was 94.2% since the increase in WUE compensated the lack of water.

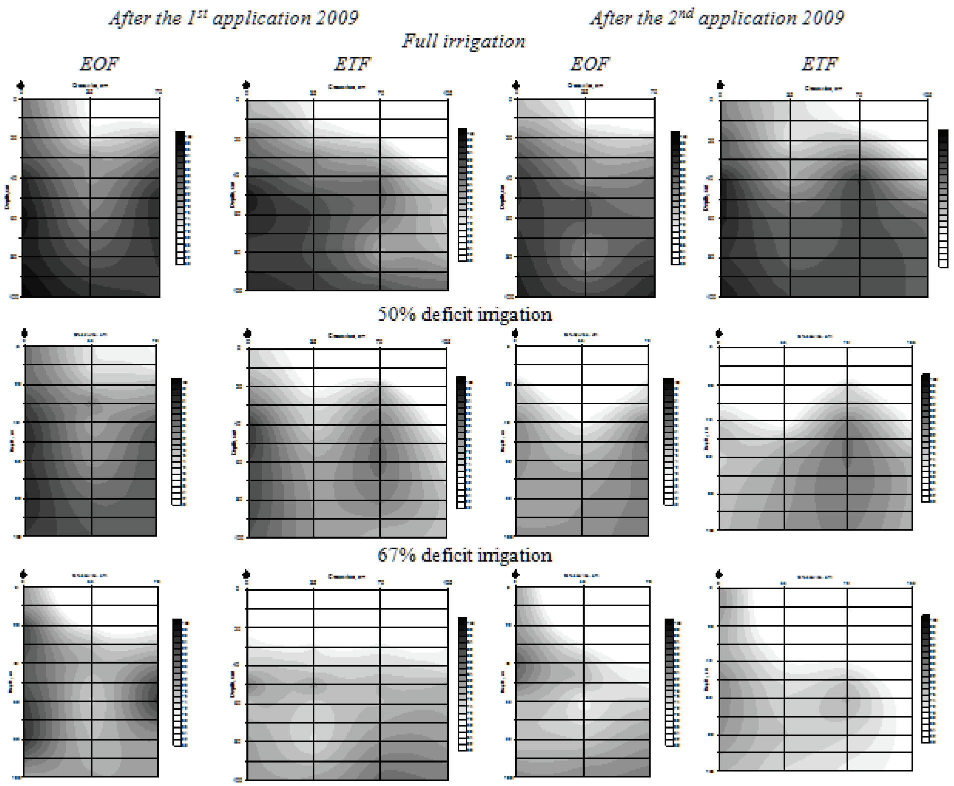

Figure 6. Distribution of soil moisture, which is above 70% of FC across furrow direction in 1-m soil profile

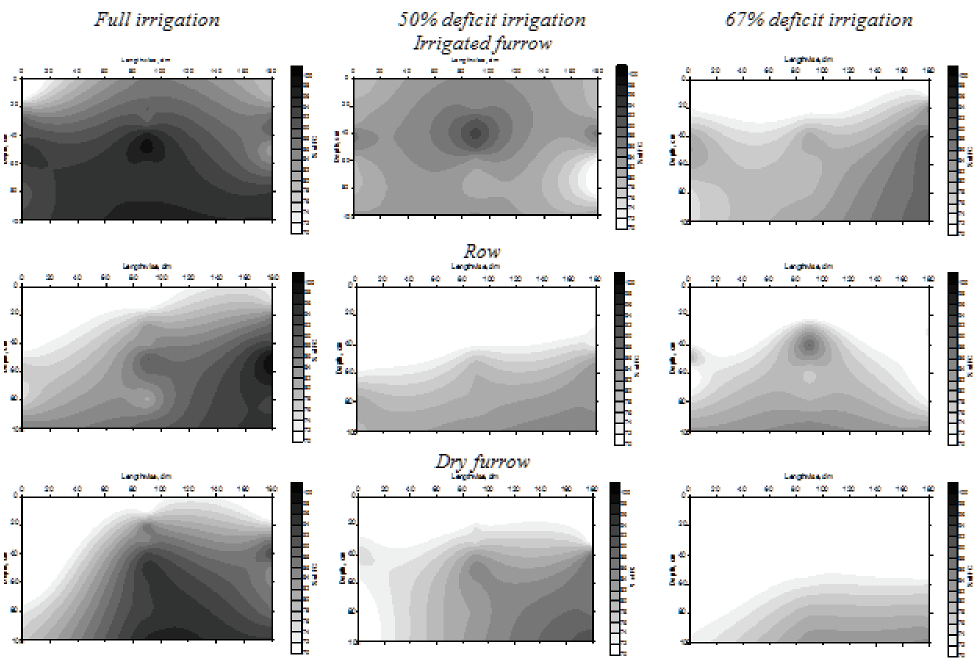

Figure 7. Distribution of soil moisture along furrow direction after 1st application 2009 in EOF

This was probably due to the specific distribution of water in relation to the hydrological properties of the soil. 90.2-93.0% relative yield was obtained under 67% DI. It appeared high because of the moist conditions of the year. In 2012, 88.4-92.0% relative yield was obtained by 50% DI and 81.9-82.7% - by 67% DI (col. 10 and 11 of Tables 2 and 3). Water deficit at every variant of water distribution (EF, EOF or ETF) caused significant yield decrease (col. 14 of Tables 2 and 3). In 2009 and 2012 the relative yield at 50% DI in EF was 93.2% and 88.4% and at 67% DI - 93% and 82.3% respectively (Col. 13 of Tables 2 and 3). In EOF relative yield was 90.3% and 90.9% under 50% DI; and 87.9% and 81.7% under 67% DI. In ETF, relative yield was 93.9% and 89.5% under 50% DI; and 90.6% and 80.5% under 67% DI. These yields were very close to the maximum ones. The combination of a mid weather (in terms of moisturizing) and good capillary soil properties catered for water supply with RAW in the deep horizons of the soil profile. The distance between the furrows didn't significantly impact the yield regardless of application depth (col. 17 of Tables 2 and 3). This is probably due to the hydrological properties of the soil, which allowed an even distribution of the irrigational water at a depth 40-100 cm (also seen on Figure 6). In this soil layer the wetted by irrigation contours connected, the infiltrating water overflowed and was available to the plants.

Yield losses, caused by the irrigational water deficit were smallest, when applying 50% DI in EOF (Figure 9). The results from both experimental years showed that the distribution of the application water in every other furrow contributed for obtaining the highest yields

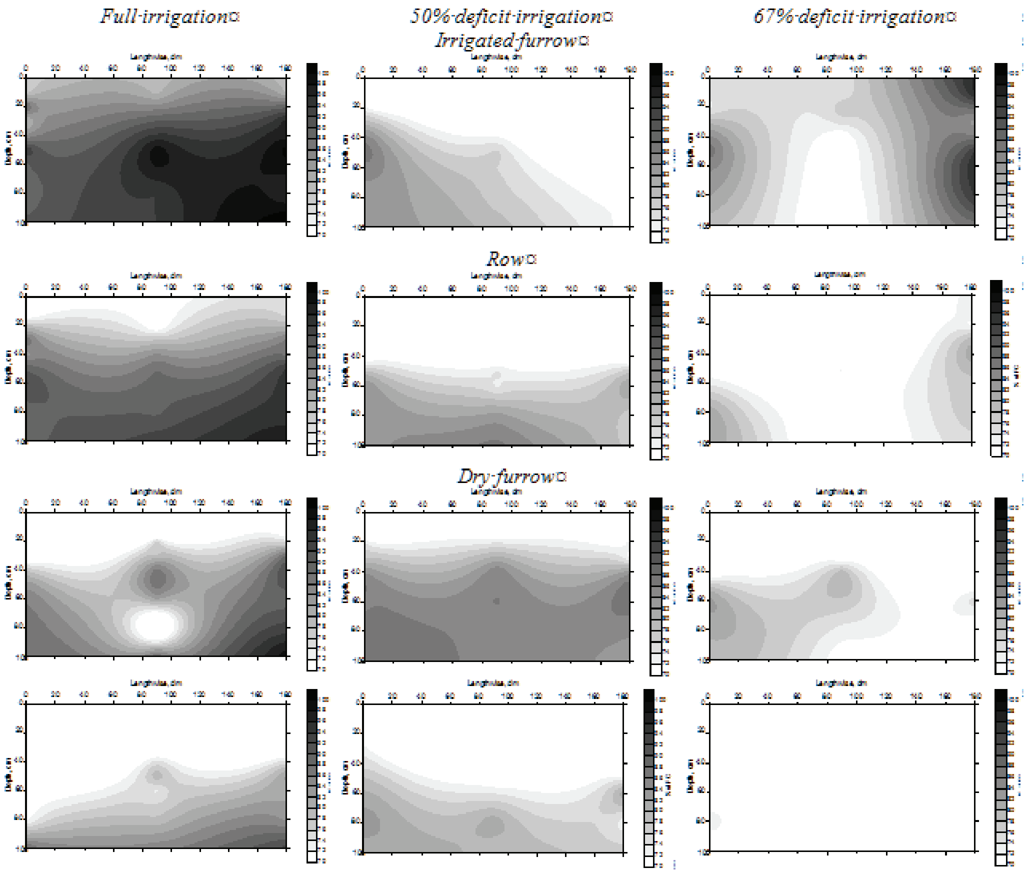

Figure 8. Distribution of soil moisture along the furrow after 1st application 2009 at ETF

Table 2. Significance of irrigation impact in 2009

Var.	Intra-furrow space	Irrigation depth		Grain Yield	Irrigation impact			Water deficit impact			Water deficit impact within EF/EOF/ETF			Intra-furrow space impact		
					Difference	Relative yield	Signnif.	Difference	Relative yield	Signnif.	Difference	Relative yield	Signnif.	Difference	Relative yield	Signnif.
		Mm	%	Mg/ha	±	%		±	%		±	%		±	%	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	RF	-	-	6.92	St.	100		-279	71.3	ooo						
2	EF	134.4	100	9.71	+2.79	140.3	+++	St.	100.0		St.(1)	100		St.[1]	100.0	
3	EOF	134.4	100	10.13	+3.21	146.4	+++	+0.42	104.3	-	St.(2)	100		+0.42	104.3	-
4	ETF	134.4	100	9.68	+2.76	139.8	+++	-0.04	99.6	-	St.(3)	100		-0.04	99.6	-
5	EF	67.2	50	9.06	+2.14	130.9	+++	-0.66	93.2	o	(1)-0.66	93.2	o	St.[2]	100.0	
6	EOF	67.2	50	9.15	+2.23	132.2	+++	-0.56	94.2	-	(2)-0.98	90.3	oo	+0.09	101.0	-
7	ETF	67.2	50	9.09	+2.16	131.2	+++	-0.63	93.5	o	(3)-0.59	93.9	o	+0.03	100.3	-
8	EF	44.8	33	9.03	+2.11	130.4	+++	-0.68	93.0	o	(1)-0.68	93.0	o	St.[3]	100.0	
9	EOF	44.8	33	8.91	+1.99	128.7	+++	-0.80	91.7	oo	(2)-1.22	87.9	ooo	-0.12	98.7	-
10	ETF	44.8	33	8.77	+1.84	126.6	+++	-0.95	90.2	oo	(3)-0.91	90.6	oo	-0.26	97.1	-

$GD_{5\%}$ = 0.589 Mg/ha $GD_{1\%}$ = 0.799 Mg/ha $GD_{0,1\%}$ = 1.070 Mg/ha

Table 3. Significance of irrigation impact in 2010

Var.	Intra-furrow space	Irrigation depth		Grain Yield	Irrigation impact			Water deficit impact			Water deficit impact within EF/EOF/ETF			Intra-furrow space impact		
					Difference	Relative yield	Signnif.	Difference	Relative yield	Signnif.	Difference	Relative yield	Signnif.	Difference	Relative yield	Signnif.
		mm	%	Mg/ha	±	%		±	%		±	%		±	%	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	RF	-	-	7.09	St.	100		-198	78.2	ooo						
2	EF	134.4	100	9.07	+1.98	127.9	+++	St.	100.0		St.(1)	100		St.	100.0	
3	EOF	134.4	100	9.17	+2.08	129.4	+++	+0.11	101.2	-	St.(2)	100		+0.11	101.2	-
4	ETF	134.4	100	9.22	+2.13	130.0	+++	+0.15	101.7	-	St.(3)	100		+0.15	101.7	-
5	EF	67.2	50	8.01	+0.92	113.0	+++	-1.05	88.4	ooo	(1)-1.05	88.4	ooo	St.	100.0	
6	EOF	67.2	50	8.34	+1.25	117.6	+++	-0.73	92.0	ooo	(2)-0.83	90.9	ooo	+0.33	104.1	-
7	ETF	67.2	50	8.26	+1.17	116.4	+++	-0.81	91.1	ooo	(3)-0.96	89.5	ooo	+0.24	103.0	-
8	EF	44.8	33	7.46	+0.37	105.2	-	-1.61	82.3	ooo	(1)-1.61	82.3	ooo	St.	100.0	
9	EOF	44.8	33	7.49	+0.40	105.7	+	-1.57	82.7	ooo	(2)-1.68	81.7	ooo	+0.04	100.5	-
10	ETF	44.8	33	7.42	+0.33	104.7	-	-1.64	81.9	ooo	(3)-1.80	80.5	ooo	-0.04	99.5	-

$GD_{5\%}$ = 0.389 Mg/ha $GD_{1\%}$ = 0.526 Mg/ha $GD_{0,1\%}$ = 0.700 Mg/ha

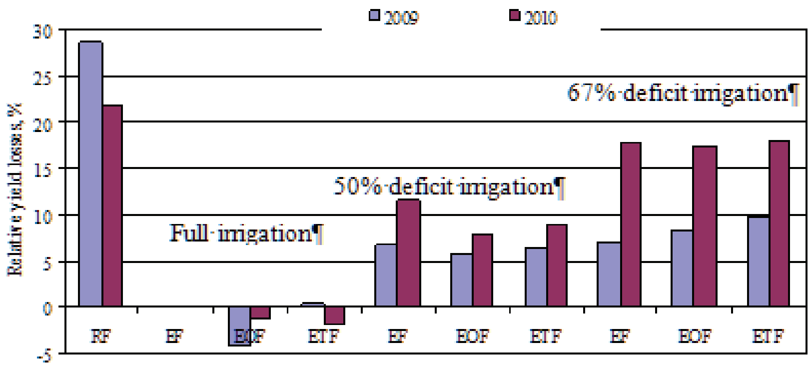

Figure 9. Relative yield losses

under deficit irrigation. This proved to be the most effective technology for maximizing the effect of the irrigational water and saving water by using soil hydrological properties for the best. This way of distribution of the application irrigational water is some kind of localized irrigation technology. It presupposes reduction of the open water evaporation losses, preservation from deep percolation losses, as well as considerably uniform water supplying of the 40-100-cm soil layer. By keeping the top soil layer dry, evaporation from soil is also slowed down. Thus irrigational water is mostly used for crop production purposes. These results are similar to the results of such studies on chromic luvisols and smolnitsa (Moteva, 2005; Stoyanova, 2008) in Bulgaria.

CONCLUSIONS

Applying 50% irrigation deficit by distributing water in every-other-furrow on chernozems proves to be the most effective technology for maximizing the effect of the irrigational water on maize yield and saving water by using soil hydrological properties for the best. In medium and mid-moist years moisture is uniformly distributed in the 40-100-cm soil layer during all the growing season and is available for the plants. With 50% of the irrigational water needed, 92-94% of maximum yield can be obtained in medium and mid-moist year.

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RESEARCHES ON THE MAIN FIELD CROPS YIELDS VARIATION IN THE BURNAS PLAIN BETWEEN THE DRY YEARS 2000 AND 2012

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Abstract

In this paper an objective synthesis is made on the productions obtained from wheat, barley, maize, sunflower and rapeseed crops in a quite long period of time, during which at least 4 years may be considered as being dry and extremely dry (2000, 2003, 2007 and 2012). To achieve the established objective we chose Burnas Plain as case study, part of the Romanian Plain, well known for its agricultural importance in Romania. Also, within this subdivision we will make a brief analysis of the meteorological phenomena produced on the territory of Teleorman County, the place where we conducted our field researches and for which we collected information regarding the evolution of temperatures and precipitations. Based on all these results we have calculated the impact of thermo-hydric stress on the agriculture in the territory. The data used for maps, tables and graphs creation were taken from the Statistical Yearbooks of the National Institute of Statistics and from the National Institute of Meteorology and Hydrology database, while those for 2012, which weren't centralized and disclosed yet, are obtained from our own experimental fields and from others big agricultural producers in the area. In this way we will be able to emphasize the important role of climatic conditions for agricultural yield in the south part of Romania, currently with poor irrigation possibilities, and the necessity of finding solutions to this problem through research.

Key words: *Burnas Plain, drought, temperature, rainfall, production.*

INTRODUCTION

For worldwide agriculture the drought became one of the determinant factors of productivity, until now being impossible to find any ways to combat it or control it. Research has shown that the amelioration of varieties in order to resist to drought leads, in the same time, to a decrease in productive yield (Blum, 2005), which is a contradiction with the growing food demand. One solution could be the irrigation process, but it is difficult to achieve, involving excessive costs and water resources that are not available to everyone. Also, if to the lack of water are added high temperatures and strong winds, which increase the water evaporation, even irrigations become ineffective. Weather changes noticed lately, with pronounced drought and with a trend of climate aridisation in the Romanian Plain, led to an increased frequency of the years without rainfalls (Meluca et al., 2011).

MATERIALS AND METHODS

As it will be seen from the analysis of statistical data collected, regardless of the period in which is installed, the thermo-hydric stress negatively affects the crops, in a greater or lower extent (Puiu, 2006).

To reach the results that we have proposed, namely to demonstrate the influence of heat and water on agricultural productivity of field crops, we realized conclusive maps, tables and figures, based on which we were able to draw the final conclusions.

We started with the establishment of the geographical area for which we conducted the research and for which we used the information concerning the evolution of temperature and precipitation. The graphs that show the annual productions were made individually for each crop so as to be more clearly visible the differences from one year to another.

Having the combined graph of precipitation and temperatures and the one of the annual productions for the 5 crops taken into study we can overlap them, thus obtaining the actual effect of drought on agricultural yield.

RESULTS AND DISCUSSIONS

Intervals with prolonged droughts existed in Romania over the years, the most notable being those from 1894-1907, 1945-1951, 1983-1994. Berbecel et al. (1981) make a classification of agricultural droughts, which he divides into 3 categories that succeed each other – atmospheric drought, soil drought and mixed drought.

We will start by making a short presentation of the region. Benefiting from a large surface of arable land (Figure 1) – 437,727 ha out of the total of 487,171 ha – Teleorman County manages to be on the second place at national level in terms of vegetal production.

Another plus is the high quality of soils. Of the total arable land surface, about 65% is placed in the 1st and 2nd class of fertility.

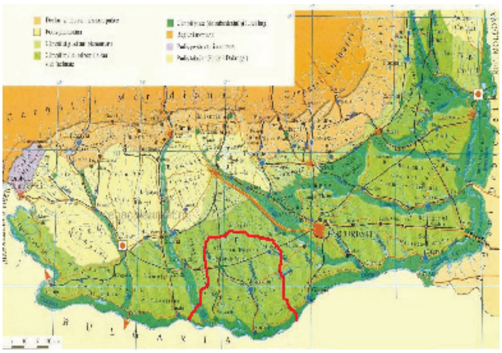

Figure 1. Teleorman County delimitation on the map of Romanian Plain

With all these strengths that we have mentioned till now, the analyzed territory, as well as the entire Romanian Plain, should obtain some record yields at European and even global level. However, this doesn't happen so that the reasons have been and are still in the attention of researchers.

One of the aspects is represented by climatic conditions, that vary from year to year and that have the capacity to reduce the agricultural productivity for all crops. Of almost half a century began the interest of everyone concerning the climate change occuring around the world, the intensification of aridity phenomen, the loss of land surfaces to the detriment of seas and oceans water etc.

Romania wasn't spared by any of the environmental effects mentioned above, since the beginning of the XXIst century becoming obvious that droughts, floods, storms and frosts are succeeding in a much faster rhythm.

Analysing the climate map of the studied territory we chose to use the values from the meteorological and hydrological stations in Alexandria, Turnu Magurele and Teleorman (INS, 2008, 2009, 2010, 2011, 2012; SCDA Teleorman) in order to elaborate graphs showing the temperatures and precipitations evolution. In Figure 2 are presented the annual average temperatures for Burnas Plain, being evident their increase compared to the reference period, which is 1961-2000.

The only return to normal was in the years 2010 and 2011, when there was an annual decrease of 0.5°C from one year to another.

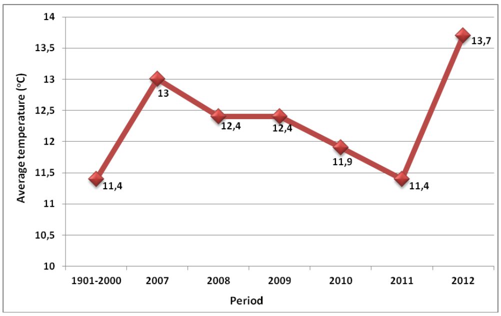

Figure 2. The values of annual average temperatures registered in Burnas Plain (Turnu Magurele and Teleorman meteorological stations)

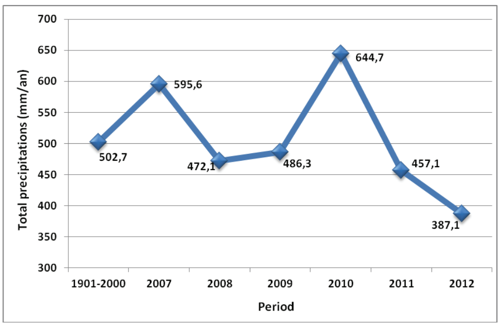

Figure 3. The values of total annual rainfall recorded in Burnas Plain during periods 1901-2000 (average) and 2007-2012 (total yearly)

Also based on the chart we note that the average of 2012 grew by 2.3°C, even exceeding the one recorded in 2007. The difference was, however, limited by low temperatures in the first part of the year, the winter 2011-2012 being very frosty and with a lot of snow, which provided the resources of water in the ground for a few months. Then, the year didn't seem to be a dry one.

From the two graphs above (Figure 2 and Figure 3) we can conclude that temperatures and rainfall are not fully consistent with each other. 2007, for example, was one of the driest years, but although the annual average temperature grew by more than 1°C compared to the normal values, rainfall have increased in the same measure.

The explanation comes from the fact that the two indicators are not uniformly distributed per months.

It is shown (Figure 4) that heat factor was higher in 2007 only in a few months, January, February, May, June and July, the rest of the months being in the normal range for the southern part of Romania. Most probably yields were affected by additional degrees from spring and summer, more than 2°C in May, almost 3°C in June and 4°C in July.

Similarly, we can see the chart for 2012, with higher temperatures starting with June and continuing till October.

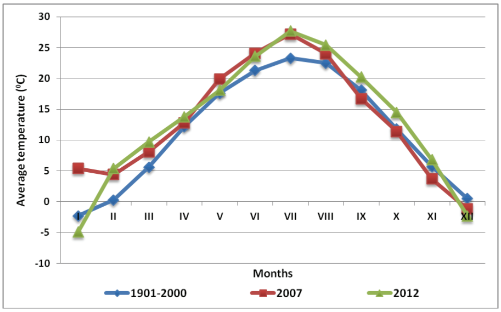

Figure 4. Monthly average temperatures for Burnas Plain in 1901-2000, 2007 and 2012

Can't be made the same analysis based on Figure 5, which presents large differences in rainfall volume recorded in 2007 and 2012 compared to the average for 1901-2000.

Looking at the red line (2007) we conclude that April was a month without rainfall, and in January, June and July, water from rains not even reached 30-40% of necessary. The green line (2012) is, on the contrary, extremely high in April, but after that is followed by a 7 months period with low precipitation (May-November).

While the reduced amount of water in January or February wasn't a calamity, the lack of rainfall from other months, in which take place the most important stages of plant growth, was what led to disastrous productions in those two years.

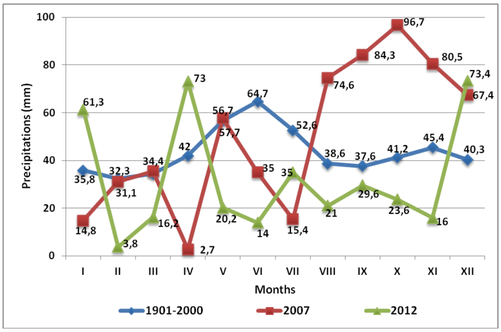

Figure 5. Monthly average rainfall for 1901-2000 period, 2007 and 2012

Instead, the rainfall volume was very high in autumn and winter through massive snow falls, also accompanied by temperatures lower than the average, so bt severe frosts.

The agriculture is the first affected by weather conditions, plants being the most sensitive regarding the intense effects of thermic and hydric stress, the sudden transitions from hot to cold, from dryness to heavy rains and vice versa.

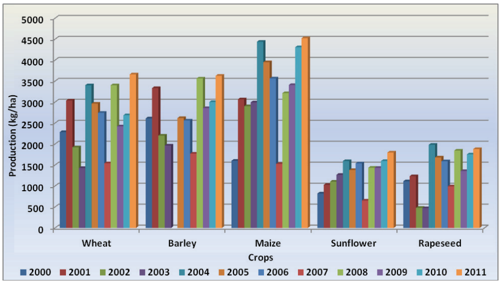

Figure 6. Annual average productions for Romania during 2000-2011

Throughout Romania crops are suffering in adverse weather conditions. The five studied field crops register great differences in

productions from one year to another (Figure 6).
In the XXI[st] century the years with a yield positive balance of all cultures were only 2004, 2008, 2010 and 2011.
The fact that only 4 of the 13 years have managed to reach to the desired agricultural level is not encouraging at all, especially because of the modernization of inputs, culture technologies, varieties, phytotechnics.
Since dry years begin to reappear more often, research should continue the experiments for finding solutions and these can only come from ecologization and genetics.
By protecting the environment can be stoped or slowed down the process of global warming and desertification, can be adjusted to a certain measure the seasons alternation, the soil ecologization extending their life, productivity and resistance to extreme climatic events.
Genetics' role is to support the production by ameliorating new varieties that can be cultivated in any environmental conditions, but none of them can't be resistant to all abiotic factors.
Another factor that must be taken into account is the zonal one, protected regions (like depressions, intra-mountain plains or hilly areas) are not affected as much by drought.
Teleorman, which is a plain county and almost exclusively agricultural, doesn't succeed, in most cases, to exceed the annual average yields of Romania (Table 1).

Table 1. Annual average productions during 2007-2011 in Romania and Teleorman County

Year / Culture	2007 (kg/ha)		2008 (kg/ha)		2009 (kg/ha)		2010 (kg/ha)		2011 (kg/ha)	
	RO	TR	RO	TR	RO	TR	RO	TR	RO	TR
Wheat	1541	1166	3403	3395	2421	2276	2688	2635	3663	3794
Barley	1772	1281	3564	3672	2858	2874	3003	2895	3628	3306
Maize	1526	618	3215	2247	3409	3899	4309	4948	4525	4428
Sun-flower	654	455	1437	1171	1433	1667	1597	1791	1798	2087
Rapiţă	991	920	1844	2023	1357	1635	1755	2021	1882	2164

With several exceptions (all crops in 2011, rapeseed, sunflower and corn in 2009 and 2010) in Plain Burnas are obtained average annual yields lower than national.

Comparing these data with those of thermic and hydric indicators will point out that unfavorable years led to significant decreases in production.
Detailed for each crop and for the entire period 2000-2012 we made the graphs below (Tempo-online). For 2012 we took partial data, declared by the County Agricultural Departments after a large part of the cultivated area was harvested (www.revista-ferma.ro; http://agroinfo.ro).
Burnas Plain **wheat** production was very poor in 2003 and 2007 (Figure 7), both years having a few months with almost no rainfall. In the other unusual years the production didn't decreased by more than 20-30%, managing to stay above 2000 kg/ha, mentioning that high yields were just in four years (2001, 2004, 2008 and 2011).

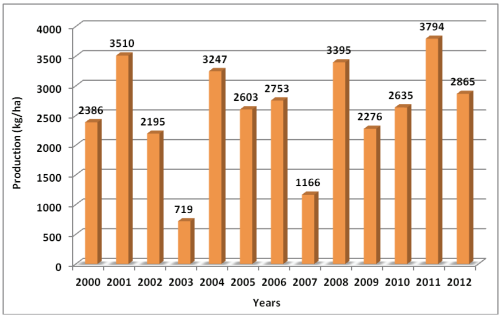

Figure 7. Wheat yields (kg/ha) obtained in Burnas Plain in 2000-2012

Barley harvest, similar to wheat in terms of environmental requirements, still manage to has slightly better yields, but it is necessary to say that productions were major affected in the same years, 2003 and 2007. Exceptionally good were 2001 and 2008 (Figure 8), years that followed after periods with thermo-hydric stress.
Analyzing Figure 7 and Figure 8 we can draw a first conclusion on the cereals production, for which we have taken as representative wheat and barley, namely that dry years differ greatly among themselves, influencing crop yields in various ways. Very important is the month when the atmospheric drought begins, if it is combined with a hydrological/pedological drought or if plants really need water at that time etc.

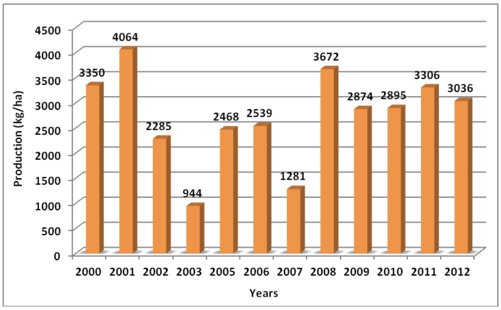

Figure 8. Barley yields fluctuation in Burnas Plain 2000-2012

For **maize** the yields values recorded in the same period stands at the opposite pole, in each of the years considered dry production being significantly affected (Figure 9). Critical were 2000 and 2007, when the production was lost at a rate of 80-95%-only 355 kg/ha in 2000 and 618 kg/ha in 2007.

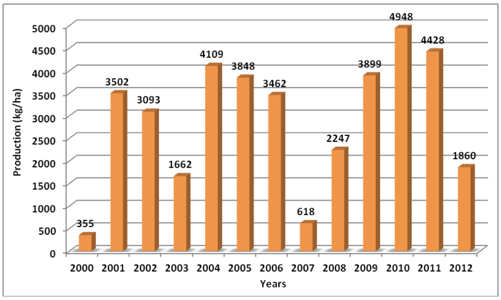

Figure 9. Maize productions in Burnas Plain in the period 2000-2012

Similarly were the years 2003, 2008 and 2012, the maize harvest barely reached 50% of the normal.

The graph shows a periodically gradation, with increases in production for 2-3 years, then sudden drops again.

Sunflower respected the pattern imposed by maize, the less productive years also being 2000 and 2007. In comparison with expected production the losses reached, in this two years, about 70-80%, while in the rest of the period were achieved average yields of 1000-1500 kg/ha.

Exceptions were just 2009-2011, when it went over the threshold of 1600 kg/ha, the maximum being in 2011 – 2087 kg/ha.

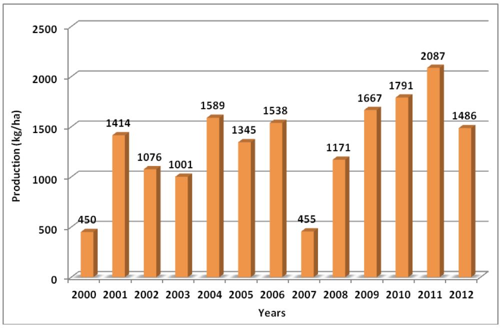

Figure 10. Sunflower production during 2000-2012 in Burnas Plain

Regarding **rapeseed**, it is necessary to note that in 8 of those 13 years graphically represented were obtained yields of over 1600 kg/ha, values that managed to exceed the annual average for the entire country, so we can conclude that Burnas Plain is more favorable to this culture compared to other areas.

Lowest productions were, curiously, in 2002 and 2003, although 2002 was a medium year as temperatures and precipitation (Figure 11). Instead, in 2000, 2001 and 2007 were lost about 50% of the entire productions.

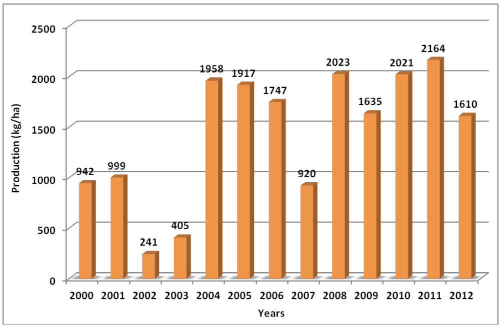

Figure 11. Productions recorded between 2000-2012 in rapeseed crop in Burnas Plain

CONCLUSIONS

Abiotic factors (the temperature and the rainfall) have a very important role in agriculture, largely influencing the yields of all crops, also depending on other characteristics of plants: thermo-hydric stress resistance, the moment of stress installation etc.

The only way to mitigate the effects of extreme weather conditions that succeeding each other during the year (droughts, floods) is currently represented by soil ecologization and farmers must be trained to do so.

In Burnas Plain dry years have affected crops more than the rainy years done it, in 2007 (dry year) yields being with 50-70% lower than in 2010 (wet year).

Finding some plant varieties resistant to water stress is possible only partially, while the need of water can't be totally eliminated.

It is necessary to be implemented an irrigation system across all the southern part of Romania if we want competitive production at European level.

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YIELD COMPONENTS OF DIFFERENT HYBRIDS OF MAIZE (*Zea mays* L.) CULTIVATED IN SOUTH ROMANIA UNDER DROUGHT CONDITIONS

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Abstract

Maize (Zea mays L.) is the most important crop in Romania as harvested area. The grain yield is determined by the yield components, these been the elements which participate to the yield formation. These components have to be known by farmers, as well as the farmers have to understand the plant responses to drought. Thus, the farmers will have the possibility for a correct choice of hybrids and to take appropriate decisions as a premise to obtain the best yield for the specific soil and climatic conditions.
The aim of the paper was to present the results obtained at an assortment of maize hybrids regarding yield components and grain yield under the soil and climatic conditions from South Romania in the drought year 2012. Ten hybrids created in Romania were studied, respectively: Cera 270, Cera 290, Cera 370, Cera 390, Cera 6, Cera 420, Cera 2504, Cera 4505, Bărăgan 48, and Cera 10. The hybrids were studied in four different locations in South Romania, respectively: Fundulea – Călăraşi County; Vâlcelele – Călăraşi County; Vişani – Brăila County; Poşta Câlnău – Buzău County.
Some of the studied maize hybrids (CERA 10, CERA 390, CERA 270, CERA 2504, CERA 420, CERA 290) showed to have the potential to produce good grain yield (more than 4 tons/ha) under water stress. The grain yield obtained in 2012 in South Romania at the studied hybrids of maize was between 24.1 and 53.4% from the yield obtained in favourable climatic conditions. It is interesting to notice that at the studied hybrids of maize the weight components of yield are much more affected by drought than the numerical component of yield.

Key words: *maize, hybrids, yield, yield components, drought.*

INTRODUCTION

Maize (*Zea mays* L.) is the most important crop in Romania as harvested area. In the last decade, the annual harvested area with maize was between 2 and 3.2 million hectares, while the average grain yield of maize was between 1.6 and 4.5 tons per hectare.

As harvested area of grain maize, Romania ranges the first place in European Union, while as total grain production ranges the second place, after France. Romania has a real potential for developing the maize crop by increasing first of all the yield. Achieving this aim need to overcome one of the main constraints which is the drought especially in South Romania, the most important Romanian growing area for maize.

Drought stress is a major constraint factor affecting crop production in arid and semiarid climates (Beheshti and Behboodi, 2010; Haldrup, 2012).

In maize, reductions in grain yield caused by drought ranged from 10 to 76% depending on the severity and the stage of its occurrence (Bolaòos et al., 1993, cited by Khodarahmpour and Hamidi, 2012).

The effect of water deficit is depending on genotype (hybrid) ability to tolerate water stress. Under limiting water conditions, the correct choice of varieties (hybrids) are among the most important possibilities to efficiently use the available water.

Understanding plant responses to drought is of great importance and also a fundamental part of making the crops tolerant to stress (Reddy et al., 2004; Zhao et al., 2008, cited by Khayatnezhad et al., 2011).

The yield increasing is continuously achieved by developing new hybrids with high grain yield and better tolerance to biotic and abiotic stress factors. That is why the farmers have to often change the cultivated maize hybrids with new created ones as a basic condition to get better yields.

The newly hybrids of maize have to be studied in different cultivation conditions for identifying the most suitable hybrids for each cultivation area. Thus, the farmers will have the possibility for a correct choice of hybrids based on knowledge regarding their yielding capacity on the specific soil and climatic conditions.

The yielding capacity of plants is determined by the yield components, which are the components that are participating to the yield formation. These components have to be known by farmers in view to take the appropriate decisions for obtaining the best values for them under the specific growing conditions as a premise to obtain the best yield for the given conditions.

The aim of the paper was to present the results regarding yield components and grain yield obtained at an assortment of Romanian maize hybrids studied under soil and climatic conditions from South Romania.

The study was realised under field conditions in the year 2012, which was characterised as a drought year.

MATERIALS AND METHODS

Researches were performed in the years 2012 on an assortment of ten hybrids of maize created in Romania, respectively: Cera 270 (FAO group 270), Cera 290 (FAO group 290), Cera 370 (FAO group 370), Cera 390 (FAO group 390), Cera 6 (FAO group 390), Cera 420 (FAO group 420), Cera 2504 (FAO group 440), Cera 4505 (FAO group 450), Bărăgan 48 (FAO group 480), and Cera 10 (FAO group 540).

The hybrids were studied in four different locations in South Romania, respectively:

- Fundulea – Călăraşi County, which is characterised by: average altitude of 68 m; cambic chernozem soil; medium to heavy texture; pH between 6.4 and 6.8; humus content between 2.8 and 3.2%; nitrogen content of 0.17-0.18%; phosphorus content of 10-25 ppm; potassium content of 135-170 ppm; average temperature of 10.4°C; sum of precipitation of about 550 mm.
- Vâlcelele – Călăraşi County, which is characterised by: altitude between 40 and 45 m; chernozem soil; clay-loam texture; pH between 7.2 and 7.8; humus content between 2.2 and 2.8; phosphorus content of 36 ppm; potassium content of 180 ppm; average temperature of 11.2°C; sum of precipitation of about 514 mm.
- Vişani – Brăila County, which is characterised by: average altitude of 43 m; cambic chernozem soil; loamy texture; soil reaction is slightly acid in the soil above layer, but slightly alkaline between 30 and 64 cm depth; humus content of 3.03% in Am layer, and 2.12% in AC layer; nitrogen content of 0.157%; phosphorus content of 15-23 ppm; potassium content of 129-163 ppm; average temperature of 11°C; sum of precipitation of about 460 mm.
- Poşta Câlnău – Buzău County, which is characterised by: average altitude of 151 m; cambic chernozem soil; pH between 6.00 and 6.78; humus content between 1.20 and 2.74%; low nitrogen content; small to medium phosphorus content; medium potassium content; average temperature of 11,8°C; sum of precipitation of about 410 mm.

The year 2012 can be characterized as been a warm and dry year in early spring, summer and autumn. With the exception of February, when temperatures were below the multiannual average, in all other months till November temperatures were higher than multiannual averages, especially in April and August (monthly average temperature higher with 3.1°C than multiannual average value), and in July (monthly average temperature higher with 4.7°C than multiannual average value).

March and April registered a rainfall deficit, but crops used water reserves accumulated in the soil during winter and developed well in early growing stages. May month was very wet with rain rate of 160 mm, which means more than double compared to the normal value. After May month with excess of rainfall, one followed a dry period which has been extended until autumn, period that culminated in July with only 2 mm precipitation (about 70 mm deficit). The lack of water (Figure 1) has affected good plant growth and development, and as a result the yield components and grain yield.

The crop technology was the usual one for cultivating grain maize in South Romania.

To the studied hybrids of maize, determinations were performed in view to establish the yield components and the grain yield, respectively: plant population (number of plants per hectare), ear length (cm), number of rows per ear, number of kernels per ear, number of kernels per row, ear weight, kernel weight per ear, kernel rate per ear, weight of thousand seeds, grain yield at 14% humidity (kg per hectare).

Figure 1. Effect of drought in 2012 in South Romania

In each location and for each hybrid, two plants in four replications (in total eight plants) were analysed for establishing the yield components. The analysed plants were representative (average plants) for the plant population in the crop. The ears were detailed analysed in laboratory.
The obtained data were statistically processed by analyses of variance (Anova-single factor).

RESULTS AND DISCUSSIONS

Under the drought conditions of 2012, the ear length at the studied hybrids of maize varied between 10.8 and 17.7 cm (Table 1). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 270 hybrid (16.4 cm), while the smallest average value was obtained for CERA 4505 (13.1 cm). Among the four areas where the hybrids were studied, the highest values (15.9 cm in average for the studied hybrids) were obtained in Vişani area from Brăila County, and the smallest values (13.6 cm in average for the studied hybrids) were obtained in Poşta Câlnău area from Buzău County.

In average for all the studied hybrids and locations the ear length under the 2012 climatic conditions registered 14.8 cm.

Table 1. Average ear length (cm) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	17.4*	14.4	16.9	17.0	*16.4*
CERA 290	15.6	16.8	14.8	12.7	*15.0*
CERA 370	13.5	13.4	17.0	13.6	*14.4*
CERA 390	14.5	15.7	16.5	13.6	*15.1*
CERA 6	13.5	17.4	17.7	13.6	*15.6*
CERA 420	17.0	14.8	15.1	12.8	*14.9*
CERA 2504	15.4	16.0	15.9	15.0	*15.6*
CERA 4505	13.1	12.4	12.4^{oo}	14.4	*13.1*
Bărăgan 48	12.0^{o}	13.3	15.3	12.8	*13.4*
CERA 10	15.4	13.9	17.4	10.8	*14.4*
Average (control)	*14.7*	*14.8*	*15.9*	*13.6*	*14.8*
LSD 5%	*2.5*	*3.9*	*2.6*	*4.2*	*2.0*
LSD 1%	*3.3*	*5.3*	*3.5*	*5.6*	*2.8*
LSD 0.1%	*4.4*	*7.0*	*4.6*	*7.4*	*3.7*

The average number of rows per ear at the studied hybrids of maize varied between 11.0 and 17.5 (Table 2). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 2504 hybrid (15.6 rows per ear), while the smallest average value was obtained for CERA 290 (13.0 rows per ear). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (15.2 rows per ear), while the smallest value was obtained in Vâlcelele area from Călăraşi County (13.3 rows per ear).
In average for all the studied hybrids and locations, the number of rows per ear under the 2012 climatic conditions was of 14.
The average number of kernels per ear at the studied hybrids varied between 215.9 and 518.5 (Table 3). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (378.1 kernels per ear), while the smallest average value was obtained for CERA 370 (257.0 kernels per ear). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (385.3 kernels per ear), while the smallest value was obtained in Poşta Câlnău area from Buzău County (297.5 kernels per ear).

The highest number of kernels per ear obtained in Fundulea area is the result of the high values of rows per ear and ear length.
In average for all the studied hybrids and locations the number of kernels per ear under the 2012 climatic conditions was of 332.2.

Table 2. Average number of rows per ear at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	15.8	12.8	12.3	15.6	*14.1*
CERA 290	13.5	13.3	12.8	12.3	*13.0*
CERA 370	15.5	13.5	13.5	13.0	*13.9*
CERA 390	13.0	13.3	12.5	14.3	*13.3*
CERA 6	17.5	13.8	13.0	13.3	*14.4*
CERA 420	16.5	12.3	14.0	12.5	*13.8*
CERA 2504	17.3	14.8	15.3	14.8	*15.6*
CERA 4505	14.3	13.5	12.5	13.3	*13.4*
Bărăgan 48	12.5^{o}	11.0	16.5**	13.8	*13.5*
CERA 10	16.5	14.8	14.3	13.5	*14.8*
Average (control)	*15.2*	*13.3*	*13.7*	*13.6*	14.0
LSD 5%	*2.4*	*3.2*	*2.0*	*2.4*	*1.8*
LSD 1%	*3.2*	*4.4*	*2.7*	*3.2*	*2.4*
LSD 0.1%	*4.3*	*5.8*	*3.6*	*4.2*	*3.2*

Table 3. Average number of kernels per ear at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	474.4	207.8	304.6	326.3	*328.3*
CERA 290	406.3	371.6	330.6	288.8	*349.3*
CERA 370	305.6	229.1	272.0	221.4	*257.0*
CERA 390	334.0	409.4	375.6	373.3	*373.1*
CERA 6	387.9	397.8	346.3	238.9	*342.7*
CERA 420	518.5	322.9	342.3	266.0	*362.4*
CERA 2504	421.5	308.8	378.1	346.3	*363.7*
CERA 4505	333.6	241.5	215.9^{o}	339.4	*282.6*
Bărăgan 48	237.0	244.9	370.0	286.1	*284.5*
CERA 10	434.3	371.6	418.6	288.0	*378.1*
Average (control)	*385.3*	*310.5*	*335.4*	*297.5*	332.2
LSD 5%	*156.3*	*140.6*	*107.7*	*150.0*	*83.7*
LSD 1%	*210.8*	*189.5*	*145.2*	*202.2*	*112.8*
LSD 0.1%	*279.7*	*251.6*	*192.7*	*268.3*	*149.8*

The average number of kernels per row at the studied hybrids varied between 16.5 and 31.3 (Table 4). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 390 hybrid (28.2 kernels per row), while the smallest average value was obtained for CERA 370 (18.4 kernels per row). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (24.9 kernels per row), while the smallest value was obtained in Poşta Câlnău area from Buzău County (21.3 kernels per row).
In average for all the studied hybrids and locations the number of kernels per row under the 2012 climatic conditions was of 23.4.

Table 4. Average number of kernels per row at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	30.2	15.5	24.8	19.5	*22.5*
CERA 290	30.5	28.2	26.4	21.7	*26.7*
CERA 370	19.0	17.2	20.6	16.9	*18.4*
CERA 390	25.5	31.3	30.0	25.9	*28.2*
CERA 6	21.7	28.8	27.2	17.7	*23.9*
CERA 420	31.0	24.7	23.7	20.0	*24.9*
CERA 2504	23.9	20.7	24.7	23.9	*23.3*
CERA 4505	23.4	17.1	16.5	25.7	*20.7*
Bărăgan 48	18.0	19.4	22.3	20.2	*20.0*
CERA 10	25.8	24.8	29.3	21.1	*25.3*
Average (control)	*24.9*	22.8	*24.6*	*21.3*	23.4
LSD 5%	*9.2*	*9.7*	*6.6*	*11.0*	*5.1*
LSD 1%	*12.4*	*13.0*	*8.8*	*14.8*	*6.8*
LSD 0.1%	*16.5*	*17.3*	*11.7*	*19.6*	*9.1*

The average ear weight at the studied hybrids varied between 28.9 and 116.6 g (Table 5). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 390 hybrid (78.1 g), while the smallest average value was obtained for CERA 4505 (47.3 g). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (81.3 g), and the smallest value was obtained in Poşta Câlnău area from Buzău County (59.4 g).
In average for all the studied hybrids and locations the ear weight under the 2012 climatic conditions was of 67.7 g.
The average kernel weight per ear registered a comparable situation with those of the average ear weight at the studied hybrids. Thus, the average kernel weight per ear varied between 22.9 and 95.0 g (Table 6). The highest average value of the kernel weight for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (63.9 g), while the smallest average value was obtained for CERA 4505 (39.2 g). Among the areas where the

hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (67.5 g), while the smallest value was obtained in Poşta Câlnău area from Buzău County (47.7 g).
In average for all the studied hybrids and locations the kernel weight per ear under the 2012 climatic conditions was of 54.7 g.

Table 5. Average ear weight (g) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	116.6*	47.3	63.9	77.6	*76.4*
CERA 290	86.9	72.9	68.3	68.6	*74.2*
CERA 370	82.2	45.5	59.0	47.5	*58.6*
CERA 390	75.6	77.8	90.8*	68.0	*78.1*
CERA 6	61.2	75.6	68.0	41.8	*61.7*
CERA 420	97.3	76.4	76.1	61.6	*77.9*
CERA 2504	86.4	54.6	83.7	76.9	*75.4*
CERA 4505	60.7	49.5	28.9^{ooo}	50.0	*47.3^{o}*
Bărăgan 48	48.9^{o}	45.5	55.5	57.0	*51.7*
CERA 10	97.5	70.4	89.4*	44.8	*75.5*
Average (control)	*81.3*	*61.6*	*68.4*	*59.4*	*67.7*
LSD 5%	*27.1*	*31.5*	*20.2*	*33.8*	*19.0*
LSD 1%	*36.6*	*42.5*	*27.3*	*45.5*	*25.6*
LSD 0.1%	*48.5*	*56.4*	*36.2*	*60.4*	*34.0*

Table 6. Average kernel weight per ear (g) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	95.0*	35.9	50.5	62.0	60.9
CERA 290	70.1	56.9	54.5	56.0	59.4
CERA 370	67.7	35.6	45.2	37.1	46.4
CERA 390	65.7	61.4	72.2*	55.2	63.6
CERA 6	51.9	58.0	49.9	30.2	47.5
CERA 420	75.6	64.4	58.9	49.7	62.2
CERA 2504	73.5	43.3	67.6	59.3	60.9
CERA 4505	51.7	41.2	22.9^{ooo}	40.8	39.2
Bărăgan 48	40.5^{o}	36.2	45.8	49.1	42.9
CERA 10	83.0	58.1	77.3**	37.2	63.9
Average (control)	*67.5*	*49.1*	*54.5*	*47.7*	*54.7*
LSD 5%	*24.2*	*23.8*	*16.3*	*27.5*	*15.7*
LSD 1%	*32.6*	*32.1*	*22.0*	*37.1*	*21.1*
LSD 0.1%	*43.2*	*42.5*	*29.2*	*49.2*	*28.1*

The average kernel rate per ear at the studied hybrids varied between 64.5% and 87.0% (Table 7). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (84.1%), while the smallest average value was obtained for CERA 6 (74.7%). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (82.5%), while the smallest value was obtained in Poşta Câlnău area from Buzău County (78.4%).
In average for all the studied hybrids and locations the kernel rate per ear under the 2012 climatic conditions was of 80.0%.

Table 6. Average kernel rate per ear (%) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	81.4	75.7	79.0	79.3	*78.9*
CERA 290	80.7	77.9	80.7	80.5	*80.0*
CERA 370	80.2	78.6	76.3	77.4	*78.1*
CERA 390	87.0	79.1	78.2	77.2	*80.4*
CERA 6	84.3	76.4	73.4	64.5^{ooo}	*74.7^{o}*
CERA 420	75.1^{oo}	83.6*	78.3	77.9	*78.7*
CERA 2504	84.5	76.9	80.8	76.8	*79.8*
CERA 4505	85.5	83.6*	74.7	81.4	*81.3*
Bărăgan 48	82.0	84.6**	82.5	86.2*	*83.8*
CERA 10	84.5	82.3	86.6	82.9	*84.1*
Average (control)	*82.5*	*79.9*	*79.1*	*78.4*	*80.0*
LSD 5%	*5.4*	*3.9*	*8.1*	*7.8*	*5.0*
LSD 1%	*7.3*	*5.3*	*10.9*	*10.5*	*6.7*
LSD 0.1%	*9.7*	*7.0*	*14.5*	*13.9*	*9.0*

The average weight of thousand seeds at the studied hybrids varied between 110.6 and 223.7 g (Table 8). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 270 hybrid (183.5 g), while the smallest average value was obtained for CERA 6 hybrid (133.9 g). CERA 6 hybrid which registered the smallest average value of weight of thousand seeds has the smallest kernel rate per ear. Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (177.3 g), while the smallest value was obtained in Poşta Câlnău area from Buzău County (160.4 g).
In average for all the studied hybrids and locations the weight of thousand seeds under the 2012 climatic conditions was of 165.6 g.
The average plant population at the studied hybrids was in normal limits for maize cultivation in South Romania under rainfall conditions (no-irrigation), this varying between 62.5 thousand plants per hectare in Vâlcelele area from Călăraşi County and 66.0 thousand plants per hectare in Fundulea area from Călăraşi County (Table 9).

Table 8. Average weight of thousand seeds (g) of the studied maize hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	200.1*	172.9	166.5	194.5	*183.5*
CERA 290	173.3	152.3	164.8	194.1	*171.1*
CERA 370	223.7***	152.8	166.8	166.2	*177.4*
CERA 390	196.6	149.3	192.8*	149.8	*172.1*
CERA 6	134.2^{ooo}	145.7	145.2	110.6^{oo}	*133.9*
CERA 420	146.0^{oo}	198.7	172.9	191.6	*177.3*
CERA 2504	175.5	142.2	179.9	171.3	*167.2*
CERA 4505	155.9	183.9	116.7^{ooo}	119.5^{o}	*144.0*
Bărăgan 48	172.3	172.1	127.1^{oo}	172.4	*161.0*
CERA 10	195.6	158.3	183.8	133.8	*167.9*
Average (control)	*177.3*	*162.8*	*161.7*	*160.4*	*165.6*
LSD 5%	*21.6*	*38.8*	*24.7*	*36.8*	*32.4*
LSD 1%	*29.1*	*52.3*	*33.3*	*49.6*	*43.6*
LSD 0.1%	*38.6*	*69.4*	*44.1*	*65.8*	*57.9*

Table 9. Average plant population of the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Plant population (no of plants per hectare) in different locations			
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău
CERA 270	66,783	62,491	62,432	67,353
CERA 290	60,925	65,803	67,794	63,294
CERA 370	68,567	53,528	66,471	57,133
CERA 390	64,581	62,893	65,321	61,221
CERA 6	67,076	63,843	61,732	53,923
CERA 420	64,616	60,645	57,850	62,447
CERA 2504	64,458	68,960	63,580	66,599
CERA 4505	69,224	61,255	60,040	67,129
Bărăgan 48	66,059	61,346	69,099	62,258
CERA 10	68,194	64,961	59,606	66,646
Average	*66,048*	*62,573*	*63,393*	*62,800*

The average grain yield at the studied hybrids varied between 1,453 and 6,958 kg per hectare (Table 10). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (4,445 kg per hectare), while the smallest average value was obtained for CERA 4505 (2,754 kg per hectare). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (4,776 kg per hectare), while the smallest value was obtained in Poşta Câlnău area from Buzău County (3,241 kg per hectare). In average for all the studied hybrids and locations the grain yield under the 2012 climatic conditions was of 3,756 kg per hectare. The specific climatic conditions from South Romania in the year 2012, characterised as a drought year, affected significantly the values of the yield components and the grain yield compared to the normal values, respectively values obtained in favourable climatic conditions (Table 11, Table 12). The most affected hybrids, with grain yields less than 30% from normal values, were CERA 4505, CERA 370, and Bărăgan 48, while the less affected hybrid, with grain yields higher than 50% from normal values, was CERA 270 (Table 12). Middle affected hybrids, with grain yields between 30 and 50% from normal values, were the following: CERA 2504, CERA 290, CERA 390, CERA 10, CERA 420, and CERA 6.

Table 10. Average grain yield at 14% humidity (kg per hectare) of the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				*Average (hybrid)*
	Fundulea	Vâlcelele	Vişani	Poşta Câlnău	
CERA 270	6,958*	2,232	3,358	4,524	*4,268*
CERA 290	4,662	4,050	3,959	3,572	*4,061*
CERA 370	4,592	1,941	3,217	2,233	*2,996*
CERA 390	4,589	4,076	5,069*	3,653	*4,347*
CERA 6	3,869	3,985	3,266	1,713	*3,208*
CERA 420	5,271	4,161	3,583	3,375	*4,098*
CERA 2504	4,953	3,133	4,639	4,295	*4,255*
CERA 4505	3,882	2,676	1,452^{ooo}	3,004	*2,754*
Bărăgan 48	2,876^{o}	2,840	3,406	3,396	*3,130*
CERA 10	6,111	4,095	4,929*	2,643	*4,445*
Average (control)	*4,776*	*3,319*	*3688*	*3,241*	*3,756*
LSD 5%	*1,803*	*1,466*	*1,151*	*1,884*	*1,188*
LSD 1%	*2,431*	*1,976*	*1,552*	*2,540*	*1,601*
LSD 0.1%	*3,226*	*2,623*	*2,060*	*3,371*	*2,125*

The grain yield as average value at the studied hybrids in all the four areas from South Romania was of 37.8% from the normal value (Figure 2).

Among the yield components, the kernel rate per ear is almost not affected by drought (98.9% in 2012 of normal value). Less affected by drought are the number of rows per ear (82.5% in 2012 of normal value) and the ear length (69% in 2012 of normal value). Middle affected by drought are the weight of thousand seeds (57.1% in 2012 of normal value), number of kernels per row (55.1% in 2012 of normal value), and number of kernels per ear (46.1% in 2012 of normal value). The most affected by drought are the ear weight (24.3 in 2012 of normal value) and the kernel weight per ear (24.1 in 2012 of normal value) (Figure 2).

Table 11. Normal* values of the yield components and yield at the studied hybrids of maize

Maize hybrid	Ear length (cm)	Number of rows per ear	Number of kernels per ear	Number of kernels per row	Ear weight (g)	Kernel weight per ear (g)	Kernel rate per ear (%)	Weight of thousand seeds (g)	Grain yield at 14% humidity (kg per hectare)
CERA 270	20	14-16	650	43	220	180	81	270	7,000-9,000
CERA 290	20	16	720	45	250	200	80	280	8,000-11,000
CERA 370	22	18	700	40	320	256	80	290	8,800-13,100
CERA 390	20	18	680	40	300	250	82	310	8,500-11,900
CERA 6	22	14-16	680	45	235	185	78	275	7,500-11,000
CERA 420	22	16	720	45	310	250	80	320	7,900-12,300
CERA 2504	22	16	750	48	265	215	80	290	8,200-11,300
CERA 4505	24	20	920	46	350	295	84	260	8,300-14,600
Bărăgan 48	24	16	760	48	330	270	82	310	9,000-13,200
CERA 10	20	22	710	32	300	250	82	300	7,800-14,000

*Values obtained in favourable climatic conditions.

Table 12. Average values of the yield components and yield at the studied hybrids of maize in 2012, in South Romania

Maize hybrid	Ear length (cm)		Number of rows per ear		Number of kernels per ear		Number of kernels per row		Ear weight (g)		Kernel weight per ear (g)		Kernel rate per ear (%)		Weight of thousand seeds (g)		Grain yield at 14% humidity (kg/ha)	
	cm	*%-n*	Nr.	*%-n*	Nr.	*%-n*	Nr.	*%-n*	g	*%-n*	g	*%-n*	%	*%-n*	g	*%-n*	kg/ha	*%-n*
CERA 270	16.4	*82.0*	14.1	*94.0*	328.3	*50.5*	22.5	*52.3*	76.4	*34.7*	60.9	*33.8*	78.9	*97.4*	183.5	*68.0*	4,268	*53.4*
CERA 290	15.0	*75.0*	13.0	*81.3*	349.3	*48.5*	26.7	*59.3*	74.2	*29.7*	59.4	*29.7*	80.0	*100.0*	171.1	*61.1*	4,061	*42.7*
CERA 370	14.4	*65.5*	13.9	*77.2*	257.0	*36.7*	18.4	*46.0*	58.6	*18.3*	46.4	*18.1*	78.1	*97.6*	177.4	*61.2*	2,996	*27.4*
CERA 390	15.1	*75.5*	13.3	*73.9*	373.1	*54.9*	28.2	*70.5*	78.1	*26.0*	63.6	*25.4*	80.4	*98.0*	172.1	*55.5*	4,347	*42.6*
CERA 6	15.6	*70.9*	14.4	*96.0*	342.7	*50.4*	23.9	*53.1*	61.7	*26.3*	47.5	*25.7*	74.7	*95.8*	133.9	*48.7*	3,208	*34.7*
CERA 420	14.9	*67.7*	13.8	*86.3*	362.4	*50.3*	24.9	*55.3*	77.9	*25.1*	62.2	*24.9*	78.7	*98.4*	177.3	*55.4*	4,098	*40.6*
CERA 2504	15.6	*70.9*	15.6	*97.5*	363.7	*48.5*	23.3	*48.5*	75.4	*28.5*	60.9	*28.3*	79.8	*99.8*	167.2	*57.7*	4,255	*43.6*
CERA 4505	13.1	*54.6*	13.4	*67.0*	282.6	*30.7*	20.7	*45.0*	47.3	*13.5*	39.2	*13.3*	81.3	*96.8*	144.0	*55.4*	2,754	*24.1*
Bărăgan 48	13.4	*55.8*	13.5	*84.4*	284.5	*37.4*	20.0	*41.7*	51.7	*15.7*	42.9	*15.9*	83.8	*102.2*	161.0	*51.9*	3,130	*28.2*
CERA 10	14.4	*72.0*	14.8	*67.3*	378.1	*53.3*	25.3	*79.1*	75.5	*25.2*	63.9	*25.6*	84.1	*102.6*	167.9	*56.0*	4,445	*40.8*

*%-n = percent of values obtained in 2012 from the normal values (*from the values obtained in favourable climatic conditions*).*

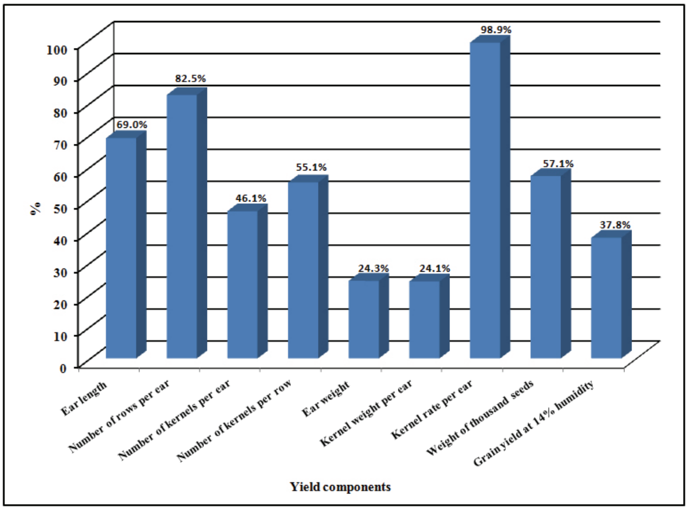

Figure 2. Yield components at the studied hybrids of maize as average percent of values obtained in 2012 from the normal values (values obtained in favourable climatic conditions)

CONCLUSIONS

The drought from the year 2012 affected significantly the values of the yield components and the grain yield at the studied hybrids of maize compared to the normal values.

The grain yield obtained in 2012 in South Romania at the studied hybrids of maize was between 24.1 and 53.4% from the yield obtained in favourable climatic conditions.

Some of the studied maize hybrids (CERA 10, CERA 390, CERA 270, CERA 2504, CERA 420, CERA 290) showed to have the potential to produce good grain yield (more than 4 tons/ha) under water stress.

Among the studied hybrids, the most affected by drought (with grain yields less than 30% from yield obtained in favourable climatic conditions) were CERA 4505, CERA 370, and Bărăgan 48, while the less affected by drought (with grain yields higher than 50% from yield obtained in favourable climatic conditions) was CERA 270.

The yield components at the studied hybrids of maize were affected by the drought conditions from the year 2012 as follows:

- not affected by drought: kernel rate per ear (98.9% of normal value);
- less affected by drought: the number of rows per ear (82.5% of normal value) and the ear length (69% of normal value);
- middle affected by drought: the weight of thousand seeds (57.1% of normal value), number of kernels per row (55.1% of normal value), and number of kernels per ear (46.1% of normal value);
- most affected by drought: the ear weight (24.3% of normal value) and the kernel weight per ear (24.1% of normal value).

The weight components of yield are much more affected by drought than the numerical component of yield.

Among the four areas from South Romania in which the hybrids of maize were studied in the climatic conditions of the year 2012, Fundulea area from Călăraşi County was the most favourable for maize while Poşta Câlnău area from Buzău County was the less favourable.

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AN INTEGRATED WEED MANAGEMENT (IWM) MODEL FOR MAIZE CROP

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Abstract

In the new conditions, IWM goal is both to protect plant biodiversity and cultural environment. Promoting such a system requires complex research on: i) weed flora, ii) the climatic conditions, iii) interaction between weeds and crop plants, iv) various control methods, chemical and non-chemical, v) combining control methods for promoting the non-chemical. Very diverse flora from maize crop has reached averages of 16.9 t.ha^{-1}, benefiting the rich rainfall years. Naturally weed encroachment of maize produced total biomass and grain to about 50% of that without weeds. Manual and mechanical hoed have minimized the degree of weed. In witness an-hoed weeds produced 1.5-1.7 kg.m^{-2} biomass, competing strongly maize plants. Specific herbicides have maintained levels of weed coverage degrees (WCD) below 20% during the growing season. The comparison of hoeing and herbicides effects showed similar circumstances.

Key words: *IWM, maize, weeds interaction, hoed system, herbicides.*

INTRODUCTION

Maize, like other hoed plants have strongly levels of weed encroachment (Berca and Ciorlaus, 1994) regardless of the area where it grows. Relatively large area of nutrition allows the first phases of plants, it is compete by many weed species (Courtney, 1996), favored both by sunlight falling directly on the ground and the moisture which is usually sufficient to seed emergence. Another factor already known is the energy of germination (EG) of grains of different species (Sagar, 1968). Mostly weeds springing up faster than maize, which result in a compact green carpet immediately after sowing (Figure 1).

Of good practice control and correct as of maize weed, commonly is called intercalation of chemical treatment with mechanical hoed (large surfaces) and the manual hoed (small surfaces). This complex of weed control methods could be more accepted part of the rules integrated weed management (IWM) of maize (Auld, 1996; Blair and Green, 1993; Sarpe et al., 1983).

Research conducted both in our country and in other parts (Adamczewski and Radajczyk, 1995; Ionescu et al., 1997; Sarpe et al., 1983) has shown the need to reduce the level of weeds in maize and highlighting the best and suitable chemical strategies.

Figure 1. The weeds encroachment of maize crop

To promote herbicide is to avoid human effort, increasing productivity and reducing the cost price per unit.

Lately, new rules of agro-environmental protection (Mortensen et al., 2000), limiting require exclusive control only by chemical methods (herbicides). Farmers' inclination towards finding new ways to control, as appropriate, possibly cheaper, and their application in complex show that these new trends may meet a specific IWM for each maize crop area. Still be deemed to compile an

IWM as appropriate, necessary studies and experiments us about: ecological nature of interrelations between species (Norris, 1992; Mortensen et al., 2000), the economic damage threshold (Courtney, 1996; Zanin et al., 1994), non-chemical methods of control.

In this paper we present some studies of ecology and weed control methods, whose expression is specifically supported in luvic-soil maize area in the South. It is hoped that the immediate prospect to be able to find common ground that will lead to a possible reduction of chemical treatments. Herbicide will agro-technical complex works of nature, with other non-chemical methods such as biological control of target species. Just as is already known across Europe, our system is practical chemical or organic plant culture and where this whole chemical system is totally excluded. Its share of the entire agriculture is today, however, only a few percentage.

MATERIALS AND METHODS

In the past 21 years has conducted research on maize weed and weed control methods by several directions. Given the resort area a study on the formation of biomass based weed rainfall regime in which they grew. As important as weed biomass is the structure according to the main categories. Thus, separated annual monocots (AM), perennial monocots (PM), annual dicots (AD) and perennial dicots (PD) and observe their structure. Their evolution over time of known specific variability.

Another line of research aimed at how different degrees of infestation of these weeds influenced the growth and development of maize plants. Interaction studies of weeds and maize plants are needed because justifies making control measures and their intensity. In this regard, weed samples were collected every 11 metric frame moments of maize vegetation from emergence to maturity, with and without weeds and have developed these charts.

One of the ways known and used for weed control in maize is the hoed method. The total hoeing, both on the rows interval and between plants in the row, is done “cleansing” of unwanted species, such as maize plants grow and develop normally. To see the practical importance of total maize hoed is the comparison with an-hoed variant. Yield differences obtained between the two extremes were very apparent in each agricultural year. If the witness was drawn diagram with natural weed deposit total biomass of the species during the growing season.

A specific direction researched covers exclusive use of chemical methods, using herbicides. In order to express the importance of herbicides suing, was analysed expressed influence of weed coverage (WC) of maize crop, on the loss of production. Along with this chart was made comparison of efficacy in weed control with herbicides, expressed as a time during the growing season.

Comparison of different weed control systems becomes important, proving the need for one or the other. On one side is the influence of hoed: the mechanical, the manual and the combination of them, compared with the no-control variant. On the other hand, compares the influences of effective herbicides with complex hoed (manual and mechanical). The results were quite similar.

RESULTS AND DISCUSSIONS

Given the degree of competition reduced maize with weeds especially in early phases of vegetation (Ionescu et al., 1996; Wilson, 1998), it was considered appropriate to study specific species infestation in natural eco-system conditions of white luvicsoil. Of the many species present in a complex culture (Anghel et al., 1972), most cause damages usually obvious in maize. Interaction between them can be studied separately according to weed be chosen, either all unwanted vegetation carpet. When targeted means of weed control in a crop, it is preferable that weeding be seen especially in its entirely.

<u>Natural weeding maize crop.</u> At maturity the species were harvested with metric frame. Once you have weighted all together, then separation was four categories: annual monocots (AM), perennial monocots (PM), annual dicots (AD) and perennial dicots (PD). In a multi-year study analysed the correlation of weeds that were formed as total biomass in this area where rainfall regime was quite high, including maize vegetation period (Figure 2). The graph shows the direct link between rains that fell in maize vegetation and weed biomass ($r = 0.296$).

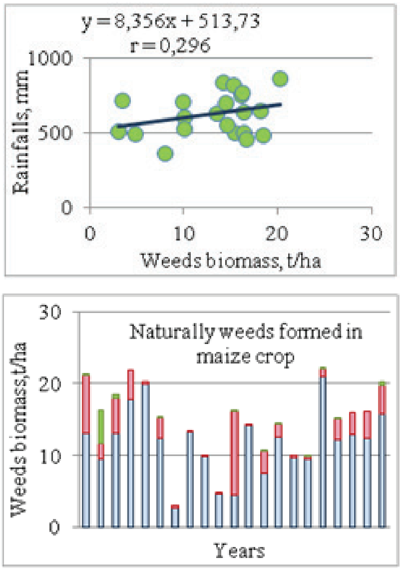

Figure 2. The weed biomass formed by rainfalls and structure: blue-AM, rose-AD, green-PD and PM

Quantitative analysis of annual weeds have quite different values. Smaller quantities were obtained due driest climate, while values of 15-20 t.ha^{-1} d.w. formed in wet years, favourable. Structure between the four categories of annual weeds was also different fluctuating. The structure was found dominance AM type: *Echinochloa crus-galli, Digitaria sanguinalis, Setaria glauca*. AD group followed by the species represented more obvious: *Amaranthus retroflexus, Chenopodium album, Bidens tripartita.* PD *Cirsium arvense* and *Convolvulus arvensis* were counted in some years, and PM *Cynodon dactylon* and *Agropyron repens* appeared sporadically in the form of hearts.

<u>Interaction between weeds and maize plants.</u> Effect of weed on maize plants proved to be harmful (Figure 3). The average maize biomass accumulation showed delays. Lower values were recorded during grain filing substances. Average natural weeding maize reduced accumulation of biomass at about half (1/2) of normal.

<u>Hoed use in weed control.</u> Practice has proved that hoeing maize had provided good conditions for growth and development. Are controlled by hoeing weeds in young stage, taking place and loosening the soil, thereby improving aero-hydraulic regime and nutrition of maize roots. It is usual mechanical hoeing (1-2 times), which completes the one hand (2-3 times). Hoed influence on the production of maize, compared with an-hoed proved to be very obvious. Thus, it was found that regardless of culture year, hoeing maize produced at much higher than an-hoed (Figure 4). Control weeds in accumulated biomass, which at maturity exceeded over 1500 g.m^{-2}.

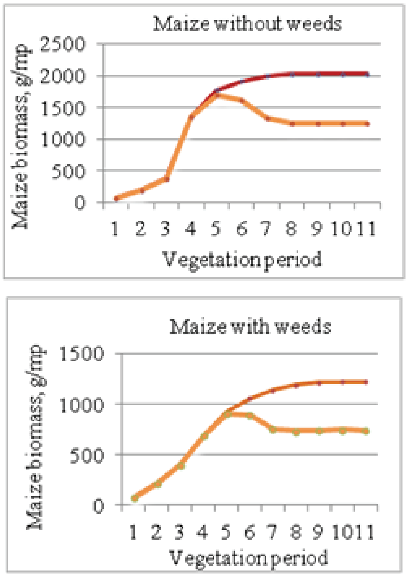

Figure 3. Diagrams of maize plant biomass formation, without and with weeds

<u>Herbicide using in maize crop.</u> Currently it has a real arsenal of herbicide active substances characterized by high degrees of efficiency and selectivity. Both companies industry and research can provide the best and appropriate choice of maize weed control.

To demonstrate the need of herbicide in maize crop, it was made a study on production losses depending on the degree of weed coverage degrees (WCD) crop by weeds (Figure 5).

The results show that only 20% WCD in maize showed 50% loss of production (grains). Nothing maize, both variant treated with herbicides and the witness natural weed encroachment were found specific changes. In March weeds covered culture in a fast pace since the first three weeks, thus absorbing vegetation factors (Berca and Ciorlaus, 1994; Ionescu, 2000). Compared with the control, herbicides have fought and kept fresh ground

100% in the first 6 weeks of growth. Finally WCD stood towards 20%. The situation was due to the emergence and subsequent evolution of re-infestation of weeds and residual effect of herbicides disappearance gentle with agricultural environment.

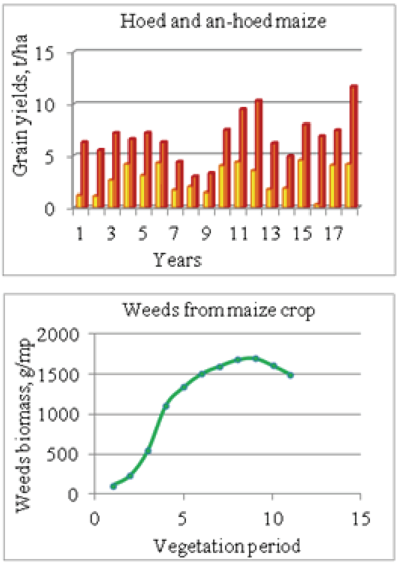

Figure 4. Evolution of maize yields from hoed, mechanical & manual, and no-hoed with an-controlled weeds evolution

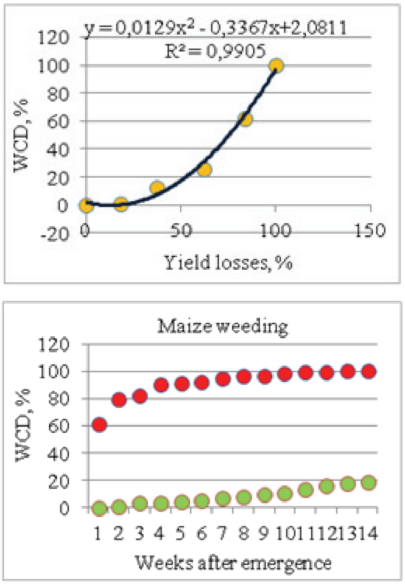

Figure 5. Correlations between weed covered degrees (WCD) with loss of production and WCD with control systems from maize crop

Nonchemical control methods. The most common method of control without herbicides is by hoeing. There are situations where only mechanically or manually, either mechanical or manual. Comparison of these systems with an-hoed showed different effectiveness and grain production (Figure 6). At the same time, on observed that the effectiveness of herbicides was quite equal to mechanical and manual hoed (Gus and Sebök, 1995).

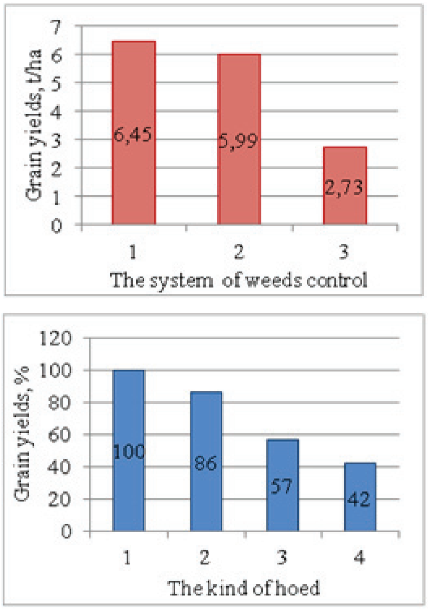

Figure 6. Weed systems control from maize crop (left 1-hoed, 2-herbicide, 3-check plot), and by hoed system (right 1-mechanichal and manual, 2-manual, 3-mechanical, 4-an-hoed)

From the graph it is found that the values were approximately equal (within the limits of error). Thus, if mixed hoed systems were formed on average over 7.1 $t.ha^{-1}$ d.w. grains and 6.9 $t.ha^{-1}$ d.w. maize through herbicide. Witness an-hoed and without herbicide produced an average of 2.1 $t\text{-}ha^{-1}$ d.w. grains of maize. The similarity between the two systems: chemical and non-chemical concluded that they are interchangeable (Brown, 1968; Derksen et al., 1993).

CONCLUSIONS

Maize has weeds every year, with characteristic species at levels considered high. The main causes are: high reserve of seeds in the soil and very low power to compete with maize weeds. Apply an appropriate IWM will control weeds until acceptable limits. The multi studies demonstrated a positive correlation with rainfall regime and the formation of different weed biomass due to drought or rainy regime. Thus, total weed biomass ranged from 3.0 $t.ha^{-1}$ d.w. and 22.4 $t.ha^{-1}$ d.w. Weeds structure was as follows: 80% annual monocots AM, very competitive with maize, 17% annual dicots (AD) and 3% perennial dicots (PD) and perennial monocots PM.

Study the interaction between weeds with maize plants showed how losses occur in total biomass and grain level. Media of competition show reduction in biomass present in 50% of normal maize. There are cases in some years when reduction can reach below 10%.

Between hoeing maize and an-hoed were obtained significant differences. Mechanical and manual hoed not only provides sufficient control of weeds, and improved physical and chemical statement of environment. Weeds of witness an-hoed constantly accumulated biomass, with meant maturity over 15 $t.ha^{-1}$ d.w.

In the IWM, herbicides have been and remain the main means of weed control in maize crop. Expressed weeding coverage degrees (WCD) was maintained at very low levels, total not by herbicides. WCD only 20% resulted in maize production losses of 50%, which demonstrated the need for control measures, including herbicides.

Effectiveness of non-chemical and chemical methods by hoeing was located approximately at the same level, so they can be replaced. In the future, by combining them, or otherwise, could get as good results, creating the conditions to reduce the amounts of active chemical ingredients, a situation consistent with the new European requirements.

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COMBINING ABILITY ANALYSIS IN INTRA SPECIFIC F_1 DIALLEL CROSS OF UPLAND COTTON

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Abstract

The research work comprised of combining ability and genetic variability in a 6 × 6 F_1 diallel cross carried out during 2008 and 2009 at the University of Agriculture, Peshawar, Pakistan. The parental upland cotton genotypes were CIM-446, CIM-496, CIM-499, CIM-506, CIM-554 and CIM-707. Significant (P=0.01) differences were observed among genotypes for days to first flowering, locules boll^{-1}, seeds locule^{-1}, lint% and seed cotton yield plant^{-1}. The F_1 hybrids showed significant increase over parents in mean values for all the traits. Mean squares due to general (GCA) and specific combining ability (SCA) were highly significant for all the traits, except locules for GCA. The GCA mean squares were higher than SCA for majority of the traits revealed that additive type genes governed their inheritance. The best general combiners (CIM-446 and CIM-554) followed by CIM-496 and their utilization as one of the parents produced best specific F_1 hybrids (CIM-446 × CIM-499, CIM-446 × CIM-554, CIM-496 × CIM-707 and CIM-506 × CIM-554) having valuable SCA determination and remarkable mean performance for most of the traits. Correlation of yield was significantly positive with majority of yield traits and negative with days to first flowering and lint%. The promising F_1 hybrids exhibited earliness, and could be used for selection in early segregating generations, and some specific F_1 hybrids can be used for hybrid cotton production. However, the combined performance of F_1 and F_2 hybrids could be a good indicator to identify the most promising populations.

Key words: *Combining ability, diallel cross, earliness, seed cotton yield, upland cotton.*

INTRODUCTION

Plant breeders are looking for desirable genes and gene complexes, and identification of promising individuals are very important in any breeding program. Diallel mating design is one of the tools that help the breeder to identify the potential genotypes and the promising recombinants produced by combining the parental individuals through GCA and SCA. In diallel mating, the parental lines crossed in all possible combinations to identify parents as best/poor general combiners through GCA and the specific cross combinations through SCA. It involves both direct as well as reciprocal crosses through which maternal effects can also be ascertained.

In combining ability, the entire genetic variability of each trait can be partitioned into GCA and SCA as defined by Sprague and Tatum (1942) and reciprocal effects as sketched by Griffing's (1956). They stated that GCA effects administer the additive type of gene action whereas SCA effects are shown due to genes which are non-additive (dominant or epistatic) in nature. Sayal et al. (1997), Hassan et al. (1999) and Batool (2011) reported the importance of non-additive type of gene action for different cotton traits. However, Khan et al. (1991), Baloch et al. (2000), Bhutto et al. (2001) and Khan (2010) stressed upon the appreciable degree of variance due to GCA for morpho-yield traits. Khan (2003), Khan et al. (2005 & 2009a) and Makhdoom (2011) observed that mean squares due to GCA and SCA were highly significant; however, the genetic variances due to SCA were greater than GCA and more important for the yield related traits, showing the predominance of non-additive gene action. High × low and low × high GCA parents performed well in SCA determination (Makhdoom, 2011). Many commercial cotton cultivars despite their high/low agronomic performance combine in a better way/poorly when used as a parental cultivars in cross combinations (Batool et al., 2010; Makhdoom et al., 2010). Therefore, the said research work was conducted to analyze the important cultivars to ascertain their relative performance regarding their genetic potential and combining ability effects for various traits.

MATERIALS AND METHODS

Breeding material and field procedure

The research work pertaining to study the genetic potential of genotypes and combining ability in F_1 hybrids of cotton (*Gossypium hirsutum* L.) was conducted during 2008 and 2009 at the University of Agriculture, Peshawar 25130, Pakistan. Six diverse genotypes (CIM-446, CIM-496, CIM-499, CIM-506, CIM-554 and CIM-707) of upland cotton were hand sown during May 2008 and were crossed in a complete diallel fashion. During 2009, the parents and 30 F_1s were also hand sown in a RCB design. Parents and F_1s planted in a single row measuring six meter with four replications. The row and plant spacing were 75 and 30 cm, respectively. Thinning performed after 15 to 20 days when the plant height reached up to 20 cm to ensure single plant per hill. Recommended cultural practices carried out and the crop grown under uniform field conditions to minimize environmental variations to the maximum possible extent. Picking made during the month of November on single plant basis and ginning performed with eight saw-gins.

Traits measurement and statistical analyses

Data were recorded for days to first flowering, locules boll^{-1}, seeds locule^{-1}, lint % and seed cotton yield plant^{-1}. The recorded data were subjected to analysis of variance technique as outlined by Steel and Torrie (1980) to test the null hypothesis of no differences among various F_1 populations and their parental line means. Least Significant Difference test was also used for means separation and comparison after significance. The data of all the parameters on 30 F_1s and six parental genotypes were further subjected to the combining ability analysis according to Griffing's (1956) Method-I based on Eisenhart's Model-II as also stated by Singh and Chaudhary (1985).

RESULTS AND DISCUSSIONS

Mean performance

According to analysis of variance, the F_1 hybrids and their parental lines showed highly significant differences for all the traits (Table 1). According to genetic potential and mean performance (Tables 2), the parental cultivars CIM-554, CIM-499 and CIM-707 found with best performance for all the traits. However, their use in F_1 hybrids also showed extraordinary performance and found as best general combiners. The involvement of the cultivar CIM-554 as paternal/maternal parent with other cultivars in F_1 hybrids (CIM-554 × CIM-496, CIM-554 × CIM-707 and CIM-506 × CIM-554) exhibited best mean values and excelled other genotypes for the traits i.e. minimum days to first flowering (52.00 days), and increased lint% (38.78%) and seed cotton yield plant^{-1} (190.88 g). The other two F_1 hybrids of above said cultivar (CIM-554) i.e. CIM-554 × CIM-499 and CIM-554 × CIM-506 also manifested 2nd maximum mean values for lint% (37.80%) and less days to first flowering (52.33 days).

The cultivars CIM-499 and CIM-707 were second promising cultivars and there involvement in F_1 hybrids with other cultivars (CIM-499 × CIM-707, CIM-499 × CIM-446 and CIM-554 × CIM-707) also showed best performance for three traits viz; locules boll^{-1} (4.94), seeds locule^{-1} (8.11) and lint % (38.78%), respectively. Genetic potential studies of different cultivars in form of their expression for different morpho-yield traits were earnestly needed for selection of parental lines for breeding programme (Badr, 2003; Khan, 2003, Khan *et al*. 2010). The F_1 hybrids of CIM-554 found earlier in flowering through which the crop can escaped from pests attack and land can be vacated earlier for following crop like wheat. Different *G. hirsutum* cultivars evaluated for yield and other economic characters and observed significant variations for morphological and yield related traits (Khan et al., 2007b).

Combining ability

The significance through ANOVA for all the traits in a 6 × 6 F_1 diallel hybrids and their parental lines (Table 1), allowed arbitrating the genetic components of variance due to GCA, SCA and reciprocal effects. Means squares due to GCA (Table 1) were significant (P=0.01) for days to first flowering (10.67), lint % (5.12), seed cotton yield plant^{-1} (5566.19), merely significant (P=0.05) for seeds locule^{-1} (0.12) and non-significant for locules boll^{-1}. As far as SCA is concerned, highly significant differences (Table 1) were observed for all the traits viz; days to first flowering (10.42), locules boll^{-1} (0.02), seeds locule^{-1} (0.27), lint % (2.22) and seed cotton yield plant^{-1} (1390.01). The mean squares due to reciprocals were also found highly significant for three traits (Table 1) i.e. days to first flowering (10.43), seeds locule (0.36) and lint % (3.79). The traits locules boll and seed cotton yield plant^{-1} showed non-significant maternal effects. Significant mean squares for GCA and SCA for seed cotton yield and other yield contributing traits have been observed by earlier researchers (Baloch et al., 1999; Ali et al., 2000; Hassan et al., 2000; Tuteja et al., 2003; Hague et al., 2008).

Overall, the GCA mean squares were greater in magnitude than SCA and reciprocals for three traits viz; days to first flowering (10.67), lint % (5.12) and seed cotton yield plant (5566.19) seems that these trait were controlled by additive genes. The trait locules boll^{-1} was having maximum SCA mean squares (0.02) as compared to GCA and reciprocals. However, for seed cotton yield plant^{-1} the SCA mean squares (1390.01) followed the GCA values but greater than reciprocal mean squares. The trait seeds locule^{-1} was having maximum mean square (0.36) due to reciprocal as compared to GCA and SCA. Additive type of gene action for most of the traits noticed in upland cotton (Chinchane et al., 2002; Yuan et al., 2002; Khan et al., 2005; Aguiar et al., 2007). Additive genetic effects with enough genetic variability observed for most of the yield traits having effective selection (Lukonge *et al.*, 2008). However, non-additive type of gene action for different yield traits observed by Hassan *et al.* (1999), Muthu *et al.* (2005) and Ahuja and Dhayal (2007) for yield related traits and lint%. Such contradictions may be due to different genetic backgrounds of breeding material used under various environmental conditions.

In case of genetic components of variance (Table 3), the magnitude of SCA variances were found greater than GCA and reciprocals for three parameters i.e. days to first flowering (4.56), locules boll^{-1} (0.007) and seed cotton yield plant^{-1} (560.18). In reciprocal variances, the traits viz; seeds locule^{-1} (0.15) and lint % (1.85) revealed maximum genetic variances as compared to GCA and SCA. In seed cotton yield, the GCA variance (350.60) followed the SCA (560.18) and found greater than reciprocals. However, none of the trait showed promising variances due to GCA. Significant genetic variances due to GCA and SCA were also noted by Baloch et al. (1997 & 1999), Ali et al. (2000) and Hassan et al. (2000) for different morpho-yield traits in upland cotton.

Parent cultivar CIM-446 superseded all other cultivars for GCA (Table 4) and showed highest GCA effects for seeds locule^{-1} (0.14) and seed cotton yield plant^{-1} (26.69), and found 2nd ranking genotype for locules boll^{-1} (0.01). Cultivar CIM-554 was having maximum GCA effects for locules boll^{-1} (0.02) and was the 2nd best cultivar for lint% (0.43) and seed cotton yield (19.85). Cultivar CIM-496 was found 3rd ranking cultivar by having maximum GCA effects for lint % (0.71), desirable negative GCA effects for days to first flowering (-1.01) and 2nd top values for locules boll^{-1} (0.01) and seeds locule^{-1} (0.05). The performance of cultivars CIM-499, CIM-506 and CIM-707 was poor and showed maximum negative GCA effects for majority of the traits. Results also confirmed that parent cultivars CIM-446 and CIM-554 were best general combiners, followed by CIM-496.

The positive SCA effects ranges for different traits (Table 5) were 0.04 to 0.13 for locules boll^{-1}, 0.02 to 0.68 for seeds locule^{-1}, 0.06 to 0.48 for lint%, 4.32 to 58.58 for seed cotton yield plant^{-1} and desirable negative SCA effects for days to first flowering (-0.27 to-3.21). In case of SCA effects (Table 5), the F_1 hybrid CIM-446 × CIM-499 had highest SCA effects for lint% (0.48) and desirable negative SCA (-2.06) for days to first flowering. The cross combination CIM-446 × CIM-554 found best for seeds locule^{-1} (0.68), while for locule boll^{-1} and seed cotton yield plant^{-1} the crosses CIM-496 × CIM-707 and CIM-506 × CIM-554 had highest SCA effects of 0.13 and 58.58, respectively. Most of the crosses with high SCA have at least one highest GCA parent (CIM-446, CIM-554 and CIM-496). Therefore, high × low, low × high and in some cases high × high GCA parents performed well in SCA determination and revealed best mean performance. Coyle and Smith (1997), Hassan et al. (2000) and Lukonge et al. (2008) also concluded that parents with maximum GCA found better responsive to produce high yielding hybrids. F_1 hybrids with high heterosis were also associated with higher inbreeding depression (Khan et al., 2000; Soomro and Kalhoro, 2000; Basal and Turgut (2003); Khan et al., 2007c). Therefore, after analyzing the F_1 hybrids through combining ability with reasonable SCA variance, the medium type of heterosis in such specific cross combinations may have some stability and such promising F_1 hybrids can be used for hybrid cotton productions.

The F_1 reciprocal cross (CIM-554 × CIM-506) having one good general combiner, also manifested maximum reciprocal effects for two traits (Table 6) viz; seeds locule^{-1} (1.00) and seed cotton yield plant^{-1} (51.46). The remaining traits were also controlled by such reciprocal crosses which involve at least one general combiner as one of the parents and manifested maximum reciprocal effects for locules boll^{-1} (0.10; CIM-554 × CIM-499), lint% (2.11; CIM-554 × CIM-496) and highest desirable negative reciprocal effects (-3.17) were shown by cross CIM-707 × CIM-554 for days to first flowering. In combining ability the maternal effects which came through cytoplasmic effects cannot be ignored also and the F_1 hybrids having desirable reciprocal effects should also be kept under consideration during future breeding.

Parental cultivars with best GCA i.e. CIM-446, CIM-554 followed by CIM-496, and their utilization as one of the parents produced excellent F_1 hybrid combinations and performed well in GCA and SCA determination in addition to excellent mean performance for majority of the traits. Results also revealed that majority of traits governed by additive genes and partially by non-additive gene action and selection in such promising population could be effective in early segregating generations. The F_1 hybrids having extraordinary performance could also be used as such (seed source for F_2 crop) for hybrid cotton production to boost up the seed cotton yield as also mentioned by Basal and Turgut (2003), Muthu *et al.* (2005) and Khan *et al.* (2007c) that high SCA effects associated with standard heterosis.

CONCLUSIONS

Best general combiners i.e. CIM-446, CIM-554 followed by CIM-496 and their use as paternal/maternal parent in F_1 hybrids viz; CIM-446 × CIM-499, CIM-446 × CIM-554, CIM-496 × CIM-707 and CIM-506 × CIM-554 performed well with highest SCA determination. However, it concluded that combined performance of F_1 and F_2 hybrids could be a good selection criterion for assortment of most promising populations to be utilized either as F_2 hybrids or as a source population for further selection in advanced generations.

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Table 1. Mean squares for ANOVA and combining ability in a 6 × 6 F1 diallel cross of upland cotton

Parameters	Mean Squares						
	ANOVA			Combining Ability			
	Reps.	Genotypes	Error	GCA	SCA	Rec.	Error
Days to first flowering	13.36	29.76**	7.57	10.67**	10.42**	10.43**	2.55
Locules boll^{-1}	0.07	0.02**	0.01	0.00$^{N.S}$	0.02**	0.00$^{N.S}$	0.00
Seeds locule^{-1}	0.06	0.87**	0.14	0.12*	0.27**	0.36**	0.05
Lint%	0.15	9.92**	0.24	5.12**	2.22**	3.79**	0.08
Seed cotton yield plant^{-1}	1883.37	4798.73**	1275.21	5566.19**	1390.01**	495.30$^{N.S}$	425.25

** = Significant at *P£0.05* & *P£0.01*, N.S. = Non-significant

Table 2. Mean performance for morpho-yield traits in a 6 × 6 F1 diallel cross of upland cotton

Parents and their F_1 Hybrids	Days to Flowering	Locules boll^{-1}	Seed locule^{-1}	Lint%	Seed cotton yield plant^{-1} (g)
CIM-446	62.67	4.60	7.35	33.28	125.86
CIM-496	59.67	4.57	6.49	37.42	85.69
CIM-499	57.33	4.43	6.45	32.73	46.77
CIM-506	58.33	4.63	6.62	35.68	109.56
CIM-554	57.67	4.60	6.56	34.49	101.36
CIM-707	57.67	4.63	6.93	35.66	81.51
CIM-446 × CIM-496	55.33	4.74	6.99	34.71	165.19
CIM-446 × CIM-499	57.00	4.76	7.22	33.44	84.54
CIM-446 × CIM-506	57.33	4.79	7.21	30.74	140.07
CIM-446 × CIM-554	57.33	4.73	7.91	34.69	176.87
CIM-446 × CIM-707	56.67	4.61	6.99	32.58	146.42
CIM-496 × CIM-446	57.00	4.61	7.43	32.30	172.00
CIM-496 × CIM-499	54.00	4.80	7.03	34.69	66.24
CIM-496 × CIM-506	55.33	4.70	7.31	33.04	85.42
CIM-496 × CIM-554	52.67	4.67	7.39	37.79	112.83
CIM-496 × CIM-707	52.67	4.83	6.69	35.51	77.75
CIM-499 × CIM-446	52.33	4.76	8.11	34.94	75.16
CIM-499 × CIM-496	55.00	4.77	6.36	37.32	118.20
CIM-499 × CIM-506	62.00	4.64	7.61	36.28	91.96
CIM-499 × CIM-554	57.67	4.75	6.87	33.53	101.68
CIM-499 × CIM-707	57.00	4.94	7.22	35.21	53.69
CIM-506 × CIM-446	59.67	4.72	7.40	31.95	178.50
CIM-506 × CIM-496	57.33	4.62	7.62	36.15	104.38
CIM-506 × CIM-499	58.33	4.72	7.19	35.00	121.88
CIM-506 × CIM-554	65.33	4.76	8.01	33.28	190.88
CIM-506 × CIM-707	54.00	4.62	7.42	30.84	75.61
CIM-554 × CIM-446	53.00	4.83	7.63	33.48	172.84
CIM-554 × CIM-496	52.00	4.80	6.16	33.57	89.97
CIM-554 × CIM-499	52.67	4.75	6.17	37.80	113.15
CIM-554 × CIM-506	52.33	4.77	6.02	34.45	151.29
CIM-554 × CIM-707	52.67	4.78	7.08	38.78	130.05
CIM-707 × CIM-446	53.67	4.70	6.88	34.26	121.35
CIM-707 × CIM-496	52.67	4.85	7.95	31.69	149.13
CIM-707 × CIM-499	58.00	4.78	7.36	34.16	78.90
CIM-707 × CIM-506	53.00	4.66	6.59	35.05	69.44
CIM-707 × CIM-554	59.00	4.62	7.04	33.25	130.26
$L.S.D_{(0.05)}$	4.48	0.18	0.62	0.79	64.05

Table 3. Genetic components of variance due to GCA, SCA and reciprocals in a 6 × 6 F1 diallel cross of upland cotton

Components of Variation	Day to flowering	Locules bolls^{-1}	Seeds locule^{-1}	Lint %	Seed cotton yield plant^{-1}
G.C.A	0.04 (0.36)	-0.001 (-16.66)	-0.01 (-3.22)	0.24 (7.04)	350.60 (25.57)
S.C.A	4.56 (41.16)	0.007 (116.66)	0.12 (38.71)	1.24 (36.36)	560.18 (40.86)
Reciprocals	3.93 (35.47)	-0.0001 (0.00)	0.15 (48.39)	1.85 (54.25)	35.02 (2.55)
Error	2.55 (23.01)	0.00 (0.00)	0.05 (16.12)	0.08 (2.35)	425.25 (31.02)
Total	11.08 (100)	0.006 (100)	0.31 (100)	3.41 (100)	1371.05 (100)

Table 4. GCA effects for morpho-yield traits in a 6 × 6 F1 diallel cross of upland cotton

Cultivars	Days to flowering	Locules boll^{-1}	Seeds locule^{-1}	Lint%	Seed cotton yield plant^{-1}
CIM-446	0.77	0.01	0.14	-1.06	26.69
CIM-496	-1.01	0.01	0.05	0.71	-4.32
CIM-499	0.27	0.00	-0.09	0.41	-33.23
CIM-506	1.32	-0.03	0.04	-0.35	7.85
CIM-554	-0.45	0.02	-0.14	0.43	19.85
CIM-707	-0.90	-0.01	0.00	-0.15	-16.84

Table 5. SCA effects for morpho-yield traits in a 6 × 6 F1 diallel cross of upland cotton

F_1 Hybrids	Days to flowering	Locules boll^{-1}	Seeds locule^{-1}	Lint%	Seed cotton yield plant^{-1}
CIM-446 × CIM-496	0.12	0.04	-0.07	-0.51	46.42
CIM-446 × CIM-499	-2.66	0.04	-0.34	0.48	-30.09
CIM-446 × CIM-506	0.12	0.06	0.03	-1.61	8.27
CIM-446 × CIM-554	-1.44	0.04	0.68	0.35	11.84
CIM-446 × CIM-707	-0.99	-0.06	-0.29	0.26	7.56
CIM-496 × CIM-499	-1.05	0.06	0.52	0.19	13.30
CIM-496 × CIM-506	-0.27	-0.04	0.28	-0.14	-25.10
CIM-496 × CIM-554	-2.49	-0.02	-0.22	0.17	-30.60
CIM-496 × CIM-707	-1.71	0.13	0.18	-1.33	18.13
CIM-499 × CIM-506	-0.27	-0.04	0.28	-0.14	-25.10
CIM-499 × CIM-554	-0.94	0.11	-0.34	0.46	4.32
CIM-499 × CIM-707	1.84	0.06	0.29	0.06	-0.11
CIM-506 × CIM-554	1.68	0.06	0.02	-0.58	58.58
CIM-506 × CIM-707	-2.21	-0.04	-0.13	-0.92	-34.96
CIM-554 × CIM-707	0.90	-0.03	0.11	0.34	10.67

Table 6. Reciprocal effects for morpho-yield traits in a 6 × 6 F1 diallel cross of upland cotton

F_1 Hybrids	Days to flowering	Locules boll^{-1}	Seeds locule^{-1}	Lint %	Seed cotton yield plant^{-1}
CIM-496 × CIM-446	-0.83	-0.04	-0.22	1.21	13.26
CIM-499 × CIM-446	2.33	0.00	0.42	-0.75	4.69
CIM-506 × CIM-446	-1.17	0.03	-0.09	-0.61	-19.22
CIM-554 × CIM-446	2.17	-0.05	0.14	0.61	2.01
CIM-707 × CIM-446	1.50	-0.04	0.05	-0.84	12.54
CIM-499 × CIM-496	-0.50	0.01	-0.54	-1.65	-25.98
CIM-506 × CIM-496	-1.00	0.04	-0.16	-1.55	-9.48
CIM-554 × CIM-496	0.33	-0.07	0.62	2.11	11.43
CIM-707 × CIM-496	0.00	-0.01	-0.63	1.91	-35.69
CIM-506 × CIM-499	1.83	-0.04	0.21	0.38	-14.96
CIM-554 × CIM-499	2.50	0.10	0.35	-2.13	-5.74
CIM-707 × CIM-499	-0.50	-0.02	-0.07	0.53	-12.61
CIM-554 × CIM-506	6.50	-0.01	1.00	-0.59	51.46
CIM-707 × CIM-506	0.50	-0.02	0.42	-2.11	3.09
CIM-707 × CIM-554	-3.17	0.08	0.02	1.43	-0.11

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ANALYSIS OF THE GREEN MASS YIELD'S STRUCTURE OF SUDANGRASS AND SORGHUM X SUDANGRASS HYBRIDS

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Abstract

Analysis of the green mass yield's components of Sudangrass and Sorghum x Sudangrass hybrids was made, the yield obtained by mowing in brooming and flowering stages during 2010-2011.The results of the tests confirm the high productivity potential of the sorghum-sudangrass hybrids in conditions of optimum soil's water reserve and temperatures during the vegetation. The sorghum-sudangrass hybrids show excellent adaptive potential in conditions of more often going extreme deviations from the agro-climatic norms. The total and the relative productivity in the separate swaths does not differ substantially in the brooming and the flowering stages. The lack of enough moisture reflects most significantly on the productivity in the later swaths and on the intensity of dry matter accumulation. The agroclimatic conditions do not affect the favourable leaf part in the green mass.

Key words: *dry matter, green mass, Sudangrass, Sorghum x Sudangrass hybrids.*

INTRODUCTION

Sudangrass forages are grown extensively to provide supplementary forage for animals as pasture, greenchop, silage and hay (Moyere et al., 2004). They are known for their better tolerance to drought than other annual summer grasses and are more yielding than corn in areas with higher temperatures and lower and uneven precipitation (Friboarg et al., 1995)

The sudangrass *Sorghum sudanense* (Piper) is introduced in 1900's in the USA from Ethiopia and Sudan, and in 1930's its introduction in Russia and Eastern Europe begins (Haecker, 1992).

Since 1950's Sudangrass has been hybridized with other *Sorghum* ssp to increase forage productivity. The development of the CMS-system in Sorghum widens dramatically the possibilities of use of MS-lines as maternal component and lines and varieties of Sudangrass as pollinators for obtainment of F_1 hybrids (House, 1995). The study of the combining ability and the correlations of yield components with the concrete agro-climatic conditions multiplies the selection potential of great genetic diversity of Sorghum hybrids (Sotomayor Rios et al., 1984; Shon Yun et al., 1999; Paknejad et al., 2001).

The Sudangrass hybrids of Sudangrass MS-lines and restorers resemble the common Sudangrass in growth and quality characteristics however they tend to be taller, have an intermediate stem diameter and are higher yielding than Sudangrass. These hybrids recover rapidly after harvest and are very productive (Beurlein et al., 1968).

Sorghum x Sudangrass hybrids, *Sorghum bicolor* (L) Moench x *Sorghum sudanense* (Piper) Stapf, are more vigorous and taller than Sudangrass, have larger stems and coarser leaves, and give higher forage yield when harvested two or more times at the flower stage for green chop, or one time at the late milk stage for silage production (Snyman and Youbert, 1996; Paknejad et al., 2001).

The hybrids of Sudangrass show their high productivity potential in optimum conditions of cultivation, but owe their wide spreading to their high adaptability and resistance to extreme droughts, high temperatures and salt resistance, that's why it attains actuality in South-Western Europe (Antocha, 1994; Kertikov, 2007; Uzun et al., 2009).

In the article is made an analysis of the components of the green mass yield, obtained by mowings in the stages of brooming and flowering of Sudangrass and Sorghum x Sudangrass hybrids of the breeding program of the Agricultural Institute – Shumen, Bulgaria.

MATERIALS AND METHODS

This study was conducted at the Agricultural Institute-Shumen, located in North-Eastern Bulgaria, during the period 2010-2011. The soil type of the experimental fields was a carbonate black-earth with good mechanical structure and weakly alkaline reaction of the soil solution.

The used experimental design for the tests of the varieties and hybrids was a random complete block in 4 repetitions. The experimental plot was 10.8 m^2, in three rows with 8 m length, row spacing was 45 cm. Seeds were sown at 20 $kg.ha^{-1}$ seed rate, at 4-5 cm depth, in the period 25.04 – 05.05. The tested origins were harvested trice at brooming stage, twice at flowering stage and once at late milk stage.

Sudangrass variety Verkor and Sorghum x Sudangrass hybrid variety Susu were tested. A stabilized Sudangrass population and a Sorghum x Sudangrass hybrid from the breeding program of AI-Shumen, were also included in the tests.

Green mass yield was measured by reaping and weighing the fresh herbage in the plots. Afterwards, the dry matter content and dry matter yields were determined by drying (at 70^{o}C for 48h).

RESULTS AND DISCUSSIONS

The vegetation rainfalls have the biggest effect on the productivity of the Sudangrass and its hybrids. The development of Sorghum and Sudangrass is strongly affected by the vegetation temperature sum. The significant differences in the agro-climatic factors of the years of our study (Table 1) allow reliable assessment of the productive potential and the adaptability of the sorghum x sudangrass hybrids in conditions of extreme deviations from the norm.

Table 1. Agroclimatic conditions of Sudangrass and Sorghum x Sudangrass hybrids cultivation during 2010 and 2011

	2010			2011		
	Days of vegetation	Sum of rainfalls	Temperature sum	Days of vegetation	Sum of rainfalls	Temperature sum
I swath brooming	70	250	1182	60	75	954
II swath brooming	35	41	793	30	49	796
III swath brooming	30	38	661	40	46	863
Total brooming	135	329	2636	130	170	2613
I swath flowering	85	285.0	1499	75	82.0	1058
II swath flowering	45	43.0	1116	45	68.0	1554
Total flowering	130	328.0	2615	120	150.0	2612

2010 is characterized as a mean favorable for the development of the Sorghum and the Sudangrass. The total rainfalls sum is extremely high. The conditions during July, August and September favoured realization of productive grow up of green mass by mowing in the brooming and flowering stages. The spring of 2011 is continuous and cool, the air temperature exceeded 15^{o}C after 15th of May, which forced the late sowing (12-15th of May). The low temperature sum brought to the slow temps of development. The rainfalls were unevenly distributed during vegetation, which also proves the year to be unfavorable.

On Table 2 are given the results from the analysis of the green mass yield's components from the tested in 2010 origins of Sudangrass and Sorghum x Sudangrass hybrids. The total productivity from three swaths during brooming exceeds insignificantly the productivity from two swaths in flowering stage. The first swaths are most productive and vary from 34 to 41% of the total yield in brooming stage and from 48 to 67% of the total yield in the flowering stage. The second and third swaths in brooming stage are equalized. The low variation of the leaves: stems ratio for the three swaths in brooming stage is impressive. The part of the stems is increased for the swaths in flowering stage (83 to 86%).

Table 2. Analysis of green mass yield's components for Sudangrass and Sorghum x Sudangrass hybrids in brooming and flowering stages, 2010

Origin	Green mass (t/ha)	Proportion in %:		Share of the swath in the total yield (%)	Dry matter (%)	Dry mass per day (t/ha)
		Leaves	Stems			
I mowing at brooming						
Susu	44.4	24	76	34.3	33.9	0.251
Verkor	38.9	16	84	38.0	38.7	0.215
SVE	41.1	19	81	41.4	34.9	0.239
AxSVE	45.5	19	81	41.2	49.3	0.374
II mowing at brooming						
Susu	30.0	25	75	35.0	25.0	0.250
Verkor	35.5	29	71	32.0	21.7	0.256
SVE	34.4	30	70	29.0	21.3	0.244
AxSVE	39.6	27	73	34.9	21.3	0.282
III mowing at brooming						
Susu	33.3	20	80	30.7	44.4	0.369
Verkor	32.2	13	87	30.0	50.0	0.402
SVE	26.6	15	85	29.6	35.7	0.237
AxSVE	38.9	17	83	23.9	35.3	0343
I mowing at flowering						
Susu	66.6	14	86	57.1	41.0	0.364
Verkor	41.1	15	85	48.5	42.3	0.232
SVE	52.2	17	83	50.8	38.4	0.267
AxSVE	63.3	14	86	67.8	38.4	0.324
II mowing at flowering						
Susu	50.0	15	85	42.9	38.8	0.431
Verkor	42.2	15	85	51.5	39.3	0.369
SVE	47.7	16	84	49.2	39.2	0.415
AxSVE	53.3	15	85	32.2	38.9	0.461

Table 3. Analysis of green mass yield's components for Sudangrass and Sorghum x Sudangrass hybrids in brooming and flowering stages, 2011

Origin	Green mass (t/ha)	Proportion in %:		Share of the swath in the total yield (%)	Dry matter (%)	Dry mass per day (t/ha)
		Leaves	Stems			
I mowing at brooming						
Susu	45.6	21	79	49.2	29.7	0.193
Verkor	38.6	23	77	45.1	28.4	0.157
SVE	48.3	23	77	44.0	29.9	0.206
AxSVE	69.2	19	81	43.2	29.1	0.288
II mowing at brooming						
Susu	33.3	24	76	34.9	28.1	0.267
Verkor	30.3	26	74	36.3	25.9	0.222
SVE	30.6	21	79	35.5	24.1	0.211
AxSVE	40.6	24	76	38.1	32.5	0.377
III mowing at brooming						
Susu	15.0	27	73	15.9	27.0	0.135
Verkor	16.4	27	73	18.6	32.0	0.175
SVE	18.6	31	69	20.5	29.0	0.180
AxSVE	18.1	30	70	18.7	32.0	0.193
I mowing at flowering						
Susu	49.7	24	76	59.9	25.7	0.150
Verkor	41.1	14	86	59.1	26.7	0.129
SVE	55.6	19	81	54.6	30.7	0.201
AxSVE	75.3	16	84	59.7	30.7	0.271
II mowing at flowering						
Susu	39.2	23	77	40.1	28.1	0.245
Verkor	30.3	25	75	40.9	25.9	0.174
SVE	31.7	20	80	45.4	24.1	0.170
AxSVE	43.3	23	77	40.3	32.5	0.313

The dry matter content is relatively stable – from 30 to 50%. There is an exception from that rule for the second swath in brooming stage, where a significant decrease to 21-25% has been measured.

The intensity of green mass accumulation, given as a production for a day of the vegetation of each of the swaths, in 2010 is remarkably high. The highest values are registered for the last swaths, and for the second swath in flowering stage the value reaches 0.470 $t.ha^{-1}$.

The analysis of the yield's components during 2011 is given on Table 3. The total productivity is significantly lower than the yields obtained in 2010 as a result of the late sowing, cool spring and extreme drought. This decrease is due also to the lower productivity in the later swaths of the shortened vegetation and the combination of low rainfalls quantities and high temperatures during this period. The part of grow up for the third swath in brooming stage is decreased to 15-20% of the total productivity.

The relative part of the leaves in the green mass is insignificantly increased, at the later swaths reaches 25-32%. The unfavorable conditions affect the lower values for conten

CONCLUSIONS

The results of the tests confirm the high productivity potential of the sorghum-sudangrass hybrids in conditions of optimum soil's water reserve and temperatures during the vegetation. The sorghum-sudangrass hybrids show excellent adaptive potential in conditions of more often going extreme deviations from the agro-climatic norms.

The total and the relative productivity in the separate swaths do not differ significantly for mowings in brooming and flowering stages. The negative affect of the water deficiency is the strongest for the productivity in the later swaths and for dry matter accumulation. The agroclimatic conditions do not affect the favorable share of the leaves in the green mass.

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DYNAMICS OF BIOMASS GROWTH AND DRY MATTER ACCUMULATION IN SUDANGRASS AND SORGHUM X SUDANGRASS HYBRIDS

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Abstract

It has been studied the growth of biomass and the dry matter accumulation during the stages of brooming, flowering, milky-wax maturity and technical maturity of Sudangrass and Sorghum x Sudangrass hybrids. The tests were performed in the Agricultural Institute – Shumen, Bulgaria during 2010 and 2011. The parameters of development and the intensity of dry matter accumulation were determined by biometrical analysis.
The vegetation rainfalls have the biggest effect on the productivity of the Sudangrass and its hybrids. The development of Sorghum and Sudangrass is strongly affected by the vegetation temperature sum.Theshortened vegetations due to the extreme agroclimatic deviations are compensated by intensive dry matter accumulation.
The parameters of biomass and dry matter accumulation are manifested with different levels depending on the genotype, as with the Sorghum x Sudangrass hybrids the high productivity is combined with intensive dry matter accumulation.

Key words: *accumulation, biomass, dry matter, Sorghum x Sudangrass hybrids.*

INTRODUCTION

The often appearing during the last years droughts are preconditions for a larger use of the Sudangrass and the Sorghum x Sudangrass hybrids in the production of green mass for fresh forage, silage and hay. Thanks to its strongly developed root system these crops ensure high yields in drought conditions and if cultivated on poorer soils, as well as the possibility of numerous grow-ups and the receipt of green mass in the hottest and dry moths of the vegetation. (Smith and Federiksen, 2000; Kikindonov et al., 2008).
The Sudangrass (*Sorghum vulgare* var. *Sudanensis* Piper) is used traditionally for green mass. The productivity of this crop is higher compared to other annual forage plants, reacts very well to nutrition and irrigation, use more effectively the available moisture quantities (Moga et al., 1996). Their water requirements are the same as corn but they have the ability to go dormant during extended drought periods. Growth will begin when the rains come. The Sudangrass hybrids of Sudangrass MS-lines and restorers resemble the common Sudangrass in growth and quality characteristics however they tend to be taller, have an intermediate stem diameter and are higher yielding than Sudangrass. (Beurlein et al., 1968). Sorghum-Sudangrass hybrids (*Sorghum bicolor* (L) Moench x *Sorghum sudanense* (Piper) Stapf), are more vigorous and taller than Sudangrass, have larger stems and coarser leaves, and give higher forage yield when harvested two or more times at the flower stage for green chop, or one time at the late milk stage for silage production (Snyman and Youbert, 1996; Paknejad et al., 2001).
The hybrids of Sudangrass show their high productivity potential in optimum conditions of cultivation, but owe their wide spreading to their high adaptability and resistance to extreme droughts, high temperatures and salt resistance, that's why it attains actuality in South-Western Europe (Antocha, 1994; Kertikov, 2007; Uzun et al., 2009).
The green mass yield is a result of the interaction between the hereditary features and the surrounding media conditions, where the dynamics of biomass growth and dry matter accumulation are determinative (Gumaniuc and Varga, 1988; White et al., 1989).
The aim of the research is to assess the parameters of growth and asccumulation of dry matter in Sudangrass and Sorghum x

Sudangrass hybrids depending on the genotype and the agroclimatic conditions in Agricultural Institute – Shumen, Bulgaria during 2010-2011.

MATERIALS AND METHODS

This study was conducted at the Agricultural Institute-Shumen, located in North-Eastern Bulgaria, during the period 2010-2011. The soil type of the experimental fields was a carbonate black-earth with good mechanical structure and weakly alkaline reaction of the soil solution.

The used experimental design for the tests of the varieties and hybrids was a random complete block in 4 repetitions. The experimental plot was 10.8 m^2, in three rows with 8 m length, row spacing was 45 cm. Seeds were sown at 20 $kg.ha^{-1}$ seed rate, at 4-5 cm depth, in the period 25.04 – 05.05.

The Sudangrass variety Verkor and the Sorghum x Sudangrass hybrid Susu have been tested, as well as a stabilized Sudangrass population and a Sorghum x Sudangrass hybrid from the breeding program of the Agricultural Institute – Shumen.

The weight of 15 plants of each repetition is measured with the mowings at brooming, flowering, milky-wax and technical grain's maturity phases. Afterwards, the dry matter content is determined by drying at 70^{o}C for 48h. The intensity of dry matter accumulation is counted by absolute growth index (AGR-g/ plant per day).

RESULTS AND DISCUSSIONS

2010 is characterized as a mean favorable year for the development of Sorghum and Sudangrass. The total rainfalls sum is extremely high. The conditions in July, August and September favoured the realization of productive grow-ups of green mass with mowings at brooming and flowering stages.

The spring of 2011 is continuous and cool, just after 15th of May the air temperature exceeded 15^{o}C, which forced late sowing – on 12-15th of May. The low temperatures caused the development delay. The rainfalls are unevenly distributed during the vegetation, which could also proof the year to be unfavorable.

Data given on Table 1 represent the dynamics of growth of the biomass and the dry matter during the development of the tested in 2010-2011 varieties. We have chosen the phases brooming, flowering, milky-wax and technical maturity, when in the practice mowings are made for fresh forage and silage.

An intensive growth of the biomass goes to the technical maturity stage, and it strongly depends on the genotype, and not so strongly – on the agroclimatic conditions. During the favorable 2010 the mean weight increases from 104 g at brooming stage to 235 g at milky-wax maturity stage. The lack of enough rainfalls in 2011 does not affect substantially on the weight, as the mean values increase from 93 to 242 g. More significant are the differences between the different genotypes. The Sorghum x Sudangrass hybrid has the highest values of plants weight, which increases from 159 to 316 g in 2010. It is impressive the intensive increase of the other tested sorghum x Sudangrass variety – from 70 to 255 g. In technical maturity phase, in both years, as a result of drying the vegetative mass a decrease of the green mass begins.

The dry matter content is influenced at greatest extent by the agroclimatic factors. The mean values of the tested origins in 2010 start from 28% at brooming and flowering stages, by 56% at milky-wax and to 72% at technical maturity stages. In the dry 2011 the differences are manifested in the initial phases – brooming and flowering – 40% dry matter. After that the values equalize with those from 2010.

The information from Table 2 allows us assess the intensity of dry matter accumulation during the vegetation in dependence on the agroclimatic factors and the genotype. As a result of the later sowing and the following extreme drought in 2011 the phases of development are shortened with 5-15 days. The cool spring decreases the vegetation temperature sum with more than 200 degrees.

The most significant for the two years is the extreme drought from the sowing to milky-wax maturity in the middle of August. These differences strongly affect the dry matter accumulation. The mean values of accumulation intensity until technical maturity stage in 2011 increase with 0.20 g per day of the vegetation. The drying of the vegetative mass due to the continuous drought strongly decreases the intensity after the milky-wax stage.

The productive potential is manifested in the parameters of biomass growth and dry matter accumulation intensity. Their interaction with the genotype compensates the unfavorable agroclimatic conditions, which makes the adaptivity of Sudangrass and the Sorghum x Sudangrass hybrids unique.

Table 1. Variability of weight and dry matter during the development of Sudangrass and Sorghum x Sudangrass hybrids, 2010-2011

Origin	2010				2011			
	Weight, g			Dry matter %	Weight, g			Dry matter %
	X	± Sx	C %		X	± Sx	C %	
Brooming								
Susu	69.5	9.36	42.6	24.9	70.7	6.83	37.4	41.0
Verkor	82.0	11.02	42.5	25.3	61.3	5.13	32.4	42.3
SVE	108.2	12.91	37.7	31.5	108.3	13.60	48.6	38.4
A x SV	158.5	16.66	33.2	31.1	130.3	10.33	30.7	38.4
Flowering								
Susu	122.0	9.97	31.6	29.7	118.9	14.43	47.0	33.9
Verkor	127.3	18.94	53.4	28.4	100.9	6.46	35.3	38.7
SVE	126.7	16.22	37.7	29.9	111.7	7.10	38.3	34.9
A x SV	274.3	25.55	36.0	29.1	239.3	26.05	42.2	49.3
Milky-wax maturity								
Susu	255.3	14.02	21.3	53.1	245.0	14.54	22.4	57.3
Verkor	223.3	15.09	47.4	54.9	226.5	18.09	27.7	53.1
SVE	147.0	12.26	32.3	64.4	196.0	12.25	19.8	51.1
A x SV	316.7	28.01	34.3	52.6	303.5	59.80	56.7	60.7
Technical maturity								
Susu	200.0	12.6	21.2	82.7	172.8	8.23	22.9	68.2
Verkor	149.0	15.0	39.5	78.5	124.1	5.29	14.6	73.3
SVE	138.9	8.53	20.9	76.7	118.0	7.94	22.9	75.9
A x SV	243.1	9.71	15.5	71.0	200.6	10.9	18.5	69.5

Table 2. Intensity of dry matter accumulation, measured by absolute growth index (AGR, g/ plant-1/ day-1), 2010-2011

Variant	2010				2011			
	Broom	Flower	Milky-wax maturity	Technical maturity	Broom	Flower	Milky-wax maturity	Technical maturity
Rainfalls sum	250	285	301	328	75	82	143	168
Temperature sum	1182	1499	2233	2929	954	1058	1863	2683
Days of vegetation	70	85	110	135	60	75	100	130
Susu	0.25	0.43	1.23	1.24	0.49	0.54	1.40	0.91
Verkor	0.30	0.42	1.11	0.87	0.43	0.52	1.20	0.70
SVE	0.49	0.45	0.86	0.79	0.69	0.52	1.00	0.69
SAxSV	0.70	0.94	1.50	1.28	0.83	1.56	1.85	1.08
Average	0.46	0.64	1.22	1.12	0.63	0.84	1.41	0.99

CONCLUSIONS

The vegetation rainfalls have the biggest effect on the productivity of the Sudangrass and its hybrids. The development of Sorghum and Sudangrass is strongly affected by the vegetation temperature sum**.** The shortened vegetations due to extreme agroclimatic deviations are compensated by intensive accumulation of dry matter.

The significant differences in the agro-climatic factors of the years of our study allow reliable assessment of the productive potential and the adaptability of the sorghum-sudangrass hybrids in conditions of extreme deviations from the norm.

The parameters of biomass and dry matter accumulation are manifested with different levels depending on the genotype, as with the Sorgum x Sudangrass hybrids the high productivity is combined with intensive accumulation of dry matter.

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EFFECTS OF DIFFERENT NITROGEN FORMS ON SOME AGRONOMICAL CHARACTERISTICS OF *Echinacea purpurea* IN SEMI-ARID CONDITIONS OF TURKEY

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Abstract

Echinacea, commonly known as coneflower, is a member of the Asteraceae family. The plant is one of the most commonly medicinal plant, is herbaceous perennials with large daisy-like flowers. The roots and aerial parts of Echinacea purpurea is used commercially as herbal plant for enhancing the immune system and treating common cold. This research was conducted to determine the effects of different nitrogen forms on some agronomical characteristics on purple coneflower. In terms of agronomical parameters, plant height, number of branches, stem diameter, number of head, fresh root weight, fresh flower weight, whole plant fresh weight, dry root weight, dry flower weight, whole plant dry weight per plant were examined. According to the results, the nitrogen forms had no statistically significant effects on yield parameters except fresh & dry root weight. Dry root, dry flower weight and dry whole plant weight were determined as 24.6-31.3 g/plant, 9.3-15.4 g/plant and 76.2-106.6 g/plant, respectively.

Key words: *Echinacea, coneflower, nitrogen forms, agronomical characters.*

INTRODUCTION

Echinacea are herbaceous perennials belonging to the Asteraceae family natural lands of North America, with wild populations spreading from the Eastern and Central United States to Southern Canada. They are widely used for wild flower as ornamental plants in gardens (Chen et. al., 2008). Echinacea also called "pembe koni cicegi" in Turkish (Kucukali, 2012).

Three species of Echinacea are used medicinally: *E. purpurea* (L.) Moench*, E. pallida* (Nutt.) Nutt., and *E. angustifolia* DC because of their antiviral, antibacterial and immunostimulatory benefit to human health (Chen, 2008). All three species show pharmacological activity, which appears to result from the combined effects of caffeoylphenols, alkamides, and polysaccharides. However, *E. purpurea* is the most cultivated and widely used of the three species, due to ease of cultivation and total use of the whole plant (Chen, 2009). The most widespread use of Echinaceae drugs is aerial parts of *E. purpurea* and *E. pallida*'s roots (Mat, 2002).

Medicinal and aromatic plants are strongly affected by environmental factors. These factors influence the fresh and dry weight, as well as active substances of herbs. In this respect, the use of chemical fertilizers and their different forms can increase the yield of active substances and main components of medicinal plants. For example, there is evidence that there is an increase in biomass with N fertilization but not fertilization phosphorus and potassium (Shalaby et al., 1997). Meanwhile, utilization of chemical fertilizers and nutrients increase the yield and yield components in a positive way. Nitrogen is an important nutrient for

MATERIALS AND METHODS

E. purpurea was cultivated at the Department of Field Crops, Faculty of Agriculture, University of Dicle, Turkey located at 20^{o}45'S, 42^{o}51'W and at 670 m above the sea. Seeds of *E. purpurea* were sown in a seedbed nursery, from where at 10-15 cm plant height, they were transplanted to field (April 2009). Field trial was conducted under different fertilization forms of 10 kg/da named control, ammonium sulphate, ammonium nitrate and **diammonium phosphate,** according to randomised block design with three replications. Each plot was arranged as 4 rows each of 45x20 cm. Fertilizer was applied as two times; ½ applied during transplanting and ½ applied at first irrigation. Weeds were controlled by manually. Plants were irrigated three times.

Plants in the trial were harvested by each plant separately on 13 September 2010 at full blooming stage. All the harvested plants were separated into leaves, flowers and roots for evaluated characters. Plant height, number of branches, stem diameter, number of head, fresh root weight, fresh flower yield, whole plant fresh weight, dry root weight, dry flower yield and whole plant dry weight per plant were investigated for each fertilization form. The experimental design was a randomised complete block with three replications. Plot size was 5.1 m^2. Data on all parameters were assessed by analysis of variance and treatment means separated by DUNCAN test (SPSS 18:00).

RESULTS AND DISCUSSIONS

The differences between treatments with respect to the plant height, number of branches, stem diameter, number of head, fresh root weight per plant, fresh flower yield per plant, whole plant fresh weight, dry root weight per plant, dry flower yield per plant, whole plant dry weight per plant were given for each fertilization form in Table 2 and Table 3.

Table 1. The mean values of some agronomical characteristics in *E. purpurea*

Fertilization Forms	Plant height (cm)	Number of branch	Stem diameter (cm)	Number of flower head	Fresh root weight (g/plant)
Control	79.9 b*	5.8	7.33b	14.2ab	51.8
Diamonium Phosphate	85.5ab	8.1	8.28ab	12.8b	61.1
Amonium Nitrate	79.8b	6.9	8.07ab	14.8ab	71.0
Amonium Sulphate	91.6a	6.3	9.18a	17.7a	57.6
Duncan (0.05)	*	ns	*	*	ns

Means followed by the same letter are not different according to Duncan Range Test (P=0.05)

Plant Height

The mean values of the trial were given in Table 2. According to the results of research, different nitrogen doses had significant effect on plant height. The maximum plant height obtained from ammonium sulphate as 91.6 cm, while the minimum plant height from control as 79.8 cm. The plant height of *E. purpurea* reported as 82.5 cm by Yaldiz et al. (2012), as from 46.21 to 50.01 cm by Chen et al. (2008), as from 36.13 to 46.21 cm by Chen (2009), as from 78.0 to 100.4 cm by Kan (2010), as from 38.6 to 41.6 cm in first year while from 74.6 to 91.6 cm in second year by Sati (2012). Kucukali (2012) determined plant height of *E. purpurea* as 63.3 cm. Morphological characteristics are affected from different ecological factors such as light, temperature, irrigation etc., so some plants growing different ecological conditions could create their ecotype. Therefore, differences in literature relating with Echinaceae could be arose this cause.

Number of Branch

There was no significant difference among the nitrogen forms for the number of branch per plant. However, the highest number of branch was obtained from diammonium phosphate with 8.1 per plant, while the lowest number of branch was obtained from ammonium sulphate as 5.8 per plant. Yaldiz et al. (2012) found that number of branch per plant was 13 per plant, Kan (2012) reported that number of branches of *E. purpurea* ranged from 9.5 to 26.6 per plant, Yarnia et al. (2012) determined number of branches values as 13.4 per plant. Kucukali (2012) also reported that the average of number of branch of *E. purpurea* was 9.20 per plant. Our data was found lower than literature, this may cause from ecological conditions, especially from semi-arid climatic.

Stem Diameter

Table 2 shows that there were significant differences among nitrogen doses for the stem diameter. The high stem diameter found in ammonium sulphate fertilization form as 9.18 cm, while the lowest stem diameter was obtained from control as 7.33 cm. Differences among nitrogen sources relation with stem diameter might be caused from ammonium sulphate nitrogen forms which is resists loss from leaching and its efficiency is long-lasting (Anonymous, 2012).

Number of Flower Head

Significant differences were determined between fertilization forms for number of flower head.

Fresh Root Weight

There were no significant differences between the different fertilization forms for fresh root weight. The highest fresh root weight was obtained from ammonium nitrate (71.0 g/plant) and lower fresh root weight (51.8 g/plant) from control plots. Kucukali (2012) reported that fresh root yield per plant varied due to different plant densities and harvest number, and reported mean fresh root yield as 109.16 g/plant. Results of Seidler and Dabrowska (2003) indicate that fresh root yield per plant is 100.5 g/plant in rosette stage, 377.5 g/plant in rosette stage of second year and 1270 g/plant flowering stage.

Fresh Flower Weight

Data in Table 3 revealed that fresh flower weight gave the maximum result in Ammonium sulphate form (66.0 g/plant), while, control was ranked in the lowest position (35.9 g/plant). Kucukali (2012) reported that fresh flower yield of *E. purpurea* was 214.82 g/plant. Chen et al. (2008) determined that flower yield per plant ranged from 25.61 to 51.19 g. In their study, all the morphological, agronomic and biochemical traits in harvested plants were highly variable, this variability could be explained by environmental and cultural conditions, with the inter-individual differences being the main source of variability. *E. purpurea* is a cross-pollinated plant and tends to be self-incompatible. Therefore, the large variability in its morphological and agronomic traits is not unexpected. Differences in our results seem to verify it.

Whole Plant Fresh Weight

There were no statistical differences in fresh herbage weight. However, higher fresh herbage weight (264.3 g/plant) was recorded at forms of diammonium phosphate and lower fresh herbage weight (187.6 g/plant) was recorded on control plots. Fresh herbage yield per plant were reported as 664.4 g/plant by Kucukali, 2012), and as between 61.52 and 112.89 g/plant by Chen (2008). The reason of variable yield parameters in Echinacea is better able to grow efficiency; neutral, efficient, light, well-drained and alkaline pH of soils (Douglas, 1993).

Dry Root Weight

In this experiment, dry root weight was not affected by fertilization forms, however the maximum value obtained from ammonium nitrat as 31.3 g/plant. The lowest value also was obtained from control plots with 24.6 g/plant. Parmenter and LittleJohn (2002) found the maximum root yield after two season of growth as 30 g/plant in different plant densities. Powell et. al. (2001) stated that dry root yield of *E. angustifolia* is variable due to soil type and depth and reported that root weight ranged from 6.9 to 55.6 g/plant. Chen (2009) also reported that dry root yield of *E. purpurea* lines varied from 8.89 to 16.77 g/plant. The results are compatible with the findings of the mentioned authors.

Dry Flower Weight

In connection with fresh flower weight, ammonium sulphate gave the maximum yield for dry flower weight with 15.4 g/plant. The lowest dry flower weight was obtained from control with 9.3 g/plant. Kucukali (2012) reported that average of dry flower yield was 54.3 g/plant, Shalby et al. (1997) indicated that dry flower yield was 45 g/plant. In the words of Chen et al. (2008), *E. purpurea* is a cross-pollinated plant and tends to be self-incompatible. Therefore, the large variability in its morphological and agronomic traits is not unexpected. According to Chen et al. (2009), dry flower head yield per plant varied from 26.08 to 31.60 g/plant.

Whole Plant Dry Weight

No significant differences were observed among nitrogen forms in whole plant dry weight. However, the high value obtained from diamonium phosphate as 106.6 g/plant, while the low one (76.2 g/plant) achieved in the control treatment. Kucukali (2012) indicated that dry herbage yield per plant was 164.81 g/plant, Shalbay et al. (1997) also reported dry herbage yield as 53 g/plant. Yarnai (2012) found 41.41 g/plant for above ground dry yield. Chen (2009) indicated that aerial part of *E. purpurea* varied between 50.80 to 92.93 g/plant depending on different Echinecea lines. Differences between these studies might cause from different ecological conditions, different harvest stages or applications.

Table 2. The mean values of some agronomical characteristics in *E. purpurea*

Fertilization Forms	Fresh flower weight (g/plant)	Whole plant fresh weight*	Dry root weight (g/plant)	Dry flower weight (g/plant)	Whole plant dry weight (g/plant)
Control	35.9b**	187.6	24.6	9.3b	76.2
Diamonium Phosphate	44.9b	264.3	29.6	12.8ab	106.6
Amonium Nitrate	51.1ab	237.5	31.3	12.6ab	95.9
Amonium Sulphate	66.0a	212.2	25.6	15.4a	84.2
Duncan (0.05)	*	ns	ns	*	ns

Leaves stem and flower

* Means followed by the same letter are not different according to Duncan Range Test (P=0.05)

CONCLUSIONS

Purple coneflower is an important medicinal plant that has the potential for future consumption in our country. It was determined that the nitrogen forms had significant effects on dry flower weights and the other some plant growth parameters. Further studies should be planned for this purpose, but efficiency of the diammonium sulphate was better than the ammonium sulphate, DAP and control for investigated characters.

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STUDIES ON SOYBEAN GROWING IN TULCEA COUNTY

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Abstract

Grain legumes are agricultural crops of food, fodder, and agronomic importance. However, they are demanding to growing conditions and sensitive to stress factors, which limit their expansion.
Among legumes, soybean had a spectacular development in recent decades, reaching 100 million ha worldwide, as a source of protein and fat of outstanding value.
In Romania, soybean was grown on about 500 thou ha in the years 1987-1989, and crop declined to 40-60 thou ha, with a short turnaround (in 2001-2006) when it was officially permitted to grow genetically modified soybean varieties.
In Tulcea County, soybean growing has tradition and a trend similar to that reported at the country level. The evaluation marks for soybean of agricultural land in Tulcea County is 41, because of low rainfall, but can be greatly enhanced by irrigation.
In the years when genetically modified soybean growing was permitted, soybean sown areas have doubled and number of soybean growing farms increased from 12-13 to 43 holdings.
Assortment of soybean genotypes included Romanian varieties (Danubiana, Columna, Triumf, etc.), varieties of world collection (Condor, Avila, etc.) and genetically modified varieties (S2254RR, SP9191RR).
Soybean yields achieved by farms in Tulcea County are on average 1,500-2,500 kg/ha, but in irrigated holdings, yields consistently exceeded 4,000 kg/ha, which illustrates the profitableness of this crop. It is to emphasize some traditions soybean growing farms fro Tulcea County: SC Acvila Macin, SRL, SC Lombardi Agro SRL, SC Adam Agrorent SRL, SC Soia Agro SRL.

Key words: *soybean crop, Tulcea County, soybean growing areas, productions and farms, varieties.*

INTRODUCTION

Soybean is currently one of the most important agricultural crops in the world, holding, with over 100 million ha sown annually, the 4th place after wheat, rice and corn. Extent that soybea cultivation has taken in recent decades is due to: chemical composition of the crop, rich in biochemical constituents with high biological value (approximately 20% lipids and proteins around 40%, formed a significant proportion of essential fatty acids and amino acids for human body); very varied possibilities of processing and use of crop (edible fats, animal feed concentrates, protein preparations for food, biofuels, other uses as raw material in very different industries); importance as leguminous plant for land fertility improvement in crop rotation. Introduction and expansion of GM soybean cultivation has been an essential step in promoting soybean globally (currently over 60% of the area planted with soybean are genetically modified varieties). In this context, decreasing soybean growing in Romania, while in the 80s it had reached over 500 thou ha (the area cultivated was more than other European countries together), is an unwanted process with multiple causes and negative consequences that deserves to be analyzed.

In this respect, it was considered that the study of the evolution and current situation of soybean growing in Tulcea County, a county with strong agricultural vocation by favorable natural resources and long traditions can contribute with useful information on efforts to identify the causes of the decline in soybean crops, assessment of recovery prospects of crop and establishing a concrete strategy for the future.

Studies in 2009-2012, about these issues in Tulcea County led to interesting conclusions regarding: the natural resources of the area for soybean crop; cultivated areas and yields;

growing agricultural farms; evolution of varieties assortment.

Our approach comes in the context of discussions at EU level on the acceptance of GM soybean growing in Europe, and the launch of 'Donau Soya' project according to a document signed by agriculture ministers from 14 European countries, to support traditional soybean varieties growing, including organic soybean crop.

MATERIALS AND METHODS

Study on soybean growing in Tulcea County was conducted based on information provided by national and zonal agricultural administration. In addition, we organized a study-survey in farms on the evolution of soybean growing and on the varieties grown in the county. Field trips have included discussions with soybean growing farmers in the county or with farmers interested in expanding soybean crop (Figure 1).

Figure 1. Tulcea County location in southeast of Romanian territory (www.rovt.ro/romania_map_ro)

An important objective of the study was the evaluation of the county's natural environment and the favorability for soybean crop. It should be noted that Tulcea County (located in the Region of Development South-East) has a total area of 849.87 thou ha of which 361.50 thou ha agricultural areas (42.5% of the county), 95.19 thou ha of forest and other land with forest vegetation, 353.29 thou ha waters and ponds, 39.88 thou ha of other destinations. Of the agricultural area, arable land has 288.59 thou ha (34.0% of the total area of the county), 60.92 thou ha pastures, 11.98 thou ha vineyards, orchards and nurseries (Statistical Yearbook, 2013; Epure, 2006). In the past, 128.29 thou ha were areas under irrigation, representing 44.4% of the total arable area of Tulcea County.

RESULTS AND DISCUSSIONS

Natural conditions in Tulcea County. From this study, it appeared that, in terms of **relief** in Tulcea County meet the highest heights in Dobruja (Macin Mountains) and large areas below sea level, in the Danube Delta. In the center of the county are areas with the highest rates of relief (467 m), its height decreasing towards the edges of the county, where there are areas with heights up to 100 m.

Tulcea county has a rich **hydrographic regime**, surrounded to the west and north by the Danube and east by the Black Sea and lagoons Razelm lake (Figure 2).

Figure 2. Physical map of Tulcea County (www.pe-harta-ro/tulcea)

Rivers in the county are small, and of low economic importance: Topologu, Cerna, Luncoviţa, Isaccea (which flows into the Danube), Taita, Teliţa, Slava, Ceamurlia, Agighiol (which flows into lakes complex Razelm). Surface water network in Northern Dobrudja is well represented by lakes (rivers limans and lagoons of Razelm complex). As such, the main source of water for irrigation is the Danube which partially adds lakes of Razlm complex.

After Köppen, the **Dobrudja climate** is of Bsax type, which means that it meets the features of a dry steppe climates (BS), the temperature of the hottest month is less than 22°C (a), and the maximum rainfall at the beginning summer (x).

Average yearly *temperature* (period 1963-2006) in the area is 11.3°C. Month with the lowest average temperature of the year is January (-0.9°C), varying between 8°C (in 1963) and -2.9°C (1983). Month with the highest average temperature is July with 22.7°C, varying between 20.4°C (1969) and 25.4°C (2001 and 2002).

Average temperatures in spring illustrates the existence of cold springs and of very hot summers. The autumns are long and relatively warm and the winters are moderate from thermal point of view.

It was found that in April and May, the months when the soybean crop is established, the monthly average temperature varies between 9°C and 11.4°C in April and between 15.8°C and 19.6°C in May.

Average *rainfall* recorded at county level is 375 mm annually, and very limited area distinguished with low rainfall, with an average of 288 mm total annual, located in the Danube Delta. Continental area of the county have very small areas with annual rainfall of 450-550 mm. During the warm season (April 1 to September 30) fall in average 246 mm rainfall, representing about 59% of the total.

The analysis of air relative humidity shows that higher multiannual values were found in the cold season (82-86%), while during the warm season, they are lower (73-75%). Dobrudja has the highest level of cloudless across the country. On average during 1967-2006, annual sunshine duration was 2,340 hours, with values in the soybean growing season between 191 hours and 314 hours, in May in July.

Under the influence of topography, soil formation rock, climate, water and vegetation emerged a wide range of **soils**. So, meet chermozem soils in the areas with altitudes between 0 and 110 m, on loess and loess deposits, where rainfall averages less than 450 mm and annual average temperatures up to 11.3°C. These soils occupy large areas in Depression Nalbant-Mihail Kogalniceanu, in Babadag Plateau, eastern Casimcea Plateau and Valley, and in the Danube Valley (Macin - Greci, Ostrov-Dăeni, Garliciu) (Mihalache, 2006). Carbonate and cambic chernozems occupy the higher altitude, more than 150 m. Cernisols occur on areas that exceed an altitude of 200 m, and lithosols occupy significant areas in Macin Mountains, in Babadag Plateau, and Casimcea Plateau. Tulcea soils are poor (27.2%) and medium (61.6%) in nitrogen supply, are very good, good and medium supplied with phosphorus, and are very good, good and medium supplied with potassium. In most the soils in the county have weak alkaline reaction, and the remaining land have from strong to moderately and slightly acid reaction.

Dobrudja has a characteristic **vegetation** of the steppe zone. Presence of forest soils and isolated trees demonstrate the great expanse of forest in the past that have substantially narrowed over the past 200 years, as a result of human intervention and natural degradation.

Of crop plants, the weight of cultures hold: winter wheat, barley, maize, sunflower, rapeseed and lower surfaces are cultivated with soybean, alfalfa, mustard, coriander.

Suitability of the area for soybean crop. From the analysis undertaken, it is concluded that soybean has good conditions for growing in Tulcea County, as thermal and soil conditions. Limiting factor of soybean production in this area is water supply.

Figure 3. Zoning of soybean crop based on thermal resources ($\Sigma t>10^{o}C$) (Roman et al., 2011) I – 1.600-1.750°C; II – 1.400-1.600°C; III – 1.100-1.400°C; IV – 1.200-1.400°C; V – 1.100-1.250°C

Moreover, based on thermal resources, Tulcea County is framed in the Sustainability zone I for soybean (Figure 3). Zone I comprises the Southern Romanian Plain and Dobrudja; the sum of active temperatures (temperatures above 10°C) is higher than 1600°C, and it is recommended to grow mainly semi-late varieties (Balkan, Danubiana, Triumph), and semi-early (Columna, Daciana, Neoplanta, Perla), and less late varieties (Venerra).

In this area, priority must be to place soybean crops on irrigated land or on areas with groundwater supply (Roman et al., 2011).

Table 1. Suitability marks of agricultural land for soybean crop in Dobrogea

Conditions	Tulcea	Constanta
Non-irrigated crop	42	42
Irrigated crop	87	86

Evaluation marks for soybean under natural conditions are poor: 41 to Tulcea County (and 42 for Constanta County, Table 1), while a series of measures to enhance the productive potential of soils, especially investment in irrigation, mark of evaluation is doubled.

Evolution soybean growing in Tulcea County. Considering the benefits of soybean crop - many uses of the harvest and suitability as previous crop in crop rotation -, soybean cultivated area has registered significant growth until 1989 (Enciu et al., 1982). In this respect, prior to 1990, soybean covered in Tulcea County tens of thousands ha, soybean crops being one of the beneficiaries of irrigation systems extending over nearly half of the arable land of the county.

Table 2. Evolution of soybean crop growing in Tulcea County in the years 2000-2006

Year	Area (ha)	Total production (tone)	Average yields (kg/ha)
2000	3,950	2,503	633
2001	1,878	2,723	1,450
2002	1,658	3,843	2,045
2003	4,233	11,230	2,653
2004	5,021	10,159	2,023
2005	3,938	8,736	2,218
2006	5,229	9,748	1,864
2007	3,466	2,710	782
Media	3,671	6,456	1,708

In the years 1990-2000 there was a sharp reduction in soybean areas due to reduced activity of the livestock sector, but also to dramatic decrease in irrigated area (Table 2).

For example, in 1999 soybean occupies only 7,241 ha, and the average production was of 1,472 kg/ha, leading to a total production of 10,658 tons. In the years that followed, areas planted annually with soybeans ranged from 1,878 ha in 2001 and 1,658 ha in 2002, to 5,021 ha in 2004 and 5,229 ha in 2006.

The Table 3 show that average yields fluctuate greatly from year to year depending on rainfall, and the opportunity to intervene through irrigation in some areas (e.g. in 2003) (Chelu, 2008; Statistical Yearbook, 2013).

Soybean growing farms. Analysis performed in Tulcea County illustrated that there was a large fluctuation from year to year in terms of acreage in soybean and their distribution on individual farms.

Thus, in 2000, 3,950 ha were cultivated with soybean, which contributed 13 farms with areas between 10 and 1,381 ha. The higher surface with soybean detaches SC Agrodelta Sireasa (1,381 ha) and SCA Vacareni (870 ha) (Table 3). The average yields were low, with 1,000 kg/ha or more registering only 3 farms. The following year (2001), total soybean area decreased to 1,878 ha; the 12 farms growing soybean were sown less that 200 ha, except SCA Vacareni (844 ha). The average yields were higher, as follows: SC Victoria Trading Ltd (2,100 kg/ha), SC Agrodelta Sireasa (2,000 kg/ha) and SCA Vacareni (1,919 kg/ha). A series of years, the expansion of GM soybean varieties boosted soybean growing.

In 2002, the number of growing farms increased to 20, but the cultivated area decreased to 1,658 ha; areas planted in a farm ranged from 5 ha up to 508 ha (SC Acvila Macin Ltd). The county average yield this year was 2,045 kg/ha, and few farms harvested over 3,000 kg/ha, including SC Lombardi Agro Ltd, SC Acvila Macin Ltd, SC Soia Agro Ltd (Table 4).

In 2003, the number of soybean growing farms increased to 43, but the areas per farm were very small in most of them. The most important areas are distinguished primarily SC Acvila Macin Ltd (484 ha) and SC Agrodelta Sireasa (482 ha), but SC Lombardi Agro Ltd, SC Adam Agrorent Ltd and SC Euroavipo Ltd, too (over 200 ha each).

Year 2005 was characterized by lower soybean areas (1,950 ha) and 25 growing farms, none with more than 200 ha sown with soybean. More than 100 ha were sown few farms, including SC Acvila Macin Ltd and SC Lombardi Agro Ltd. The average yields achieved were good, 9 farms harvesting over 3,000 kg/ha, including SC Soia Agro Ltd (4,009 kg/ha) and SC Adam Agrorent Ltd (3,664 kg/ha).

Table 3. The most important soybean growers in Tulcea County (2001-2006)

Year	Succesion of soybean growing farms in accordance to sown area				
	1	2	3	4	5
2001	SC Vacareni 844 ha	SC Euro-avipo SRL 204 ha	SCA Macin 193 ha	SC Agroin-dustriala Murighiol 148 ha	SC Spicoza SRL 90 ha
2002	SCA Acvila Macin SRL 508 ha	Greci 178 ha	SC Agro-delta Sireasa 156 ha	Jijila 140 ha	SC Agro-schinau SRL 135 ha
2003	SC Acvila Macin SRL 484 ha	SC Agro-delta Sireasa 482 ha	SC Euro-avipo SRL 280 ha	SC Adam Agrorent SRL 265 ha	SC Lombardi Agro SRL 214 ha
2004	SC Comert Cerale SRL 550 ha	SC Aldo Impex SRL 343 ha	SC Acvila Macin SRL 235 ha	SC Cold Prod Com SRL 229 ha	SC Riambo SRL 210 ha
2005	SC Transion-Trading SRL 192 ha	SC AMP Tornea SRL 170 ha	SC Acvila Macin SRL 155 ha	SC Lombardi Agro SRL 140 ha	SC Agrodar SRL 120 ha
2006	SC Agro Eco Sanitas SRL 610 ha	SC Miti-Geo SRL 313 ha	SC Acvila Macin SRL 300 ha	SC Spicoza SRL 247 ha	SC Agrocom Soimul SRL 230 ha

In 2004, the area planted with soybeans was 3,752 ha and growing farms number was 34, with a large dispersion surfaces, from only 7 ha to 550 ha in SC Commerce Cereals Ltd and 343 ha in SC Aldo Impex Ltd, plus a few farms over 200 ha sown with soybeans, including SC Acvila Macin Ltd. In that year, resulted better productions, SC Spicoza Ltd and SC Acvila Macin Ltd harvesting just over 4,000 kg/ha.

In 2006, the area planted with soybeans increased to 3,434 ha, dispersed in 34 farms, each with areas between 2 ha and 313 ha. More than 300 ha of soybean were sown in SC Agro Eco Sanitas Ltd (610 ha), SC Miti-Geo Ltd (313 ha) and SC Acvila Macin Ltd (300 ha). This year can be considered as very favorable for soybeans, if they consider yields over 4,000 kg/ha achieved by SC Soia Agro Ltd (5,950 kg/ha), SC Airem Ltd (5,190 kg/ha), SC Mancov Ltd (5,000 kg/ha) and SC Acvila Macin Ltd (4,216 kg/ha).

Aspects in soybean seeds productions in Tulcea County. The study-survey concluded that some of the soybean seeds for the establishment of soybean crops in Tulcea County are produced in seeds crops located only in conditions of irrigation. Most of the biological material (seeds) comes from neighboring counties (Constanta, Braila), or from companies that sell seeds material.

Table 4. Farms in Tulcea County with higher soybean yields (2001-2006)

Year	Succesion of soybean growing farms in accordance to average yields				
	1	2	3	4	5
2001	SC Victoria Trading SRL 2100 kg/ha	SC Agro-delta Sireasa 2000 kg/ha	SCA Vaca-reni 1919 kg/ha	SCA Macin 1326 kg/ha	SCA Lombardi Agro SRL 1321 kg/ha
2002	Grindu 3400 kg/ha	SC Acvila Macin SRL 3289 kg/ha	SCA Lombardi Agro SRL 3000 kg/ha	SC Soia Agro SRL 3000 kg/ha	SC Agrodelta Sireasa 3000 kg/ha
2003	Grindu 4114 kg/ha	SC Acvila Macin SRL 3523 kg/ha	SC Adam Agrorent SRL 2800 kg/ha	SC Teodema Serv Com SRL 2800 kg/ha	SC Soia Agro SRL 2798 kg/ha
2004	SC Spicoza SRL 4560 kg/ha	SC Acvila Macin SRL 4230 kg/ha	SC Agrodar SRL 3814 kg/ha	SC Lord SRL 3600 kg/ha	SC Inextenso SRL 3500 kg/ha
2005	SC Soia Agro SRL 4009 kg/ha	SC Agro-dunarea SRL 3750 kg/ha	SC Adam Agrorent SRL 3664 kg/ha	SC Lord SRL 3618 kg/ha	SC Agrodar SRL 3500 kg/ha
2006	SC Soia Agro SRL 5950 kg/ha	SC Airem SRL 5190 kg/ha	SC Mancov SRL 5000 kg/ha	SC Acvila Macin SRL 4216 kg/ha	SC Lombardi Agro SRL 3974 kg/ha

Between 2001 and 2006, farmers included in the assortment GM soybean varieties (S0994RR, S1484RR, S2254RR, PR92B05RR, PR92B71RR, AG0801RR).

Among the varieties listed in Official Catalogue of Varieties, in Tulcea County were grown mainly Danubiana, Columna and Triumf. In the analyzed period soybean seeds crops totaled between 35 ha (in 2005) and 370 ha (in 2000). Varieties for which seed were produced were Danubiana, Columna, Triumf (of current range), Avila, Condor, Dekabig, Orlando (which were removed from the national assortment). Among farms producing soybean seeds are found farms that have been previously distinguished for results in crops for consumption, such as: SC Acvila Macin Ltd and SC Teodema Serv Com Ltd.

CONCLUSIONS

The analysis undertaken has revealed that soybean find suitable condition for growing in Tulcea County, as thermal and soil conditions. The limiting factor of soybean production in this area is water supply.

For soybean crop in Tulcea County, the land mark of evaluation is modest (41), as a result of decreased rainfall. This however is doubled under irrigation.

Based on thermal resources, Tulcea County is included in Suitability Zone I for soybean; the sum of active temperatures ($\Sigma t>10^oC$) is higher than 1600°C; it is recommended to cultivate mainly semi-late varieties (Danubiana, Triumf, etc.), and semi-early varieties (Columna, Daciana, Perla), and less, late varieties (Venerra). In this area, priority must be to place soybean crop on lands under irrigation or with groundwater supply.

Prior to 1990, soybean covered in Tulcea County tens of thou ha, soybean crop being one of the beneficiaries of irrigation systems extending over nearly half of the arable land of the county. Subsequently, the surfaces were considerably reduced under 10,000 ha.

Analysis performed in Tulcea County illustrated that there was a large fluctuation from year to year in terms of acreage in soybeans crops and their distribution on farms, from 1,658 ha in 2002 and 1,878 ha in 2001 to 7,241 ha in 1999.

The number of soybean growing farms ranged from 12 to 13 in 2000 and 2001 and 43 in 2003.

Average soybean yields achieved were very different, depending on the technology and climatic conditions from 633-782 kg/ha recorded in 2000-2007, up to 2,653 kg/ha in 2003.

In the analyzed period, traditional soybean growers in the county, constantly grown soybean for consumption and/or for seeds with good results were: SC Acvila Macin Ltd., with 155-508 ha, and 3,289 to 4,230 kg/ha; SC Lombardi Ltd., with 140-214 ha and 3,000 to 3,974 kg/ha; SC Adam Agrorent Ltd, with 265 ha and from 2,800 to 3,664 kg/ha; SC Soia Agro Macin Ltd, with 183-193 ha and up to 4,009 kg/ha.

Seeds for establishment of crops fro consumption, are partly produced in the county, and most come from neighboring counties like Constanta, Braila or companies that produce and sell seeds.

At current prices prevailing external market for 530 USD/ton of seeds and 1,160 USD/ton of oil, soybean crops in Romania are cost effective and can build significant sources of revenue for farmers.

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HAPLOIDY IN MAIZE *(ZEA MAYS* L.*)* BREEDING AND RESEARCH

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Abstract

A haploid is a plant that contains a gametic chromosome number (n). They can appear spontaneously in nature or as a result of different induction techniques. For maize (Zea mays L.), in situ induction of maternal haploids, results by using a selected inducing genotype (line). The first inducer line was Stock 6 discovered by Coe in 1959, with an induction rate of 2.3%. Over the years through hybridization and selection the induction rate improved. A homozygous line is obtained by crossing the inducer line with an initial material, selecting the resulted haploids, doubling the number of the chromosomes and performing a self-pollination. Using this technique in maize breeding allows a reduction in the time needed to obtain a homozygous line. Also, this technique can be incorporated in different breeding schemes, like recurrent selection. One of the best inducer at this moment is PHI with an induction rate of 12-15%.

Key words: *Zea mays L., haploid, induction rate, homozygous line, breeding schemes, PHI.*

INTRODUCTION

Haploidy is the phenomenon by which the chromosome number of somatic cells is reduced by half, so haploids are plants that contain a gametic chromosome number (n). Haploid plants can spontaneously appear in nature or they can be the result of various induction techniques (Murovec et al., 2012). However, spontaneous occurrence is a rare event and therefore of limited practical value. Thus, various induction techniques have been studied and improved. For maize (*Zea mays* L.) the most used induction technique is *in vivo* induction of maternal haploids. This technique is based on the use of special genotypes that have the characteristic to induce haploids. Two hypotheses have been proposed about the mechanisms of maternal haploid induction. The first hypothesis supported by Wedzony et al. (2002) states that one of the two sperm cells coming from the inducer line pollen is defective but still capable of fusing to the egg cell. During cell division, the chromosomes from the inducer parent deteriorate and are eliminated from the primordial cells. The second hypothesis supported by Chalyk et al. (2003) states that one of the two sperm cells is unable to fuse with the egg cell. As a result of this phenomenon, haploid embryogenesis is activated. The second sperm cell then fuses with the central cell. The resulted haploids are small, present low plant vigor and are sterile. In order to propagate them, their fertility must be restored. This can be obtained by spontaneous doubling of the chromosomes or by induced doubling. The resulted doubled haploids (DH) are completely homozygous and homogeneous (Chalyk et al., 2003).

Production of doubled haploids. Producing DH lines typically requires four steps: (i) inducing haploids by crossing heterozygous plants with a haploid inducer; (ii) identifying haploid kernels through morphological markers; (iii) chromosome doubling of haploids by colchicine treatment; and (iv) selfing to obtain seeds of DH lines (Melchinger et al., 2005; Seitz, 2005). While the use of DH lines in maize breeding was first proposed nearly 60 years ago (Coe, 1959), with the use of the first recognized inducer line, Stock 6, with a haploid induction rate of 2.3%, the routine production of maize DH lines became possible only upon the development of haploid inducers that lead to a high frequency of haploids (Seitz, 2005).

(i) DH lines are typically induced among F_1 plants, but recent studies suggest that F_2 plants

are a better material for haploid induction (Bernardo, 2009).
(ii) The *R1-nj* marker gene (purple scutellum and a "purple crown" of the aleurone) is widely used for the screening of haploids in dry seeds (Gordillo et al., 2010; Rotarenco et al., 2010).

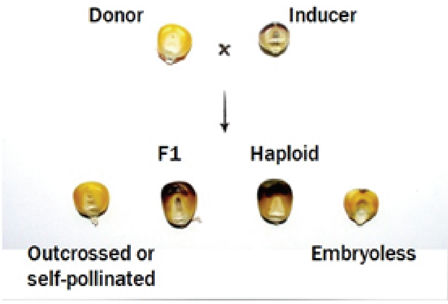

Figure 1. Haploid identification, kernel marker R1-nj (Rotarenco et al., 2010)

However, the expression of this gene has a strong female influence: sometimes the screening of haploids might be very confusing or even impossible, especially in those cases when there are inhibitor genes (*C1-I)* in females (common for flint maize) (Gordillo et al., 2010; Rotarenco et al., 2010).
In this case, the combination of *B1* and *Pl1* marker genes (sunlight – independent purple pigmentation in plant tissues) allows haploids to be identified by the lack of anthocyanin coloration in seedlings (Rotarenco et al., 2010).

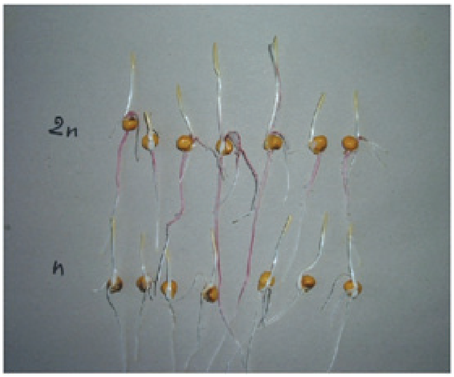

Figure 2. Haploid identification, root markers - combination of B1 and Pl1 (Rotarenco et al., 2010)

(iii) Chromosome doubling can occur naturally or artificially. Spontaneously the doubling rate is around 3% (Deimling et al., 1997). Thus, for a practical use, artificial doubling is required. Colchicine treatment is the most used procedure for chromosome doubling. The colchicine mechanism of action consists in stopping cell division during mitosis. As a result, the anaphase and telophase doesn't occur, so after metaphase the number of chromosomes is doubled (Nebel, 1937).
Presently, one of the most known and used chromosome doubling method is the Deimling procedure (Deimling et al., 1997).
(iv) After chromosome doubling, the resulted DHs are self-pollinated to obtain DH lines.
Applications of doubled haploids in maize breeding. Through the use of DH technology, completely homozygous plants can be obtained in two generations, compared with the conventional methods were multiple generations of self-pollination are required to obtain a partially homozygous plant (Gordillo et al., 2010; Melchinger et al., 2005; Picard et al., 1994; Rober et al., 2005; Rotarenco et al., 2010; Seitz, 2005). The efficiency of selection for qualitative and quantitative characters is increased since the recessive alleles are expressed due to the complete homozygousity. Doubled haploids can be used in a recurrent selection scheme, were after multiple cycles of crossing, DH production and selection, an improvement of the population is expected due to recombination and selection (Bouchez et al., 2000; Gallais, 2009; Gordillo et al., 2010). Another use of DH technology would be in mutation breeding. The homozygousity enables the fixation of mutations in the first generation after mutagenic treatment (Murovec et al, 2012).
Alternatively to the DH technology, pure haploid plants can be used for breeding and research purposes. This is a possibility caused by their ability to produce normal kernels after pollination with the pollen from diploid plants. (Chalyk et al., 2001; Rotarenco et al., 2012).

MATERIALS AND METHODS

The initial material was two haploid inducers lines: MHI with a haploid-inducing rate of 6 to 8% (Chalyk, 1999) and Stock 6 with a haploid-inducing rate of 1 to 2% (Coe, 1959). Selection for desirable characteristics and traits was carried out in the progeny of the hybrid MHI × Stock 6. The desirable characteristics were high haploid inducing rate anthocyanin marker genes, a good pollen production and improved agronomic traits.

RESULTS AND DISCUSSIONS

For the use of DH technology in maize breeding and research is necessary a haploid inducer with a high haploid - inducing rate, with anthocyanin marker genes, with a good pollen production and with improved agronomic traits. Thus, Procera Genetics started, in 2005, breeding for an improved haploid inducer containing all the characteristics mentioned above.

In generation F_5, 9 new inducers were identified. By phenotype and other characteristics, they were divided into four groups and called Procera Haploid Inducers (PHI).

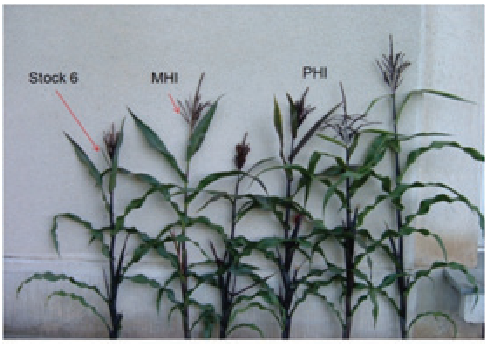

Figure 3. Initial and PHI inducers, (from left to right) Stock 6, MHI, PHI-1, PHI-2, PHI-3 and PHI-4 (Rotarenco et al., 2010)

Haploid-inducing rates were almost twice as high in the PHI inducers as in the best initial inducer MHI (Rotarenco et al., 2010). In 2011 and 2012, haploid-inducing rate estimates of generations F_7 and F_8 confirmed the high haploid-inducing efficiency of the new PHI inducers (Figure 4 and 5).

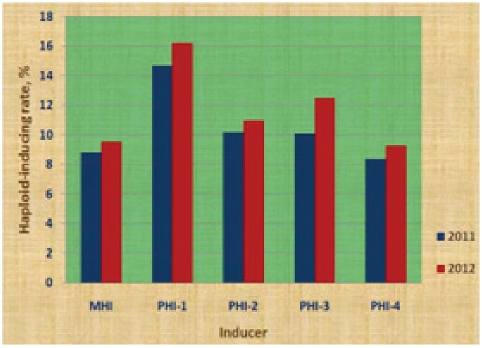

Figure 4. Haploid-inducing efficiency of five lines in crosses with the donor B73 x Mo17

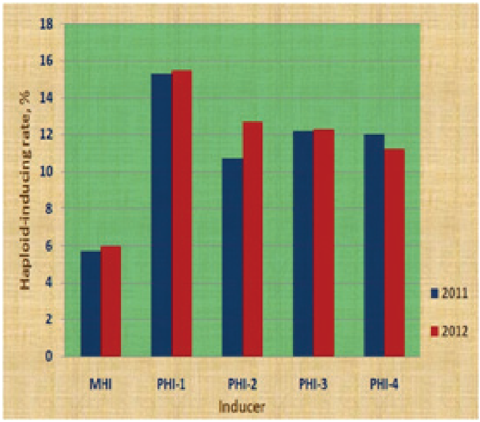

Figure 5. Haploid-inducing efficiency of five lines in crosses with the donor A619 x A464

The expression of the main grain color marker gene, *R1-nj,* was improved in the PHI inducers (Figure 6).

Additionally, the PHI inducers possess a combination of two marker genes, *Pl1* and *B1,* allowing haploids to be identified at the stage of 4-day-old seedlings and among mature plants (Figure 7 and 8).

The inducers also excelled in good pollen shedding and seed set. In addition, improved agronomic performance (plant height, tassel size, logging resistance etc.) was achieved by selection in 2011 and 2012 (Figures 9, 10, 11, and 12).

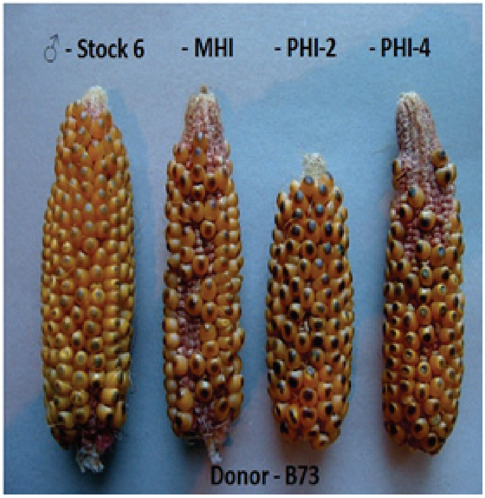

Figure 6. Embryo and endosperm marker – the R1-nj gene

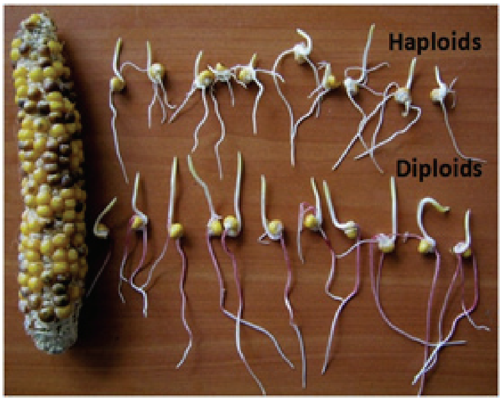

Figure 7. Root marker - the Pl1 and B1 genes

Figure 8. Stalk marker - the Pl1 and B1 genes

Figure 9. PHI-1

Figure 10. PHI-2

Figure 11. PHI-3

Figure 12. PHI-4

CONCLUSIONS

DH technology allows reducing the time and the expenses in maize breeding and increasing the efficiency of selection procedures significantly. The new inducers (PHI) can significantly increase the efficiency of *in vivo* haploid induction. Also we can say that haploid induction is a rather complex phenomenon which requires further studies. In conclusion, we suggest that haploids and DHs should widely be used in breeding and research projects.

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RESEARCHES CONCERNING THE INFLUENCE OF DISTANCE BETWEEN THE ROWS AT SOWING ABOVE THE WINTER RAPESEED CROP YIELD UNDER EXISTING CONDITIONS OF THE MOARA DOMNEASCĂ DIDACTIC FARM

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Abstract

The paper present research want to show which is the influence of distance between the rows at sowing above the productivity elements as: average number of ramification per plant, average number of pots per plant, average number of beans per plant, average weight of beans per plant and TWK, as the influence of the distance between the rows at sowing above the plants flowering. The experience was made at Didactic Farm Moara Domneasca, between 2009 – 2012. There been studied four distance between rows: 12.5 cm, 25 cm, 37.5 cm and 50 cm, and their influence above two rapeseed cultivars : Alaska variety and Exagone hybrid. The cultivation technology was the same for all variant and experimental years. The results obtained in the experimental years shows that the best results was obtained at rapeseed variety and hybrid when the distance between the rows at sowing was 25 cm,37.5 cm and 50 cm.

Key words: *distance between rows, sowing period, TWK,variety, yield.*

INTRODUCTION

In the last 10 years, winter rapeseed has a very important place in the economy as a source of vegetable oil used in industry as aliment or to obtain fuel oil (biodiesel) and as an important agrotechnical plant for farmers (Borcean, 1995; Budoi and Penescu, 1996; Sandoiu, 2008; Bâlteanu, 2011; Buzdugan, 2011; Roman, 2012). The expanding area of the rapeseed cultivation, the high offer of cultivation, the new varieties and hybrids and the variety of conditions during sowing period the research to clarify and determine the exact influence of each technological link such as: the seeding, the distance between rows, density and rate of seed, production and quality. The technological links with great influence over production include the distance between rows at seeding. Until the emergence of hybrids, it was recommended 12.5 cm for varieties with low branching capacity and 25 cm for those with strong branching, so at the harvest time we could obtain 60-110 plants/m^2 (Picu and Tianu, 1983; Pop, 1988; Borcean, 1991; Sin et al., 2007; Muntean, 2008; Sandoiu, 2008; Bâlteanu, 2011; Roman, 2012). The occurrence of rapeseed hybrids with higher potential of branching and the development of selective herbicides segment that can controle weeds in this culture, allowed us to study the various distances between rows at sowing and to investigate which is their influence on production. Thus, between 2009-2012, we organized the experimental field of the discipline Agrotechnics at Moara Domneasca, an experiment in which we have studied the influence of four sowing distance between rows (12.5 cm, 25 cm, 37.5 cm, 50 cm) on the variety of Alaska and the hybrid Exagone. This study aims to establish the influence of the distance between rows at sowing over the productivity elements and the production of rapeseed varieties and hybrids for Southern Romania.

MATERIALS AND METHODS

The research was conducted during 2009-2012, at Moara Domneasca, in a typical red preluvosol with 2.5% humus, pH 5.5 and clay content of 38%.

The experience was bifactorial, located on plots subdivided into four replication method. Factor A was represented by the varieties and hybrids, and factor B – the sowing distances. Throughout the 3 years of study we used the same technology in a rotation of 4 years of wheat-rapeseed-corn-sunflower. The preceding plant was wheat, after plowing was performed at 25 cm. The soil was fertilized manually with N100 and P80 kg/ha. The seedbed was prepared with the harrow discs and combiner. The sowing was done in optimal time prior to September 10 of each year. The weeds were controlled with herbicides products specific to the rapeseed culture, also there were executed operations against pests and diseases. The harvesting was done manually on each plot in early July.

The following determinations were made:

- no. of weed species determined at their arising and harvesting time
- phenological measurements for the rapeseed varieties and hybrids
- no. of plants/m^2 at the arising, leaving the winter and before harvesting
- no. of branches / plant
- no. of pods / plant
- no. of grains in the pod and pod's length
- weight of 1000 grains (TWK)
- production.

It should be stressed that the rising of the rapeseed culture was made uniformly throughout the experience only in 2010, in 2011 and 2012, there were extremely dry autumns and the rising was staggered.

RESULTS AND DISCUSSIONS

The observations made during the three years of research on the phenological development of the studied cultivars are presented in Table 1.

We can draw a conclusion after three years of research on phenological development of the tested varieties and hybrids as follows:

- number of leaves per plant increases with distance of seeding between rows (25, 37.5 and 50 cm);
- the plant height becomes typical for the variety or hybrid when the seeding distances between rows are larger (25, 37.5 and 50 cm);
- the flowering starts earlier for closely sown variants in rows of 12.5 and later for larger sowing distances (37.5 and 50 cm);
- the pods begin to form faster at the variants sown closely (12.5 and 25 cm) and extended for larger distances (37.5 and 50 cm) between rows;
- the full maturity and beginning of harvesting is done 2-3 days earlier when rapeseed is sown in close rows (12.5 and 25 cm) and extended by 2-3 days when seeding is done at larger distances between rows (37.5 and 50 cm).

The influence of seeding distance between rows on the level of weeds in winter rapeseed culture between 2009-2012 at Moara Domneasca.

The results on the level of weeds in the three years of study (2009 - 2012), are presented in Table 2. On the level of weeds we can say that in the three years of study, the spectrum of weeds remained about the same with a dominance of annual and perennial dicotyledonous weeds. One can notice the abundance of species of both dicotyledonous and monocotyledonous weeds when used larger distances between rows (25 cm, 37.5 cm and 50 cm), for both cultivated variety and hybrid. We can draw a conclusion that must be taken into account when rapessed is grown at larger spacings between rows, namely that the culture's success is conditioned by the success of weed control. To illustrate the level of weed depending on seeding distance between rows, we depict graphically the level of annual dicotyledonous and annual monocotyledonous weeds in Figures 1 and 2. In terms of the proportion of participation of weed species in the rapeseed culture it is observed:

Annual dicotyledonous weeds 40%	Annual monocotyledonous weeds 25%
Perennial dicotyledonous weeds 25%	Perennial monocotyledonous weeds 15%

The results obtained in the three years at Moara Domneasca, referring to the influence of seeding distance between rows for the winter rapeseed, are presented in Table 3.

There was a higher density for the variety Alaska when compared to hybrid Exagone, especially when it was sown at a distance of 12.5 cm between rows.

Table 1. The influence of seeding distance between rows on the phenological development in Alaska variety and Exagone hybrid between 2009-2012 at Moara Domnească

Variety / hibrid cultivated	Distance between rows (cm)	Average no. of leaves at flowering time	Plants' height (cm)	Flowering time	Forming pods	Forming grains	Full maturity
Alaska	12.5	8	88	14.04-30.05	25.04-30.05	27.04-14.06	6.07
	25.0	11	80	16.04-28.05	20.04-30.05	25.05-14.06	8.07
	37.5	13	82	18.04-29.05	21.04-31.05	28.04-10.06	9.07
	50.0	14	85	18.04-28.05	22.04-30.05	28.04-8.06	10.07
Exagone	12.5	9	100	20.04-25.05	24.04-26.05	08.05-10.06	8.07
	25.0	10	102	21.04-26.05	24.04-27.05	06.05-10.06	9.07
	37.5	12	105	21.04-27.05	25.04-28.05	03.05-10.06	11.07
	50.0	13	108	20.04-28.05	24.04-29.05	04.05-10.06	12.07

Table 2. Weed species present in the experiment with seeding distances between rows for winter rape (Average 2009-2012) Moara Domnească

Annual dicotyledonous	No weeds / m²				Perennial dicotyledonous	No.weeds / m²			
	12.5	25	37.5	50		12.5	25	37.5	50
Amaranthus retroflexus	4	7	12	14	*Cirsium arvense*	2	3	5	6
Chenopodium album	3	5	7	11	*Convolvulus arvense*	5	7	8	10
Xanthium strumarium	4	8	12	13	*Sonchus arvense*	2	3	4	6
Matricaria matricarioides	0	2	4	8	*Lepidium draba*	1	3	5	7
Papaver rhoeas	2	3	5	6	*Poligonum aviculare*	6	9	12	14
Sinapis arvensis	0	2	3	4					
Portulaca oleracea	2	5	6	7					
Fumaria scleicheri	3	5	6	7					
Hibiscus triorum	5	7	8	9					
Total	23	44	63	79	Total	16	23	35	47
Annual monocotyledonous	No.weeds / m²				Perennial monocotyledonous	No.weeds / m²			
	12.5	25	37.5	50		12.5	25	37.5	50
Setaria glauca	3	5	10	14	*Sorghum halepense*	5	9	11	16
Setaria viridis	4	5	7	12	*Cynodon dactylon*	0	2	4	4
Echinochloua crus gali	4	5	7	9					
Digitaria sanguinalis		5	7	9					
Total	15	20	31	44	Total	5	11	15	20

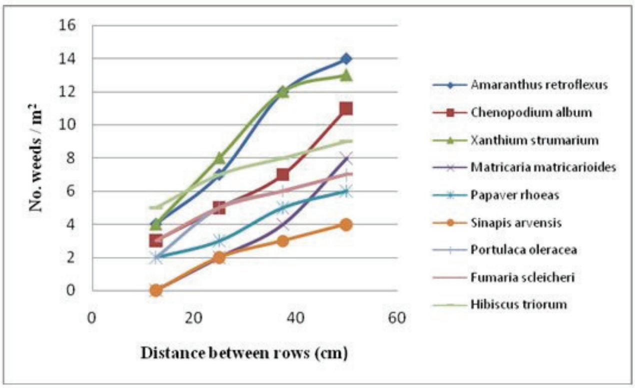

Figure 1. Level of annual dicotyledonous weeds in experience (Average 2009-2012) Moara Domneasca

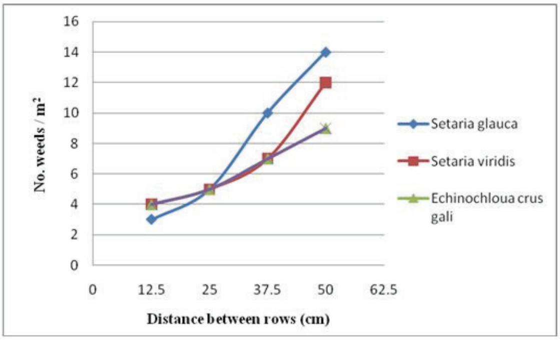

Figure 2. Level of annual monocotyledonous weeds (Average 2009-2012) Moara Domneasca

Table 3. The influence of seeding distance between rows on winter rapeseed plant density Average 2009-2012) Moara Domnească.

Cultivated variety / hybrid	Distance between rows (cm)				Average
	12.5	25.0	37.5	50.0	
AUTUMN					
Alaska	67.5	58.7	60.1	60.2	61.63
Exagone	65.0	66.0	58.9	58.0	61.9
SPRING					
Alaska	60.1	58.2	59.0	60.4	60.43
Exagone	60.5	57.7	56.0	54.0	57.8
		DL 1% 4.7		DL 0.1% 5.2	

The influence of seeding distance between rows on branching level in rapeseed crop.
Another problem in our research has been the influence of seeding distance between rows on the level of branching in Alaska variety and Exagone hybrid, as presented in Table 4.

Table 4. The influence of seeding distance between rows of plants branching rape. Average 2009-2012 (Moara Domnească)

Cultivated variety / hybrid	Number of branches / plant											
	Seeding distance between rows (cm)											
	12.5			25.0			37.5			50.0		
	RP	RS	Average/pl	RP	RS	Average/pl	RP	RS	Average/pl	RP	RS	Average/pl
Alaska	4	28	31.0	5.1	32	37.1	5.7	38	43.7	6.1	40	46.1
Exagone	3.8	26	29.8	4.2	31	35.2	6.2	43	51.3	7.5	46	52.4
Media	3.9	27	30.4	4.65	31.5	36.5	5.95	39.5	47.45	6.8	43	49.25

RP-Main branch
RS-Secondary branch

Thus when sown at 12.5 cm between rows number of main branches is 3.9 and the secondary branches is 27, and when planted at 50 cm between rows, number of main branches was 6.8 and the secondary branches 43, with significant differences. In other words, the larger distance between rows (25.0 cm, 37.5 cm, and 50 cm), the higher number of ramification, the number of pods will be higher, and the production will be bigger.

Influence of seeding distance between rows on the number of pods/plant, their length and number of grains in pods. An important objective of the research was the influence of seeding distance between rows on the number of pods / plant and their length. The results are presented in Tables 5, 6 and 7.
The analysis of the results on the number of pods / plant highlights that the sowing distance has a great influence on the number of pods / plant, both in Alaska variety and especially in

Exagone hybrid. Thus, when sown at 12.5 cm between rows, pods average number per plant was 26 in Alaska and 28 in Exagone, and when sown at 50 cm, pods average number per plant was 66 in Alaska variety and 76 in Exagone hybrid. Very suggestive are the differences in Figure 3.

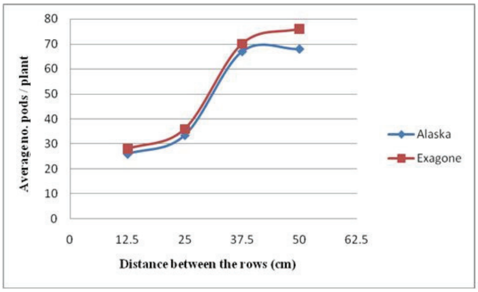

Figure 3. Influence of distance between rows on the number of pods / plant

Table 5. The influence of sowing distance between rows on the number of pods of the winter rapeseed plants. Average 2009-2012 (Moara Domneasca)

Cultivated variety / hybrid	Pods number / plant											
	Sowing distance between rows (cm)											
	12.5			25.0			37.5			50.0		
	RP	RS	Medie/pl	RP	RS	Medie/pl	RP	RS	Medie/pl	RP	RS	Medie/pl
Alaska	5.5	8	26	11	14	33.5	12	16	67	15	20	68
Exagone	8	10	28	12	15	36	14	18	70	21	24	76
Average	6.75	9	27	11.5	14.5	34.75	13	17	68.5	18	22	72

RP-Main branch
RS-Secondary branch

Table 6. The influence of sowing distance between rows on the pods

Cultivated variety / hybrid	Pods length (cm)											
	Sowing distance between rows (cm)											
	12.5			25.0			37.5			50.0		
	RP	RS	Total	RP	RS	Total	RP	RS	Total	RP	RS	Total
Alaska	4.65	4.7	4.67	5.01	5.36	5.18	5.31	5.78	5.54	5.46	6.1	5.78
Exagone	3.85	4.2	4.02	5.17	6.01	6.15	5.94	6.25	6.10	6.11	6.26	6.12
Average	4.25	4.45	4.35	5.09	5.68	5.66	5.62	6.01	5.82	5.78	6.18	6.0

RP-Main branch
RS-Secondary branch

Table 7. The influence of sowing distance between rows on the average number of grains in the pod in Alaska variety and Exagone hybrid. Average 2009-2012 (Moara Domneasca)

Cultivated variety / hybrid	Average number of grains in pods											
	Sowing distance between rows (cm)											
	12.5			25.0			37.5			50.0		
	RP	RS	Total	RP	RS	Total	RP	RS	Total	RP	RS	Total
Alaska	16.8	15.7	16.25	16.6	14.3	15.45	16.8	13.4	15.1	17.3	17.1	17.2
Exagone	15.7	14.3	15.0	16.4	17.8	17.5	21.6	19.2	19.85	19.5	19.7	19.7
Average	16.25	15.0	15.6	16.5	16.05	16.41	20.7	16.45	17.47	18.4	18.4	18.45

We say that, after three years of research, the winter rapessed has the largest number of pods/plant when sown at larger distances between rows (25 cm, 37.5 cm and 50 cm).
The results of research on pods' length and number of grains in pods are presented in Table 6. The values obtained in the three-year research clearly shows that sowing distance between rows has a big influence on pods' length and the number of grains in pods.
Thus, for the Alaska variety, when sown at 12.5 cm distance between rows, the pods' average length was 4.65 cm, with an average number of grains in pod of 16.25, and when sown at 50 cm between rows, the pods' average length was 5.88 cm and the average number of grains was 17.2 / pod.

For Exagone hybrid, when sown at 12.5 cm between rows, the pods' average length was 4.02 with an average number of 15.0 grains / pod and when it was planted at 50 cm between rows, the pods' length was an average of 6.12 cm with an average number of 19.7 grains / pod. In other words, the sowing distance between rows is larger (25.0 cm, 37.5 cm and 50 cm) and the length of pods and number of grains per pod is higher.

This statement is supported by higher nutrition space and all the other factors of vegetation of rapeseed are improved when sowing distances between rows are larger.

An important studied parameter was related to the size and weight of seeds / plant, depending on the seeding distance between rows. Values obtained on grain weight per plant and MMB are shown in Table 8, Figures 4,5 and 6.

Influence of sowing distance between rows on plant desity, grain weight/plant and TWK.

Table 8. The influence of sowing distance between rows on plant density at harvest, grain weight / plant and TWK. Average 2009-2012 (Moara Domneasca)

Cultivated variety / hybrid	Density of plants				Grain weight/plante (g/pl)				TWK			
	Sowing distance between rows (cm)											
	12.5	25.0	37.5	50.0	12.5	25.0	37.5	50.0	12.5	25.0	37.5	50.0
Alaska	65.0	60.0	52.0	58.0	3.9	5.2	5.8	6.4	3.5	4.8	5.7	6.0
Exagone	60.5	56.5	54.4	50.4	4.7	5.7	6.4	6.9	4.2	5.95	6.9	7.1

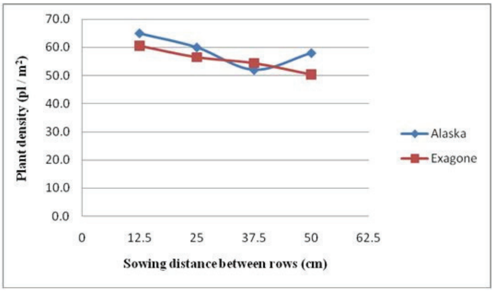

Figure 4. Influence of seeding distance between rows on plants density

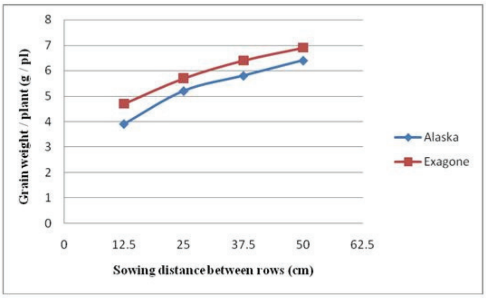

Figure 5. Influence of seeding distance between rows on the grain weight / plant

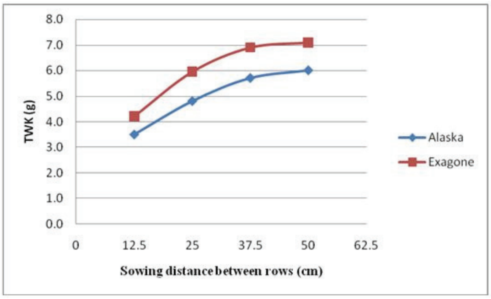

Figure 6. Influence of seeding distance between rows on MMB

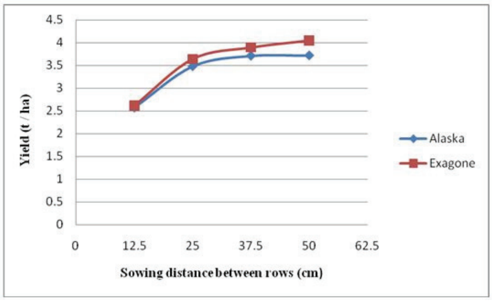

Figure 7. Influence of seeding distance between rows on yield

Production results, obtained in the three years of experimentation, highlight the importance of seeding distance between rows of winter rapeseed (Table 9).

Table 9. The influence of sowing distance between rows of winter rape production. Average 2009-2012 (Moara Domneasca)

Cultivated variety / hybrid	Yield (kg/ha)										
	Distance between rows (cm)										
	12.5	25.0	37.5	50.0	12.5	25.0		37.5		50.0	
						Dif (kg/ha)	Semnif	Dif (kg/ha)	Semnif	Dif (kg/ha)	Semnif
Alaska	2570	3481	3712	3719	Mt	911	*	1142	***	1149	***
Exagone	2610	3641	3896	4050	Mt	1031	**	1286	***	1440	***
				DL 1% = 875 kg/ha				DL 0.1% = 1090 kg/ha			

Analysis of the obtained production results highlight the following:

- for the Alaska variety, when sown at 12.5 cm distance between rows, the obtained production was 2570 kg/ha, and when sown at 50 cm distance between rows, the obtained production was 3719 kg/ha, with a difference of 1149 kg/ha.
- for the Exagone hybrid, when sown at 12.5 cm distance between rows, the obtained production was 2610 kg/ha, and when sown at 50 cm between rows, the obtained production was 4050 kg/ha, with a most significant difference of 1440 kg/ha. We can thus draw a conclusion, which is that larger sowing distances between rows, can bring significant gain production to both varieties and especially for the rapeseed hybrids.

CONCLUSIONS

The researches carried on at Moara Domneasca Didactic Farm during the period 2009-2012 regarding the influence of the sowing distance between the rows for the autumn rape crop allowed us to formulate the following conclusions adapted for southern part of Romania.

The sawing distance between the rows of 12.5 cm can be successfully used for all cultures no matter their branching potential. For the hybrids cultivated in the Southern part of the country, the distance of 12.5 cm is not recommended. Sowing distances of 25 cm; 37.5 cm and 50 cm can be used.

The usage of sawing distances between the rows of 25cm; 37.5 cm and 50 cm can be successfully made in all the farms were the weed control technology is well implemented.

The best plants density values, number of pods / plants, the height of the pods, the weight of the grains and MMB were obtained for the hybrid Exagone for sawing distances of 25 cm; 37.5 cm and 50 cm between the rows.

The influence of the sawing distances between the rows is very important for the new types and hybrids of rape cultivated in the Southern part of Romania, on condition that this culture is sawn in the optimal period, it emerges in due time; so that by the first frost a heat constant of $\sum$ = 550-700°C utile grades is achieved, thing that leads to a good resistance of the rape culture for the winter period.

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GENOTYPE INFLUENCE UPON PRODUCTION AND QUALITY OF WHEAT GROWN IN GĂVANU-BURDEA PLAIN

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Abstract

In order to know the production and quality potential of the wheat grown in a crop system adapted to climatic changes, in 2011 we organised an experiment based on 6 Romanian varieties, 11 foreign varieties and a wheat hybrid grown in two soil tillage variants. The genotypes tested belonged to the very early – medium early varieties that are highly resistant to drought, heat and winter conditions.
The experimental field consisted in reddish preluvosoil at an altitude of 130 m and was part of SC Polirom Prod SRL located in the Găvanu-Burdea Plain, the village of Scurtu Mare, Teleorman County.
All experimental variants were fertilized with N60 P_2O_5-60 at the time of sowing preparation and N100 on early spring vegetation. The specific weed, disease and pest control was based on herbicide and insecto-fungicide treatments, according to the conventional farming technology.
In terms of climate, the crop year 2011-2012 was dry, with uneven rainfall during the growing season. 374 mm rainfall was recorded from sowing to harvesting, and 252 mm at the end of winter and during the growing season.
The results obtained under a dry year highlighted the following: very high production potential of the wheat genotypes under study (4457 kg/ha on average); better soil tillage, compared with the conventional system (38% higher production). The hybrid Hystar ranked first in production: 4925 kg/ha (32% higher than the genotype average) in the conventional tillage variant and 6349 kg/ha (22% increase, compared with the average) in the minimum tillage variant; however, its quality for bread-making was low. The variety Izvor recorded the highest quality and production (4457 kg/ha) of the Romanian varieties.
Based on the results recorded in 2012, in terms of productivity under similar growing conditions, we recommend the Romanian early varieties Izvor, Litera, Glosa, Boema 1, Gruia and Faur F, and the foreign varieties Felix, Renata, Kalasz, Akratos and Csillag.

Key words: *production, quality, tillage, varieties.*

INTRODUCTION

Once with the evolution of climate changes, which occur more and ore frequently lately, there are requested cropping technologies adjusted to new conditions. On the one side, these cropping technologies take into account the use of the biological material with important tolerance to hydrical and thermical stress (determined by high temperatures and water shortage), and on the other side the cropping system which ensures water preservement in soil and its effective valorization.

In our country, there is made important progress in the field of creating wheat varieties with high production potential and of good quality, but which are earlier and resistant to drought and extreme temperatures (Saulescu, 2007, 2010; Ittu, 2012).

Research effected until nowadays in Romania (Mustatea et al., 2008; Sin et al., 2010; Lupu et al. 2010; Meluca et al., 2011; Voinea, 2011; Neacsu, 2012) and in other countries (Cailliez, 2008; Egesel, 2012; Favre, 2012) have assured only an extremely insignificant solution to the ever complex issues generated by cropping environment conditions complexity, of genotypes assortment and their genetical vulnerability to ecological factors, with consequences on quality and stability of production.

In this work, we present the first experimental results obtained in the Plain Găvanu-Burdea, in 2012, with an assortment of 18 autumn wheat types from the newest Romanian and European creations.

MATERIALS AND METHODS

In order to know the production potential and quality of the wheat crop in the cropping system adapted to climate change, in the year 2011 there has been organized a field bifactorial experiment, in 4 repetitions within SC Polirom Prod SRL, located in the commune of Scurtu Mare, Teleorman County, Romania. Scurtu Mare is located in the North of Teleorman County, inside Gavanu-Burdea Plain, at an altitude of 130 m.

The soil on which it has been made the experiment is of the type preluvosol, characteristic to the area of Gavanu-Burdea Plain.

Overall climate. From climate point of view, we find here, a region of interference between the Romanian Western Plain climate and that of the Romanian Eastern Plain, bounded by the Arges River.

The climate of the experimental period. Agricultural year 2011-2012 has been a dry year (Figure 1).

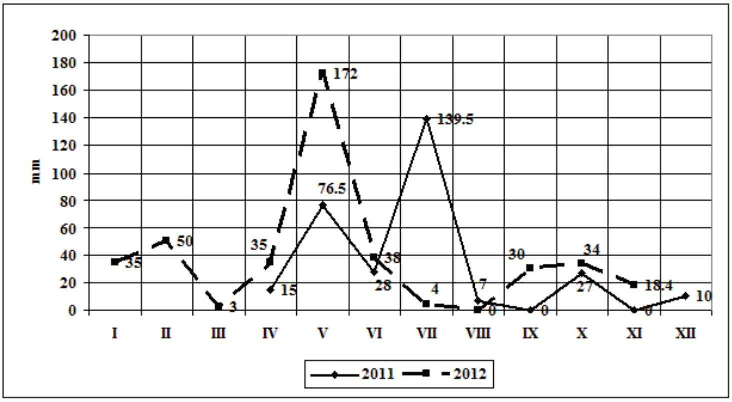

Figure 1. Precipitations regime from the experimental field during 2011-20012

In the fall of 2011 (September-November) fell only 27 mm precipitation. To these, there were added 95 mm in winter (December-February), 210 mm in spring 2012 (March-May) and 42 mm further up to harvesting (June-July).

It appears that from sowing to harvesting 374 mm precipitation fell, and during the growing season after coming out of winter, 252 mm. As it results from Figure 1, rainfall was very unevenly spread over the months of the year. Thus, there has been an excess of precipitation in May 2012 (172 mm) and in July 2011 (139.5 mm), while in the other months from 2012, the quantities of water from rainfall ranged between zero and 50 mm.

Although the pluviometric regime was generally found to be ineffective (252 mm during the spring-summer growing season, compared to a minimum of 350-450 mm, which would ensure the daily water consumption of about 4 mm/day during this period), rainfall during May and June (which totallized 210 mm) have assured environmental consumption of 3.5 mm/day in the last two months of vegetation. In these circumstances, the majority of wheat varieties are characterized by superior precocity, high-efficiency valued water from rainfall, and as you will see ahead, there have been achieved in non-irrigated, production performance that make them competitive with the most intensive cropping technologie.

Experimental variants. There have been studied 6 varieties of winter wheat created in INCDA Fundulea over the past decade, from very early and half-precocious varieties, with increased resistance to drought, hot climate and winter, compared to 11 foreign and hybrid varieties, all from the same groups of precocity. In the experiment, there was introduced as a separate factor, the soil tillage system in two variants (conventional and minimum tillage).

Experimental variants are presented in Table 1.

A Factor: Soil tillage system
a1 – *Conventional tillage system*
a2 – *Minimum tillage system*
B Factor: Variety

Table 1. Experimental variants

Levelling	Variety (Hybrid)	Origin	Precocity
b1	Boema 1	RO	Very early varieties
b2	*Ilinca*	HR	
b3	Glosa	RO	Early varieties
b4	Litera	RO	
b5	Gruia	RO	
b6	Faur F	RO	
b7	Izvor	RO	
b8	*PKB Kristina*	SRB	
b9	*Genius*	DE	
b10	*Hystar*	FR-Hybrid	
b11	*GK Petur*	HU	Medium early varieties
b12	*GK Csillag*	HU	
b13	*Felix*	HR	
b14	*GK Kalasz*	HU	
b15	*BC Renata*	HR	
b16	*Mulan*	DE	
b17	*Akratos*	DE	
b18	*Quebon*	DE	

The run-up was rapeseed plant.
For the variants with the conventional system of soil tillage, there has been carried out a ploughing at the depth of 20-30 cm, after which there was prepared a growing bed with disc harrows and combinator.
In the system of minimum tillage the first mechanical work was carried out with slight disc harrows (GD-7) for vegetal debris chopping, after which it followed a soil tillage with heavy disk harrows (GD-4.2) at about 15-17 cm. Before sowing, there was prepared the seed bed with the combinator.
In both systems of soil tillage, fertilizing and maintenance works during the vegetation, there were uniformous for all variants.
Before sowing there was fertilized with complex fertilizers (20:20:0) in the dose of N60 P_2O_5-60, after which the bed was prepared with the combinator. In the spring, at the beginning of vegetation, N100 was applied as urea (during the last snow).
Sowing was carried out between 1 and 20 October, for the period of research.
After all weeds growth, the sprayer with 0.5 l/ha Sekator (amidosulfuron 100 g/l + iodosulfuron-methyl-Na 25 g/l + mefenpyr-diethyl 250 g/l), along with a leaf with the fungicid Falcon 0.6 l/ha (tebuconazol 167 g/l+ triadimenol 43 g/l +spiroxamina 250 g/l).

In blossoming and grains formation stage, there was effected a second treatment for foliar diseases, with 0.8 l/ha from Nativo fungicide (200 g/l tebuconazol+100 g/l trifloxystrobin), simultaneously with Faster insecticide (cypermethrin 100 g/l), at a dose of 0.2 l/ha. There was determined the grains production, and in the laboratory, some indexes of baking value (MH, moist gluten content and gluten deforming index).

RESULTS AND DISCUSSIONS

Soil tillage system influence on production. On average, for all varieties in the experiment, in the system of minimum tillage, there was achieved a production with 38% higher than in the conventional system, in other words a gain in production of 1428 kg/ha, statistically significant (Table 2).
This superior effect on production of soil without ploughing is due to the conservation and recovery of water into the soil for the vegetation period of autumn and it ensures normal growth and development of plants until harvest.

Table 2. Soil tillage system influence on wheat production (2012)

Soil tillage system	Production		Differemce	
	kg	%	kg	%
Conventional tillage	3723	100	Control	Control
Minimum tillage	5151	138	1428	***

The influence of genotype on production.
Table 3 compares the output of all the genotypes with their media.
Compared with the average, we remark Hystar hybrid, with the largest production (5637 kg/ha), with difference in addition, which is statistically very significant (26% or 1180 kg/ha). With above-average yields, with very significant differences (485-828 kg/ha) we meet Felix, Renata and Kalasz foreign varieties.
The lowest production was obtained from Quebon and Genius varieties (3646 kg/ha), which represents only 82% of the average yield of all genotypes; the difference in minus compared to the average represents 811 kg/ha, mirroring a very significant negative statistical point of view.

Table 3. Genotype influence on wheat production (2012)

Variety (Hybrid)	Average production for two working systems		Production difference	
	kg/ha	%	kg/ha	Signification
1. Boema 1	4196	94	-261	oo
1. *Ilinca*	3949	89	-508	ooo
1. Glosa	4354	98	-103	
1. Litera	4511	101	54	
1. Gruia	4156	93	-301	oo
1. Faur F	4088	92	-369	ooo
1. **Izvor**	**4785**	**107**	**328**	***
1. *Kristina*	4541	102	84	
1. ***Genius***	***3646***	***82***	***-811***	***ooo***
1. ***Hystar***	**5637**	**126**	**1180**	***
1. *Petur*	4328	97	-129	
1. *Csillag*	4542	102	85	
1. *Felix*	5285	119	828	***
1. *Kalasz*	4942	111	485	***
1. *Renata*	5239	118	782	***
1. *Mulan*	3741	84	-716	ooo
1. *Akratos*	4645	104	188	
1. ***Quebon***	***3646***	***82***	***-811***	***ooo***
AVERAGE	***4457***	***Control***	***100***	

LSD 5% =190 kg/ha; LSD 1% =252 kg/ha; LSD 0.1% =325 kg/ha.

Also, below-average production, with very significant differences in minus (508-716 kg/ha) were obtained from foreign varieties such as Ilinca and Mulan.

Among Romanian varieties, only Izvor variety is superior to the average, having a production difference statistically assured (7% or 328 kg/ha). Other Romanian varieties either are below average, with distinctly significant production differences (Boema 1, Gruia) or very significant (Faur F) or are non-differentiated statistically compared to the average (Glosa, Litera).

Out of the 18 genotypes studied in this experiment, 6 varieties yield productions at the level of the average yields (4457 kg/ha) : the two Romanian varieties already mentioned, Glosa and Litera, plus Kristina, Petur, Csillag and Akratos varieties.

Multiple comparisons among the genotypes used in the experiment, conducted with the help of Duncan test, are presented in table 4. In this table the genotypes are in descending order of productions achieved and according to the significance of the experimental differences between them. Variants (varieties/hybrid) which do not differ significantly between them are marked with the same letter. Table 4 analysis shows the following conclusions:

- Hystar hybrid achieves production gains statistically provided compared with any of the experiment varieties, up to 55%;
- depending on the statistical significance absence of the differences between the different production types, these are grouped as 2 species with similar productions (Felix-Renata, Izvor-Kalasz, Ilinca-Mulan), 3 varieties with similar yields (Mulan-Genius-Quebon), up to 5 varieties;
- there are two different groups of five varieties, not different significantly, comprising Romanian varieties too:

1. **Izvor** - Akratos - Csillag - Kristina - **Litera** (4500-4700 kg/ha);
2. **Glosa** - Petur - **Boema 1 - Gruia - Faur F** (4000-4300 kg/ha).

Genotype influence on production depending upon the soil tillage system (Table 5).

Table 5 emphasizes the followings:

- in the conditions of a dry year, the wheat experienced genotypes are characterized by very high production potential, between 3117 kg/ha and 6349 kg/ha;

- in the same climatic conditions, the minimum tillage system is superior compared to the conventional system; on average, version with minimum tillage realized production of 5191 kg/ha, compared with 3723 kg/ha for the conventional system of working the soil;
- within each variant of tillage system, Hystar hybrid ranks first in the production with 4925 kg/ha, respectively 6349 kg/ha.

Increases production of Hystar hybrid in comparison with the the average of variants in the experiment represent 32% in conventional tillage and 22% in the version with minimum tillage. These relative differences are equivalent to increases of over 1.1-1.2 t/ha from all variants within each system of soil tillage, differences that are addured very significantly statistically.

Table 4. Multiple comparisons among variants (Duncan test)

Variety (Hybrid)		Average production		Signification
		kg/ha	%	
10	***Hystar***	**5637**	155	**a**
13	*Felix*	5285	145	b
15	*Renata*	5239	144	b
14	*Kalasz*	4942	136	c
7	Izvor	4785	131	cd
17	*Akratos*	4645	127	de
12	*Csillag*	4542	125	def
8	*Kristina*	4541	125	def
4	Litera	4511	124	def
3	**Glosa**	**4354**	119	efg
11	*Petur*	4328	119	fg
1	**Boema 1**	**4196**	115	gh
5	Gruia	4156	114	gh
6	Faur F	4088	112	gh
2	*Ilinca*	3949	108	hi
16	*Mulan*	3741	103	ij
9	***Genius***	***3646***	100	j
18	***Quebon***	***3646***	100	j

Table 5. The influence of genotype on production, according to the work of the soil

Variety (Hybrid)	Production				Production difference (kg/ha)	
	kg/ha		%			
	Conventional tillage	Minimum tillage	Conventional tillage	Minimum tillage	Conventional tillage	Minimum tillage
1. Boema 1	3431	4960	92	96	-292^{o}	-231
1. *Ilinca*	3335	4563	90	88	-388^{oo}	-629^{ooo}
1. Glosa	3557	5151	96	99	-166	-41
1. Litera	3267	5754	88	111	-456^{oo}	563^{***}
1. Gruia	3351	4960	90	96	-372^{oo}	-231
1. Faur F	3215	4960	86	96	-508^{ooo}	-231
1. Izvor	3618	5952	97	115	-105	761^{***}
1. *Kristina*	3725	5357	100	103	2	166
1. *Genius*	***3125***	***4166***	***84***	***80***	$\boldsymbol{-598^{ooo}}$	$\boldsymbol{-1025^{ooo}}$
1. *Hystar*	**4925**	**6349**	**132**	**122**	$\mathbf{1202}^{***}$	$\mathbf{1158}^{***}$
1. *Petur*	3498	5158	94	99	-225	-33
1. *Csillag*	3726	5357	100	103	3	166
1. *Felix*	4617	**5952**	124	**115**	894^{***}	$\mathbf{761}^{***}$
1. *Kalasz*	4329	5555	116	107	606^{***}	364^{**}
1. *Renata*	**4725**	5753	**127**	111	$\mathbf{1002}^{***}$	562^{***}
1. *Mulan*	***3117***	4365	***84***	84	$\boldsymbol{-606^{ooo}}$	-826^{ooo}
1. *Akratos*	3735	5555	100	107	12	364^{**}
1. *Quebon*	3720	***3571***	100	***69***	-3	$\boldsymbol{-1620^{ooo}}$
AVERAGE	**3723**	**5191**	**100**	**100**	**Control**	**Control**

LSD 5% =269 kg/ha; LSD 1% =357 kg/ha; LSD 0.1% =460 kg/ha

The lowest yields were obtained from Mulan and the Genius varieties with conventional tillage (3117-3125 kg/ha) and from Quebon and Genius varieties for the version with minimum tillage (3571-4166 kg/ha).

The influence of genotype on the baking value in the system of minimum tillage (Table 6).

Hectolitrical mass. The data in table 6 show that the minimum value for the bakery of the hectolitrical mass (70 kg/hl) is achieved in all

Romanian varieties from the experiment, as well as the majority of foreign varieties.
Of all the varieties of experiment, only Izvor has over 78 kg/hl hectolitrical mass, being included in the varieties class with very good bakery value according to this criterion.

Romanian varieties are generally good, with the exception of Boema 1 variety, which is satisfactory.
Most of foreign varieties have satisfying baking value, Kalasz has good value and Kristina, Petur and Quebon varieties have unsatisfactory bakery value.

Table 6. Indexes concerning baking value of experienced genotypes

Variety (Hybrid)	Hectolitric mass (kg/hl) - MH	Moist gluten content (%) - Gu	Gluten deformation index (mm) - Id	Baking value		
				MH	Gu	Id
1. **Boema**	**73.0**	**28.0**	**10.5**	S	FB	FB
1. Ilinca	73.5	31.0	13.5	S	FB	B
1. Glosa	75.6	29.0	13.0	B	FB	FB
1. Litera	75.7	30.4	13.0	B	FB	FB
1. Gruia	76.2	31.4	8.0	B	FB	FB
1. Faur F	77.1	32.0	12.5	B	FB	FB
1. **Izvor**	**78.3**	**27.6**	**12.0**	FB	FB	FB
1. **Kristina**	**69.6**	**27.0**	**12.0**	N	FB	FB
1. Genius	74.8	29.0	10.5	S	FB	FB
1. **Hystar**	**72.3**	**25.0**	**12.5**	S	B	FB
1. **Petur**	**68.6**	**30.8**	**12.0**	N	FB	FB
1. Csillag	73.3	30.2	10.5	S	FB	FB
1. Felix	70.4	30.0	12.0	S	FB	FB
1. Kalasz	76.7	**32.5**	12.0	B	FB	FB
1. Renata	74.8	30.8	10.0	S	FB	FB
1. Mulan	73.1	31.2	12.0	S	FB	FB
1. Akratos	73.0	30.0	10.0	S	FB	FB
1. **Quebon**	**67.5**	**31.6**	**13.0**	N	FB	FB

It is interesting to note that Hystar hybrid is the most productive and it is just satisfactory as bakery value according to the MH criterion.
Moist gluten content is very good for all varieties, except Hystar hybrid, which has the lowest content (25%), being characterized as having good bakery value.
The index of the gluten deformation. On the basis of this criterion, with the exception of Ilinca variety (good bakery), all other varieties have very good bakery value (deformation index comprised between 3 and 13 mm).

CONCLUSIONS

Experimental results obtained under the conditions of a dry year highlights:

- very high production potential of studied wheat genotypes (3117-6349 kg/ha);
- the superiority of soil minimum tillage system in comparison with conventional systems; on average, the version with minimum tillage realized production of 5191 kg/ha, compared with only 3723 kg/ha in the conventional system of working the soil, which means a difference of production in addition to 1428 kg/ha (38%), statistically very significant;
- within each variant of tillage system, Hystar hybrid ranks first in the production with 4925 kg/ha, respectively 6349 kg/ha. Increases production of Hystar hybrid in comparison with the average of variants in the experiment represent 32% in conventional tillage and 22% in the version with minimum tillage.

On average for the two variants of working the soil, the experienced varieties are grouped as follows:

- with productions over the experiment average, with very significant differences (328-828 kg/ha): Felix Kalasz, Renata and Izvor; these include the Hystar hybrid, with a difference of production of 1180 kg/ha compared to the average;

- with productions at the level of the average (4457 kg/ha): Glosa, Litera, Kristina, Petur, Csillag and Akratos;
- with production below average, with differences statistically provided: Quebon, Genius, Ilinca, Mulan, Boema1, Gruia, Faur F (261-811 kg/ha).

According to the statistical significance of the differences between the different production types, there are two different groups of 5 varieties (with similar productions), where we include the Romanian varieties too:

- Izvor – Akratos – Csillag – Kristina-Litera (4500-4700 kg/ha, on average for the two tillage systems);
- Glosa – Petur - Boema 1 – Gruia - Faur F (4000-4300 kg/ha, on average for the two tillage systems).

From a qualitative point of view, the most appreciated is Izvor variety, which is characterized by a very good bakery value for all 3 determined indicators: hectolitrical mass, the content of moist gluten, deformation gluten index.

The trait which differentiates the varieties studied in terms of the amount of bread is the hectolitrical mass, the other indicators being usually recorded in the category of very good value.

According to the hectolitrical mass, the Romanian varieties are generally good, with the exception of

Hybrid Hystar, the most productive one, is just satisfactory as bakery value according to hectolitrical mass, good gluten content and very good deformation index criteria.

Based on the results obtained in 2012, in similar conditions, there are recommended early Romanian varieties, in the order of productivity: Izvor, Litera, Glosa, Boema 1, Gruia, Faur F, as well as the foreign varieties: Felix, Renata, Kalasz, Akratos, Csillag.

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RESEARCH ON THE EFFICACY OF FUNGICIDES FOR CONTROL OF *MONILINIA LAXA* (ADERH. & RUHL.) HONEYON PLUM TREE

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Abstract

Monilinia laxa is an important species in Romania causing brown rot blossom blight of pome and/or fruit of plum. The disease is also known as,,monilinia blossom blight" or,,brown rot blossom blight". The blossom blight occurs mainly on stone fruit, including plum. Monilinia laxa (Aderh. & Ruhl.) Honeyis an ascomycete fungus.
Research followed all the stages of the disease attack, as well as the occurrence of the first symptoms correlated with weather conditions, the evidence of the symptoms in plum tree, the data related to frequency (disease incidence), intensity (severity) and efficacy treatments with fungicides Dithane M-45 WP (80% mancozeb active ingredient), Topsin AL 70 WP (70% thiophanate methyl active ingredient), Merpan 80 WDG (80% captan active ingredient), Bravo 500 SC (500 g/l clorotalonil active ingredient), Alcupral 50 WP (50% cooper oxychloride active ingredient), Teldor 500 SC (500 g/l fenhexamid active ingredient) and Signum FG (26.7% boscalid + 6.7% piroclostrobin active ingredient) the pathogen Monilinia laxa, the varieties Anna Späth, d'Agen, Record, Stanley and Tuleu timpuriu.
The study was developed during the proces of doctoral studies programme financed trough project POSDRU/107/1.5/S/76888.

Key words: *attack, disease, monilia, plum, fungicides.*

INTRODUCTION

Monilinia laxa is an important species in Romania causing brown rot blossom blight of pome and/or fruit of plum.
The disease is also known as „monilinia blossom blight" or „brown rot blossom blight" (Rudolph, 1925 cited by Holb, 2008).
The blossom blight occurs mainly on stone fruits (Weaver, 1950), including plum (Schlagbauer & Holz, 1990).
Monilinia laxa (Aderh. & Ruhl.) Honey is an ascomycete fungus, class: *Letiomycetes*, order: *Helotiales*, family: *Sclerotiniaceae* (Kirk et al., 2008.).
The range of disease attack is highly variable each year, according to crop and area (Gheorghieş & Geamăn, 2003). From this point of view, this paper presents aspects regarding the *Monilinia* attack degree in plum tree.
Monilia disease, brown rot of fruit or plum mummification is a widespread disease of plum growing in all countries and may cause serious damage by destroying flowers and fruit (Bolay et al., 1972).
The results of this paper are the included in the topic of the personal of doctoral thesis.

MATERIALS AND METHODS

Visual observation is the fastest method to identify a disease based on signs and symptoms shown by infected plants. This method involves a high degree of subjectivity, depending largely on the diagnosing person's level of knowledge.
The scoring attack for *Monilinia laxa* has a particular importance for the plum tree in establishing the need for chemical treatments during the vegetation season.
The attack value is represented by frequency (F%), intensity (I%) and attack degree (AD%). Frequency is the percentage of fruit attacked out of 100 examined fruit. Attack intensity indicates the degree to which the fruit is attacked under examination. Intensity was noted directly in percentage. The attack degree referred to the severity of disease in the crop and was calculated using frequency and intensity.
Calculations included five fruit trees belonging to the same variety in each variant (with or without treatment). For accurate information, we noted the attack/tree in every third row of fruit trees. We observed the attack in the same

tree on two levels by moving on the diagonal of the row, and we calculated the average.
Intensity was noted directly in percentage. The attack degree present severity of disease in the crop and was calculated using the frequency (disease incidence) and intensity (severity).
The fungicides used were Dithane M-45 WP (80% mancozeb active ingredient), Topsin AL 70 WP (70% thiophanate methyl active ingredient), Merpan 80 WDG (80% captan active ingredient), Bravo 500 SC (500 g/l clorotalonil active ingredient), Alcupral 50 WP (50% cooper oxychloride active ingredient), Teldor 500 SC (500 g/l fenhexamid active ingredient) and Signum FG (26.7% boscalid + 6.7% piroclostrobin active ingredient) (Henegar C., 2011).
The varieties used in this study were: Anna Späth, d'Agen, Record, Stanley and Tuleu timpuriu.
Experiments took place in an orchard of 10 years old from Bucharest.
Research was conducted between 2010 and 2012.
Treatments were applied as follows: first, at the end of vegetation; second, white button phenophase treatment; the third, treatment when 10-15% of petals were shaken and the last treatment applied at the beginning of fruit ripeningt (Popa et al., 2012). Four treatments were applied in different variants (Table 1).
For calculating the efficacy was taken into account attack degrees of variants with and without treatments.
The results were statistically assured by using variance analysis.

Table 1. Treatment options

Treatment	Phenophase	Fungicides	Concentration (%)
1	end of vegetation	Alcupral 50 WP	0.4
2	white button	Dithane M-45 WP	0.2
		Merpan 80 WDG	0.15
		Bravo 500 SC	0.15
3	10-15% petals shaken	Bravo 500 SC	0.15
		Dithane M-45 WP	0.2
		Merpan 80 WDG	0.15
4	beginning of fruit ripeningt	Teldor 500 SC	0.08
		Topsin AL 70 WP	0.07
		Signum FG	0.05

RESULTS AND DISCUSSIONS

Successful management of *Monilinia laxa* involves a combination of health practices aimed to reduce the amount of initial inoculum and the judicious use of fungicides.
Observations took place a week after the application of the last treatment for each plum tree variety.
Only the effect of chemical treatments in different combinations was highlighted as cultural hygiene measures imposed by technology were applied in all variants.
Climatically, 2010 was more favorable than 2011 and 2012 for the attack of the pathogen *Monilinia laxa*.

It must be noted that the attack on the flowers, leaves and shoots in spring was insignificant in the three years of research and all varieties under study.
Dangerous attack was reported in the fruit, as most of the fruit attacked fell while only few remained mummified in the tree crown, most of them in 2012.
Table 2 presents the variants as follows:

- Variant 1 of treatment consisted of application of fungicides: Dithane M-45 WP, Bravo 500 SC, Teldor 500 SC.
- Variant 2 of treatment consisted of application of fungicides: Merpan 80 WDG, Dithane M-45 WP, Topsin AL 70 WP.
- Variant 3 of treatment consisted of application of fungicides: Bravo 500 SC, Merpan 80 WDG, Signum FG.

The data presented in Table 2 show that the results on the behaviour of the plum tree varieties to the pathogen *Monilinia laxa* in all variants treated with various fungicides (V1, V2 and V3) and the efficacy of treatments.
It is noteworthy that there was no attack of *Monilinia laxa* in the variety Record during the three years of research in the variants treated with fungicides Bravo 500 SC (applied in phenophase white button), Merpan 80 WDG (applied in phenophase 10-15 petals shaken) and Signum FG (applied at the beginning of fruit ripeningt).

Table 2. Efficacy of some fungicide used in season to prevent and control the attack of Monilinia laxa on some variety of plum

Variant	Variety	Years					
		2010		2011		2012	
		A.D.[1] (%)	E[2] (%)	A.D. (%)	E (%)	A.D. (%)	E (%)
1 Dithane M-45 WP, Bravo 500 SC, Teldor 500 SC.	Anna Späth	7.00	85.1	4.00	90.5	3.00	85.0
	d'Agen	7.00	85.4	5.00	87.2	4.00	81.8
	Record	5.00	86.1	2.00	92.9	2.00	83.3
	Stanley	9.00	87.3	7.00	87.3	5.00	79.2
	Tuleu timpuriu	6.00	86.7	4.00	88.6	2.00	85.7
2 Merpan 80 WDG, Dithane M-45 WP, Topsin AL 70 WP.	Anna Späth	8.00	83.0	5.00	88.1	4.00	80.0
	d'Agen	8.00	83.3	6.00	84.6	4.00	81.8
	Record	5.00	86.1	3.00	89.3	2.00	83.3
	Stanley	10.00	85.9	6.00	89.1	5.00	79.2
	Tuleu timpuriu	7.00	84.4	4.00	88.6	2.00	85.7
3 Bravo 500 SC, Merpan 80 WDG, Signum FG.	Anna Späth	3.00	93.6	1.00	97.6	2.00	90.0
	d'Agen	3.00	93.8	2.00	94.9	2.00	90.9
	Record	0.00	100.0	0.00	100.0	0.00	100.0
	Stanley	6.00	91.5	4.00	92.7	4.00	83.3
	Tuleu timpuriu	2.00	95.6	1.00	97.1	1.00	92.9
DL 5% = 72.6%; DL 1% = 76.5%; DL 0.1% = 78.9% - for efficacy							

[1]A. D. (%) = Attack degree;
[2]E (%) = Efficacy of treatment with fungicides.

The varieties Anna Späth and d'Agen had approximately a similar response to *Monilinia laxa* in 2010 in the variants treated with fungicides (85.1% respectively 85.4% efficacy). Efficacy for prevention of *Monilinialaxa* attack, ranged in the year 2010, at the first variant of phytosanitary treatments, from 85.1% (the variety Anna Späth) to 87.3%. (the variety Stanley). In the second variant, in the same year, the efficacy of treatments in the vegetation of plum against pathogen *Monilinia laxa* ranged from 83.3% (the variety Anna Späth) to 86.1%. (the variety Record). The highest value of efficacy were recorded in the third variant, ranging from 91.5% (the variety Stanley) to 100.0% (the variety Record).

In 2011, the efficacy of treatment varied in variant V1 between 87.2% (the variety d'Agen) and 92.9% (the variety Record) in variant V2 between 84.6% and 89.3% for those varieties and in the variant V3 between 92.7% (the variety Stanley) and 100.0% to Record variety.

In 2012, it was the least favorable climatic for pathogen *Monilinia laxa* were recorded following variations efficacy of treatments: in V1 from 79.2% (the variety Stanley) to 85.7% (the variety Tuleu timpuriu); In V2 were recorded the same values to the same variety, respectively 79.2% (the variety Stanley) and 85.7% (the variety Tuleu timpuriu)

Should be noted that the application of systemic fungicides in the ripe fruit phenophase played an important role in protecting the fruit when rainfall occurred until the harvest.

CONCLUSIONS

Monilia disease, brown rot of fruit or plum mummification, is a widespread disease of plum growing in all countries and may cause serious damage by destroying flowers and fruit.

The range of *Monilinia laxa* attack in plum tree is highly variable each year.

The variety Record showed the lowest attack degree of the pathogen *Monilinia laxa*.

In all variants with different combinations of fungicides applied were recorded very good values of efficacy of phytosanitary treatments during the growing season.

In the three years of research, the highest values of efficacy treatments we recorded for the third variant of treatment, with fungicides Bravo 500 SC, Signum FG and Merpan 80 WDG.

The best values of efficacy treatments are recorded at the year with average pressure in the attacking pathogen *Monilinia laxa* in plum.

Treatments is fully justified especially in a highly favorable climatic year (with many precipitation and heat) for *Monilia* disease, as it was in 2010.

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ROMANIAN WHEAT – STRATEGIC PRODUCT FOR NATIONAL ECONOMY

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Abstract

Wheat has always been an agricultural crop and a product of the greatest importance to human existence and activity. It is a component of the field crops assortment in Romanian agriculture, an important source of income for farms and rural households, whose harvest is used as raw material in the milling and baking industry, but also represents an important article for domestic and international trade. Wheat fits well with agricultural vocation of Romania and should be considered a strategic product for the national economy, for reasons that require special attention on the productive potential, but especially on crop quality. Wheat is grown in average on about 2,100 thou ha per year and produces over 5,500 thou tones on average and over 7,000 thou tons in good years, which covered the requirements for domestic consumption and are designed, as a rule, for export availability too.
Assortment of wheat varieties grown in Romania includes over 100 varieties, Romanian creations and imported. Romanian varieties sown areas represent about 70% of the total wheat grown areas.
Based on these considerations, based on the initiative of central agricultural authorities, the National Institute of Research&Development for Food Bio-Resources, in collaboration with regional agricultural institutions organized a nationwide study on the quality of wheat grains produced in Romania. For more than 10 years were analyzed the wheat quality, for each variety, county, geographical area and agricultural year and the evolution of the grown varieties.
Based on these results, we found that the physical-chemical quality of the harvest of wheat produced in Romania, especially in West Plain, in Oltenia Plain and South Plain and Dobrudja, meets the requirements for the assessment category very good for the bakery, including the terms contents in proteins and wet gluten.
On the other hand, the quality of the wheat crop was affected, in some small areas of cultivation and only in certain years, grain buds attack, the significant presence of sprouted grains, harmful or toxic seeds, and, quite seldom , the ergot.

Key words: *Romanian wheat, growing areas and productions, quality of the harvest, wheat varieties.*

INTRODUCTION

Romania is a cultivator and a traditional producer of wheat grains. Romanian agriculture produce enough wheat to meet domestic consumption, and the Romanian ever enrolled between agricultural regions leading provider of high quality wheat for international trade.

Agricultural areas in Romania meet suitable conditions for wheat growing (according to studies, 20% of arable land offers very favorable conditions for wheat and 70% offer favorable conditions), which are favorable pre-requisite for good yields and high quality (Roman, 2011). Quality for bread wheat grain and flour obtained by grinding depends on a large number of factors: the choice of the varieties grown; natural conditions for plant development; applied technology; storage, transport and processing conditions (Nitu, 2010). In this context, research in this paper aimed to study the status of wheat growing area and production according to the natural conditions of agricultural regions and the assortment of varieties. Have also been studied the physical and chemical indicators of wheat yields produced in Romania, in order to assess the potential quality of both varieties used and growing areas.

MATERIALS AND METHODS

The study was conducted based on national statistical data (National Statistical Yearbook) and information provided by R&D network of the Romanian Academy of Agricultural and Forestry Sciences, related to the wheat crop and assortment of varieties. The study on the quality of wheat crops harvested in the years 2003-2010 was conducted in six agricultural regions of Romania, namely: Southern Plain and Dobrudja (counties Braila, Calarasi, Constanta, Giurgiu, Ialomita, Ilfov, Teleorman, Tulcea), Western Plain (Arad, Bihor, Satu Mare, Timis) Oltenia Plain (Mehedinti, Dolj, Olt), Southern Hilly Region (Arges, Buzau Caras-Severin, Dâmbovita, Gorj, Prahova, Valcea) Moldova (Bacau, Botosani, Galati, Iasi, Neamt, Suceava, Vaslui, Vrancea) Transylvania (Alba, Bistrita-Nasaud, Brasov, Cluj, Covasna, Harghita, Hunedoara, Maramures, Mures, Salaj, Sibiu) (Figure 1) (The Catalogue "Quality of Cereals").

In this respect, in Romania operates a national program approved by the Ministry of Agriculture and Rural Development, which is reviewed annually of wheat crop for baking quality. To determine harvest quality, in each county, wheat are sampled after a well-defined methodology (2003-2010). Samples are taken from the territory and are subject to a set of tests carried out in laboratories of the National Institute of R&D for Food Bio-Resources, Bucharest, by standardized and RENAR accredited methods, namely: Hectoliter mass (using hectoliter balance, ISO 7971-2 / 2002); grains moisture (drying in the oven, ISO 7970/2002); broken and shriveled grains; germinated grains; grains with *Fusarium*; grains with grains bugs attack (*Eurygaster* and *Ailia*); toxic and/or harmful seeds; grains with *Tilletia* attack; ergot presence (ISO 7970 '2001); protein content (Kjeldahl method); wet gluten content and Gluten-Index; Gluten Deformation Index; Falling Number (Hagberg-Perten method) (Belc et al., 1998; Nitu, 2010; Roman et al., 2003; Toader, 2008).

The date have been statistically processed and interpreted, separately for different wheat growing areas (counties and regions), and cultivated varieties. Statistical processing included calculation of averages, coefficients of variation, significance of differences and differences limits. The results allow drawing conclusions on the status and evolution of wheat crop and wheat crop quality in Romania, depending on the region of growing, variety, climate conditions of different agricultural years.

RESULTS AND DISCUSSIONS

Climatic conditions in wheat growing areas. Figure 1 shows that, on average over the period analyzed, there were annual amount of rainfall of over 550 mm in all wheat growing areas; it is to emphasize 668.7 mm in Transylvania and 729.3 mm in Southern Hilly Region.

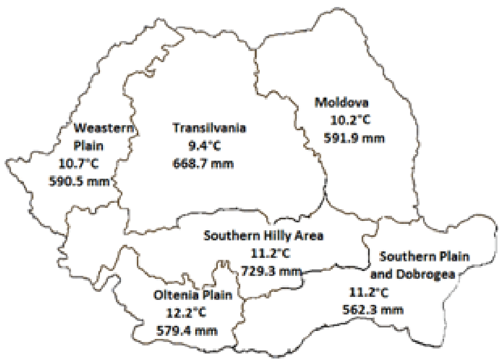

Figure 1. Annual rainfall (mm) and air temperatures (°C) in Romania (mean values 2003-2010)

Average annual air temperatures were 11.2 to 12.2°C in the Southern part of the country, from 10.2 to 10.7°C in Moldova and Western Plain and below 10°C in Transylvania. It should be noted that in all studied years and regions, rainfall and temperatures exceeded multiannual averages. Unequal distribution of rainfall and high temperatures imprinted the hot and dry character to the years 2003 and 2007, which was reflected in week results of wheat crop.

Wheat grown areas and yields. On average, between 2003-2010 (Figure 2) were grown with wheat annually in Romania 2,101 thou ha and 5,562 thou tons were harvested, resulting in an average of 2,647 kg/ha. Except for the years 2003 and 2007 (1,748 thou ha and 1,965 thou ha respectively), the areas under wheat exceeded 2,000 thou ha, and maximum was recorded in 2005 (2,475 thou ha). Distribution on national territory of wheat growing areas and their share of total grown area have a certain stability over time. In this respect, Southern Plain and Dobrudja are highlighted with an average of 34.3% of the nationwide, followed by about 20% in Oltenia Plain, 15% in Western Plain, 12% in Moldova, and 9-10% in South Hilly Region and in Transylvania (Epure, 2006; Nitu, 2010).

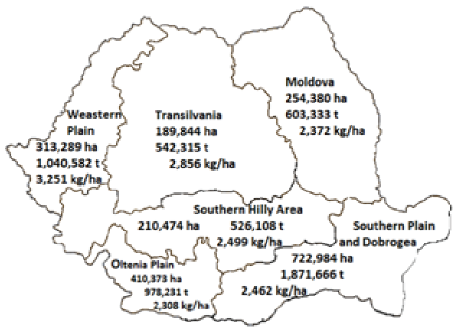

Figure 2. Wheat growing areas and yields in Romania (mean values 2003-2010)

By comparison, total wheat production and the contribution to national production of different growing areas were highly variable from year to year, under the influence of temperature and precipitation conditions. Total production ranged from 2,486 thou tons in 2003 (an average of 1,422 kg/ha) and 3,026 thou tons in 2007 (1,540 kg/ha) (years with insufficient rainfall during wheat vegetation period) to 7,812 thou tones in 2004 (3,402 kg/ha) and 7,180 thou tons in 2008 (3,403 kg/ha) (Roman et al., 2011).

It can be seen that in the period under review, agricultural years were of different degree of favorable for wheat crop and this was reflected in crop size (and quality). On the other hand, the diversity of natural conditions in different Romanian agricultural areas located at the confluence of large geographical areas and under the influence of very different climates (excessive temperate continental climate in the Eastern part Romania, specifically for Russian Great Plain; oceanic climate in Western Plain and Transylvania, specifically for Western Europe; Mediterranean climate in Banat and Oltenia regions, specifically for South Europe), determined that different degree of favorability of wheat growing regions vary in the same agricultural year, and as a result, the share in national wheat yields of wheat harvested in different regions vary considerably from one year to another. In this regard, the greatest variations were found in the Southern Plain and Dobrudja which contributes an average of 30.8% to the national yield (3.2% less than the percentage of wheat acreage), with variations from only 12% (severe drought in 2003), to 30.1 and 32.7% in 2004, 2007, 2005 and up to 43.1% in 2008 (the two dry were taken only 1,500 kg/ha in average in the area). A more stable yield was recorded in Transylvania (average production of over 2,200 kg/ha in all years), Southern Hilly Region and even Moldova. Western Plain contributed on average 21% of the national harvest, therefore exceeded 6% share of cultivated area, and has achieved higher production averaged of 3,251 kg/ha (in all the years have resulted over 2,500 kg/ha and in 2004 were harvested 4,059 kg/ha).

The assortment of wheat varieties. Of the study showed that, in the analysed period in Romania were grown 123 varieties of wheat, of which 46 Romanian varieties. It has also been reported the introduction of new varieties of Romanian wheat breeders creations (Crina, Glosa, Dor, Izvor, etc.) that have been fast and well received by farmers and the increased tendency to take over foreign varieties (of firms from Hungary, France, Austria, Serbia, etc.); some of the new wheat varieties introduced into culture in Romania were not tested in the official testing network of the State Institute for Testing and Recording Varieties (ISTIS) and not included in the Official Catalogue of Agricultural Crops Varieties in Romania (Nitu, 2004; Nitu, 2010; National R&D Institute of Food Bio-Resources, 2003-2010).

Assortment diversity of varieties available to growers Romanian is well illustrated by the data in Figure 3. From figure shows that in the Southern Plain and Dobrudja, and Transylvania the assortment was formed in 33-41 Romanian varieties, which were numerically from 42.4 to 43.9% of total cultivated varieties. By comparison, the extremes were found in Moldova, with 34 varieties grown in total, of which 79.4% Romanian varieties, and in the Western Plain, with 82 varieties, of which only 28% of Romanian varieties.

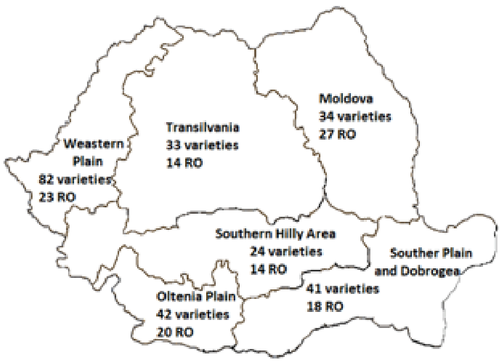

Figure 3. Assortment of wheat varieties cultivated in wheat growing regions of Romania

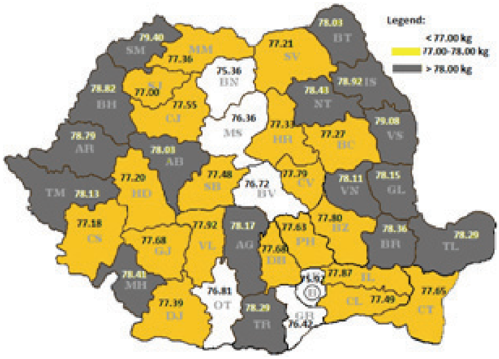

Figure 4. Hectolitre mass (kg/hl) of wheat harvest in Romania (2003-2010)

In terms of areas sown every year, however, prevailed Romanian varieties with 60-70% of the total shares, of which valuable varieties were: Boema, Dropia, Crina, Rapid, Flamura 85, Fundulea 4, Romulus (NARDI Fundulea creations); Alex, Ciprian, Lovrin 34 (ARDS Lovrin); Briana, Albota, Trivale (ARDS Albota-Pitesti); Simnic 30 (ARDS Simnic); Ariesan, Transilvania, Turda 95 (SCDA Turda); Aniversar, Gasparom (ARDS Suceava), to which have been added in recent years varieties Glosa, Dor, Izvor, Delabrad, Turda 2000, and other. Of foreign varieties were grown in a stable on large areas is to mention Serina, Renan, Apache, and other.

Quality of wheat harvest. Hectolitre mass (Figure 4) showed zonal averages over 77 kg/hl; below 75 kg/hl hectoliter mass (the recommended minima for bread wheat) were recorded in the Southern Plain and Dobrudja (in 2003 and 2009) and in Oltenia Plain (2003).

Regional average *protein contents* ranged from 12% (minimum recommended for bread wheat) and 13% (Figure 5); values over 13% protein were determined in Southern Plain and Dobrudja (in dry years 2003 and 2007), Western Plain (in 2003, 2006, 2007) Oltenia Plain (2003 and 2007), Southern Hilly Region (2003 and 2007), Moldova (2003) and Transylvania (2003 and 2009).

Under 12% protein resulted in South Plain and Dobrudja (in the year 2006), Western Plain (2004) Oltenia Plain (2004, 2005, 2006), Southern Hilly Region (2006, 2008), Moldova (years 2004, 2005, 2008) and Transylvania (2004, 2005, 2008).

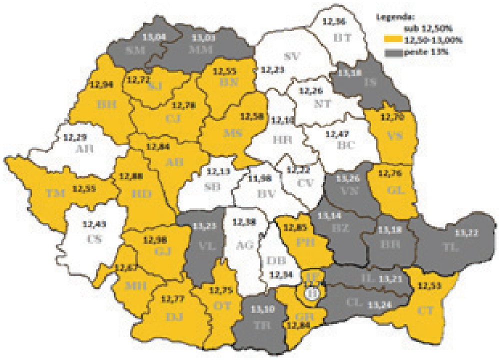

Figure 5. Protein content (%) of wheat harvest in Romania (2003-2010)

In terms of *wet gluten*, regional mean values ranged between 24 and 26%, with a maximum of 25.88% in Western Plain and a minimum of 24.95% in Oltenia Plain (Figure 6); these values meets the requirements for bread wheat.

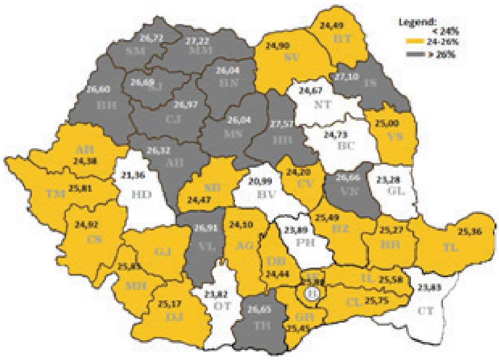

Figure 6. Wet gluten content (%) of wheat harvest in Romania (2003-2010)

Values over 26% wet gluten were determined in Southern Plain and Dobrudja, in South Hilly Region and in Oltenia Plain (in the years 2003 and 2007), in Western Plain (2003, 2006, 2007, 2008), in Moldova (year 2003) and in Transylvania (2003, 2006, 2007, 2009). Values below 22% wet gluten were found in Southern Plain and Dobrudja (2006 and 2009), Oltenia Plain and Southern Hilly Region (2005 and 2006), and Transylvania (2004).

Gluten Index (Figure 7) registered values of above 65 in all wheat growing areas in Romania (these values are considered optimal for backing grains), except Transylvania (57.39), an area where, in 2003, the average was below 40 (values below 65 indicate a gluten not able to form a good bread structure). This means a generally good and very good quality of gluten; it is to emphasize in some years, and in some areas, there may be situations to harvest wheat grains with worse gluten quality.

Figure 7. Gluten Index (mm) of wheat harvest in Romania (2003-2010)

Mean *Gluten deformation Index* ranged between 3.40 mm and 5.43 mm Moldova Southern Plain and Dobrudja, which reflects, in this regard, good quality of wheat crop in Romania (Figure 8).

Germinated grains in the ear represented more than 1% (the maximum allowed) in Southern Plain and Dobrudja and in Oltenia Plain (in the years 2003 and 2009, especially in Giurgiu county), in Southern Hilly Region (2005 and 2009, especially in Prahova and Valcea counties), in Moldova (2008 and 2009, especially in Iasi and Botosani counties), and in Transylvania (2003, 2008 and 2009, in Maramures, Salaj, Sibiu, Bistrita-Nasaud Harghita, Alba counties). In Western Plain have not found annual average higher as 0.5% of germinated grains and the highest percentage (average 2003-2010) was determined in Transylvania (1.08%) (Figure 9).

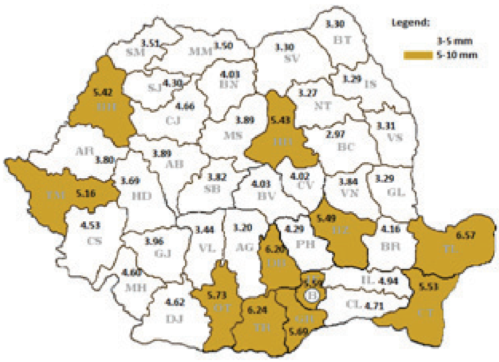

Figure 8. Gluten deformation Index (mm) of wheat harvest in Romania (2003-2010)

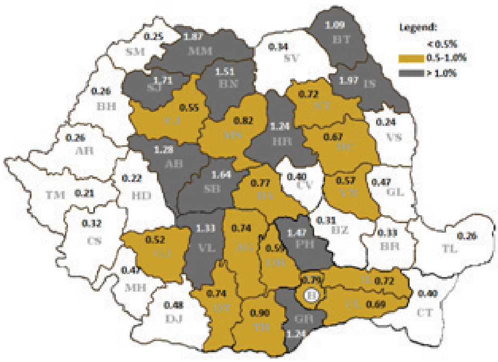

Figure 9. Germinated grains in the ear (%) of wheat harvest in Romania (2003-2010)

Of pests that affect the yield amount and quality, grain bugs (*Eurygaster* sp., and *Aelia* sp.) can create special problems; as a result, is not accepted the presence of attacked grains by grain bugs in baking wheat.

In research conducted on average over the period analyzed (Figure 11), grain bugs attack over 1% was revealed in the Southern Plain and Dobrudja (Ialomita and Teleorman counties, especially in Calarasi and Constanta, with more tna 2% attack) and in Oltenia Plain (Olt county) (2003 and 2009), in Western Plain (2003 and 2004), in Southern Hilly Region and

Transylvania (2003); in Moldova annual average values were below 0.5% attack.

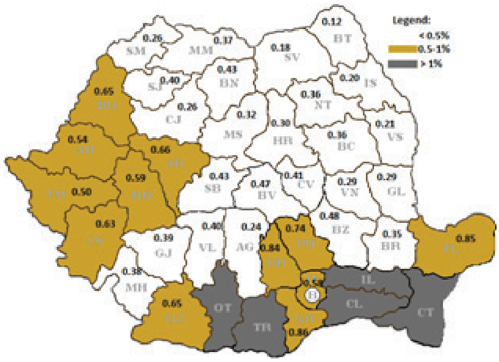

Figure 10. Grain buds attack (*Eurygaster* and *Aelia*) of wheat harvest in Romania (2003-2010)

In 2003, grain bugs attack was favored by dry and hot weather (Figure 12), so that the percentage of attacked grains was extremely high in some areas. Can be observed values over 5% registered in Ilfov and Olt counties and over 3% in Prahova, Teleorman, Giurgiu, Dâmbovita, Hunedoara, over 2% in Alba, Constanta, Ialomita, Sibiu, Buzau, Bacau and over 1% in most other counties.

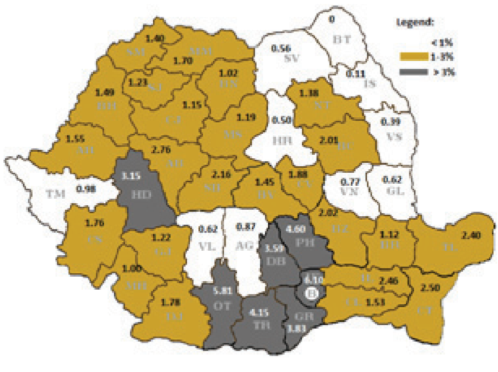

Figure 11. Grain buds attack (*Eurygaster* and *Aelia*) of wheat harvest in the year 2003 in Romania

Research have shown in some samples of wheat with harmful and/or toxic seeds, with values above 0.05% (maximum acceptable) in the Southern Plain and Dobrudja (in 2008), in Oltenia Plain (2003, 2007 and 2008) and in Southern Hilly Region (2007); in Western Plain, Moldova and Transylvania the percentage of harmful and/or toxic seeds was low (below 0.05%) and the highest values were determined in Oltenia Plain.

Fusarium attack on wheat grains in the analyzed years have a low zonal average accounted, the highest value being found in Transylvania (0.40%) and the lowest in Oltenia Plain (0.09%).

Percentage of broken and shriveled grains was generally less than 3% and not more than 2.13% in the Western Plain and least 1.56% in Moldova (compared to 5% maximum acceptable). It should be emphasized that in all wheat growing areas was observed grains with *Tilletia*, but in insignificant values (below 0.02%, against 0.05% acceptable limit). Also ergot attack frequency was sporadic (usually under agreed maximum of 0.05%). Higher percentages of ergot were reported in the year 2005 (very rainy), in Oltenia Plain (5.39% in Dolj county) as well as in Moldova (0.65% in Galati county).

CONCLUSIONS

Research has shown that wheat (winter wheat) - traditional crop for this geographical area - falls among the five basic agricultural crops of Romanian agriculture, with corn, sunflower, rapeseed and potato.

Wheat is grown in average on about 2,100 thou ha per year and produces over 5,500 thou tones on average and over 7,000 thou tons in good years, which covered the requirements for domestic consumption and are designed, as a rule, for export availability too.

Wheat growing areas are concentrated in the plains, especially in the Southern Plain and Dobrudja (on average 34% of the total wheat area and 30% of the total production), followed by Western Plain (12% of area and 15% of production) and Oltenia Plain (20% of the cultivated area and 17% of the national harvest).

Average annual production of wheat grown in Romania ranged from 1,422 kg/ha and 3,403 kg/ha, so very different from one year to another, with a remark on the Western Plain, with average productions of over 2,500 kg/ha in all years and over 4,000 kg/ha in the most favorable year 2004.

At current prices prevailing external market of 263-298 USD/tons, Romania wheat is cost effective and can build a significant source of revenue for farmers and national economy.

Assortment of wheat varieties grown in Romania includes over 100 varieties, Romanian creations and imported. Romanian varieties sown areas represent about 70% of the total wheat grown areas.

Of Romanian varieties, especially popular for farmers, depending on growing areas, are varieties Boema, Glosa, Alex, Briana, Ciprian, Delabrad, Izvor, Albota, Ariesan, Transilvania, who gradually replacing old varieties like Dropia, Flamura 85, Lovrin 34.

Based on research results, and on physico-chemical characteristics it can be seen that wheat yields produced in Romania fits into the category of good assessment for bakery.

In some areas, especially in the Western Plain (2003, 2006 and 2007), Oltenia Plain and the Southern Plain and Dobrudja (2003 and 2007), wheat quality correspond to requirements for a category very good assessment for bakery, including in terms of protein and wet gluten content. On the other hand the quality of the wheat crop was affected in some cultivation areas of the country and years of grain bugs attack (*Eurygaster* and *Aelia)*, the significant presence of germinated grains, harmful and/or toxic seeds, and, quite seldom, ergot.

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THE BEHAVIOR OF RED CLOVER AND ITALIAN RYEGRASS MIXTURE, FERTILIZED WITH GULLE AND MANURE

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Abstract

It is well known that red clover (Trifolium pratense L.) has a good agricultural value when is cultivated in wet and cold areas, with annual rainfall of 600 mm. Italian ryegrass (Lolium multiflorum Lam.) requires special climatic conditions, but is complementary with red clover. This mixture is often used by farmers due to the high productivity and quality of the feed. The objective of this study is to track the performance of mixture Trifolium pratense L. + Lolium multiflorum Lam. in both gulle and farmyard manure fertilization management, according to the specific conditions of Subcarpathian Basin Cobatesti-Şimonesti, Harghita, Romania. In the experiment were used four graduations of fertilization both with gulle (0 t gulle/ha, 5 t gulle/ha, 10 t gulle/ha and 20 t gulle/ha) and manure (0 t manure /ha, 10 t manure/ha, 30 t manure/haand 50 t manure/ha). Floristic composition was determined by gravimetric method and the results were interpreted by appropriate statistical methods. After two experimental years it was noticed that mixture's production suffered significantly influenced by both types of fertilizers. When larger quantities of fertilizer are applied, Italian ryegrass becomes very aggressive, being dominant in the mixture.

Key words: *gulle, grass/clover, farmyard manure, mixture, Sub-Carpathian Basin.*

INTRODUCTION

Red clover has been an important forage crop since the Middle Ages and the agricultural cultivar has been widely grown since the 17th century. It is found in fields and meadows throughout Europe and North America and prefers deep, rich, dry or moderately moist soils, being adapted to cooler areas (Rotar and Carlier, 2010). Red clover culture has a long tradition in Romania, but in mixture with Italian ryegrass is mostly used in Transylvania area. Romanian farmers cultivate the mixture of Italian ryegrass and red clover, observed by us in this study, due to the high productivity and quality of the feed. We aimed by this study to provide a deep and comprehensive analysis of the mixture *Trifolium pratense* L. + *Lolium multiflorum* Lam under different treatments: gulle and manure fertilization, with special attention to its productivity, floristic composition and protein content.

MATERIALS AND METHODS

Our experience was located in Transylvania region on a loamy soil with pH 6.7. The experimental area is characterized by annual temperatures average around 9.8^{0}C and by total annual rainfall of 553 mm year^{-1}. The experience was established in 2009 and carried out for a period of three years (between 2009 and 2011). The experimental field was installed after the subdivided parcels method, in 4 repetitions. Every variant was fertilized with two types of fertilizer, a liquid one (gulle) and a solid one (manure), in 4 different doses.

The agrochemical composition of gulle and manure was determined on/by the Agency for Pedological and Agrochemical studies from Mures and is presented in Table 1.

Gulle fertilization was applied in the following doses: F1 = 0 gulle, F2 = 5 Mg gulle ha^{-1}, F3 = 10 Mg gulle ha^{-1}, F4 = 20 Mg gulle ha^{-1}. Fertilization with manure was as follows: F1 = 0 manure, F2 = 10 Mg manure ha^{-1}, F3 = 30 Mg manure ha^{-1}, F4 = 50 Mg manure ha^{-1}. The statistic part was made according to variance analysis and statistical interpretation method by using the Duncan test. Floristic studies were performed using the Gravimetric Method (known also as the weighing method), which is used more in studies conducted on sown grassland. This method is commonly use to record changes that occur in grassland vegetation subjected to the action of certain treatments aimed to improve its quality, or when the usage category is subjected to some changes (Rotar and Carlier, 2010).

Table 1. The agrochemical composition of fertilizers

Nr. Crt.	Type of fertilizer	Agrochemical content (ppm)			
		$N\text{-}NO_3$	N (Nitrogen)	P (Phosphorus)	K (Potassium)
1	Gulle	1461	0.730	112	3438
2	Manure	1150	0.815	645	2694

RESULTS AND DISCUSSIONS

As is predicted in literature, crop dry mixture consisting of *Trifolium pratense* L. + *Lolium multiflorum* Lam. is influenced by gulle application (De Vliegher and Carlier, 2008). At the maximum dose applied we obtained a yield difference of 1.03 Mg ha^{-1} DM. Soil and climate conditions, very favorable for red clover and Italian ryegrass (clay content, pH, etc.) led a higher value to the crop control variant, of 13.88 Mg ha^{-1} DM. This and the large area occupied by red clover in 2010 (48%) made the differences between the first crop fertilization with 5 Mg gulle ha^{-1} (which has negative graduations,-0.39) and the second one with 10 Mg gulle ha^{-1} (graduations value 0.74). Manure applied to this mixture gives a similar increase of harvest, of 1.29 Mg ha^{-1} DM than the application of 50 Mg ha^{-1} manure (Table 2).

Table 2. Influence of fertilization with gulle on Dry matter content (2010).

Fertilization graduation	Production of DM (t/ha)	Difference (%)	Semnification	Production of DM (t/ha)	Difference (%)	Semnification	Mean
	2010			2011			
F1 (0 Mg gulle ha^{-1})	13.88	0.00	-	5.60	0.00	-	9.74
F2 (5 Mg gulle ha^{-1})	13.49	-0.39	-	8.01	4.41	***	10.75
F3 (10 Mg gulle ha^{-1})	14.62	0.74	**	10.92	5.32	***	12.77
F4 (20 Mg gulle ha^{-1})	14.91	1.03	***	10.94	5.34	***	12.92
F1 (0 Mg manure ha^{-1})	13.88	0.00	-	5.13	0.00	-	19.01
F2 (10 Mg manure ha^{-1})	13.65	-0.23	-	7.15	2.02	***	10.4
F3 (30 Mg manure ha^{-1})	14.62	0.74	**	8.23	3.10	***	11.42
F4 (50 Mg manure ha^{-1})	15.17	1.29	***	11.43	6.30	***	13.30

DL 2010 gulle (*p 5%*) 0.42; DL 2010 gulle (*p 1%*) 0.60; DL 2010 gulle (*p 0.1%*) 0.88
DL 2010 manure (*p 5%*) 0.48; DL 2010 manure (*p 1%*) 0.68; DL 2010 manure (*p 0.1%*) 1.01
DL 2011 gulle (*p 5%*) 0.25; DL 2011 gulle (*p 1%*) 0.36; DL 2011 gulle (*p 0.1%*) 0.53
DL 2011 manure (*p 5%*) 0.36; DL2011 manure (*p 1%*) 0.52; DL 2011 manure (*p 0.1%*) 0.77

In 2011, the strongest response is observed to the first graduation of fertilization with gulle, 4.41 Mg ha^{-1} DM. By doubling the dose of it to 10 Mg gulle ha^{-1}, we observed a difference in yield to the previous application of 0.91, a difference that justifies this dose. Dose increasing up to 20 Mg gulle ha^{-1} is not justified in this mix because the difference between the application of 20 Mg gulle ha^{-1} and 10 Mg gulle ha^{-1} is only 0.02 Mg ha^{-1} DM, the higher fertility being explained by the large percentage of occupation of 63% by *Lolium multiflorum* Lam. Manure application in 2011, lead to harvest differences at all graduation fertilization, between 2.02 Mg ha^{-1} DM when 10 Mg manure ha^{-1} is applied and 6.3 Mg ha^{-1} DM when 50 Mg manure ha^{-1} is applied. 50 Mg manure ha^{-1} application causes differences in DM from 6.3 Mg ha^{-1} DM to 4.28 Mg ha^{-1} DM on 10 Mg manure ha^{-1} and 3.20 Mg ha^{-1} DM, on 30 Mg manure ha^{-1}).

In terms of floristic composition from the second year, the species *Trifolium pratense* L. reduces its percentage of participation to 48% on the fertilization with gulle (Figure 1), and to 51% on the fertilization with manure, such that in 2011 decreased to 35% for fertilization with gulle and 32% for the fertilization with manure. It was noticed that the mixture had a good behavior, with a reduced participation of weed of 2% in 2010, to fertilized variants, 2% in 2011, to the variant fertilized with gulle and 1% in the variant fertilized with manure. *Lolium multiflorum* Lam. sp. increases its coverage to both fertilization variants. Generally the intensive culture system is detrimental to *Trifolium pratense* L. and significantly reduce their participation, thus increasing the percentage of coverage of *Lolium multiflorum* Lam.

The protein content of the forage produced depends on many factors from which the most important are the time of harvest, the percentage of species in the mixture and fertilization. Thus, it can be seen that on both fertilization variants (with gulle and manure), once the doses of fertilizers are increased grows also the protein content of the feed (Figure 2).

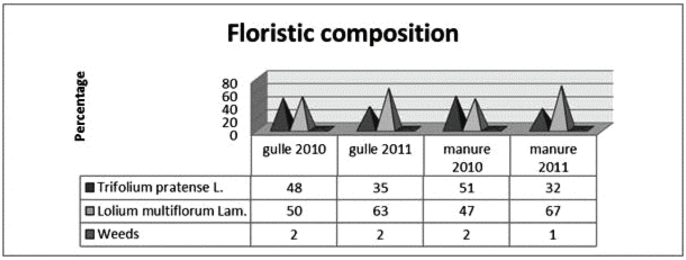

Figure 1. The floristic composition of Trifolium pratense L. and Lolium multiflorum Lam.

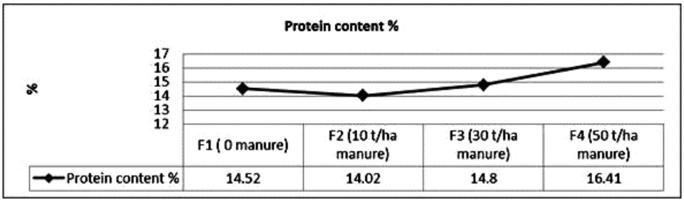

Figure 2. Effect of fertilization on the crude protein content

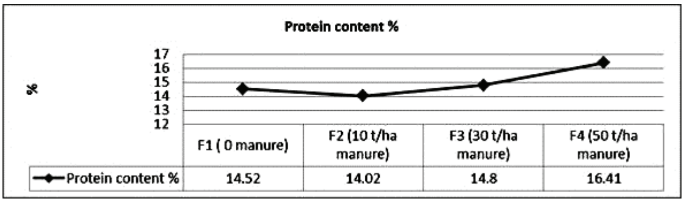

Figure 3. Effect of fertilization on the crude protein content

CONCLUSIONS

Analyzing the DM and green mass production obtained for the mixture consisting in *Trifolium pratense* + *Lolium multiflorum* we conclude that the mixture is extremely favorable for the conditions encountered in the study area, showing its full capacity of production. This mixture is a valuable forage crop, able to exploit specific soil and climate conditions, with high economic efficiency.

Even on high doses of fertilizers (gulle and manure) the vegetation's response was positive, leading us to recommend this highly productive mixture for the region of Transylvania.

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RESULTS REGARDING DROUGHT RESISTANCE OF SAME MAIZE HYBRIDS IN SOUTH PART OF ROMANIA CONDITIONS

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Abstract

Cultivating the most adequate hybrids, well adapted to specific environmental conditions, resistant to main abiotic (frost, drought) and biotic (insects and diseases) stress factors, with superior yielding ability and high quality potential facing all requirements under different cultivation areas, is recognized as major purpose in obtaining high economical performances for major crops, especially in maize.

The aim of this research is studying yielding potential and quantification of 14 hybrid drought tolerance in field crops, under dry year conditions, 2012. The experiments were carried out in Romanian Plain, under both dry-land at Caracal, and irrigation at Brăila.

In 2012, in Southern of Romania, the cumulated rainfall during June and August was under multiannual average, insufficient for covering the corn water requirements. Thus, conditions were favorable to select the genotypes with a good drought resistance. The drought was very severe in Caracal, where the tested genotypes yielded, on an average, only 2.01t kernel ha^{-1}, as compared to 8.08 t kernel ha^{-1}in Brăila. The highest yield was obtained by the hybrid GW 8.7 t kernel ha^{-1}, with 11.53 t kernel ha^{-1}, under irrigation with 700 mm/ha, in Brăila, followed by GW 49003 and GW 48002 with 10.58 and 10.05 t kernel ha^{-1}, respectively. On average experiments, the hybrid GW 8691 emphasized by yield, achieving 7.04 t kernel ha^{-1}. The yielding results are correlated with the water utilization degree. The water utilization degree during the entire vegetation period was different at all 14 hybrids and for each location apart. Among the two testing trials, the first place was occupied by the hybrids GW 8002 and GW 9003 with 13,0 and 12,8 kg kernel/mm water, respectively. The results are part of Ph.D. thesis.

Key words: *drought, hybrids, maize adaptability, yielding.*

INTRODUCTION

Maize is grown on over 2.5 million hectares, representing more than 25% from total arable land of Romania. The largest areas cultived with maize are situated in plain regions, where drought is very frequent.

Prolonged drought, occuring during the flowering and grain filling period (July-August), which generally are enhanced by heat and low relative moisture, are the most damageable for maize (Bîlteanu, 1998; Cristea et al. 2004). Climate changes are increasingly felt during the last past decades, especially regarding alternations between high temperatures and low rainfall levels. In this case, the plant physiological mechanisms are disturbed and the yielding potential significantly decreases (Banziger, 2007; Tollefson, 2011). This type of drought causes an increased frequency of barren plants and incomplete seed setting. Based on these considerations, identifying maize hybrids with genetically improved characteristics and high level of adaptability in order to have low yielding losses is indeed relevant.

According to European legislation, Romania allows for commercialization on its territory any corn hybrid registered in EU countries, even if it has not been tested under Romanian conditions and registered in Romanian Official Catalogue. Under these circumstances, the Romanian farmers are not covered by the risks arising from the cultivation of some hybrids un-adapted to specific conditions or exceeded by the new ones.

The aim of the research was to understand the general and specific market requirements and to provide a contribution by obtaining hybrids with superior yielding performances, drought resistant, improved quality and a higher level of stability.

MATERIALS AND METHODS

The experiments were carried out in 2012 in two different locations, representative for the Romanian Plain, one in Southwestern area, Agricultural Research-Development Station (ARDS) Caracal, and the other one, in the Southeastern one, Agricultural Research-Development Station (ARDS) Brăila.

The experimental design was random blocks, in three replications, with a sowing area of 20 m^{-1}, of which 15 m^{-1} were harvested and the cultivation technology was similar to that applied to the field crops. The plant density was 45,000 pl/ha under dryland in Caracal and 65,000 pl/ha under irrigated conditions, in Brăila. The sowing was done on April, 27^{th}.

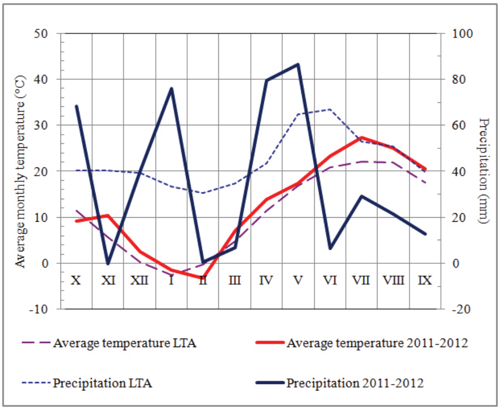

Figure 1. Rainfall and temperature registered at ARDS Caracal, in agricultural year 2011-2012, compared with multiannual average

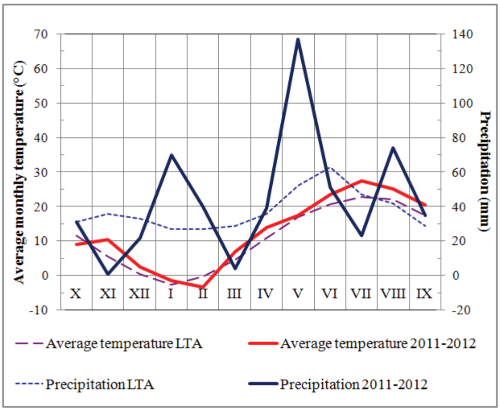

Figure 2. Rainfall and temperature registered in ARDS Brăila in agricultural year 2011-2012, compared with multiannual average

The following determinations were performed: emergence time, silking time, physiological maturity time, sum of useful unit degree of temperature, drought resistance, lodging (%), breaking (%), diseases resistance (rots and smut), *Ostrinia* resistance, “stay green” feature, plant height, ear cob insertion (cm), tassel length (cm), number of tassel branches, the leaves number, peduncle length (cm), number of husk leaves, ear cob length (cm), rachis width (cm), rows of kernels, kernel depth (cm), kernel yield, kernel/ear cob ratio, moisture (at harvest) (%), SVW and TKW. Some of them are presented in this paper.

Climatically, the year 2012 was very dry, thus monthly temperatures average, was bigger than multiannual average, with 0.5°C in Brăila and with 2.4°C in Caracal. În both testing centers, in June-August was very hot; in July, average temperature was with 3.6°C higher in Brăila and with 5.3°C higher in Caracal then multiannual average, at which added a lot of days with more then 40°C .

RESULTS AND DISCUSSIONS

Generally, in Romania and especially in southern part of the country, the agricultural year 2011-2012 was unfavorable for corn, fact that led to very low yields achieving. Under dryland, at ARDS Caracal, the yielding level has ranged between 0.89 t kernels ha^{-1} at genotype GS-4/12 and 3.2 t kernels ha^{-1} at Unimeza, a semi-early hybrid, with an average of 2.01 t kernels ha^{-1}, that means 1/5 from the potential of the genotypes (Table 1).

In Caracal, good results were also registered by the following hybrids: GW 9003 which accomplished a level of 3.07 t kernels ha^{-1}, followed by Efrat with 2.9 t kernels ha^{-} and GW 8691 with 2.5 t kernels ha^{-1}.

The yield level, in Caracal, was strongly influenced by rainfall repartition. The Figures 1 and 3 show that the total rainfall quantity was very ununiform distributed, with no rain in February, March and June, especially.

The high yield differences were determined by the rainfall registered during June-August, period of maximum consumption for maize. At ARDS Caracal, the total rainfall during this period was only 57.4 mm and was distributed as follows: 6.7 mm in June, 29.2 mm in July and 21.6 mm in August, while the multiannual average for this period is 170.6 mm (67 mm in June, 52.9 in July and 50.7 mm in August). This explains the yielding level in 2012 in Caracal, but in the same time, this condition had allowed to select the hybrid more tolerant to drought from the tested germoplasm.

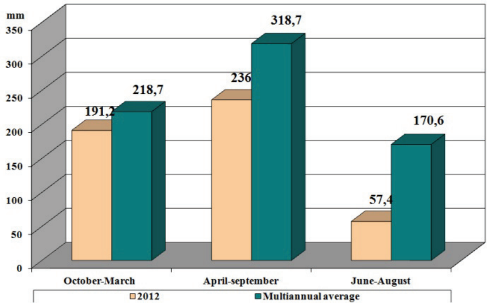

Figure 3. Rainfall registered under different periods in ARDS Caracal

At ARDS Brăila the rainfall was also un-uniform distributed, compared with the multiannual average, (Figure 2), but the heat and drought were not so intense. Thus, for the multiannual average of 152 mm during June-August (with 63 mm in June, 47 mm in July and 42 mm in August) in 2012 year, 148 mm (with 51 mm in June, 23 mm in July and 74 mm in August, Figure 4) were registered, at which is added the amount of 700 mm provided by irrigation.

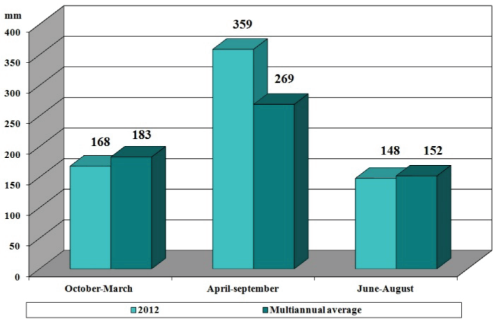

Figure 4. Rainfall registered under different periods in ARDS Brăila

This situation allows to obtain an average yield of 8.08 t kernels ha^{-1} with the maximum level registered by GW 8691 hybrid, consisting of 11.53 t kernels ha^{-1}. Good results were also achieved by GW 9003 hybrid and the GW 8002 hybrid, with 10.58 t kernels ha^{-1} and 10.46 t kernels ha^{-1}, respectively.

Table 1. Kernel yield achieved by maize hybrids tested at ARDS Caracal, and ARDS Brăila in 2012

No	Hybrid	CARACAL		BRĂILA		Average	
		t/ha	%	t/ha	%	t/ha	%
1	GW 8691	2.54	126	11.53	147	7.04	140
2	GW 9003	3.07	153	10.58	135	6.82	135
3	GW 8002	2.15	107	10.46	133	6.31	125
4	UNIMEZA	3.21	160	8.83	113	6.02	119
5	EFRAT	2.73	136	8.78	112	5.76	114
6	GW 8008	1.42	71	9.22	118	5.32	106
7	GW 8037	2.58	129	7.59	97	5.09	101
8	STATUS	1.41	70	8.63	68	5.02	100
9	GW 8653	1.54	76	8.22	106	4.88	97
10	GW 8194	1.86	92	7.70	98	4.78	95
11	KONSUR	1.13	56	8.06	103	4.59	91
12	GS-2/12	2.18	107	535	68	3.77	75
13	GS-3/12	1.44	72	3.95	50	2.70	54
14	GS-4/12	0.89	44	4.18	53	2.53	50
Average		2.01	100	8.08	100	5.04	100
LDS 5%		*0.16*	*8*	*0.48*	*6*	*0.32*	*6*

Even though the water requirements were supplemented by irrigation, the high temperatures recorded during pollination stage affected considerably the yielding potential for all the hybrids tested in this research. Most of them, especially GS-4/12 and GS-3/12, recorded a 50% decreasing level beneath the experience average On experiment average of the two locations placed under different climatic conditions of Romanian Plain, one can highlight the semi-early hybrid GW 8691, with an average yield of 7.04 t kernels ha^{-1}, followed by GW 9003 and GW 8002 with 6.82-6.31 t kernels ha^{-1}, outyielded with 25-39.5% the average of the experiment.
The yielding correlated distribution recorded by those 14 hybrids tested in two locations, under dry-land at Caracal and under irrigated land at Brăila, revealed a strong connection, provided statistically as significantly distinct one (Figure 5). Thus, good results under both testing conditions were achieved by the following five hybrids: GW 8691, GW 9003, GW 8002, Unimeza and Efrat. Besides them, GW 8037 hybrid is suitable for severe heat and drought conditions. The third group consists of the late hybrid Konsur and semi-late hybrids: GW 8653, Status and GW 8008 which kept their higher yielding potential only under irrigated conditions, fact demonstrated by the testing activities during past years (Schitea, 2010).

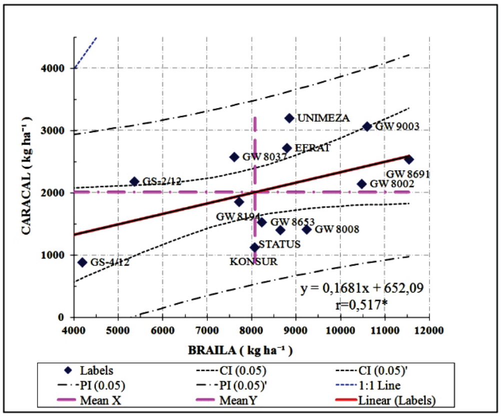

Figure 5. Relationship between the kernel yield under both dryland and irrigation, in 2012

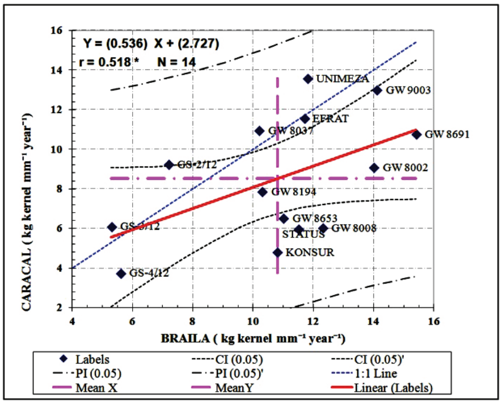

Figure 7. Water use efficiency in Caracal (rainfall from vegetation period) and Brăila (rainfall from vegetation period +700 mm irrigation)

The data presented in Figures 6-7 emphasize the way of water utilization by the tested hybrids, expressed by the achieved yield, kernel mm^{-1} water. The report depends on total rainfall and rainfall registered during vegetation period in Caracal and Brăila at which, 700 mm from irrigation has added in Brăila. This revealed the fact that a high capacity of water utilization, feature determined by genetically potential of drought tolerant genotypes connected with the environmental conditions (Tollenaar, 1999).

On the two testing centers average, the GW 9003 hybrid was the first regarding the water utilization capacity (13.5 kg kernels/mm water), followed by the GW 8691 hybrid, with 13.1 kg kernels/mm water and the Unimeza hybrid with 12.7 kg kernels/mm water.

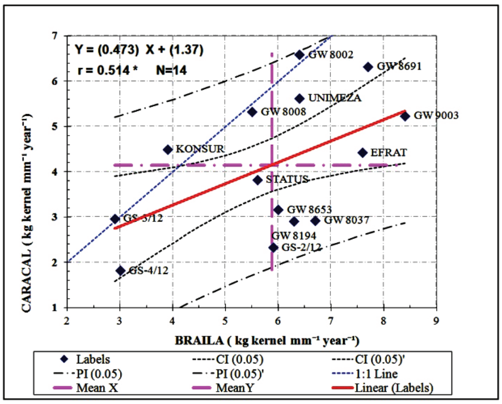

Figure 6. Water use efficiency in Caracal (yearly rainfall) and Brăila (yearly rainfall + 700 mm irrigation)

The water utilization degree for the entire vegetation stage ranged between 3.8-13.6 kg kernels/mm water at Caracal and 5.3-15.4 kg kernels/mm water at Brăila, with an average of 8.1 kg kernels/mm water.

The water utilization degree was different at each genotype and ranged between 1.8-6.6 kg kernels/mm water at Caracal and 2.9-8.4 kg kernels/mm water at Brăila. This calculation was related at annual water amount (only rainfall at Caracal, rainfall plus 700 mm provided by irrigations, at Brăila) with an average of 5 kg kernels/mm water for those two locations and hybrids, respectively.

Correlated distribution for the coefficient of water efficiency in the two testing conditions, allow a complete characterization of the tested hybrids, as statistically significant correlation (Figures 6-7).

Concerning the main morphological characteristics (Table 2) the drought reduced especially the plant height, the ear cob length, rows of kernel and TKW.

Regarding the other characteristics such as kernel depth, rachis width, the differences among tested hybrids were small, and no significant trend of them in relation with drought was registered. The other morphological traits presented in Table 2 show high variation limits of the genotypes tested above. For instance, number of husk leaves varied between 6.5 at GW 9003 hybrid and 12 at status hybrid.

Table 2. The main morphological characteristics of maize hybrids tested in 2012

Hybrid	FAO grupe	Σ^0C Entire vegetation stages	Plant height (cm)	Ear cob insertion (cm)	Number of leaes	Number of husk leaves	Ear cob length (cm)	Rachis width (cm)	Rows of kernels	Kernel depth(cm)	SVW	TKW
GW 9003	370	3064	230	90	16.5	6.5	19.0	2.4	12-14	1.1	63.4	296
KONSUR	590	3055	210	86	15.0	7.3	17.0	2.3	14-16	1.0	68.3	334
GW 8008	450	2951	240	95	14.5	7.0	19.1	2.1	14	1.0	65.0	208
GW 8194	340	2942	230	95	15.0	8.5	18.5	2.3	14-16	1.0	62.0	259
GW 8653	330	3019	260	110	17.0	8.3	18.3	2.3	14-16	1.1	71.0	234
GW 8002	380	2995	225	95	17.0	9.0	16.0	2.2	12-14	1.1	68.1	306
GS-2/12	290	2972	230	96	17.0	9.0	18.0	2.4	14-16	1.0	71.0	271
GS-3/13	300	2952	220	90	16.5	10.0	16.2	2.1	14	1.0	70.7	257
GW 1691	400	2951	210	80	15.0	11.5	16.0	2.4	14	0.9	73.5	282
UNIMEZEA	350	3078	220	90	15.0	10.0	17.0	2.2	12-14	1.0	77.1	309
STATUS	480	3063	190	70	15.0	12.0	16.0	2.1	12-14	0.9	76.2	252
EFRAT	290	2947	210	75	14.1	12.0	16.2	2.3	14-16	0.9	74,1	283
GW 8037	280	3005	270	125	16.2	8.0	18.5	2.3	14-16	1.1	70.0	247
GS-4/12	280	2929	240	90	16.0	8.5	16.5	2.4	16-18	1.1	72.5	246

Between the vegetation period and moisture at harvesting, a very strong correlation was emphasized (Figure 9).

Breeding maize for sustainable agriculture implies releasing hybrids with high yielding ability and low moisture at harvest. Fast grain dry-down rate hybrids may be harvested in grain and the crop may be immediately stored, with low costs. These issues might be solved by growing maize hybrids with a shorter period of vegetation, but important quantity of maize would be lost by incomplete utilization of favorable thermal resources on more than 50% from total maize area from Southern and Western Romania.

The tested hybrids belong to different FAO maturity groups, those between 280–590 (Table 2). The drought and heat especially, led to a shortening of vegetation period, causing forced maturation of the late genotypes. Due to very high temperatures during yield formation under both dryland and irrigation, a high number of sterile plants was among tested genotypes was recorded (Figure 8). This highlights once again, the opportunity of performed researches.

These data demonstrate that releasing maize hybrids with increased resistance to drought and heat had been necessary for both irrigated and dryland area from Southern plains, with environmental conditions similar to those of Caracal and Braila. Subsequently, a field trials research was developed according to the following principles:

- hybrids released under irrigated conditions should be tested in both optimal and water stress conditions, aiming the promotion of those with superior mean performance;
- hybrids released under dryland conditions (drought tolerant) should be tested, also, under irrigations in order to select those with economic yielding potential suitable for such environments.

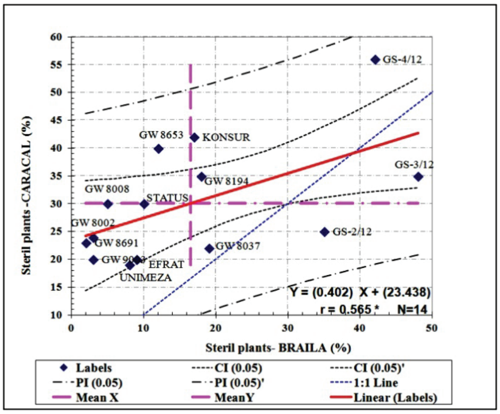

Figure 8. Relationship concerning the degree of steril plants in dry and irrigated land

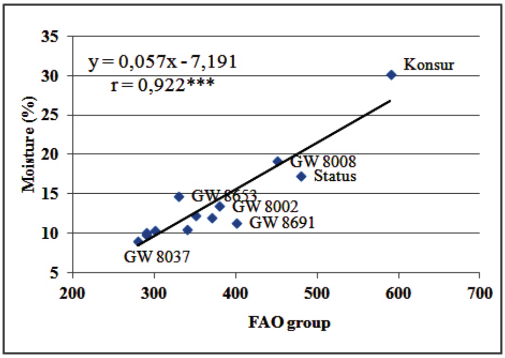

Figure 9. Relationship between the group of maturity and moisture

CONCLUSIONS

The maize hybrids tested in 2012, represent a new germplasm with a large variability regarding yielding and adaptability.

Hybrids Unimeza, GW 9003, Efrat, GW 8691 and GW 8002 revealed the highest heat and drought tolerance. These hybrids have good adaptability level, being able to use the irrigation water.

The semi-early GW 8037 hybrid revealed itself only under heat and drought conditions.

Hybrids GW 8008, Konsur, Status and GW 8653 are recommended only to crop in optimal water conditions.

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EFECT OF BIOSTIMULANT FERTIGRAIN ON BREAD WHEAT (*Triticum aestivum*) PRODUCTIVITY ELEMENTS AND GRAIN YIELD

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Abstract

The field experiment was held on selected areas in the production field in Zhrebino village (South-east Bulgaria) during the 2007 – 2010 period. The test was performed by means of a block method with four repetitions; experimental field area - 15m^2 after sunflower predecessor.
Four variants i.e seed treatment whit fertigrain start in rate 50 ml/100 kg seeds, leaf treatment whit fertigrain foliar in rate 1l/ha at tillering phase, seed treatment +leaf treatment and untreated control were considered for this study.
The aim of the study was to determine the influence of the biostimulants Fertigrain on the elements of productivity and the yield of bread wheatvariety Sadovo 772.
The results show: the biostimulant fertigrain have positive effect on the productivity of bread wheat Sadovo 772 variety. The Fertigrain contributes to higher values of structural elements of the yield, such as; length of the spike, number of the spikeletts per spike, number of the grains per spike, weightof the grains per spikeand thousand grain weight. The highest increase in the grain yield was found at variant seed treatment in rate 50 ml + leaf treatment leaf treatment in rate 1l/ha – 18% of the crop grain for the investigated period compared to the untreated control.

Key words: *biostimulant fertigrainr, bread wheat, elements of productivity, grain yield.*

INTRODUCTION

In modern cereal crops growing technologies increasingly becomes important the usage of bio-stimulators and growth regulators.
These chemicals affect plant productivity, increasing metabolism, accelerate the absorption of nutrients and contribute to their redistribution in the plant body (Nickel, 1982).
Different studies in the country and abroad have shown that the application of various bio-stimulators and growth regulators in cereal crops increased grain yield and has a positive impact on productivity and the elements of the physical properties of grain (Atanasova et al., 2001; Kolev et al., 2007; Peter 2005; Wolber and Seemann, 2006).
In other research has found that there are products that increase plant resistance to various stressors (Delchev and Kolev, 1998).
There are studies in Bulgaria about usage of a bio-stimulators and growth regulators in durum wheat (*Triticum durum*) growing, while those in ordinary (*Triticum aestivum*) are very limited (Delchev and Kolev, 2001; Kolev et al., 2006).
Therefore the aim of this study is to determine the influence of the bio-stimulant Ffertigrain on the productivity elements and the yield of bread wheat variety Sadovo 772.

MATERIALS AND METHODS

Research activities were conducted in the period of 2007-2010 at the experimental field of Jhrebino village, South-East Bulgaria. The experiment was performed on carbonate vertisols soil type whit sandy-clayed texture, by means of a block method with four repetitions; experimental field area - 15 m^2, after the predecessor sunflower. The contents of the basic nutrient elements in the 0-20 cm layer were as follows: N-26.6 mg/1000 g, P_2O_5-11.2 mg/100 g, K_2O-38.1 mg/100 g, humus-3.31 %.
Four variants - seed treatment whit fertigrain start in rate 50 ml/100 kg seeds (1), leaf treatment whit fertigrain foliar in rate 1l/ha at tillering phase (2), seed treatment + leaf treatment (3) and untreated control were considered for this study.
All the stages of the established technology for wheat growing were followed.
Soil tillage included single disking (10-12 cm) after harvesting of the previous crop, and double disking after the main fertilization has been made. The area was treated by $N_{120}P_{80}$ and

the whole quantity of the phosphorous fertilizer and 1/3 of the nitrogenous fertilizer were applied before main soil tillage. The remaining amount from the nitrogen norm was applied before permanent spring vegetation beginning. Triple super phosphate and ammonia nitrate were used. Sadovo 772 sowing was completed within the optimal for this region agrotechnical term at sowing rate 550 germinating seeds/m^2. Weeds and diseases control was done with suitable pesticides when necessary. Harvesting was done at full maturity. The grain yield is determined with standard grain moisture of 13%.

The indices; height of plants (cm), length of the spike (cm), number of the spikeletts per spike, number of the grains per spike, weight of the grains per spike (g), thousand grain weight (g), test weight (kg) and grain yield (kg ha^{-1}) were determined.

For determining the quantity dependence between the studied indicators, the experimental data was processed according to Anova Method of dispersion analysis, and the differences between the variants were determined by means of Dunkan's Multiple Range Test (Dunkan, 1995).

The research period (2007-2010) is characterized with variety of temperature and rainfall conditions which enables to evaluate the reaction of the studied varieties in accordance with their yields and quality characteristics under different climatic conditions (Figure 1).

The chart on Figure 1 showed that the temperatures during the vegetation of bread wheat cultivation were higher compared to the long-term period in all years of the research. According to the meteorological conditions data, three years of the study could be considered suitable for the bread wheat cultivation Rainfalls in autumn and during the critical spring period are decisive for the development of the wheat plants. The mean annual precipitation sums during October – March, which formed the autumn-and-winter moisture reserves in soil during the experimental years 2007-2008, 2008-2009 and 2009-2010 were 67.7, 5.9 and 59.2 mm higher than the mean sums of the long - term period.

In April-May when plants were at booting and heading stages, the mean annual precipitation sum in 2008-2009 and 2009-2010 was lower than the mean long - term value, while in 2007-2008 this sum was higher with 4.7 mm.

In June (during grain filling-maturation) rainfalls in harvest year 2008-2009 was 8.2 mm lower than the long - term period, while in 2007-2008 and 2009-2010 they were with 21.5 and 23.0 mm, respectively higher.

The most favourable for plant growth and development was the first experimental year (2007-2008), followed by the third (2009-2010), and unfavourable was the second year (2008-2009), of the experiment, having an effect on yield and grain quality of bread wheat.

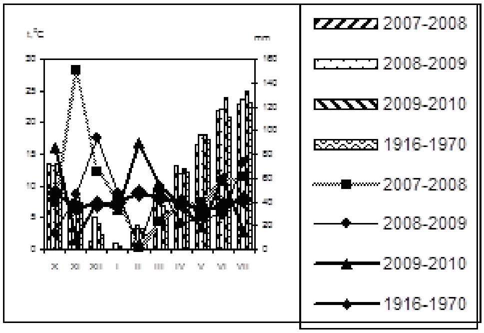

Figure 1. Temperature and rainfall distribution during the period 2007-2010

RESULTS AND DISCUSSIONS

Because of same trend in the data in all three years of the study there are presented averaged values of the structural elements of yield in table 1. The results showed that the treated with bio-stimulant Fertigrain plants are up to 6.4 cm higher than the untreated control.

The spike analysis show that when bio-stimulant Fertigrain is used the spikes are longer, compared to the control. As a result of the bio-stimulant usage there are 1.6 to 3.5 cm longer spikes in treated variant, compared to the control.

The highest values of this parameter are given in options with seed treatment in rate 50 ml + leaf treatment leaf treatment in rate 1 l/ha (12.5 cm), followed by leaf treatment whit Fertigrain foliar in rate 1 l/ha at tillering phase (11.3 cm) and the variant where the seeds are treated whit Fertigrain start in rate 50 ml/100 kg - 10.6 cm. Statistically proven the spike length has lowest values at the untreated control (9.0 cm).

Table 1. Height of plants and structural elements of the yield, average during the period 2007-2010

Variants	Height of plants (cm)	Length of spike (cm)	Number of spikeletts per spike	Number of the grains per spike	Weight of the grains per spike (g)	Thousand kernel (grain) weight (g)	Test weight (kg)
1	94.1 [b]	10.6 [b]	17.0 [a]	40.6 [b]	1.86 [b]	48.9 [b]	78.2 [a]
2	93.7 [b]	11.3 [b]	17.8 [a]	43.0 [c]	1.94 [b]	50.2 [c]	78.0 [a]
3	96.6 [c]	12.5 [c]	20.5 [b]	46.7 [d]	2.18 [c]	51.4 [d]	80.1 [b]
Control	90.2 [a]	9.0 [a]	16.5 [a]	40.0 [a]	1.51 [a]	46.5 [a]	77.5 [a]
LSD 5%	*2.4*	*1.1*	*2.5*	*1.2*	*0.21*	*1.0*	*2.1*

The number of spikeletts per spike increases under the bio-stimulant Fertigrain influence. All the treated variants exceed the untreated one up to 24.2 %. Statistically proven the highest number of spikeletts per spike differs variant with the seed treatment in rate 50 mlleaf treatment leaf treatment in rate 1 l/ha – 20.5.

The grains number per spike vary from 41.0 to 46.7 compared to 40.0 at the untreated control. Statistically proven the largest increase in values of this index 16.8% was recorded at the variant with seed treatment in rate 50 mlleaf treatment in rate 1 l/ha, compared to the untreated one. In all other variants

Applying Fertigrain leads to increasing the grain number from 3 to 7.5% at all treated variants compared to the untreated one. The grain weight per spike in all treated variants also exceed the control. The excess is 0.35 – 0.67 g, which is statistically proven. Highest increase of this indicator is reported at seed treatment in rate 50 mlleaf treatment in rate 1 l/ha – 2.18 g compared to 1.51 g, obtained to the control. Thousand kernel (grain) weight increases uder the influence of the bio-stimulant Fertigrain up to 10.5 % compared to the control. Highest values are reported at seed treatment in rate 50 mlleaf treatment leaf treatment in rate 1 l/ha – 51.4 g, followed by leaf treatment whit fertigrain foliar in rate 1l/ha at tillering phase - 50.2 g and the variant where the seeds are treated with fertigrain start in rate 50 ml/100 kg - 48.9 g.

The Fertigrain variant (seed treatment in rate 50 ml + leaf treatment leaf treatment in rate 1 l/ha) – 80.1 kg statistically proven exceed the control – 77.5 kg. In all other variants the value increasing compared to the control is not statistically proven.

The favorable combination between the the temperature and the moisture during the wheat vegetation is a prerequisite for obtaining higher yields in 2007-2008 compared to 2008-2009 and 2009-2010 year.

In the first year of the experiment the grain yield vary from 5710 kg/ha at the control to 6854 kg/ha at the variant seed treatment in rate 50 ml + leaf treatment leaf treatment in rate 1 l/ha. All other Fertigrain treated variants exceed the control from 632 up to 955 kg/ha which is also statistically proven (Table 2).

Table 2. Grain yield, kg/ha

Variants	Years of study			Average for the period (kg/ha)
	2007-2008 kg/ha	2008-2009 kg/ha	2009-2010 kg/ha	
1	6342 [b]	5500 [b]	5620 [b]	5821
2	6665 [c]	5673 [c]	6100 [c]	6146
3	6854 [d]	5955 [d]	6290 [d]	6366
Control	5710 [a]	5148 [a]	5325 [a]	5394
LSD 5 %	*165.1*	*170.4*	*132.4*	

The lowest garin yield are reported in the second experimental year. At the Fertigrain treated variants they are in range from 5500 to 5955 kg/ha compared to 5148 kg/ha at the control.

In all treated variants the grain yield statistically proven exceed the control from 6,8 to 15.7%.

During the last experimental year (2009-2010) the grain yield vary from 5325 kg/ha at the control to 6290 kg/ha at the variant seed treatment in rate 50 ml + leaf treatment leaf treatment in rate 1 l/ha. Fertigrain treated variants statistically proven exceed from 295 to 965 kg/ha the untreated variant.

In average for the researched period (2007-2010), the highest yield was obtained from the variant seed treatment in rate 50 mlleaf treatment leaf treatment in rate 1l/ha- 6366 kg/ha, followed by the leaf treatment whit Fertigrain foliar in rate 1 l/ha at tillering phase – 6146 kg/ha and the variant seed treatment whit Fertigrain start in rate 50 ml/100 kg seeds where the yield is 5821 kg/ha. Statistically proven the Fertigrain application increase the grain yield from 427 to 972 kg/ha, compared to the control.

The results from the multifactor analysis of variances showed the independent effect of the investigated factors, as well as their interaction (Table 3). The variants had highest statistic influence on the seeds yield – η 97, followed by years with their climatic conditions - η 96.

Table 3. Analysis of variance for grain yield for the period 2007-2010

Source of Variation	Sum of Square	DF	Mean Square	Sig of F	η^2
Variants	6302118.92	3	2100706.3	.000	97
Years	5689763.17	2	2844881.6	.000	96
2- Way Interactions	289134.83	6	48189.14	.000	61
Residual	187001.00	36	5194.47		

Interaction - Variants x Years - η 61 was also significant for grain yield.

CONCLUSIONS

The biostimulant Fertigrain have positive effect on the bread wheat Sadovo 772 productivity. The Fertigrainr contribute to higher values of the yield structural elements, such as; length of the spike, number of the spikeletts per spike, number of the grains per spike, weight of the grains per spike and thousand grain weight.

The grain yield increasing vary from 7.9 to 18% compared to the control.

The highest grain yield increase in the grain yield was found at seed treatment in rate 50 ml + leaf treatment leaf treatment in rate 1 l/ha variant – 18.0% for the all investigated period compared to the untreated control.

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CHARACTERISTICS OF SECOND GENERATION HYBRIDS BETWEEN WHEAT SPECIES (*TRITICUM* SP.) AND *AEGILOPS CYLINDRICA* HOST.

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Abstract

Hybrids resulting from the wide hybridization in Poaceae, posses valuable qualities such as resistance to biotic and abiotic stress factors and are important for breeding programs of wheat culture. Six different second generation hybrid accessions resulting from wide hybridization between different types of wheat (Triticum aestivum, Triticum dicoccon) and Aegilops cylindrica were examined. Three of the accessions are obtained after self-pollination of the colchicined initial hybrids (a, e, f), and the other three (b, c, d)-through backcross of colchicined hybrids with bread wheat (Triticum aestivum) pollen. Only six of all hybrid seeds germinated and five survived to adult plants. Each accession exhibits a heterogeneous morphology and/or physiology, depending on the participating parental components. While in the first hybrid generation, a partial fertility in colchicined plants and complete sterility in non-colchicined plants was observed, in the examined second generation, all tested plants are fully sterile. The complete sterility was proven by the determined heterogeneous karyotype in an observation of metaphase chromosomes during the mitotic cell division. The number of chromosomes was often uneven and varies depending on the type of hybrids (selfed, backcross) and maternal component (Triticum aestivum, Triticum dicoccon). All plant hybrid accessions of the second generation that reached maturity were completely resistant to the pathogens of powdery mildew (Erysiphe graminis) and brown rust (Puccinia recondita). This makes the hybrids involving Aegilops cylindrica valuable plant resources of resistance which could be introduced into the genome of bread wheat.

Key words: *Aegilops cylindrica, Triticum sp., wide hybrids.*

INTRODUCTION

Wide intergeneric hybridization is a classical breeding method, which is used to improve bread wheat using wild species which are phylogenetically close to the genus *Triticum*. Such species are representatives of the genus *Aegilops*, *Haynaldia*, *Agropyron*, *Elytrigia*, *Elymus*, *Hordeum*, *Secale* and others. This allows valuable genes encoding resistance and tolerance of biotic and abiotic stress to be transferred into the wheat genome (Spetsov, 1998). Furthermore, through this method cultural amphidiploids as *Triticale* (Kolev, 1978) and *Tritordeum* (Knuepfer, 2009) and also synthetic hexaploid wheats (Spetsov et al., 2008; Spetsov et al., 2009) are developed. Despite major work opportunities, wide hybridization meets a number of obstacles such as low or zero crossability, germ incompatibility, hybrid necrosis in plants derived from hybrid seeds, high sterility of hybrid plants (Stoyanov, 2012). The use of colchicine to double the chromosome number and combination of biotechnological methods solves some of the problems of wide hybridization and makes it an effective method of creating varietal diversity (Ayala and Kiger, 1987).

Aegilops cylindrica (2n = 4x = 28, CCDD) is one of the closest to bread wheat species, which is coextensive with it in the process of the evolutionary shaping the *Poaceae* family (Matsuoka, 2011). Both are donors of the D genome, which with regard to their phylogenetic development, is derived from *Aegilops tauschii* (2n = 2x = 14, DD) (Nakai, 1981). This generates conditions for higher crossability and stability of hybrid plants of hexaploid species *Triticum aestivum* (2n = 6x = 42, AABBDD) with *Aegilops cylindrica*, than the tetraploid wheat species *Triticum durum* and *Triticum dicoccon* (2n = 4x = 28, AABB) with *Aegilops cylindrica* (Stoyanov et al., 2011). However, hybrids involving *Aegilops cylindrica* are characterized by extremely high or 100% sterility (Stoyanov et al., 2011). For such sterility of obtained hybrids reports Cifuentes and Benavente (2009), Shoenenberger et al. (2006), Rehman et al.

(2006), regardless of species and parental origin of the involved component of *Triticum*.

Aegilops cylindrica is a donor of high resistance to some races of the pathogen of powdery mildew (*Erysiphe graminis*) and brown rust (*Puccinia recondita*), and complete resistance to pathogen of septoria leaf blight (*Mycosphaerella graminicola* / *Septoria tritici*) (Spetsov et al., 2006). Such resistance also exhibit hybrids where the wild species is involved. These characteristics as well as the ability to transfer resistance to a number of other stress factors such as metal toxicity (Landzheva et al., 2003), drought tolerance (Plamenov, 2003), make them a valuable resource for gene transfer in bread wheat. At the same time the strong gametocydial effect of *Aegilops cylindrica* occurring in the first generation of hybrid plants (Hohman et al., 1995) hampers breeding work. This requires careful studying the morphological, physiological and cytological characteristics of the different generations of the hybrids, in order to be properly used as a starting breeding material. The similarities and differences should also be set out in relation to the impact of different accessions involved in the crosses.

The aim of this report is to be described some morphological (coleoptile color, type of the habitus, spikes fragileness, seedset), physiological (flowering type, fertility, resistance to powdery mildew, brown rust and septoria leaf blight) and cytological (chromosome number) characteristics of the second generation hybrid plants between different types of wheat and *Aegilops cylindrica* and to assess their suitability as a starting material to be included in the breeding programs of the bread wheat.

MATERIALS AND METHODS

Seeds obtained from six second generation hybrid of wheat species with *Aegilops cylindrica* were used. Hybrids and seeds number are presented in Table 1. Scheme of obtaining hybrids is presented on Figure 1. Seeds of each hybrid were germinated in Petri dishes in an incubator at a temperature of 20°C within 5 days. Young plants were acclimatized for 3 days at a room temperature for better development of the germ roots. Plants are planted in ceramic pots per hybrid types and are grown under unregulated greenhouse conditions. Second generation hybrid plants are not treated with colchicine solution.

Table 1. Hybrids and seeds between Triticum sp. and Aegilops cylindrica

No	Code	Hybrid	Type	Seeds
1	a	C1 (91683 x ACC46)	sp	1
2	b	F1 (F1k (91683 x ACC46) x Yanitsa)	bc	4
3	c	F1 (F1k (Yanitsa x ACC46) x KO/4-2)	bc	2
4	d	F1 (F1k (Goritsa x ACC46) x Enola))	bc	1
5	e	C1 (Goritsa x ACC46)	sp	1
6	f	C1 (Goritsa x ACC46)	sp	1

sp – selfed, bc – backcrossed.

Seeds of each hybrid were germinated in Petri dishes in an incubator at a temperature of 20ºC within 5 days. Young plants were acclimatized for 3 days at a room temperature for better development of the germ roots. Plants are planted in ceramic pots per hybrid types and are grown under unregulated greenhouse conditions. Second generation hybrid plants are not treated with colchicine solution.

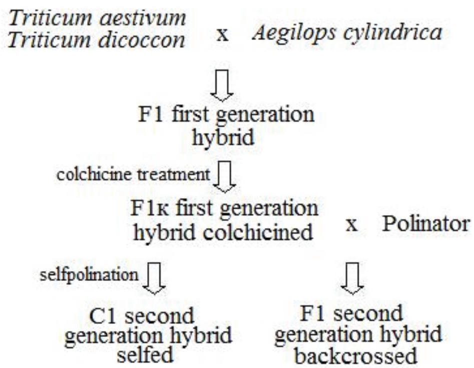

Figure 1. Scheme of hybrids' obtaining

Before planting from any offspring have been taken two of the three germ roots 1-1.5 cm long for cytological studies. Roots are dried on filter paper and fixed in 96% ethanol and glacial acetic acid (3:1) overnight (12 hours) at 4-5ºC. The fixed material was stained with 0.5% acetocarmine following a standard methodology (Georgiev et al., 2008). To establish the chromosome number, microscopic slides are prepared using standard methodology developed in Dobrudzha Agricultural Institute-General Toshevo. For each hybrid microscopic slides were prepared from which chromosomes of 10 well structured and maintained metaphase groups were counted using 400-fold zooming in. The number of chromosomes was averaged per hybrids.

Determination of phytopathogens attack was carried out under conditions of unregulated greenhouse and natural occurrence of pathogens: for powdery mildew (EG) using the methods of Stoilova and Spetsov (2006) for brown rust (PR) methodology of Ivanova (2012); for septoria leaf blight (ST) using the methods of Eyal et al. (1987). Reporting is done by established resistant (R), medium resistance (M) and sensitive (S) accessions. Evaluation is carried out in accordance with standard varieties for susceptibility to powdery mildew (*Erysiphe graminis*)-Sadowska ranozreyka, brown rust (*Puccinia recondita*)-Michigan Amber, septoria leaf blight (*Septoria tritici*)-Enola.

For each hybrid plant coleoptile color of young plantlets and the type of habitus-retracted, open, intermediate were defined, it is also made a comparative characteristics between different types of hybrids. The spike fragileness was estimated in comparison with the spikes of *Aegilops cylindrica*. An assessment of the flowering of the second generation hybrid plants-open or closed was also made.

From each hybrid plants two spikes were selected, which are isolated with paper isolators for selfing and determining male fertility/sterility. Two other spikes were castrated and baccrossed with pollen of wheat variety Enola for determining the female sterility/fertility. The other spikes are left without isolators to examine the natural possibility of receiving grains of the second generation hybrids. For each hybrid an analysis of male, female and natural sterility/fertility is made by counting the seedset.

An analysis of the normal course of meiosis in the previous generation is made and the chromosome coefficient for each hybrid is calculated as a ratio of the real average chromosome number (RChN) to the expected number of chromosomes (EChN) in the second generation hybrids. The expected chromosome number is calculated based on parental forms involved in the crosses.

RESULTS AND DISCUSSIONS

The results of the morphological characteristics of second generation hybrids involving *Aegilops cylindrica*, are presented in Table 2 and Table 3. From the tables it can be established that according to the studied properties coleoptile colour (CC), seedset (SS), habitus type (HB), spike fragileness (SF), flowering type (FT) and (stamens mode) SM, the plants grown do not differ significantly. This is probably due to the identity of the cross (Gorica x ACC46). Although one of the studied accession is selfed and the rest are baccrossed with bread wheat pollen, the morphology of pollinator apparently remains discreet. In the first generation hybrids the impact of maternal component on the morphological characteristics of plants is clearly highlighted (Stoyanov et al., 2011).

Table 2. Germination characteristics of hybrid plants

No	Hybrid	SSN	GSN	SvPN	CC
1	a	1	1	1	green
2	b	4	4	4	green
3	c	2	0	-	-
4	d	1	0	-	-
5	e	1	0	-	-
6	f	1	1	0	green

SSN – sown seed number, GSN – germinated seed number, SvPN – survived plants number, CC – coleoptile colour.

A characteristic feature of all grown second generation hybrids plants is that their flowering is an open type but stamens apparently do not burst. They are small, distorted, when grinding they do not release normally developed pollen, which indicates the presence of variations in the generative processes, and in particular variations in meiosis. Lack of seedset in all collected spikes of hybrid plants also involves abnormal generative processes.

Open habitus type and fragile spikes are typical of the first generation hybrid plants (Stoyanov et al., 2011; Stoyanov, 2010). The similarities between the two generations and the dominance of the morphological features of the paternal component in the crosses (ACC46) even into the backcrossed accessions, is indicative of the possibility of amphiploidisation, but due to its strongly gametocydial action of the imported genetic material from *Aegilops cylindrica*, the subsequent reproducing is prevented.

Table 3. Morphologic characteristic of hybrid plants

No	Hybrid	HB	SF	SS	FT	SM
1	1b	open	fragile	0	open	unburst
2	2b	open	fragile	0	open	unburst
3	3b	open	fragile	0	open	unburst
4	4b	open	fragile	0	open	unburst
5	f	open	fragile	0	open	unburst
6	ACC46	open	very fragile	0	closed	burst

HB – habitus type, SF – spike fragileness, SS – seedset, FT – flowering type, SM – stamens mode.

Rehman et al. (2006) reported zero seedset in hybrids *Triticum aestivum* x *Aegilops cylindrica* first generation and the inability to obtain second generation hybrids. Shoenenberger et al. (2005, 2006) succeeded in producing seeds in F1 and obtaining the second and third generation hybrids, but using the reverse cross (*Aegilops cylindrica* x *Triticum aestivum*) and backcrossing the hybrid plants with pollen of *Aegilops cylindrica*. The same authors state that the third generation self-pollinated hybrids are possible to obtain. Such results highlight the depressant effect on wheat chromosomes of the genes from *Aegilops cylindrica*. The stabilization of the genome of the wild species by repeatedly baccrossing of the quoted authors allows more consistent generation of hybrids to be achieved.

With regard to the sterility of second generation hybrids, all plants are 100% male and female sterile. Seedset is not observed either in isolated spikes or in baccrossed with pollen from Enola. Natural sterility, which is seen as the complex influence of all factors on the growing conditions is also 100%. This indicates that the studied plants are completely unable to reproduce. The data are presented in Table 4. From the data, and from morphological characteristics can be concluded that in the studied hybrids deviations in the mechanism of generative processes are observed.

Shoenenberger et al. (2006), in a second inbred generation hybrids succeed to achieve fertility in two samples-0.16% and 5.21% respectively. The resulting fertility rates are again in relation to baccrossed hybrids with *Aegilops cylindrica* from the reverse cross (*Aegilops cylindrica* x *Triticum aestivum*). The authors point to the very high levels of fertility (up to 87.7%) in the third generation hybrids after self-pollination. Wang et al. (2005) also reported the presence of fertility in baccrossed second generation hybrids and selfed-ones in the third generation.

Table 4. Physiological characteristics of hybrid plants

No	Hybrid	MS,%	FS,%	NS,%	TS,%	EG	PR	ST
1	1b	100	100	100	100	R	R	R
2	2b	100	100	100	100	R	R	R
3	3b	100	100	100	100	R	R	R
4	4b	100	100	100	100	R	R	R
5	f	100	100	100	100	R	R	R
6	ACC46	-	-	-	-	M	M	R
7	SR	-	-	-	-	S	M	M
8	MA	-	-	-	-	M	S	M
9	EN	-	-	-	-	M	M	S

MS – male sterility, FS – female sterility, NS – natural sterility, TS – total sterility, EG – powdery mildew, PR – brown rust, ST – septoria leaf blotch, SR – Sasovska Ranozreika, MA – Michigan Amber, EN – Enola.

The high degree of sterility of the observed second generation hybrids is directly dependent on the reduced chromosome number and the presence of variation in chromosome number reported in microscopic observations. Table 5 presents data on the cytology features of the three germinated hybrid accessions. The table shows that in all investigated samples is observed as an even and odd number of chromosomes, which is indicative of unequal cell division, and thus the physiological difficulties most clearly expressed in the accession 'a', which died in phase 'first leaf'. Although all three samples hybrids were obtained in different ways and with different maternal parental forms, heterogeneous set kariotypes were formed under the influence of the same accession of *Aegilops cylindrica*. The difference between the expected chromosome number and reported real chromosome number defined the wrong course of meiosis in the first generation hybrid plants. This is emphasized by the chromosomal coefficient that clearly differs from 1.00 i.e. normal course of cell division (ChC ≠ 1.00).

Shoenenberger et al. (2006) also described a strong variation in chromosome number in the second generation hybrids. While the first generation hybrid plants all had 35 chromosomes, in the second their number is between 30 and 84.

Table 5. Cytological characteristics of hybrid plants

No	a	b	f
1	56	49	68
2	55	47	67
3	55	49	69
4	56	47	69
5	54	48	70
6	53	48	70
7	56	49	68
8	56	48	69
9	55	49	68
10	55	47	69
AChN	55	48	69
EChN	56	49	70
ChC	0.9821	0.9796	0.9857
SD	0.9944	0.8756	0.9487

AChN – average chromosomes number, EChN – expected chromosomes numer, ChC – chromosome coefficient, SD – standard deviation.

The presence of the same chromosome number is not indicative of the presence of sterility, as these authors reported partial fertile and fully sterile plants, each possessing 41 chromosomes. The same study reported no difference in the chromosome number of the same hybrid and the same microscope slide. In the hybrids studied by us, different numbers of chromosomes were observed even at the cellular level. These results identify significant deviations in generative processes of hybrids a, b and f. Crémieux (2000) reported 28 to 49 chromosomes in second generation backcrossed hybrids. For similar results reported Cifuentes and Benavente (2009) in hybrids involving *Triticum durum*. Sears (1943) states that in *Triticum* hybrids with *Aegilops cylindrica*, deviations resulting in a reduction of chromosome number in the second generation backcrossed hybrids are mainly due to improper interaction between wheat genome and that of *Aegilops cylindrica*, and misallocation of bivalents and univalents in meiotic division in the first generation hybrids.

Despite the negative impact of the genome of the wild species, the studied second generation hybrids showed very good pathogen resistance. At all stages of their development to their maturity all grown accessins were completely resistant to the pathogen of powdery mildew, brown rust and septoria leaf blight in the native represented races and forms into the growing conditions. These results are proved by the presence of typical symptoms of the three diseases on standard varieties for susceptibility to the pathogens.

CONCLUSIONS

From these results the following conclusions could be drawn:

- Second generation hybrids between wheat species and *Aegilops cylindrica*, are characterized by similar morphology resembling that of wild species.
- Flowering of the all hybrids plants is an open type, and stamens do not burst, which defines zero seedset.
- Studied hybrids are 100% sterile, as evidenced by the non-homogeneous chromosome number.
- Although differences in their obtaining and involved mother component, the chromosomal aberrations are caused by improper interaction between wheat genome and that of the wild species.
- Despite their negative qualities, all studied accessions are characterized by complete resistance to the pathogen of powdery mildew, brown rust and septoria leaf blight, which makes them a good starting material for inclusion into the bread wheat breeding programs.

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RESEARCH REGARDING NEW RACES OF *PLASMOPARA HALSTEDII* IN FUNDULEA AREA

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Abstract

One of the most important disease of sunflower crop is downy mildew, wich is caused by Plasmopara halstedii fungus (Farl.) Berl. et de Toni (syn. Plasmopara helianthi Novit). Downy mildew is a common disease in many areas of the world where sunflower is grown and infects young plants in spring when soil moisture is high and temperatures range from 15 to 18°C. Loss of young plant caused by pathogen may be up to 80%. The pathogen could be controlled growing resistant genotypes and that is why the major objective of this study was to develop sunflower hybrids genetically resistant to dominant races of downy mildew in Fundulea area. To prevent losses caused by downy mildew, we start create hybrids genetically resistant to this pathogen, parental lines were backcrossed to introduce new genes using resistant sources from maintainer line HA 335 and restorer line RHA 274. We test resistance for our genotypes artificial infested in collaboration with Institute of Field and Vegetable Crops Novi Sad. In the future we proposed to test our hybrids in Romania using the international set of differentials for Plasmopara halstedii pathogen races. Is absolutely necessary to create resistant varieties for the newest Romanian races, considering downy mildew is one of the most important disease for sunflower crop.

Key words: *backcross, downy mildew, Helianthus annuus, pathogen, races.*

INTRODUCTION

Downy mildew caused by the fungus *Plasmopara halstedii* (Farl.) Berl. et de Toni is one of the most harmful sunflower diseases. Downy mildew is widespread in all sunflower-growing countries with the exception of Australia. It had been first discovered on sunflowers in the United States in 1883, and in 1892 it was found on *Helianthus tuberosus* in Russia. In Romania, first described in 1964 by Radulescu in Cluj area, next year had been mentioned in South part of Romania (Baneasa-Ilfov), north of Moldova and Banat. In Yugoslavia, had been identified in sunflower crops in 1949 by Piersic and described by Nikolic (1952). Inoculum nature, plant stage, temperature and humidity, interaction between host plant-parasite and plants nutrition are the most favorable factors for downy mildew development. Considering the way fungus mycelium is developing and extended through cells tissues of plants, it exists two infections: primary (systemic) and secondary. While the primary infection causes significant yield losses, secondary infection has no importance for the production of sunflower. Primary infection is realized during seed germination in the soil and the emergence of sunflower seedlings. It may be caused by fungus mycelium or oospores present on infected seeds, or by oospores present in infected soil into which healthy seeds are sown. The fungus penetrates the root, stem, cotyledons and reaches the meristematic tissue at the top of young plants. Classic symptoms of systemic infections are leaf chlorosis and sporulation, stunted growth, short internodes and with a platform head. On the infected plant parts, the root, cotyledons, the stem and especially the leaves, there occurs abundant white mycelium, which is typical for this disease. The mycelium occurs also on the reverse side of the leaves and it contains the vegetative organs of the fungus conidiophores and conidia (zoosporangia). Secondary infection has no important impact on sunflower yield, it is originate from summer conidia, it is transported by wind and only affects certain organs or portions as angular spots, chlorotics, which appear on leaves. To prevent downy mildew losses it is necessary to include cultivation practices, like healthy seeds for planting, seed treatment with fungicides against downy mildew, crop rotation, intervals of 4-5 years between two sunflower crop in the same field, distance of 500 m away from a field planted with sunflower the previous year, sowing at optimum time and deep plowing of the field after sunflower harvest. Seeds treatment with metalaxyl represent one of the most important measures for downy mildew control. The chemical treatment protects sunflower crop of the primary infection, at early stages of development of sunflower. It could be used different post-emergences chemicals treatments also for downy mildew control. However, the most effective control of this fungus is genetically resistance, which represent our objective to develop sunflower genotypes resistant to dominant races of downy mildew in Romania.

MATERIALS AND METHODS

For this experiment we used following inbred lines developed in North Central Regional Plant Introduction Station USDA-ARS-PIRU, Iowa State University, were used as donors of downy mildew resistance genes:

- B – lines: HA 335 (Pl 6), HA-R4 (Pl 16)
- Rf – lines: RHA 340 (Pl 8), RHA 348 (Pl 8)

The experiment start in 2009, we crossed each sourse of resistance with three of ours B – lines: 9149B, 9041B and 5017B and each resistant restorer line with three of ours Rf – lines: 5037C, 01007C and 01009C. We used back-cross method. The plants that served as female component in the crosses were manually emasculated early in the morning. The experience was located in Fundulea area, were it was sown on rows with 4.8 m length. Downy mildew resistance was tested in laboratory conditions in collaboration with Institute of Field and Vegetables Crops of Novi Sad using M. Rahim, C. C. Jan and T. J. Gulya method. Seed were surface-sterilized in 1% sodium hypochlorite solution for 10 minutes, soaked in 0.8 ml/l `ethrel` (2-cloroethyl phosphonic acid) for 18-24 h, washed with tap water, placed between moist blotting papers and put in a high-humidity germinator at 25^{o}C. Two to three-day-old seedlings with a radicle length of 10-20 mm and visible root hairs were inoculated by immersion for 3 h at 18^{o}C in a suspension containing 3-4 x 10^4 freshly harvested zoosporangia/ml. Care was taken to choose seedlings whose radicle length were similar to prevent the possibility of disease escapes. Inoculated seedlings were grown in a mixture of sand Perlite (3/2 v/v) in a greenhouse (24±3^{o}C, 16 h photoperiod) for 10-14 days. Under these inoculation and seedling growth conditions, 100% infecion was achievable in susceptible race/sunflower line combinations. The seedlings were then placed overnight in a dark chamber, maintained at 100 % relative humidity and 18^{o}C, to initiate sporulation on the cotyledons and the first true leaves of susceptible seedlings. Seedlings classified as resistant displayed no sporulation on either cotyledons or leaves, nor did they show stunting typical of systemic infection.

RESULTS AND DISCUSSIONS

In table 1, we can see results from laboratory infestation, tested in collaboration with Institute of Field and Vegetable Crops of Novi Sad Serbia:

Table 1. Results from laboratory infestation

No.	Genotype	Total number of plants	Healthy plants	Plants with downy mildew symptoms	Resistance (%)
1	9149B x HA 335	26	26	0	100
2	9041B x HA 335	30	24	6	79
3	5017B x HA 335	25	25	0	100
4	9149B x HA R-4	29	25	4	85
5	9041B x HA R-4	30	26	4	88
6	5017B x HA R-4	30	23	7	75
7	01007C x RHA 348	30	26	4	88
8	01009C x RHA 348	30	23	7	75
9	5037C x RHA 348	29	29	0	100
10	01007C x RHA 340	27	24	3	90
11	01009C x RHA 340	29	25	4	85
12	5037C x RHA 340	29	22	7	75

We can see in the table that all lines had been resistant during laboratory infection.

Results from Fundulea are relatated in table 2. The experience was sown on plots of two rows, 4.8m lenght, in three replications. For field experience in Fundulea area we used internationally set of sunflower differential lines to different physiological races of *Plasmopara halstedii.*

Table 2. Results from Fundulea

No.	Cross	Generation	Total number of plants	Resistant plants	Susceptible plants	Resistance %
1	9149B x HA 335	BC_3	21	21	0	100
2	9041B x HA 335	BC_3	22	17	5	75
3	5017B x HA 335	BC_3	19	19	0	100
4	9149B x HA R-4	BC_3	20	17	3	85
5	9041B x HA R-4	BC_3	18	16	2	88
6	5017B x HA R-4	BC_3	21	16	5	75
7	01007C x RHA 348	BC_3	21	18	3	87.5
8	01009C x RHA 348	BC_3	22	17	5	75
9	5037C x RHA 348	BC_3	20	20	0	100
10	01007C x RHA 340	BC_3	19	17	2	90
11	01009C x RHA 340	BC_3	19	16	3	85
12	5037C x RHA 340	BC_3	22	17	5	75

Genes of resistance to new races of downy mildew have been determined in wild sunflowers and they have been transferred into cultivate sunflower genotypes. Resistance to downy mildew is controlled by several single dominanat genes named *Pl- genes,* which are racially specific and which provide vertical resistance.

CONCLUSIONS

Downy mildew disease could produce losses of 80% in sunflower crops. In Romania, from approximately 35 years, there existed only two races, but in the last decade appeared five new races of the pathogen. Chemical treatment with metalaxyl represent one of the most important measures for downy mildew control, but it is absolutely necessary to create genetically resistance. These might be a good reason to create new material with genetically resistance for new races of *Plasmopara halstedii*. To control new races of the pathogen we created new resistant lines which are used to create resistant hybrids.

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EFFECT OF PLANT DENSITY ON AGRONOMIC TRAITS AND YIELD OF SOYBEAN CULTIVARS IN MASHHAD REGION

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Abstract

To study the effect of plant density on three soybean cultivars on 2008 at Mashhad region an experiment was conducted as factorial based on Randomized Complete Blocks Design with 4 replications. The experimental factors was included of three cultivars i.e. Hobit, Williams and LWK with three plant density that was 30, 45 and 60 plant/m^2. In each of three cultivars with increasing plant density, yield components decreased such as fertile node number, pod number on main stem, branch number, node number on branch and total pod in each plant. But plant height, lowest height of pod from the earth, node number on main stem, pod number on main stem node, seed number in each main stem pod, 100 seeds weight of main stem were not affected by plant density. Based on received results from the experiment, by increasing plant density, leaf area index, crop growth rate, biological and economical yield increased. Yield of cultivar Hobit with least plant height, the most short growth period duration, least biological yield and highest harvest index, was more than other cultivars and cultivar LWK showed minimum yield among three cultivars. Hobit and LWK at density 60 and 30 plant/m^2 with yield 5024 and 3378 kg/ha respectively, showed the most and least economical yield among the all of treatments.

Key words: *Soybean, Plant density, Cultivars, Yield, Yield components.*

INTRODUCTION

Plant density and planting pattern have a distinct effect on light interception and its efficiency to seed yield formation in most crops especially soybean (Wells et al., 1993). They concluded that with increasing plant density, number of branches and the total biomass is reduced. Cultivars response to population density and good impart from growing space need to genetic potential and its interaction with environment (Carpenter and Board, 1997). Cober et al., (2005) showed there was no significant difference for plant height between old and modern cultivars of soybean, but old ones simply flat down with increasing planting density. Boquet (1990) proposed the decreasing of growing season with early maturing cultivars for solving this problem. Some reports imply that with increasing plant density, plant height and yield components specially pod number, seeds per plant, and also seed weight are decreased, but the potential for branch formation is not affected (Boquet, 1990; and Purcell et al., 2002). Soybean seed yield is increased in narrower rows spacing because of increasing the crop growth rate (CGR) from emergence to R_5 stage (Flent et al., 1998). At seed filling period (R_5), Leaf area index (LAI) and total dry matter of crop have significant and positive effect on yield too (Mazaheri et al. 2005). LAI is increased with rising of plant density for better light interception and biomass and CGR production (Ball et al., 2000).

MATERIALS AND METHODS

This experiment was done on 2008 at Mashhad, Iran. The framework of experiment was factorial based on Randomized Complete Blocks Design with 4 replications. The experimental factors was included of three cultivars i.e. c_1: Hobit, c_2: LWK and c_3: Williams with three plant density that was d_1: 30, d_2: 45 and d_3: 60 plant/m^2. Traits under study were yield and yield components ie. fertile node number, pod number per plant, branch number, seed per pod and 100 seed weight. Plant height, CGR, LAI, biomass and harvest index were noticed too. ANOVA and Duncan multiple range test was used for interpretation of results.

RESULTS AND DISCUSSIONS

Mean comparison (P=0.01) for above mentioned agronomic traits has shown in Table 1. Hobit showed the least fertile nodes per plant amongst cultivars. With increasing plant density, number of nodes were decreased significantly. Total pods per plant decreased with increasing of plant density in all cultivars. Hobit and LWK showed the greatest and the least numbers of pods per plant, in 30 and 60 plant.m^{-2} respectively. The low plant density, the largest area for expansion of canopy and the more pods/plant.

Table 1. Mean comparison of yield and yield components of soybean cultivars× density interaction effects

Treatments	No.fertile nodes	Pod per plant	Branch number	Seed per pod	100 seeds weight (g)	Seed yield (Kg/ha)
$C_1 D_1$	10.2 cd	49.0 a	5.0 a	2.4 d	12.9 abc	4129 abc
$C_1 D_2$	8.70 d	31.0 c	3.3 b	2.4 d	12.8 abc	4067 abc
$C_1 D_3$	8.70 d	27.1cd	2.2 c	2.4 d	13.2 ab	5024 a
$C_2 D_1$	13.4 b	29.6 c	0.7 d	2.8 b	12.3 cde	3378 d
$C_2 D_2$	12.2 bc	26.5 c	0.2 d	2.9 a	11.7 de	3453 cd
$C_2 D_3$	10.9 c	20.4 d	0.1 d	3.0 a	11.4 e	4251 abc
$C_3 D_1$	15.4 a	41.9 b	1.8 c	2.7 b	12.6 bcd	3884 bc
$C_3 D_2$	13.1 b	30.2 c	0.9 d	2.6 bc	13.6 a	4266 abc
$C_3 D_3$	10.8 c	21.6 d	0.25 d	2.5 cd	12.9 abc	4473 ab

The low plant density, the largest area for expansion of canopy and the more pods/plant.

Branch number per plant showed the same trend and variations as pods/plant. Hobit had higher branches at all densities than the others. LWK had the more seeds per pod in different densities, because this cultivar has the least branches per plant, that creates more pods per main stem for compensation of seed yield.

Increasing plant density, decreased the 100seeds weight in all combinations of treatments. Williams and Hobit obtained the greatest 100 seeds weight. Hobit and LWK at density 60 and 30 plant/m^2 with the yield of 5024 and 3378 kg/ha respectively, showed the most and least economical yield among the all of treatments. Some of researchers have reported,the higher yield is achieved in narrower and slightly higher plant population densities (Egli, 1988: Flent et al., 1998).

Table 2 shows the interaction effects (P = 0.05) of cultivars×density on physiological parameters. LWK and Hobit showed the higher and non significant plant heights.The greatest LAI's belonged to Williams in higher densities. Hobit obtained a high LAI and CGR in 60 plant.m^{-2} too, both were prerequisite for its higher yield. The greater plant densities lead to the higher physiological growth indices and biomass too.

Harvest index (HI), was in the highest values for Hobit at all plant densities. This means, Hobit has a capable and efficient assimilate transport system for yield formation. The more partitioning carbohydrates to seeds, the most seed yield (Koocheki et al.,1991).

Table 2. Mean comparison of the interaction effects of cultivars× density on physiological parameters

Treatments	Height (Cm)	LAI	CGR (g.m^{-2}.days^{-1})	Biomass (Kg/ha)	HI (%)
$C_1 D_1$	50.0 b	3.0 d	15.78 c	9114 ab	44.25 a
$C_1 D_2$	51.40 b	3.97 cd	22.35 abc	9280 ab	43.5 ab
$C_1 D_3$	58.10 b	4.82 abc	24.11 a	11090 ab	43.25 ab
$C_2 D_1$	119.6 a	2.85 d	15.57 c	8479 b	35.75 abc
$C_2 D_2$	123.6 a	3.95 cd	20.14 abc	12050 ab	3.25 c
$C_2 D_3$	124.1 a	4.37 bc	24.15 a	12590 a	32.25 c
$C_3 D_1$	116.0 a	3.87 cd	16.52 bc	11240 ab	34.75 bc
$C_3 D_2$	114.6 a	5.27 ab	23.84 a	12500 a	34.75 bc
$C_3 D_3$	114.0 a	5.72 a	23.35 ab	12710 a	35.5 abc

Letters show significant differences based on Duncan's Test

CONCLUSIONS

Hobit produced the most seed yield between cultivars in 60 plant.m^{-2}.

The main reasons for Hobit higher yield were: increased LAI, CGR, Biomass and HI of this cultivar compared the others.

Hobit also has a good potential for branching. This traits help the plant to adjust and produce proper yield components.

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THE INFLUENCE OF SOIL TYPE AND FERTILIZATION DOSES ON THE YIELD OF WINTER BARLEY

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Abstract

Purpose of this study was to establish the most efficient polifactorial combination represented by soil type x dose of fertilizer for cultivation of winter barley Cardinal and Maresal varieties, in order to obtain higher production in terms of quantity and quality, in climate conditions of Braila Plain, which is a very favorable area for this crop.
The three experimental factors had two graduations, namely: A (soil type) with A1 – typical Chernozem and A2 Solonetz, B (variety) with B1 – Cardinal and B2 – Maresal, and C (dose of fertilizer) with C1 – economic optimum dose calculated for chernozem, C2 – economic optimum dose calculated for Solonetz and C3 – unfertilized.
In terms of economic efficiency, the largest profit of studied variants was registered by Maresal variety cultivated on Chernozem, fertilized with optimum dose for Solonetz, followed in descending order by Maresal variety cultivated on Chernozem fertilized with optimum dose for Chernozem and Cardinal variety grown on Chernozem fertilized with optimal dose calculated for Solonetz. The research found that the Maresal variety is more productive than Cardinal variety on both soil type from experience, but Cardinal variety can obtain a high production increase if additional fertilization. We studied also the correlations between soil quality indices and interaction of experimental factors studied, to determine the most efficient systems (soil type x level of fertilization x variety), while Braila Plain.

Key words: *fertilization doses, winter barley, Braila Plain.*

INTRODUCTION

Hordeum vulgare L. species is among the oldest cultivated plants because their seeds have multiple uses: human nutrition (5%), animal feed (70%), obtaining malt (20%) and other uses in industry (5%) (Wang, 2005). In terms of quality, barley grains contain on average: 10.5% protein, 2.8% fat, 4.0% cellulose, 66.2% extractive substances (of which 53% starch), a series of essential amino acids (lysine, tryptophan, arginine), vitamins B1, B2, minerals (K, P, Ca) (Figure 1).
Maresal and Cardinal barley varieties are varieties of high productivity and high quality, timely cultivation Braila Plain, with the possibility to practice fully mechanized technology and obtaining very good economic efficiency. Therefore, the aim of the experience was to identify and choose the best type of soil and fertilizer system, providing increased economic efficiency in achieving higher production of barley, in climate conditions Braila.

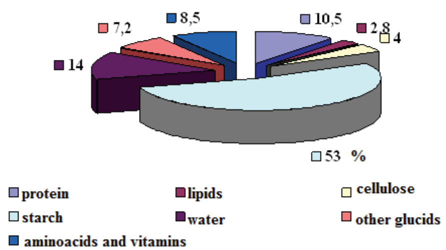

Figure 1. The average chemical composition of barley grains (%)

MATERIALS AND METHODS

Experience carried out between 2009-2011 was three-factorial, type A x B x C, with method of subdivided parcels located in 3 repetitions, each plot with 5000 m^2. These three experimental factors studied were: A = soil type, with sections: a1-typical chernozem, a2-solonetz B = winter barley variety – with sections: Cardinal b1, and b2 Maresal; C = efficient optimal dose of nutrients: c1-DOE calculated for chernozem: N-100 kg / ha P_2O_5-80 kg/ha K_2O-80 kg/ha, c2-DOE calculated for

Solonetz with N-130 kg/ha P_2O_5-110 kg/ha K_2O-100 kg/ha and C3 – unfertilized (Table 1).

Table 1. The organization of experience

V / R	a1						a2					
	c1		c2		c3		c1		c2		c3	
	b1	b2	b1	b2	b1	b2	b1	b2	b1	b2	b1	b2
R1	a1 b1 c1	a1 b2 c1	a1 b1 c2	a1 b2 c2	a1 b1 c3	a1 b2 c3	a2 b1 c1	a2 b2 c1	a2 b1 c2	a2 b2 c2	a2 b1 c3	a1 b2 c3
R2	a1 b1 c1	a1 b2 c1	a1 b1 c2	a1 b2 c2	a1 b1 c3	a1 b2 c3	a2 b1 c1	a2 b2 c1	a2 b1 c2	a2 b2 c2	a2 b1 c3	a1 b2 c3
R3	a1 b1 c1	a1 b2 c1	a1 b1 c2	a1 b2 c2	a1 b1 c3	a1 b2 c3	a2 b1 c1	a2 b2 c1	a2 b1 c2	a2 b2 c2	a2 b1 c3	a1 b2 c3

Physical and chemical characteristics of the soil in the two graduations of A experimental factor (a1 – Chernozem and a2-Solonetz) were those shown in Table 2.

Table 2. Characteristics of two types of soils

Agriculture Year	Chernozem		Solonetz	
Specification/Horizon	Am	AC	Ao	Btna
Depth (cm)	0-40	40 - 80	0-40	40-90
Pattern	L	L	LN	AL
Specific Density (g/cm^3)	2,60	2,55	2,51	2,54
Aparent Density (g/cm^3)	1,165	1,038	1,017	1,101
Total Porosity (PT%)	55,19	59,29	59,48	56,65
pH in water	7,5	7,88	8,34	9,15
Carbonates ($CaCO_3$%)	10,2	12,5	6,5	7,3
Humus (%)	3,36	2,5	3,84	2,97
Mobile Phospforus (ppm)	62	61	47	45
Soluble salts (1:5) mg per 100 g de soil	113	125	160	184
Soil Base saturation degree (V%)	89,2	90,1	100	100
Nitrogen index (IN)	2,8	2,65	2,78	2,58

The fertilized variants were fertilizer in both experimental years with different doses, depending results of soil analysis, given Yara Mila complex fertilizers with N-8 P_2O_5-24 K_2O-24 MgO-2 SO_3-5 B-0.05 Fe-0.05 Mn-0.1 Zn-0.02 in plots with chernozem soil type with quantity of 340 kg/ha, resulting: N = 27 kg/ha, P_2O_5 = 82 kg/ha, K_2O= 82 kg/ha, and in plots with Solonetz type of soil amount of 450 kg/ha, resulting N = 27 kg/ha, P_2O_5 = 82 kg/ha, K_2O = 82 kg/ha. The difference of Nitrogen was completed in stage of vegetation with 220 kg/ha NH_4NO_3, resulting 73 kg/ha N, in plots of chernozem and with 290 kg/ha NH_4NO_3, resulting 97 kg/ha N in plots of solonetz.

The results were statistically processed using MS Excel, ANOVA, and Average tests.

RESULTS AND DISCUSSIONS

Yields obtained ranged between 3650 kg/ha and 6560 kg/ha for variants placed on typical chernozem and between 3610 kg/ha and 6110 kg/ha for variants placed on solonetz type of soil (Table 3).

Table 3. Yields obtained for each combination of experimental factors

Nr. crt.	Variant			Absolute yield kg/ha		Media R
	A	B	C	2009 - 2010	2010 - 2011	
	CZ a1	Cardinal b1	DOEcz c1	5700	5560	5630
			DOEsn c2	6210	6110	6160
			NF c3	3980	3850	3915
		Mareşal b2	DOEcz c1	5920	5710	5815
			DOEsn c2	6560	6410	6485
			NF c3	3810	3650	3730
	SN a2	Cardinal b1	DOEcz c1	5520	5430	5475
			DOEsn c2	6060	5970	6015
			NF c3	3810	3720	3765
		Mareşal b2	DOEcz c1	5690	5540	5615
			DOEsn c2	6110	6090	6100
			NF c3	3620	3610	3615
Media V				5249,2	5137,5	5193,3

Calculating absolute and relative differences between experimental variants for each year experimental and control group (average yield obtained) were found following differences (Table 4):

- very significant positive differences for the following: a1b1c2, a1b2c2, a2b1c2 and a2b2c2 in both experimental years;
- significant positive differences distinct variants a2b2c1 a1b1c1 and, in 2010, while in 2011 we obtained a significant positive difference distinct a1b2c1 only version;
- significant positive differences a2b1c1 versions in 2010 and a1b1c1 and a2b2c1 variations in 2011;
- negative highly significant differences compared to the control variants obtained a1b1c3, a1b2c3, a2b1c3 and a2b2c3 in both experimental years;
- significant difference from the control obtained a2b1c1 version in 2011.

In Figure 2 were summarized results of production differences using AVERAGE test.

Table 4. Statistical interpretation yields obtained by analysis of variance (ANOVA test)

Variant	Repetition	Absolut yield	Differents		Semnification
			Abs.	Rel.	
a1b1c1	2010	5700	506,7	9,76	**
	2011	5560	366,7	7,06	*
a1b1c2	2010	6210	1016,7	19,58	***
	2011	6110	916,7	17,65	***
a1b1c3	2010	3980	-1213,3	-23,36	000
	2011	3850	-1343,3	-25,87	000
a1b2c1	2010	5920	726,7	13,99	***
	2011	5710	516,7	9,95	**
a1b2c2	2010	6560	1366,7	26,32	***
	2011	6410	1216,7	23,43	***
a1b2c3	2010	3810	-1383,3	-26,64	000
	2011	3650	-1543,3	-29,72	000
a2b1c1	2010	5520	326,7	6,29	*
	2011	5430	236,7	4,56	-
a2b1c2	2010	6060	866,7	16,69	***
	2011	5970	776,7	14,96	***
a2b1c3	2010	3810	-1383,3	-26,64	000
	2011	3720	-1473,3	-28,37	000
a2b2c1	2010	5690	496,7	9,56	**
	2011	5540	346,7	6,68	*
a2b2c2	2010	6110	916,7	17,65	***
	2011	6090	896,7	17,27	***
a2b2c3	2010	3620	-1573,3	-30,29	000
	2011	3610	-1583,3	-30,49	000
Martor	media	5193,3	0	0,00	-

DL5% = 296,64 DL1% =419,35 DL 0,1% =598,68

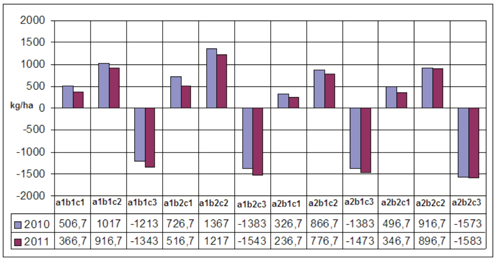

Figure 2. Yield differences recorded for each experimental variant, compared to the control (average yield)

The results of laboratory analysis about quality index of yield for each experimental variant were summarized in Table 5.

Table 5. The results of quality index of yields

Variant	Repetition	Absolute yield	Quality characteristics			
			MMB	MH	G	P
a1b1c1	2010	5700	43,6	67,4	97	99,1
	2011	5560	43,4	67,1	97	99,3
a1b1c2	2010	6210	43,8	69,9	98	99,3
	2011	6110	44,2	67,8	97	99,2
a1b1c3	2010	3980	38,6	54,4	90	98,1
	2011	3850	38,1	53,7	90	98,0
a1b2c1	2010	5920	43,8	67,7	98	99,3
	2011	5710	42,9	66,8	97	99,0
a1b2c2	2010	6560	45,1	71,3	99	99,7
	2011	6410	44,9	70,2	98	99,6
a1b2c3	2010	3810	38,2	53,9	90	98,0
	2011	3650	37,7	52,3	89	97,9
a2b1c1	2010	5520	43,1	67,2	97	99,0
	2011	5430	42,9	66,1	94	98,6
a2b1c2	2010	6060	43,4	69,5	98	99,0
	2011	5970	43,6	67,5	98	99,1
a2b1c3	2010	3810	38,0	53,7	90	97,7
	2011	3720	37,6	52,1	90	97,6
a2b2c1	2010	5690	43,5	67,3	97	99,2
	2011	5540	43,3	67,0	97	99,2
a2b2c2	2010	6110	43,7	69,8	98	99,5
	2011	6090	44,1	70,2	98	99,6
a2b2c3	2010	3620	37,2	51,9	89	97.3
	2011	3610	36,4	50,2	89	97,1
Control	Average	5193,3	41,7	63,1	94,8	98,8

MMB = the weight of a thousand grains MH = the weight of hectoliter grains

G = germination P = physical purity test

The results were summarized in figure 3, where it can observe a fluctuating evolution of the weight of thousand grains (MMB) and weight of hectoliter graine (MH) indices for experimental variants, variants that low for a1b1c3; a1b2c3; a2b1c3 and a2b2c3, on both soil types for both varieties in unfertilized sole. In contrast, the highest values of quality indices of production variants were obtained a1b1c2, a1b2c2, a2b1c2 and a2b2c2, experimental variants placed on both soil types, with both varieties of barley studied fertilized with DOE (optimal economic dose).

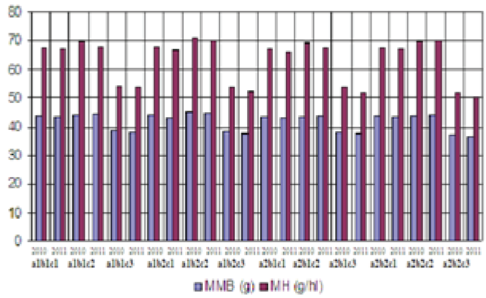

Figure 3. Graphic with indices of quality for experimental variants

Economic efficiency was calculated using the difference between incomes and expenses recorded per hectare for each combination of experimental factors. For this, we used technological currency, first by calculating the mechanical work expenses and materials used for each experimental variant and the proceeds according to the production recorded each variant was calculated profit per hectare.

The results of comparative economic efficiency recorded in the two years of the study were summarized in Figure 4. Comparing the results obtained with the control (mean variants), it has been observed that the biggest profit was recorded version a1b2c2 with a difference compared to control 664 lei/ha in 2010 and 457 lei/ha in 2011, followed in descending order of variants a1b2c1 and a1b1c2.

The lowest results on the yield compared to the control were recorded by a2b1c3 variant, which is Cardinal variety, cultivated on Solonetz and unfertilized (with a difference-98 lei/ha in 2010 and-10 lei/ha in 2011) followed by a1b2c3 variant, which is Marshal variety grown on chernozem unfertilized (with a difference-97 lei/ha in 2010-46 lei/ha in 2011).

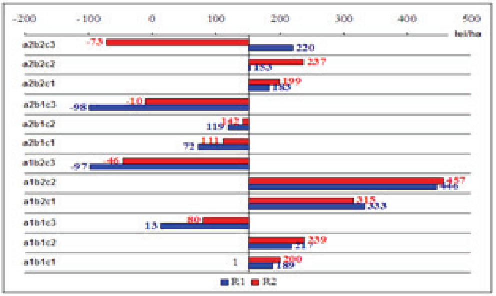

Figure 4. Chart of economic efficiency achieved by each experimental variant, compared with the control (average of variants)

CONCLUSIONS

Because of the agricultural use, there is a continuous decrease in soil nutrient content, so the study of the influence of soil type and fertilization doses are required for any crop.

a1b1c2, a1b2c2, a2b1c2 and a2b2c2 experimental variants, that means both varieties grown in both soil and fertilized with economic optimum dose for Solonetz have obtained very significant positive differences compared to the control (average of experience) in both experimental years, both on the quantitative and quality indicators on production.

Very significant negative differences compared to the control were obtained by a1b1c3, a1b2c3, a2b1c3 and a2b2c3 variants, respectively both varieties of barley grown on two soil types fertilized in both experimental years for quantitative and qualitative indices.

In terms of economic efficiency, the highest profit was recorded by a1b2c2 variant, which is Maresal variety grown on chernozem, fertilized with optimum dose for Solonetz followed in descending order of a1b2c1 variant (Maresal variety cultivated on chernozem, fertilized with optimal dose for chernozem) and a1b1c2 variant (Cardinal variety cultivated on chernozem, fertilized with optimum dose for Solonetz).

The lowest economical efficiency was recorded by a2b1c3 variant (Cardinal variety cultivated Solonetz, unfertilized) and a1b2c3 variant (Maresal variety cultivated on chernozem unfertilized), which shows that doses of fertilization influences a greater increase production and economic efficiency than soil type.

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COMPARATIVE STUDY OF CONVENTIONAL AND MODERN CLEARFIELD TECHNOLOGY FOR SUNFLOWER HYBRIDS CULTURE IN BRĂILA PLAIN

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Abstract

There are a number of technical restrictions for achieving higher production of sunflowers, including: providing temperature and water regime in critical phases of vegetation, against competition created by weeds and pests or diseases control. The experience described in this paper is to reveal the comparative results between conventional and modern Clearfield technology for three consecutive years, in pedoclimatical conditions of Braila Plain.
The biological material used in this research was four Limagrain hybrids including two used in conventional culture and other two hybrids improved genetic resistance for Pulsar herbicide, to use the Clearfield technology.
Determinations made during the vegetation period about spectrum and density of weeds, and weeds control efficiency by two chemical methods. The results were statistically interpreted by analysis of variance, with average of hybrids like control. Economic efficiency was calculated for this two culture technologies, also.
Of the four hybrids studied, the highest production was obtained hybrid LG 56.63 CL achieving very significant positive differences to average of hybrids analyzed. The lowest production were obtained of LG 56.55 hybrid grown in conventional culture system in all three experimental years, with very significant negative differences to control. LG 56.63 CL hybrid has superior quality seeds of all other hybrids studied, with values of hectoliter weight ranging between 48 and 49.8 kg/h, while a thousand grain weight values ranged from 60 to 65.8 g.

Key words: *sunflower, conventional technology, modern Clearfield technology, efficiency.*

INTRODUCTION

Vegetable oil production worldwide reach an average of 50 million tons annually. In the hierarchy of large oil producing plant fall crops as follows: first place is occupied by soybean (38% of total world production, with a production of 17 million tons annually), the second is sunflower, rapeseed third, fourth cotton and ranks fifth peanuts. Sunflower is one of the most important oilseed crops grown in the world (13% of world oil production) and most important oilseed crops in Romania, because the oil extracted from sunflower achenes is semisicativ and is characterized by color, taste, and fragrant, high in vitamins (A, D, E, K) and aromatic substances, possibility of easy storage for a longer period.

Clearfield production system used by the company BASF uses a combination of superior genetics, represented by sunflower hybrids adapted to local environmental conditions, with herbicide Pulsar 40, which is easily applied to provide the best integrated solutions in order to obtain quantitative and qualitative production. The experience described in this paper is to reveal the comparative results between conventional technology and modern technology Clearfield, in the same soil and climatic conditions of Braila Plain.

MATERIALS AND METHODS

The biological material used in the experiment was represented by four hybrids Limagrain, including two used in conventional culture and the other two, improved genetic resistance to the herbicide Pulsar, use the Clearfield technology.

The experience was bifactorial, type A x B with the experimental factors: A-culture technology with two graduations: a1-and a2 conventional technology-modern technology Clearfield, B-hybrid sunflower with two graduations for each technology (b1-b2 hybrid and LG 56.55-56.65 LG hybrid, conventional technology and b3-b4 hybrid CL and 56.63 LG-LG 56.58 CL, Clearfield technology. experimental plot was 2

ha for each variant settlement scheme experience of being in complete blocks, loft dispersed in three repetitions, as Figure 1.
The experiments were located on a typical chernozem soil type, with profile: Am-AC-Cca.

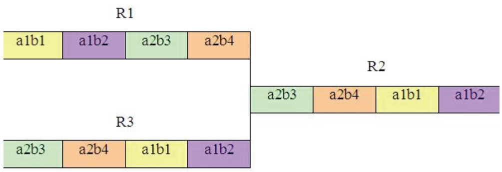

Figure 1. Scheme of experience

The experimental variants were randomized within each block to eliminate data errors variants influence and affect of neighboring. Also, they observed the isolation of 2m between variants and field uniformity for all experimental variants in the three experimental years.
During the vegetation period were made determinations plant density, determination of the degree of weed and weed spectrum present by method of metric frame. Plant density determination was performed in floral button phenophase training by attending and throwing diagonally plot at random.
For the results to be interpreted correctly, statistically speaking, the experience took place in three consecutive years (2007-2010), calculating and economic efficiency to technology analysis compared the two crops.

RESULTS AND DISCUSSIONS

Agricultural year 2007-2008, the year of climate contrasts, characterized by autumn-winter-spring rainfall assured, temperature has exceeded normal throughout the year, with an average of 1.7°C, and summer was particularly dry, intake rainfall of 105 mm is being carried under multiannual climatic deficit widened (Figure 2).
In this context, climate, moisture reserves satisfactory first half ensured the agricultural yields good autumn crops throughout the county. Shock spring crops have suffered very harsh climate of a summer rainfall and temperature, agricultural yields stood at modest levels.

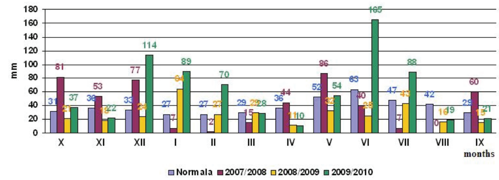

Figure 2. Rainfall (mm) recorded monthly in three experimental years compared to normal

Agricultural year 2008-2009 was poor in precipitation, with an average of 363 mm to 447 mm normal annual average, but evenly distributed in the vegetation period of sunflower, thus ensuring optimum air humidity of between 64 and 75%.
Agricultural year 2009-2010 was also a year of climate contrasts, which was characterized by excess rainfall regime in June and July, exceeding the annual average of 100 mm, a heat balance positive climate where temperatures exceeded monthly multiannuals with 1-4^{0}C. In Figures 3 and 4 are plotted the data temperature and relative humidity in the three experimental years.

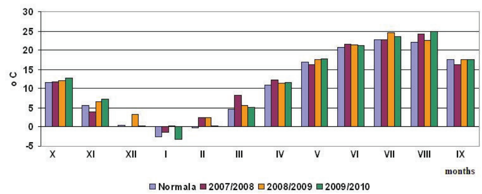

Figure 3. Chart of monthly temperatures recorded in the three experimental years compared to normal

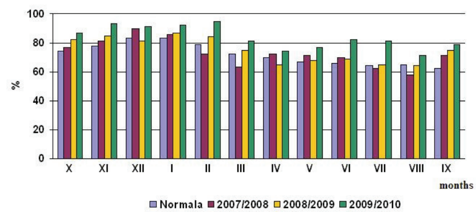

Figure 4. Chart of monthly relative humidity values in the three experimental years compared to normal

Compared to normal, the driest year was 2008/2009, while the highest values of rainfall records were recorded in June 2010 with a surplus of 100 mm and in July 2010, when it exceeded the normal 41mm.

Improved sunflower hybrids for use in Clearfield production system are tolerant to the herbicide Pulsar, produced and marketed by the company BASF. Pulsar tolerance was obtained through traditional plant breeding, which involves the introduction of DNA by genetic engineering techniques. Tolerance is not the result of genetic engineering so that sunflower plants that are grown in Clearfield system and presenting these features are not transgenic, genetically modified organisms being considered. Pulsar 40 is the first selective herbicide application after sowing, broad-spectrum weed control used in Clearfield system, which combats a wide range of weeds, both dicotyledonous and monocotyledonous some. Yields obtained for each experimental variant, in the three years of study were summarized in Figure 5.

Technology (A)		Hybrid (B)	2008	2009	2010
a1- conventional		b1- LG 56.55	2960	2900	3100
			2980	2925	3110
			2965	2930	2998
		b2- LG 56.65	3400	3340	3420
			3450	3375	3460
			3445	3380	3455
a2 – Clearfield		b3- LG 56.63 CL	3996	3985	4002
			3990	3975	4010
			4000	3990	4005
		b4- LG 56.58 CL	3350	3260	3420
			3400	3280	3410
			3380	3300	3415

Figure 5. Productions of experimental variants (hybrid x technology LG), in 2008-2010 (kg/ha)

Calculating the average for each experimental variant were obtained productions represented in Figure 6.

Was established by analysis of variance (Table 1) significance of difference between productions of hybrids using the average of all hybrids (3437.8 kg/ha).

Analysis of variance for yields of LG hybrids obtained in two different culture systems reveal that the most productive hybrid in all three experimental years was 56.63 LG CL, achieving very significant positive differences in production to witness the average of represented hybrids analyzed. LG 56.58 CL hybrid obtained a significant difference from the control distinct negative in 2009 due to strong attack by *Sclerotinia* registered in the previous two years and has obtained significant differences compared to the control, as well as hybrid LG 56.65, cultivated by conventional technology.

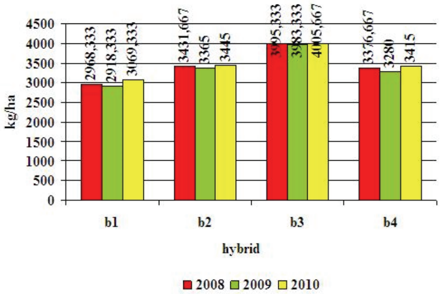

Figure 6. The average production of hybrids studied in the three experimental years

Table 1. Analysis of variance for differences between yields obtained by LG hybrids

Varianta (hibrid x tehnologie)		Producția absolută kg/ha	Producția relativă %	Diferența absolută (kg/ha)	Diferența relativă (%)	Semnificația
a1b1	2008	2968,3	86,34	-469,5	-13,7	ooo
	2009	2918,3	84,89	-519,5	-15,1	ooo
	2010	3069,3	89,28	-368,5	-10,7	ooo
a1b2	2008	3431,7	99,82	-6,1	-0,2	-
	2009	3365	97,88	-72,8	-2,1	-
	2010	3445	100,21	7,2	0,2	-
a2b3	2008	3995,3	116,22	557,5	16,2	***
	2009	3983,3	115,87	545,5	15,9	***
	2010	4005,7	116,52	567,9	16,5	***
a2b4	2008	3376,7	98,22	-61,1	-1,8	-
	2009	3280	95,41	-157,8	-4,6	oo
	2010	3415	99,34	-22,8	-0,7	-
Martor (media)		3437,8	100	-	-	-

DL 5% = 89 DL 1% = 121 DL 0,1% = 162

The lowest results were obtained for the production of hybrid LG 56.55 in all three experimental years, with very significant negative differences to the control. It was thus found that the hybrid LG 56.63 CL is the most productive in terms of Braila Plain conditions, compared with genetic counterpart LG 56.65 which is grown with conventional technology. However, other hybrid modified for resistance to treatment Pulsar achieved lower production compared with the control in 2009 (with a difference of-4.6%) due to higher sensitivity of *Sclerotinia* attack against the hybrid LG CL 56.63.

To highlight the differentiation about technology for weed control (Figure 5), was determined density and weed plants in flower button phenophase training by attending and throwing diagonally plot at random with the frame metric, and averages results were summarized in Table 2.

Tabel 2. Results on plant density and weed spectrum

Specification	Year	Variant (average of determinations)			
		a1b1	a1b2	a2b3	a2b4
Density of plants/m²	2008	65	6	5,5	5
	2009	5,5	5,5	6	4,5
	2010	6	6	6	5
No weeds/m²	2008	45	32	9	10
	2009	52	35	7	16
	2010	38	27	8	14

Determined by the metric frame results showed that the application of herbicide Pulsar in Clearfield technology reduces over 2/3 degree of weed compared to conventional technology culture, recommending its application in the climatic conditions of Braila Plain area. Determined quality indices results, means hectoliter mass and the mass of a thousand grains, for the four hybrids analyzed under different conditions of application of the technology culture, were given in Figure 7.

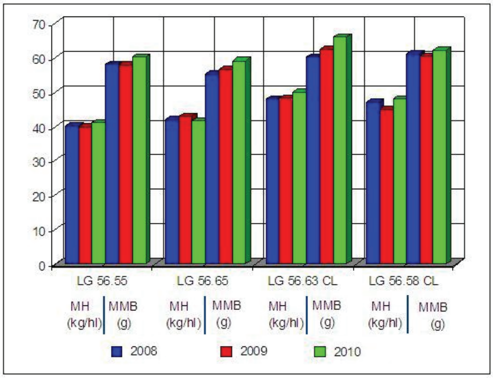

Figure 7. Indices of quality for experimental variants

The two indices of production quality (hectoliter weight MH and a thousand grains weight MMB) of LG hybrids was found that the hybrid LG 56.63 CL had a superior quality seeds to other hybrids studied, with hectolitre weight (MH) ranging between 48 and 49.8 kg/hl, while the weight of a thousand grains (MMB) were between 60 and 65.8 g of the lowest mass per storage volume and mass of a thousand grains were recorded 56.55 LG hybrid grown with conventional technology, which ranged from MH 40 kg/hl in 2008 and 41 kg/hl in 2010.

LG 56.58 CL hybrid obtained production with significant differences from the control, we found that quality indicators analyzed were superior to those of hybrids grown with conventional technology. Thus, this hybrid hectoliter weight was between value of 44.8 kg/hl in 2009 and 48 kg/hl in 2010, and a thousand grain weight ranged from 60.2 g value in 2009 and 62 g in 2010, in 2008 both qualitative indices such as intermediate values.

Figure 8 represented the economical efficiency for each technology and for each hybrid compared to average of agricultural production in three years.

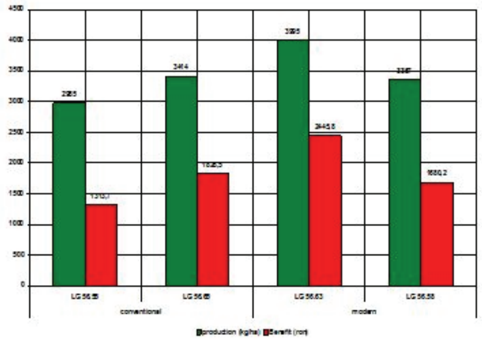

Figure 9. Economic efficiency of conventional technology and modern culture LG hybrids studied

Of economic calculations made, it can be seen that the highest efficiency was 56.63 LG CL hybrid, with a difference of 1,132 Ron per hectare of crops, compared to 56.55 LG hybrid grown in conventional systems, in terms of Braila Plain conditions.

CONCLUSIONS

The physical-chemical indices of soil showed that the soil in the Braila Plain area is favorable for sunflower crop, both in the conventional system, especially in Clearfield system.

Among hybrids LG analyzed in the three experimental years, the production of 56.63 LG CL hybrid achieving very significant positive differences in production to control represented average of hybrids analyzed.

The lowest results were obtained for the production of hybrid 56.55 LG grown in conventional culture system in all three experimental years, with very significant negative differences represented by average of hybrids

Hybrid LG 56.63 CL had a superior quality seeds of all other hybrids studied, with values ranging between 48 and MH 49.8 kg/hl, while MMB values ranged between 60 and 65.8 g

The calculation of economic efficiency for these four hybrids grown in two different culture systems (conventional and Clearfield) revealed that highest efficiency can get LG hybrid CL 56.63, a difference of 1,132 Ron per hectares of crops, to 56.55 LG hybrid grown in conventional systems, in terms of the Braila Plain.

The Clearfield opportunity to obtain superior yields compared to the conventional sunflower crop, in soil and climate conditions of the Braila County, with the recommendation to make timely treatment against diseases and pests, observing that breeding hybrids for resistance to Pulsar has a susceptibility to disease attack, especially in favorable years for these.

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THE ADAPTATION TRIAL ON DIFFERENT CHICKPEA GENOTYPES IN DIYARBAKIR, TURKEY

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Abstract

Thirty-seven chickpea (Cicer arietinum L.) genotypes and long term check (ILC 482) (Nursery:Chikpea international adaptation trial-2012) from International Center for Agricultural Research in the Dry Areas (ICARDA) also, one local check were tested at Diyarbakir, Turkey, in 2012 spring growing season. Analysis of variance revealed that differences among forty chickpea lines was significant for days to flowering and maturity, plant height, number of pods and seeds plant-1, grain yield, natural plant height, plant habit, Ascochyta blight and H. armigera. The earliest matured genotypes were FLIP82-150C, FLIP87-40C, FLIP97-263C and ILC 482. ILC3279, FLIP86-5C, FLIP97-706C were recorded as tall genotypes. FLIP88-85C, ILC 482 and ILC484 had produced more pods. ILC1929, FLIP87-8C and local variety were susceptible, ILC 482, ILC72 together seventeen genotypes was resistant for Ascochyta blight.

Key words: *chickpea, Cicer arietinum, yield, drought, Diyarbakir-Turkey.*

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a cool-season annual pulse crop that is grown in tropical, subtropical, and temperate regions of the world (Muehlbauer and Tulu, 1997, Khanna-Chopra and Sinha 1987). Most production and consumption of chickpea (95%) takes place in developing countries. It was grown on about 11.9 million hectares in 2010. Chickpea production has increased over the past 30 years from 6.6 million metric tons to 10.0 million metric tons. Most chickpeas are grown in South Asia, which accounts for more than 75% of the world chickpea area. Turkey is by far one of the largest chickpea producing country. Over the period 1980 to 2011, the area under chickpea in Turkey decreased marginally from 874 000 hectares to 400 000 hectares, similarly production decreased from 855 000 487 000 tons by average 50%. Other mainly chickpea producing countries are India, Pakistan, Mexico, Canada and Australia (TUIK, 2013). Chickpea is too an old legume crop to Southeastern Anatolia of Turkey. This region climate is characterized by rainy winters and dry and hot summers. Traditionally, the chickpea crop is predominately a late spring crop in rainfall conditions, but a little of the crop is irrigated in nowadays. Also, management practices such as pesticide, insecticide and fertilization almost never apply. Optimum plant population ranges from farmer to farmer, and mechanization is less or no, and seeds is sown generally by wheat sown machine. Therefore, yield and yield components show the fluctuations year to year, and generally total grain yield is low (Biçer and Tonçer, 2012). In South east Anatolia of Turkey, chickpeas are almost mixed populations with short plant and small seeds. However, in Turkey, many chickpea cultivars were released by Ministry of Agriculture, which were improved from either ICARDA nurseries or local varieties by crossing. New chickpea varieties adapted to warmer/cold, short-season environments are bringing increasing prosperity to all regions and offer hope for farmers elsewhere in Turkey. These cultivars were produced by research institute and private seed firms. Nevertheless, farmers need to new varieties for new requirements, so we will try to improve a new variety for region by this and others researches.

MATERIALS AND METHODS

Thirty-seven chickpea genotypes and long term check (ILC 482) (Nursery:Chikpea international adaptation trial-2012) from

International Center for Agricultural Research in the Dry Areas (ICARDA) also, one local check (Yerli Nohut) were tested at Diyarbakir, Turkey, in 2012 spring growing season. Soil of experimental area is sandy, slightly stony, low clay and low organic matter. Soil quickly dried after rainfall, due to high infiltration.

Table 1. Climatic conditions in 2012 crop season at Diyarbakir, Turkey

Months	Temperature (°C)			Precipitation (mm)	Humidity (%)
	Mean	Max.	Min.		
January	2.4	11	-8.6	78.3	85
February	1.9	14.8	-8.4	74.4	68
March	5.1	18.1	-5.8	44	59
April	15.2	27.8	2	26.2	58
May	19.6	33	8.6	41	58
June	27.7	41.7	9.4	7	27.8
July	31.3	43.7	14.5	1.6	20.9

Climatic conditions were given Table 1. Total precipitation during cropping season from February to July was 272.5 mm, but most precipitation was recorded from January to March. Plants were stressed by low precipitation and high temperature from April to July.

Each of the genotypes was planted in 2 rows with 4 m length with inter-row spacing of 45 cm. the experiment was conducted a randomized complete block design with two replications. Genotypes were sown in the second week of March. Plants were harvested in 19th July.

Observation for *Ascochyta blight* (1-9) was record two times during growing season. Overall resistance score to *H. armigera* damage during the flowering stage of genotypes was recorded. The plants were visually rated for leaf feeding on 1 to 9 damage scale. Foliage color (intensity of green color: light: 3, medium: 5, dark: 7) in flowering, plant habit after flowering (erect: 3, semi erect: 5, prostate: 7) and natural plant height when pods fully developed in field (short: 3, medium: 5, tall: 7) were observed. Ten plants were selected in harvest time for other traits. The data were statistically analyzed by using 'MSTATC' (Michigan State University, East Lansing, MI) computer package.

RESULTS AND DISCUSSIONS

The mean of genotypes were given in Table 2. Analysis of variance revealed that differences among forty chickpea lines was significant for days to flowering and maturity, plant height, number of pods and seeds plant^{-1}, grain yield, natural plant height, plant habit, *Ascochyta blight* and *H. armigera*.

Days to flowering ranged from 57 days to 73 days. FLIP87-8C, FLIP87-45C, FLIP91-77C, FLIP97-263C, FLIP97-266C and FLIP97-281C genotypes flowered 12-13 days earlier than others. The latest flowered genotypes were ILC 3279, FLIP97-137C and Elixir. All genotypes were matured between 97 day and 105 days. Maximum days to maturity (105 days) were recorded from FLIP86-5C, and FLIP97-137C. The earliest matured genotypes were FLIP82-150C, FLIP87-40C, FLIP97-263C and ILC 482, long term check variety.

Plant height ranged from 24 cm to 39 cm. ILC3279, FLIP86-5C and FLIP97-706C were recorded as tall genotypes. Natural plant height in field generally was scale 5 and 7 which plants were medium and tall. Genotype ILC 3279 and Elixir were tall by scale 7. ILC 482 and local variety were short by scale 5. Other researcher reported that ILC3279 and ILC195 were tall types (Singh, 1990).

Differences among genotypes for number of branches plant^{-1} were no significant. However, plant branching was medium or strong. Number of pods plant^{-1} varied from 3.2 to 12.9 pods. Although plants were showing the strong stand, number of pods per plant was average 7.2 pods. FLIP88-85C, ILC 482 and ILC484 had produced more pods than other genotypes. Canci and Toker (2009) reported that number of pods per plant ranged from 1.0 to 15.0 in genotypes from ICARDA.

Grain yield ranged from 31.5 g/m^2 to 227.3 g/m^2 by average 125.6 g/m^2. FLIP91-77C, FLIP93-58C and FLIP87-45C were recorded as high yielding genotypes. Minimum grain yield was obtained from FLIP81-71C, FLIP84-48C, FLIP97-137C, FLIP97-503C and Elixir.

Table 2. Chikpea International Adaptation Trial-2012

Acsess.No.	DAF	DAM	PH (cm)	PNH (3-5-7)	NBP	NPP	NSP	SYP (g)	GY (g/m^2)	FGC (3-5-7)	PGH (3-5-7)	AB (1-9)	HA (1-9)
ILC72	64	100	30	5	3.3	9.8	8.8	1.13	124.8	7	3	1	1
ILC195	60	98	30	5	2.7	7.5	5.9	0.81	144.3	5	3	1	3
ILC464	62	101	29	3	3.0	5.7	6.1	1.28	173.5	5	5	5	3
ILC484	58	98	29	3	3.8	11.2	10.7	1.50	171.5	5	5	3	3
ILC1929	58	98	28	3	3.0	10.4	8.3	1.27	143.3	7	5	8	5
ILC2555	68	104	30	5	4.0	7.9	7.3	0.87	72.0	5	3	1	3
ILC3279	73	101	39	7	2.4	7.2	5.9	0.77	77.0	5	3	1	3
FLIP81-71C	70	100	33	7	3.0	5.2	4.9	0.65	57.7	3	3	3	3
FLIP81-293C	61	99	32	7	3.9	10.0	9.7	1.70	101.5	7	3	3	5
FLIP82-150C	64	97	28	5	3.1	7.0	6.6	0.92	98.0	7	3	1	1
FLIP83-7C	65	98	34	7	3.9	9.7	7.7	1.02	113.8	5	3	3	1
FLIP84-48C	72	102	33	7	2.9	4.0	3.2	0.51	66.5	5	3	1	1
FLIP84-79C	63	100	29	3	2.7	5.6	5.4	0.66	82.3	7	3	3	1
FLIP84-92C	70	104	33	5	2.5	4.7	5.2	0.78	98.0	7	5	5	3
FLIP84-182C	68	104	32	7	2.6	7.1	7.7	1.25	92.5	5	3	3	3
FLIP84-188C	69	101	29	5	2.7	8.7	9.4	1.22	117.3	7	3	1	3
FLIP85-1C	63	100	27	5	3.1	3.2	2.4	0.47	96.3	7	5	5	5
FLIP85-17C	66	104	30	5	2.0	4.3	4.6	0.70	80.5	3	3	3	1
FLIP86-5C	61	105	35	7	2.7	6.9	6.7	1.25	138.0	5	3	3	3
FLIP86-6C	60	102	31	7	2.6	6.0	5.0	0.90	108.5	3	3	3	5
FLIP87-8C	57	99	30	3	2.6	10.4	9.1	1.91	189.3	7	5	7	3
FLIP87-45C	58	97	29	3	2.7	8.0	8.1	1.25	192.5	7	5	3	3
FLIP88-85C	63	99	32	5	2.8	12.9	10.4	1.66	189.0	5	5	1	1
FLIP90-96C	64	101	30	5	3.0	5.8	6.3	0.79	120.8	5	1	1	3
FLIP91-77C	57	100	29	3	2.8	8.3	8.4	1.25	227.3	5	5	5	3
FLIP93-58C	60	98	27	5	2.5	8.1	10.5	1.62	209.5	5	5	3	3
FLIP93-93	62	98	27	5	2.1	3.6	3.5	0.52	143.5	7	5	1	3
FLIP93-146C	66	98	32	5	3.0	10.6	10.6	1.23	124.3	7	5	3	1
FLIP97-137C	73	105	29	5	3.3	7.3	6.5	1.23	31.5	3	5	1	1
FLIP97-263C	57	97	29	3	1.7	4.5	4.6	0.90	154.0	7	5	3	1
FLIP97-266C	57	98	30	5	2.7	7.3	7.0	3.53	175.0	5	5	5	3
FLIP97-281C	57	100	30	7	2.9	6.6	5.4	0.95	129.3	7	3	5	3
FLIP97-503C	70	103	29	5	3.3	6.3	5.7	1.12	48.8	5	3	3	3
FLIP97-530C	68	104	33	7	2.6	8.3	7.6	1.52	131.3	5	3	3	3
FLIP97-677C	70	102	31	5	3.4	3.4	2.3	0.37	75.5	3	3	1	3
FLIP97-706C	68	103	39	7	2.5	7.6	8.4	1.66	159.3	5	3	1	3
FLIP98-121C	60	98	24	3	3.2	6.2	6.5	0.87	140.0	5	5	3	3
Elixir	71	100	31	7	3.2	5.4	4.6	0.56	66.5	7	5	1	3
ILC 482	59	97	28	3	2.8	11.7	13.8	2.11	187.0	7	5	3	3
Local variety	59	98	28	3	2.6	7.2	6.4	1.26	175.0	5	5	7	3
Mean	64	100	30		2.9	7.3	6.9	1.1	125.6				
LSD	**	**	**	**	-	*	*	-	**	-	**	**	**

DAF: Days to Flowering, DAM: Days to Maturity, PH: Plant Height, NBP: Number of Branches Plant-1, NPP: Number of Pods Plant^{-1}, NSP: Number of Seeds Plant-1, SYP: Seed yield plant^{-1}, PGH: Plant Growth Habit, FGC: Foliage intensity of Green Color, PNH: Plant Natural Height (When Pods Fully Developed) in Field, AB: *Ascochyta blight*, HA: *H. armigera*

Genotypes were evaluated using 1-9 scale for *Ascochyta blight*, and fourteen genotypes were free, seventeen genotypes were resistant and six genotypes were tolerant. ILC1929, FLIP87-8C and local variety were susceptible. While ILC 482 was recorded, ILC72 was resistant. These findings agree with other researcher (Reddy et al, 1992; Saccardo and Calcagno 1990). *H. armigera* was observed in genotypes, and they evaluated to 1-9 scale. Total ten genotypes were free (scale: 1), twenty-five genotypes were resistant (scale: 3) and five genotypes were moderately resistant (scale: 5). Local variety, FLIP85-1C, FLIP97-281C and ILC1929 were affected moderately by *Botrytis fabae*. Genotypes were evaluated for intensity of green color of foliage and plant growth habit. Color of foliage was mostly medium and dark green. Plant habit was semi-erect and prostate.

Table 3. Evaluation of Genotypes for Earlier, Plant Height and Antracnose

Acc.No:	Flowering	Acc.No:	Maturity	Plant height	*Ascochyta blight*
Local variety	E	Local variety	E	S	S
ILC1929	E	ILC1929	E	S	S
FLIP87-8C	E	FLIP87-8C	E	M	S
ILC 482	E	ILC 482	E	S	R
FLIP87-45C	E	FLIP87-45C	E	S	R
FLIP97-263C	E	FLIP97-263C	E	S	R
FLIP91-77C	E	FLIP98-121C	E	S	R
FLIP97-281C	E	FLIP83-7C	E	T	R
ILC484	E	ILC484	E	M	R
FLIP97-266C	E	FLIP97-266C	E	M	MR
		ILC195	E	M	F
		FLIP93-93	E	S	F
		FLIP82-150C	E	S	F
		FLIP93-58C	E	S	R
		FLIP93-146C	E	T	R
FLIP97-137C	L	FLIP97-137C	L	S	F
FLIP84-48C	L	FLIP84-48C	L	T	F
FLIP84-92C	L	FLIP84-92C	L	T	MR
FLIP97-503C	L	FLIP97-503C	L	T	R
FLIP97-677C	L	FLIP97-677C	L	M	R
ILC3279	L	ILC3279	L	T	F
		FLIP97-706C	L	T	F
		FLIP84-182C	L	T	R
		FLIP86-5C	L	T	R
		FLIP85-17C	L	M	R
		FLIP86-6C	L	M	R
		ILC2555	L	M	R
	E:early L:late		E:early L:late	S:.short M: medium, T: tall	F: free, R: resist. MR: Mod. Resist. S: suscept.

CONCLUSIONS

Thirty-seven chickpea genotypes and long term check (ILC 482) from ICARDA as Chikpea international adaptation trial-2012 and one local variety were tested at Diyarbakir, Turkey. Differences among genotypes were significant for all of traits. Ten genotypes early flowered, fifteen genotypes early matured eighty of them both early flowered and matured. Six genotypes late flowered, twelve genotypes late matured six of them late flowered and late matured. Early flowering and maturing genotypes had short plant height. Late maturing genotypes had medium or tall plant height, except FLIP97-137C. Three susceptible genotypes for *Ascochyta blight* were determined within earlier genotypes. However, association between plant height, earlier and *Ascochyta blight* not found (Table 3).

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INFLUENCE OF FERTILIZATION WITH SEWAGE SLUDGE AND MANURE ON ALFALFA DM PRODUCTION AND CHEMICAL CONTENT IN ROMANIA

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Abstract

Romania has to react to increased urbanization, and to increased demands from the European Union. Municipal waste recovery requires solutions and the reintroduction of city sludge into agricultural production systems is one of the possibilities. This could be used for forage fertilization due to its composition, rich in both macro-and micronutrients. In this study we compared the effect of sewage sludge fertilization with manure application to alfalfa culture. Sewage sludge comes from the treatment plant Tetarom III of Cluj Napoca, Romania. In our experiment we analysed 8 variants fertilized with different doses of sludge and manure. The sludge and manure were applied once (in the spring of 2010) and their effects were observed over a period of 2 experimental years, from 2010-2011. The results show a significant increase in alfalfa production following sludge fertilization, while the effect of manure at equivalent doses resulted in lower production.

Key words: *city sludge, manure, alfalfa, Romania.*

INTRODUCTION

Almost all of the wastewater treatment processes resulted from industry produce a sludge which has to be disposed of in some way. If we follow the entire treatment of sewage we can notice that the cost for it is huge. Conventional secondary sewage treatment plants generate a primary sludge in the primary stage of process (sedimentation stage) and a secondary (biological) sludge in the final stage after the biological process (Leonard et al., 2007). Approximately one half of the costs of operating secondary sewage treatment plants in Europe can be associated with sludge treatment and disposal. Due to its chemical composition, sewage sludge has valuable agronomic properties. Therefore comes the possibility of using treated sewage sludge in land fertilization and thru these reduce significantly the sludge disposal cost component of sewage treatment, as well as providing a large part of the nitrogen and phosphorus requirements of many crops. As Romania faces, as well, with large quantities of wastewater resulted to the increased urbanization, one valuable solution to dispose of it could be the reintroduction of city sludge into agricultural production systems. Around these frame we aimed by this study to compare the effect of sewage sludge fertilization with manure application to alfalfa culture.

MATERIALS AND METHODS

The experiment was conducted on an *argic faeoziom* soil type in eight variants and four repetitions after the improved Latin Rectangle Method, as follows: variant V1-control, V2-20 Mg ha^{-1} sludge, V3-30 Mg ha^{-1} sludge, V4-40 Mg ha^{-1} sludge, V5-60 Mg ha^{-1} sludge, V6-20 Mg ha^{-1} manure, V7-40 Mg ha^{-1} manure, V8-60 Mg ha^{-1} manure. We used alfalfa (Madalina variety) as biological material. Sludge and manure application was made in a single installment every two years in the spring of 2010. The used sewage sludge treatment plant comes from Tetarom III from Cluj, Romania, and the bovine manure from farmers. Both were analyzed in terms of physicochemical characteristics and the results are presented on Table 1. In order to analyze forage quality the following parameters were determined: crude protein, NDF content, ADF content, lignin, digestibility. The analyses were performed by using NIR method.

Table 1. Characteristics of city sludge and manure

Analysis	City sludge	Manure	Element analysis	City sludge	Manure
Humidity (%)	50.91	44.82	Zn (mg kg^{-1})	1145	894
Organic matter	67.50	45.9	Fe (mg kg^{-1})	20.79	14.4
pH (pH units)	7.40	8.04	Mn (mg kg^{-1})	536	314
N total (%)	3.56	0.65	Pb (mg kg^{-1})	801	-
P total (%)	1.16	0.47	Cd (mg kg^{-1})	32.5	13.8
K total (%)	0.73	0.71	Co (mg kg^{-1})	29.01	25
Mg (mg kg^{-1})	0.27	0.22	Ni (mg kg^{-1})	103	-
Cu (mg kg^{-1})	352	418	Cr (mg kg^{-1})	256.7	-

RESULTS AND DISCUSSIONS

In the first year the highest yield was recorded in the variants treated with 40 and 60 Mg ha^{-1} sewage sludge (respectively 9.16 and 9.10 Mg ha^{-1} DM with a difference of 1.69 and 1.63 Mg ha^{-1} DM compared to the control treatment, Table 2). In the variants fertilized with manure, the highest yield of 8.88 mg ha^{-1} was obtained using 40 Mg ha^{-1}, showing a difference of 1.41 Mg ha^{-1} compared to the control fertilized.

Table 2. Dry matter production (2010)

Variant	Production (Mg ha^{-1})	% compared to control	Difference compared to control	Significance of difference	Duncan Test
V1-control	7.47	100	0	Mt.	A
V2-20 Mg ha^{-1} sludge	8.92	119.4	1.45	***	C
V3-30 Mg ha^{-1} sludge	8.45	113.1	0.98	**	BC
V4-40 Mg ha^{-1} sludge	9.16	122.6	1.69	***	C
V5-60 Mg ha^{-1} sludge	9.10	121.8	1.63	***	C
V6-20 Mg ha^{-1} manure	8.84	118.4	1.37	**	C
V7-40 Mg ha^{-1} manure	8.88	118.8	1.41	***	C
V8-60 Mg ha^{-1} manure	8.06	107.8	0.59	**	AB
DL (p5%) 0.7; DL (p1%) 0.97; DL (p0,1%) 1.31			DS 0.71-0.81		

In the second year the largest dry matter productions were recorded in the variants treated with 40 Mg ha^{-1} sewage sludge and 40 Mg ha^{-1} manure (respectively 11.64 and 11.33 Mg ha^{-1} DM with a difference of 3, respectively 27 and 2.96 Mg ha^{-1} DM compared to the control treatment). At these doses equivalent to 40 Mg ha^{-1} manure and sewage sludge to obtain a difference of 0.31 Mg ha^{-1} DM for variant treated with sewage sludge.

In all experimental variants obtained, a very significant production increase from unfertilized control variant was observed, with increases ranging from 2.18 Mg ha^{-1} DM (in variant treated with 20 Mg ha^{-1} city sludge) and 3.27 Mg ha^{-1} DM (the variant fertilized with 40 Mg ha^{-1} city sludge, Table 3).

Comparing the results obtained in the two experimental years on sludge fertilization effect on DM production in alfalfa, we find superiority variant V4 (40 Mg ha^{-1} sludge) that determines the highest production increases, the application of higher doses of 40 Mg ha^{-1} sludge is justified in terms of growth of output.

In the first experimental year (2010, Table 4) in which concerns the protein content was noticed that there were no significant differences between fertilized variants and control variant.

Table 3. Production of dry matter in alfalfa (2011)

Variant	Production ($Mg\ ha^{-1}$)	% compared to control	Difference compared to control	Significance of difference	Duncan Test
V1-control	8.37	100	0	Mt.	A
V2-20 $Mg\ ha^{-1}$ sludge	11.17	133.45	2.80	***	C
V3-30 $Mg\ ha^{-1}$ sludge	10.55	126.04	2.18	***	B
V4-40 $Mg\ ha^{-1}$ sludge	11.64	139.06	3.27	***	C
V5-60 $Mg\ ha^{-1}$ sludge	10.75	128.43	2.38	***	B
V6-20 $Mg\ ha^{-1}$ manure	10.71	127.95	2.34	***	B
V7-40 $Mg\ ha^{-1}$ manure	11.33	135.36	2.96	***	C
V8-60 $Mg\ ha^{-1}$ manure	10.88	129.98	2.51	***	BC
DL (p5%) 0.39; DL (p1%) 0.56; DL (p0.1%) 0.72			DS 0.39-0.46		

Table 4. Fertilization influence upon alfalfa protein content (2010)

Variant	Protein (%)	% compared to control	Difference compared to control	Significance of difference	Duncan Test
V1-control	18.38	100	0	Mt.	B
V2-20 $Mg\ ha^{-1}$ sewage sludge	17.92	97.5	-0.46	-	B
V3-30 $Mg\ ha^{-1}$ sewage sludge	17.76	96.6	-0.62	-	AB
V4-40 $Mg\ ha^{-1}$ sewage sludge	17.38	94.6	-1.00	-	AB
V5-60 $Mg\ ha^{-1}$ sewage sludge	17.10	93.0	-1.28	-	AB
V6-20 $Mg\ ha^{-1}$ manure	16.34	88.9	-2.05	0	A
V7-40 $Mg\ ha^{-1}$ manure	17.31	94.2	-1.08	-	AB
V8-60 $Mg\ ha^{-1}$ manure	17.86	97.1	-0.53	-	B
DL (p5%) 1.13 DS					
DL (p1%) 1.54 1.13-1.30					
DL (p0.1%) 2.08					

The variant fertilized with 20 t/ha manure registered a small increase, insignificant from statistical point of view (a difference of -2.05% compared with control variant, unfertilized).

Analysing forage quality fertilized with sewage sludge compared to organic fertilization we observed that there were insignificant changes in the chemical composition of alfalfa feed. The only exception was lower protein content compared to the control, however the difference had only a significant effect at doses of sludge of 60 $Mg\ ha^{-1}$. In other words, excessive fertilization (60 $Mg\ ha^{-1}$ sewage sludge) may, in time, decreases in protein content, which could cause a decrease in long-term quality of alfalfa forage.

The results obtained after the first year of sludge confirms data obtained by other researchers (14.78%-19.78%, Brogna et al., 2009, 12.60%-24.20%, Walshaw et al., 1998), showing that in the first year of application of sludge, the chemical composition of alfalfa was less influenced.

CONCLUSIONS

Fertilizing alfalfa with sewage sludge and manure gave the highest DM yield when 40 Mg ha^{-1} of sludge/year was applied. Taking into consideration that increased production was achieved at equivalent doses of manure and sewage sludge (of 40 $Mg\ ha^{-1}$) we can recommend the fertilization with sewage sludge as a successfully replacement for the fertilization with manure.

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GRAIN QUALITY PARAMETERS OF WINTERING OAT GENOTYPES (*AVENA SATIVA* L.)

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Abstract

In the period 2010-2012 in the experimental field of the Department of Crop Production in Agricultural University-Plovdiv (Bulgaria) field experiment was conducted with 8 lines and 2 cultivars (Dunav 1 and Resor 1) wintering oats. The experiment was set in a standard method in three repetitions with the size of the plots 10.5 m^2. There was found some grain quality parameters in order to assess the potential of wintering genotypes. Line Kt 718 (14.6%) and line 07/Z1 (14.51%) have the highest amount of crude protein in the grain. The fat content is 5.04% (Kuceviste) to 8.89% (Kt 718). Starch has values which are similar for different genotypes. Line 07/Z1 has a higher value – 46.93%. The amount of ß-glucans in the grain of the tested genotypes reached 3.9%.

Key words: *wintering oats, protein, fat, starch, ß-glucans in the grain.*

INTRODUCTION

Oat grains contain 12.4 to 24.4% of protein which has the highest nutritional value among all other grain crops. Despite the genetic contingency, some authors state in their studies that they have found significant differences in the content of protein between the varieties in the different regions and year of growing (Martinez, 2010) but such influence of the agroclimatic conditions on the starch has not been established. Negative impact on grain quality and have attacks of insects (Lecheva et al., 2004).

Oat grains are relatively rich in oil compared with other cereals and can vary from 3% to 11% of grain weight in different cultivars, with lines containing up to 18% (Frey and Holland, 1999).

According to some authors, the proteins are in a state of negative dependence on the fats and according to other authors, there is no consistent relationship between these parameters (Saastamoinen, 1987).

The two main functions of ß-glucans are to improve the immune system and reduce the level of cholesterol in blood. The oats have been given a health mark owing to the ß-glucans contained their grains.

A lot of factors influence the content of ß-glucans. A number of authors have established the significance of the genotype first (Miller et al., 1993) and then the influence of the agroclimatic conditions throughout the year (Brunner, 1994).

The purpose of this survey is to establish and compare some quality indicators of the grains of eight winter lines and two winter varieties of oats.

MATERIALS AND METHODS

The field experiment was conducted within the period 2010 – 2012 in the experimental field of the Department for Plant Protection at the Agricultural University – Plovdiv (Bulgaria) on soil type Mollic Fluvisols (FAO) (Popova et al., 2012).

Eight winter lines of oats were included in the survey: No 1, 07/ Z1, 08/ Z2, M-K, Radolishta, Kuceviste, Kt 651, Kt 718 and two winter cultivars Dunav 1 and Resor 1 – yield and quality standards in Bulgaria.

The sowing was conducted in mid-October using a standard method in three repetitions over an area of 10.5 m^2 with a sowing rate of 500 germinating seeds per sq.m. The lot had previously been planted with sunflowers. The used fertilization rate was $N_6P_8K_8$.

The laboratory analyses of the grains were performed at the Central Scientific Laboratory of the Agricultural University – Plovdiv. The analysis of raw protein was made on the grounds of BDS 13490 and the analysis of fats was made based on BDS 3412 for cereals. The quantity of starch was established using a polarographic method.

The content of ß-glucans has been determined as % of the dry substance through Mixed-linkage ß-glucan assay kit (Magazyme, Ireland), based on the enzyme method published by McCleary and Codd (McCleary B. V. and R. Codd, 1991). This method has been approved by AOAC (Method 995.16) and AACC (Method 32-23). The chaff among the oat grains was removed by hand after which the grains were ground in the laboratory mill until the size of the particles was under 0.5 mm.

The statistical processing of the experimental data was performed using SPSS V.9.0 for Microsoft Windows.

RESULTS AND DISCUSSIONS

The vegetation period 2010-2011 was favourable for the growth of oats.

The frequent and heavy precipitations in October delayed the sowing and it was performed at the end of November and the low average temperatures of 10.8°C, which is 1.8°C under the norm, delayed the growth of the plants (Table 1).

The period of tasseling, blossoming and grain formation was accompanied by heavy precipitations and the quantity of rainfall in May and June was above the norm while the temperatures were close to the typical long-term ones. The wax ripeness and the overall ripeness occur under temperatures that are 1.5°C above the norm as well rainfall that is 5.5 mm above the norm. The combination of these conditions during the period of formation and ripening of the grains has a positive influence on some of the quality indicators of the grain (Table 2).

Table 1. Average diurnal temperatures in periods of ten days (°C), 2010-2011

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	11.6	12.7	7.0	0.2	4.5	0.7	13.0	13.6	22.3	24.0
II	13.2	11.8	-1.8	4.6	2.9	9.2	10.2	17	22.5	26.7
III	7.8	9.5	2.0	-0.6	0.5	10.8	12.2	20.6	22.3	25.5
Average monthly temperature t°C	10.8	11.3	2.4	1.4	2.7	6.9	11.8	17.1	22.4	25.4
Average for the period 1965-1995	12.6	7.4	2.2	-0.4	2.2	6.0	12.2	17.2	20.9	23.2

Table 2. Amount of the rainfall during the vegetation period (mm), 2010-2011

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	27.9	-	4.4	2.7	-	9.9	2.0	31.3	8.6	6.6
II	48.7	11.0	14.4	4.4	28.1	57.8	16.8	8.4	28.6	7.3
III	42.5	4.4	10.2	17.5	24.0	6.7	-	1.1	4.3	0.7
Monthly amounts	119.1	15.4	28.7	24.6	52.1	74.4	18.8	40.8	41.5	14.6
Average for the period 1965-1995	47	35	36	40	48	44	39	32	36	42

Table 3. Average diurnal temperatures in periods of ten days (°C), 2011-2012

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	15.3	7.3	3.4	-0.2	-4.5	4.1	11.2	19.6	21.3	25.9
II	10.6	1.8	5.1	1.5	-3.1	8.1	14.3	16.5	24.6	27.5
III	8.7	2.4	-1.6	-3.0	3.5	13.2	17.7	16.6	24.9	27.5
Average monthly temperature t°C	11.6	3.8	2.3	-0.6	-1.4	8.4	14.4	17.6	23.6	27.0
Average for the period 1965-1995	12.6	7.4	2.2	-0.4	2.2	6.0	12.2	17.2	20.9	23.2

Table 4. Amount of the rainfall during the vegetation period (mm), 2011-2012

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	22.8	0.0	0.4	65.6	47.2	2.0	13.5	37.3	40.1	0.0
II	38.3	0.8	12.6	0.0	2.6	2.7	8.2	73.7	0.0	2.0
III	9.3	0.1	25.8	54.6	7.0	0.2	0.5	49.8	2.3	0.4
Monthly amounts	70.4	0.9	38.8	120.2	56.8	4.9	22.2	160.8	42.4	2.4
Average for the period 1965-1995	47	35	36	40	48	44	39	32	36	42

The period of vegetation 2011-2012 was characterized as not very favourable for the growth of the winter oats.

The large amount of rainfall in October 2012 (70.4 l/m^2) delayed the sowing of the winter genotypes of oats (Table 4).

The period of grain formation and ripening (May-June) was characterized by temperatures close to and a little above the norm for the multi-year period and also by heavy precipitations in May and quantity of the rainfall above the norm in June (Table 3). This combination of weather conditions was favourable for the formation and the nutrition of the already existing grains on the ear, which is a prerequisite for the relatively high weight of the grains in the panicle.

Based on the conducted chemical analyses of the grains of the examined genotypes during the period of the survey, the highest amount of raw protein was established in line Kt 718 (14.60) and line 07/Z1 (14.51) (Table 5). All genotypes have a high content of proteins above the standard Resor 1 cultivar, with the exception of line Kuceviste.

The quantity of fats varies for the different genotypes. With reference to the selection and the use of oat grains as healthy food, we aim at achieving a lower quantity of fats in the grains.

The high content of fats impedes the long-term storage of the production. The lowest quantity of fats was established in line Kuceviste – 5.04% and Kt 651 (5.83%). All lines are characterized by a low content of fats in the grains compared with the cultivar Dunav 1 and the standard variety Resor 1 (7.13%), with the exception of line Kt 718 which was proven to have the highest content of fats (8.89%) of all genotypes included in the survey.

The content of starch varies as the values are relatively close between the different genotypes and the highest value was registered for the grains of line 07/Z1 (46.93%). Lines M-K and Kt 651 (45.88 and 45.62%) are also above the standard cultivar Resor 1.

Table 5. Average content of raw protein, fats and starch in the winter genotypes of oats for the period,%.

Genotypes	Absolute dry substance (%)	Raw protein	Fat	Starch
Line No 1	90.95	13.03 e	6.79 c	42.90 f
Line 07/Z1	90.00	14.51 a	6.37 e	46.93 a
Dunav 1	90.76	13.30 d	7.11 b	43.00 e
Linie 08 / Z2	90.61	13.90 b	6.62 d	44.08 d
Line M-K	91.07	13.45 cd	6.17 f	45.88 b
Kt 651	90.57	13.66 c	5.83 g	45.62 b
Resor 1 /st	90.93	11.86 f	7.13 b	44.94 c
Kt 718	90.64	14.60 a	8.89 a	44.57 c
Radolista	91.09	13.33 d	6.38 e	44.86 c
Kuceviste	90.95	11.42 g	5.04 h	43.91 d

The content of fibre including ß-glucans in oat grains has been very important over the last decades as regards the use of the grains in healthy food. The ambition to discover a cultivars or create one that contains a maximally high content of ß-glucans (the highest content in the world so far is up to 6-7%) is one of the main goals of many researchers.

There are a lot of factors that influence the content of ß-glucans and one of them is the weather conditions, due to which the numbers vary during the years of the survey (Georgieva et al, 2010).

Within the period of the survey, the year when the largest quantity of ß-glucans was accumulated was 2011 followed by 2010 and 2012.

Out of all examined genotypes, the one with the largest quantity of ß-glucans is line 08/Z2 – 3.948% followed by line Kt 718 (3.746%). All examined lines surpass Resor 1 cultivar in terms of ß-glucans content and six of them also surpass Dunav 1 cultivar (Table 6).

As an indicator showing the percentage of chaff and the percentage of hulled grain, the presence of chaff is very important for the food industry. The examined genotypes have a different proportion of hulled grain and chaff during the years of the survey (Table 7).

Table 6. Quantity of ß-glucans in the grains of the examined genotypes of oats

Genotypes	Absolute dry substance (%)	2010	2011	2012	Average for the period, ß-glucan (%)
No 1	90.83	1.582 e	3.430 f	2.623 i	2.545 c
07/ Z1	90.05	3.377 b	2.676 h	2.366 j	2.806 bc
Dunav 1	90.12	3.164 c	3.249 g	2.828 h	3.080 b
08/Z2	89.46	3.722 a	4.065 c	4.057 a	3.948 a
M-K	90.60	3.008 d	3.426 f	2.870 g	3.101 b
Kt 651	90.78	-	3.739 e	3.150 c	3.444
Resor 1	90.33	-	1.645 i	3.142 d	2.393
Kt 718	90.36	-	4.090 b	3.402 b	3.746
Radolishta	90.31	-	3.797 d	3.025 e	3.411
Kuceviste	90.51	-	4.097 a	2.946 f	3.521

Table 7. Percentage of hulled grain and chaff in years and on average for the period for all examined winter genotypes of oats.

Genotypes	2010 r.		2011 r.		2012 r.		Average for the period, %	
	Hulled grain (%)	Chaff (%)	Hulled grain (%)	Chaff (%)	Hulled grain (%)	Chaff (%)	Hulled grain	Chaff
No 1	80.05	19.95	86.50	13.50	73.70	26.30	80.08	19.9
07/ Z1	78.50	21.50	76.20	23.80	70.35	29.65	75.02	24.9
Dunav 1	-	-	74.50	25.50	73.30	26.70	73.90	26.1
08/Z2	66.50	33.50	64.90	35.10	71.85	28.15	67.75	32.2
M-K	70.50	29.50	85.20	14.80	73.60	26.40	76.43	23.6
Kt 651	-	-	70.95	29.05	70.30	29.70	70.62	29.4
Resor 1	-	-	71.65	28.35	70.05	29.95	70.85	29.1
Kt 718	-	-	74.90	25.10	74.45	25.55	74.67	25.3
Radolishta	-	-	73.75	26.25	70.55	29.45	72.15	27.8
Kuceviste	-	-	70.50	29.50	69.25	30.75	69.87	30.1

During the vegetation period 2010-2011, the genotypes have a higher percentage of hulled grain compared with the vegetation period 2011-2012. On average for the period of observation, the highest percentage of hulled grain was registered for line No 1 – 80.08% followed by line M-K (76.43%) and line 07/Z1-75.02%.

The highest percentage of chaff was registered for line Kuceviste – 30.1%, which, therefore, has the lowest percentage of grains.

CONCLUSIONS

Some new lines of winter oats with a high quantity of proteins are line Kt 718 – 14.6% and line 07/ Z1. The content of fats varies from 5.04 to 8.89% and the content of starch varies from 42.9 to 46.93. Depending on their use, we can choose genotypes with different proportions of the main nutrients.

The highest content of ß-glucans was registered for line 08/Z2-3.95% followed by lines Kt 718 (3.75%) and Kuceviste (3.52%).

A relatively large percentage of hulled grain and low percentage of chaff was registered for line No 1 (80.09%/19.9%), line M-K (76.43%/23.6%) and 07/Z1 (75.02%/24.9%).

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RESEARCH ON INTERCROPPING EFFECT ON CROP PRODUCTIVITY AND YIELD QUALITY OF MAIZE (*Zea mays* L.)/SOYBEAN (*Glycine max* (L.) MERRIL), IN THE ORGANIC AGRICULTURE SYSTEM

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Abstract

The research is focused on the productivity and yield quality of maize (Zea mays L.) and soybean (Glycine max (L. Merril) intercropping, in order to evaluate their adaptability to the natural conditions of South Romanian Plain and to organic cultivation. The experiment was carried out between 2007 and 2009, at Moara Domneasca Experimental Field, on a reddish preluvosoil. The seeds used for experiments were organic. Maize and soybean were sown in alternating rows (1 row of maize, 2 rows of soybean), 40 cm between the rows of soybean and 15 cm from the maize rows. In intercropping system, maize had a density of 5 plants/m^2 and soybean of 24 plants/m^2. Several parameters were determined: productivity elements, yields, land equivalent ratio and seeds quality. In average, in pure stand, maize produced a yield of 3551 kg/ha. Maize intercropped with soybean produced 3087 kg/ha. Soybean had a yield of 2431 kg/ha in pure stand and of 1274 kg/ha in intercropping, with 1157 kg/ha smaller than the control. In terms of chemical composition, maize intercropped with soybean contained 9.76 % protein, 4.88 % fats and 67.92% starch. Soybean seeds from intercropping had 36.76 % protein, 17.97% fats and 2.80% starch.

Key words: *intercropping, maize, soybean, organic agriculture, land equivalent ratio.*

INTRODUCTION

Organic agricultural practices are generally more environmentally friendly than conventional agriculture, particularly with regard to lower pesticide residues, greater resilience to drought and richer biodiversity (Dabbert et al., 2000).

Intercropping can be defined as the agricultural practice of growing two or more crops in the same space at the same time (Andrews and Kassam, 1976). This technology may enable an intensification of the farm system, leading to increased productivity and biodiversity in the intercropped fields as compared to monocultures of the intercropped species (Vandermeer, 1989).

Through a more efficient use of available resources such as nutrients, water and space substantial yield advantages can be achieved by intercropping compared to pure stand (Joliffe, 1997; Katayama et al., 1995; Morris and Garrity, 1993; Willey, 1979).

Mixtures involving soybean had been reported such as soybean/potato (Okonkwo, 1984), soybean/yam (Okigbo and Greenland, 1976), soybean/sorghum (Hiebsch et al., 1995), and soybean/maize (Olufajo, 1992).

Intercropping maize (*Zea mays* L.) and soybean (*Glycine max* (L.) Merril) reduces soybean yield considerably, but has little influence on maize yield (Hiebsch, 1980; Ahmed and Rao, 1982; Chui and Shibbles, 1984).

In this context, this research aimed at observing the effect of intercropping system on maize and soybean productivity and crop quality in order to know their adaptability to reddish preluvosoil area pedoclimatic conditions of the central part of South Romanian Plain and to the organic agriculture system.

MATERIALS AND METHODS

The experiment was carried out in between 2007 and 2009, at the Moara Domneasca Experimental Field, on a reddish preluvosoil, in randomized variants, in 4 replications.

The seeds used for experiments were organic. Maize and soybean were sown in alternating rows (1 row of maize, 2 rows of soybean), 40 cm between the rows of soybean and 15 cm from the maize rows. In intercropping system,

maize had a density of 5 plants/m^2 and soybean of 24 plants/m^2.
Several parameters were determined in this experiment, such as: agronomical parameters (productivity elements and seed yields), competition parameters (land equivalent ratio) and quality parameters (protein, fat and starch content).
The spatial distribution was as shown below (Figure 1).

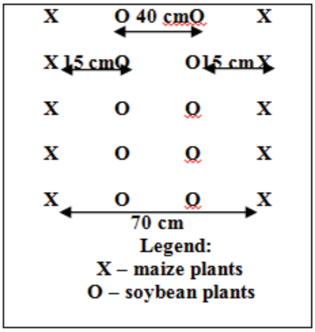

Figure 1. Spatial arrangement for maize–soybean intercropping

RESULTS AND DISCUSSIONS

A. Results for maize. Regarding the productivity elements, table 1 shows that the maize plants from pure stand formed cobs of 20.5 cm in length, with an average of 14.8 rows/cob and 597 grains/cob. Percentage of grains weight per cob was of 79.2% and the TGW of 284.2 g. The maize intercropped with soybean formed cobs of 19.4 cm in length, 14.6 grain rows/cob and 565 grains/cob. The percentage of grains weight per cob was of 77.9% and TGW was 282.4 g (Table 1).
Maize from pure stand had an average yield of 3551 kg/ha. Compared to the control, maize yield from intercropping was 464 kg/ha lower, i.e. 3087 kg/ha (Figure 2).
As far as the chemical composition is concerned, table 2 shows that maize grains from the pure stand had the following content: 12.71% moisture, 10.13% proteins, 5.30% fats and 66.94% starch. In intercropping with soybean, maize grains had a content of 9.76% protein, 4.88 % fats and 67.92% starch (Table 2).

Table 1. Productivity elements at maize, in pure stand and in intercropping (Moara Domnească Experimental Field, 2007-2009)

Productivity elements	Maize pure stand	Maize-soybean intercropping
	Average 2007-2009	
Cob length (cm)	20.5	19.4
Number of grain rows/cob	14.8	14.6
Number of grains/cob	597.1	565.0
% of grains weight/cob	79.2	77.9
TGW (g)	284.2	271.7

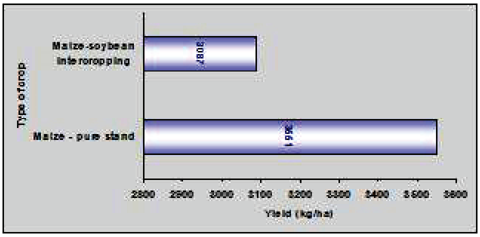

Figure 2. Average maize yields, in pure stand and in intercropping with soybean (Moara Domnească Experimental Field, 2007-2009)

Table 2. Chemical composition of maize and soybean seeds, in pure stand and in intercropping (Moara Domnească Experimental Field, 2007-2009)

Type of crop	Moisture (%)	Protein (% d.m.)	Fats (% d.m.)	Starch (%)
Maize (pure stand)	12.71	10.13	5.30	66.94
Soybean (pure stand)	11.20	38.47	19.15	3.10
Maize intercropped with soybean	12.85	9.76	4.88	67.92
Soybean intercropped with maize	11.23	36.76	17.97	2.80

B. Results for soybean. In terms of productivity elements, soybean plants from pure stand formed, on average, 21.3 pods/plant, 40.8 grains/plant, 1.9 grains/pod and TGW was 177.9 g.
In intercropping with maize, soybean formed only 17.3 pods/plant, 29.6 grains/plant, 1.7 grains/pod and the TGW was 171.8 g (Table 3).
On average for the 3 experimental years, soybean produced 1852 kg/ha. Compared to the control, in intercropping 1274 kg grains/ha

were harvested, i.e. 1157 kg/ha less (difference that is statistically ensured) (Table 4).

Table 3. Productivity elements at soybean in pure stand and in intercropping (Moara Domnească Experimental Field, 2007-2009)

Productivity elements	Maize pure stand	Maize-soybean intercropping
	Average 2007-2009	
Number of pods/plant	21.3	17.3
Number of grain/plant	40.8	29.6
Number of grains/pod	1.9	1.7
TGW (g)	177.9	171.8

Table 4. Average yields at soybean, in pure stand and in intercropping with maize (Moara Domnească Experimental Field, 2007-2009)

Type of crop	Soybean			
	Yield (kg/ha)	Difference from the pure stand		Significance
		kg/ha		%
Pure stand	2431	Mt.	100	-
Maize-soybean intercropping	1274	-1157	52,41	ooo

LSD 5%= 179.7 kg/ha
LSD 1% = 272.1 kg/ha
LSD 0.1% = 437.0 kg/ha

For soybean from pure stand, moisture content was of 11.20 % and in intercropping with maize the average was of 11.23%. The protein content was of 38.47% in pure stand and of 36.76% in intercropping. In pure crop, soybean seeds contained 19.15% fats and 3.10% starch and in intercropping with maize, the fat content was of 17.97% and starch was of 2.80% (Table 2).

Regarding the protein content, table 5 shows that in pure stand, maize produced on average 366 kg/ha proteins and soybean 976 kg/ha proteins. The total protein content of maize-soybean intercropping was of 804 kg/ha (Table 5).

The partial and the total land equivalent ratios (LER) were also determined during the research years. Thus, between 2007 and 2009, the partial LER ranged between 0.52 for soybean and 0.86 for maize.

According to Edje (1987), if LER is equal to 1, then there is no difference in yield between growing the crop in pure or in mixed stand. If LER is greater than 1, there is a yield advantage when both crops were grown as mixed compared to pure stands. If however LER is less than 1, it will be better in terms of yield to grow both crops separately, as it indicates yield disadvantage (Addo-Quaye et al., 2011).

The total LER was of 1.38, which means that there is a real advantage of intercropping maize with soybean compared to the pure stand. This value means that an area planted as pure stand would require 38% more land to produce the same yield as in intercropping (Table 6).

Table 5. Protein yields at maize and soybean in pure stand and in intercropping (Moara Domnească Experimental Field, 2007-2009)

Type of crop	Seed yield (kg/ha)		Total yield (kg/ha)	Protein yield (kg/ha)		Total protein yield (kg/ha)
	Maize	Soybean		Maize	Soybean	
Maize (pure stand)	3622	-	3622	366	-	366
Soybean (pure stand)	-	2538	2538	-	976	976
Maize-soybean intercropping	3160	1350	4510	308	496	804

Table 6. Land equivalent ratio for maize-cowpea intercropping (Moara Domneasca Experimental Field, 2007-2009)

Total LER	Type of crop	Yields in intercropping (kg/ha)	Yields in pure stand (kg/ha)	Partial LER
	Maize	3356	3551	0.86
	Soybean	1274	2431	0.52
	-	-	-	1.38

CONCLUSIONS

In terms of productivity elements, there was no big difference between maize plants from pure stand and those from intercropping. It means that in intercropping there was no competition for water, light and nutrients.

Compared to the control, which produced on average 3551 kg/ha, the yield of maize from intercropping was 464 kg/ha lower, i.e. 3087 kg/ha.

In intercropping with soybean, maize grains contain 9.76% protein, 4.88% fats and 67.92% starch.

Soybean plants from intercropping were influenced by this type of cultivation in terms of productivity elements. It means that there was a competition with maize plants for light, water and nutrients.

In intercropping, 1274 kg grains/ha were harvested, i.e. 1157 kg/ha less than the control, which produced 2431 kg grains/ha.

Soybean seeds from intercropping contain 11.23% moisture, 36.76% proteins, 17.97% fats and 2.80% starch. The total protein yield/ha for maize-soybean intercropping was of 804 kg/ha.

The total LER for maize-soybean intercropping was greater than 1, namely 1.38, which means that it is advantageous to grow maize and soybean in intercropping rather than in pure stands.

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RESEARCH ON BIOLOGY, PRODUCTIVITY AND YIELD QUALITY OF *TRIGONELLA FOENUM-GRAECUM* L. SPECIES (FENUGREEK) IN THE CENTRAL PART OF THE SOUTH ROMANIAN PLAIN

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Abstract

The main objective of the research was to study the biology, ecology and productivity of Trigonella foenum-graecum L. species, in order to know the adaptability of the species to the natural conditions of the reddish preluvosoil area in the central part of South Romanian Plain and in organic farming system.
In these experiments, a program of observations and measurements was developed, concerning: morphological and biological peculiarities of species, productivity elements and seeds yields, yield chemical composition and quality.
The experiment was carried out in Moara Domneasca Experimental Field, during 2007-2009.
Research carried out revealed that fenugreek cultivated in South Romania reaches harvesting maturity in the third decade of July, after 95 days of vegetation and the accumulation of 922.24 GDD (St>10°C). When harvested, fenugreek plants were characterized by following productivity elements: 20.1 pods/plant, 11.4 seeds/pod, 3.9 g seeds/plant and TGW values of 16.7 g.
Fenugreek seeds had as chemical composition, in average: 21.3% proteins, 4.65% fats, 63.83% glucides and 5.69% ash.
On the reddish preluvosoil from Moara Domneasca, a soil with average fertility and without irrigation, in years with various weather conditions, fenugreek achieved good yields of over 1013 kg/ha in a dry experimental year (2007), and over 1250 kg

Key words: *fenugreek, organic agriculture, productivity and yield quality.*

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L., Fam. *Fabaceae*) is one of the oldest medicinal plants and spice. The species name *'foenum-graecum"* means 'Greek hay' indicating its use as a forage crop in the past. Fenugreek is believed to be native to the Mediterranean region (Petropoulos, 2002), but now is grown as a spice in most parts of the world. It is reported as a cultivated crop in regions of Europe, northern Africa, west and south Asia, Argentina, Canada, United States of America (USA) and Australia (Edison, 1995; Petropoulos, 2002). India is one of the major producer and exporter of fenugreek; about 40,000 hectares of land is cultivated under fenugreek in India, yielding about 20,000 tonnes of which only 3,100 to 4,000 tonnes are exported annually.

Is a leguminous plant, it has tri-foliate, obovate and toothed, light green leaves and stems are erect, long and tender. Blooming period occurs during summer and flowers are yellow-white, occurring singly or in pairs at the leaf axils.

The seeds are brownish, about 35 cm long, oblong, rhomboidal, with a deep furrow dividing them into two unequal lobes. They are contained, ten to twenty together, in long, narrow, sickle-like pods.

Applications of fenugreek were documented in ancient Egypt, where it was used in incense and to embalm mummies. In modern Egypt, fenugreek is still used as a supplement in wheat and maize flour for bread-making.

In traditional Chinese medicine, fenugreek seeds are used as a tonic, as well as a treatment for weakness and edema of the legs. In India, fenugreek is commonly consumed as a condiment and used medicinally as a lactation stimulant.

Fenugreek seed contains 45-60% carbohydrates, mainly mucilaginous fiber (galactomannans), 20-30% proteins, 5-10% fixed oils (lipids), pyridine alkaloids, mainly trigonelline (0.2-0.38%), choline (0.5%), free

amino acids, such as 4-hydroxyisoleucine (0.09%), arginine, histidine and lysine, calcium and iron, saponins (0.6-1.7%), vitamins A, B1, C and nicotinic acid and 0.015% volatile oils (Mehrafarin et al., 2011).
Fenugreek can be a very useful legume crop for incorporation into short-term rotation and for hay and silage for livestock feed, for fixation of nitrogen in soil and its fertility (Sadeghzadeh-Ahari et al., 2009).

MATERIALS AND METHODS

The main objective of the research was to study the biology, ecology and productivity of *Trigonella foenum-graecum* species, in order to know the adaptability of the species to the natural conditions of the reddish preluvosoil area in the central part of South Romanian Plain and in organic farming system.
The experiment was carried out in Moara Domneasca Experimental Field, located near Bucharest, during 2007-2009 and it was organized based on the multi-stage block method with randomized variants in 4 replications.

Figure 1. Aspects from fenugreek experiment (Moara Domneasca Experimental Field, 2009)

Sowing took place between 4 and 12th of April, and the sowing parameters were: 50 cm spacing between rows; density of 30 plants/m²; sowing depth of 3-4 cm.
The cultural practices performed during the vegetation period concerned the manual weeding works, carried out as often as necessary.
In these experiments, a program of observations and measurements was developed, concerning: morphological and biological peculiarities of species, productivity elements and seeds yields, yield chemical composition and quality.

RESULTS AND DISCUSSIONS

Phenological data. During the 3 experimental years, fenugreek was sown at the beginning of optimum recommended period for this area, between April 4 and April 12. Under these conditions, fenugreek plants emerged in the second decades of April, the period between sowing and emergence being 7-9 days.
Fenugreek crop bloomed in the third decade of May, after 45 days from the emergence and after the accumulation of 277.1 GDD (St> +10ºC), with exception of spring 2008 when the fenugreek plant flowering occurred later, in the first decade of June, after the accumulation of 331.1 GDD.
Research showed that in the experimental area, fenugreek reached harvesting maturity in the second half of July, after 96 days from the emergence and after the accumulation of 922.24 GDD (St> +10ºC). An exception was 2007, when the plant reached maturity earlier, in a first half of July, due to drought (Figure 2).

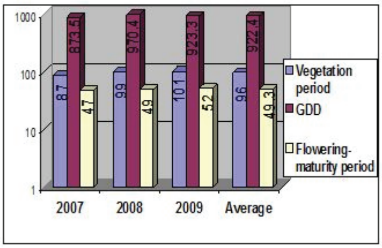

Figure 2. Duration of vegetation and flowering-maturity period at fenugreek plants (Moara Domneasca Experimental Field, 2007-2009)

Throughout the experimental cycle, under the experimental area conditions, fenugreek plants had: an average height of 44.5 cm, with a growing rate of 0.46 cm/day; 27 leaves formed on stems, with 2.73 days necessary for a leaf formation and the average heat consumption was 22.38 GDD/leaf; the maximum leaf area value was 211.1 cm²/plant.
Morphological characters and productivity compounds. The analysis of productivity elements in the three years of experiments showed the following:

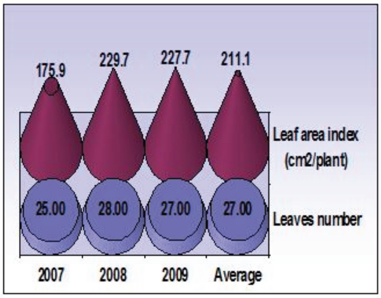

Figure 3. Dynamics of leaves growing at fenugreek (Moara Domneasca Experimental Field, 2009)

Seed moisture was of 14.2% at harvesting and it was according to the moisture standards for this species. After harvesting the seeds were dried and reached moisture of 4.54%

Chemical analysis showed following chemical composition of fenugreek seeds: 21.3% proteins, 4.65% fats, 63.83% glucides, 5.69% ash, while the energetic value was 396.54 kcal.

The data on productions harvested in the three years of experiments illustrate a very good favourability of the natural conditions for fenugreek and the productivity of the tested biological material.

Seeds yield were on average 1199 kg/ha, with variation limits of 1013 and 1328 kg/ha.

Figure 4 presents protein yields calculated based on seed yields and protein content.

The protein yields ranged between 228 kg/ha and 282 kg/ha, the average being 261 kg protein/ha.

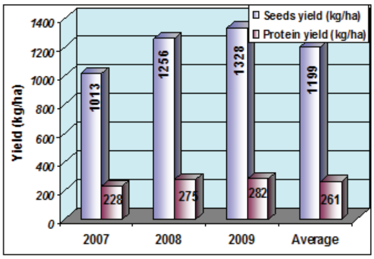

Figure 4. Seeds yield and chemical composition at fenugreek (Moara Domneasca Experimental Field, 2007-2009)

CONCLUSIONS

Research carried out revealed that the fenugreek cultivated in the south of Romania reaches harvesting maturity in the second half of July, after 95 days of vegetation and the accumulation of 922.24 GGD (St> 10°C).

When harvested, fenugreek plants were characterized by following productivity elements:

Fenugreek seeds had as chemical composition: 21.3% proteins, 4.65% fats, 63.83% glucides and 5.69% ash.

Productivity of fenugreek plants was well illustrated by yields of over 1000 kg seeds/ha in the dry year and over 1250 kg

Research showed the adaptability of fenugreek crop to the conditions of reddish preluvosoil area from the central part of Romanian Plain, as well as the possibility to cultivate this species in this area, in order to diversify the assortment of crops and to develop a correct rotation, in which, particularly grain legumes have an important role as soils improvement crops. However, introduction and expansion of growing of this species may contribute to diversification of human nutrition and as well as of animal feeding.

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STUDIES OF THE POSSIBILITY TO VALORISE SOME EXTRACTS WITH ALELOPAT AND ANTINEOPLASTIC POTENTIAL FROM *Aristolochia clematitis* (BIRTHWORT)

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Abstract

Interest in medicinal plants has increased with improving extraction and processing techniques of active products and especially with demonstrating their effectiveness in combating serious human diseases. The paper presents the way of determining chlorophyll pigments, NPK chemical compounds, obtaining a tincture; external application in order to fight against an illness or to heal wounds and their effects on the human organism are studied separately.
Its valorisation requires however extensive research to scientifically substantiate such a remedy, which ultimately transforms it from a popular remedy in a drug that is grown to serve medicine. Aristolochia clematitis L., (Birthwort) is a species of herbaceous, perennial, gabbros and smelly plant that grows in cultivated areas and bushes. This weed is one of the most powerful herbs in our flora, with many applications. The toxicity of this plant is mainly due to the aristolochic acid which is a powerful carcinogen, but also due to other compounds (De Broe ME ”exposure to aristolochic acid A, being a powerful nephrotoxin”) existing in the plant require studying regarding the possibility of being used with therapeutic purposes.
This is the reason why chlorophyll pigments have been determined which differ from plant to plant according to where the plant grows and its liveliness, the presence of certain chemical compounds, NPK content. Moreover, we also study the soil where the plants are harvested which is highly important for their development.

Key words: *Aristolochia Clematitis; argic cernoziom soil; Clorofilieni pigments; Hummus.*

INTRODUCTION

Since Aristolochia Clematitis is a very toxic plant which is used in folk remedies, there are more and more debates which aim at restoring it in the cult medicine for various treatments (Grollman, Arthur P “Aristolochic acid is a powerful carcinogen which is naturally present in Aristolochia (Wol Apple”).
Successful folk remedies started from reducing inflammations, external haemorrhoids, anal fissures, eczemas, ovarian cysts, uterine fibroids, virginities, anal fissures, dermatoses, ulceration infections, wounds which are hard to heal, burns, mammal cysts, varicose ulcer, psoriasis. It is recognised as a good antiseptic, cicatrising, calming and anti-inflammatory. Beneficial effects are obtained by using young seeds, leaves, roots and stems in various proportions and different extracts (W. F. Balistreri, H. H. A-Kader, et al ,”in order to identify distribution and concentration of active compounds”.
Aristolochia Clematitis contains an acid complex, especially aristolochic acid which, if used with a correct concentration, it stimulates the activity of white cells in the blood, while helping to heal wounds. It is safe to use this plant externally. (A. Hostage, M. Staiger, K. Haag, W. Gerok, Klin Wochenschr ”concentrations have been suggested in order to provide a simple guide to the level of severity in an illness”).
Since most of the active principles present in the Aristolochia Clematitis plant are already known, the paper presents a series of determinations which aim at complementing studies on the beneficial effects of the plant and makes an analysis of the results obtained for each studied organ of the plant (young leaves and stems).

MATERIALS AND METHODS

Aristolochia Clematitis or Wolf apple, from Busu village, Dolj district, South-West Oltenia, has been used, a plant adapted to the soils and climate of our country. Since it is a hillside, it is mainly present on all lands which have been left uncultivated, vineyards and orchards, on roadsides, woods and gardens.

Studies and researches were performed in 2012, where three different locations were taken into consideration, where Aristolochia Clematitis is frequently present, from three different places, and soil and plant, young leaves and stems analyses were performed by using spectrophotometric determinations for soil and plant and the chlorophyll pigments method for the plant.

Soil and plant samples were collected during 12-20 June 2012 when the plants were blossoming, as follows:

- from a plantation of vineyards located on an argic cernoziom soil (clay illuviation soil);
- from a vacant land, coved with spontaneous vegetation, with Northern exposition located on the hill near Busu village, with argic cernoziom soil (clay illuviation soil);
- near the woods with S-E exposition, cu Typical phaeozem soil (brown clay illuviation soil).

RESULTS AND DISCUSSIONS

The tables below present the performed analyses and obtained results:

Table 1. Determining chemical properties of argic cernoziom harvested from the vineyard 20 cm deep

No sample.	pH	Nt	P_2O5	K_2O	Ah	SB	Hummus
1.	6.15	0.191	4.1	11.5	2.71	16.8	2.16
2.	6.34	0.224	5.4	21.4	1.80	19.4	2.19
3.	6.46	0.21	5.2	14.8	2.16	19.2	2.14
4.	6.20	0.211	4.2	16.9	2.76	16.8	2.21
5.	6.25	0.216	3.8	17.5	2.14	18.0	2.24
6.	6.18	0.188	5.5	16.6	3.60	15.5	2.19

Table 2. Determining chemical properties of argic cernoziom harvested from a vacant land located on a hill 20 cm deep

No sample.	pH	Nt	P_2O5	K_2O	Ah	SB	Hummus
1.	6.01	0.077	6.3	6.2	1.31	5.2	0.53
2.	5.98	0.083	4.7	10.7	1.52	5.2	0.62
3.	5.88	0.064	5.5	7.00	1.21	5.2	0.67
4.	5.75	0.090	6.7	9.5	1.57	6.4	0.72
5.	6.00	0.095	7.6	10.7	1.49	6.0	0.57
6.	6.02	0.082	7.9	9.5	1.45	5.2	0.48

Table 3. Determining chemical properties of soil near Typical phaeozem woods (brown clay illuviation soil) 20 cm deep

No sample.	pH	Nt	P_2O5	K_2O	Ah	SB	Hummus
1.	6.20	0.055	7.6	8.0	1.26	5.2	0.67
2.	6.21	0.052	6.5	8.0	1.12	6.0	0.43
3.	6.13	0.050	8.1	9.5	1.31	5.6	0.67
4.	6.18	1.102	5.7	8.0	1.17	5.2	0.53
5.	6.17	0.077	6.6	9.5	1.22	5.6	0.48
6.	6.10	0.078	6.1	7.1	1.31	5.6	0.53

Table 4. Determining chlorophyll pigments and NPK from *Aristolochia clematitis* young leaves and stems harvested from the vineyard

No sample.	Clorofilieni pigments						N		P_2O5		K_2O	
	Chlorophyll A		Chlorophyll B		Carotene							
	leaf	stems	leaf	stems	leaf	stems	leaf	stems	leaf	stems	leaf	stems
1.	10.725	10.421	4.845	4.812	4.925	4.838	3.10	3.07	1.85	1.80	1.58	1.35
2.	10.827	10.487	5.110	5.101	4.835	4.815	3.85	3.43	2.05	2.01	1.65	1.51
3.	10.835	10.487	5.115	5.102	4.841	4.821	3.90	3.49	2.01	1.89	1.67	1.53
4.	10.730	10.420	4.846	4.813	4.927	4.847	3.08	3.00	1.83	1.78	1.54	1.34
5.	10.732	10.420	4.847	4.813	4.930	4.848	3.14	3.10	1.87	1.80	1.62	1.46
6.	10.726	10.419	4.840	4.812	4.928	4.847	3.05	2.98	1.85	1.78	1.59	1.38

Table 5. Determining chlorophyll pigments and NPK from *Aristolochia clematitis* young leaves and stems harvested from the vacant land located on the hill

No sample	Clorofilieni pigments						N		P_2O5		K_2O	
	Chlorophyll A		Chlorophyll B		Carotene							
	leaf	stems	leaf	stems	leaf	stems	leaf	stems	leaf	stems	leaf	stems
1.	9.860	9.831	3.980	3.942	3.361	3.321	3.01	2.87	1.75	1.54	1.30	1.23
2.	9.865	9.833	3.983	3.943	3.365	3.323	3.05	2.94	1.70	1.50	1.31	1.23
3.	9.920	9.902	4.010	4.003	3.618	3.324	2.75	2.35	1.65	1.52	1.27	1.18
4.	9.835	9.805	3.985	3.934	3.650	3.18	3.00	2.85	1.72	1.51	1.35	1.15
5.	9.861	9.832	3.987	3.935	3.645	3.17	3.02	2.87	1.69	1.50	1.32	1.13
6.	9.855	9.816	3.975	3.967	3.360	3.327	3.85	3.56	1.70	1.50	1.29	1.20

Table 6. Determining chlorophyll pigments and NPK from *Aristolochia clematitis* young leaves and stems harvested from the land near the woods

No sample	Clorofilieni pigments						N		P_2O5		K_2O	
	Chlorophyll A		Chlorophyll B		Carotene							
	leaf	stems	leaf	stems	leaf	stems	leaf	stems	leaf	stems	leaf	stems
1.	10.613	10.335	4.720	4.615	3.960	3.925	3.11	3.07	1.97	1.65	1.64	1.42
2.	10.615	10.335	4.728	4.620	3.965	3.927	3.08	3.01	1.90	1.60	1.64	1.42
3.	10.720	10.410	4.830	4.657	4.915	4.890	2.89	2.47	1.75	1.45	1.49	1.25
4.	10.585	10.470	4.721	4.685	4.966	4.895	3.04	2.95	1.82	1.60	1.60	1.40
5.	10.618	10.515	4.735	4.610	4.956	4.895	3.01	2.87	1.79	1.62	1.53	1.37
6.	10.610	10.513	4.710	4.614	4.950	4.893	2.83	2.55	1.68	1.35	1.35	1.20

Figure 1. Determining chlorophyll pigments

Based on the presented information, we identified and characterised chemical properties with therapeutic values extracted from Aristolochia Clematitis, from the two vegetative organs, young leaves and stems, studying the ones harvested in the vineyard with the best results at performed analyses and we prepared a tincture from leaves and another one from stems.

Loose, which we chopped finely by cutting with scissors, pressed in a mortar until we obtained a uniform paste. The obtained paste was transferred in a bowl with glass stopper and we added 96^0 ethylic alcohol until we covered the preparation, and then we closed it tightly. The obtained mixture was periodically stirred and was left to soak for 15 days.

We applied the same procedure to (AC) harvested stems. After soaking, the resulting liquids were filtrated filter paper resulting in a clear green liquid.

Figure 2. Preparing *Aristolochia clematitis* tincture in a laboratory

Next step consists of gas-chromatography analysis (GC-FID) and gas-chromatography mass spectrometry (GC/MS). The methods will be applied in order to characterise the tincture prepared from this plant and to make a comparison between the alcoholic extracts from stems and leaves.
Based on the obtained results from the two methods, continuing research is proposed by external application of the analysed tincture in treating certain illnesses under the supervision of specialists in medical and pharmaceutical field.

CONCLUSIONS

By using the spectrophotometer method, we were able to determine N, P_2O5, K_2O in leaves and stems, and the method of determining chlorophyll pigments led to identifying Chlorophyll A, Chlorophyll B, Carotene.

The presence of Aristolochia Clematitis components differs from a plant to another, from a place of harvesting to another, from a vegetative organ to another.

The presence of determinate elements in leaves and stem differs in value according to the place where the plant developed, type of soil and chemical properties respectively.

The obtained results as a whole from Aristolochia Clematitis harvested in the vineyard are emphasised, where the analyses of soil samples resulted from the presence of chemical fertilisers, as well as the effect of mechanical works which influence the physical properties of the soil.

Aristolochia Clematitis therapeutic potential can be obtained only by establishing the vegetative organ with the highest content of active principles in order to extend and harness them into different forms of pharmaceutical preparations.

By preventing intoxication with Aristolochia Clematitis, it is highly recommended only for external use. It can be used only under medical supervision.

It is not recommended that this tincture be prepared in household, where you do not have the possibility to establish the number of toxins present in the harvested plant, because these can vary greatly according to the time of harvesting, the land where it was grown, the parts of the plant which are used and also the stage of vegetation.

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PROPOSALS ON TECHNOLOGY OF MOVING *Aristolochia clematitis* (BIRTHWORT) FROM THE SPONTANEOUS SYSTEM OF GROWTH IN THE CULTIVATED SYSTEM

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Abstract

Complex valorisation of the specie of Aristolochia clematitis resulted from the spontaneous flora in Oltenia area and in other regions of the country requires the elaboration of an ecological cultivation technology.
This technology is primarily aimed at keeping bio productive qualities (biomass content in active principles, qualitative physiochemical spectrum) of selected genotypes and their conservation.
New bio products will be made by a new modern ecological technology, with machinery and equipment appropriate for the culture of Aristolochia clematitis that aims at the observance of the conditions regarding the protection of environmental quality and providing raw materials for the pharmaceutical industry.
This technology aims primarily at preserving the bio-productive qualities (biomass, active principles content, (qualitative phytochemical spectrum) of selected genotypes, as well as their preservation.
This paper presents the main links of the cultivated and protected test crop system of a plant known so far a Aristolochia clematitis weed, taken from spontaneous flora, works of preparing the soil and seedbed respectively, setting up culture, removing weed, harvesting in order to obtain extracts, harvested from seeds.

Key words: *crop system; extracts; pharmaceutical industry.*

INTRODUCTION

By using natural medication which has become more and more frequent, toxic side effects induced in the organism are removed. Since existing vegetal species are very well spread both spontaneously and in guided and protected crops, enabled discovering and using an impressive number of vegetal substances in traditional medicine, by obtaining qualitative influences to immune response, without requiring high costs, being easy to obtain and maintain, by controlling toxic effects of certain plants on the organism, which until recently was used in pharmacies under the name of REMF.

Aristolochia clematitis L. (Wolf apple) has a list of impressive cured disorders: from hepatic illnesses and recurrent infections to dermatomes resistant to any kind of treatment, benign and malign tumours or gynaecological illnesses (Natura" Magazine no. 7, 2003).

Successful folk remedies started from reducing inflammations, external haemorrhoids, anal fissures, eczemas, ovarian cysts, uterine fibroids, virginities, anal fissures, dermatoses, ulceration infections, wounds which are hard to heal, burns, mammal cysts, varicose ulcer, psoriasis. It is recognised as a good antiseptic, cicatrising, calming and anti-inflammatory. Beneficial effects are obtained by using young seeds, leaves, roots and stems in various proportions and different extracts (Balistreri et al., 1992) 'in order to identify distribution and concentration of active compounds".

MATERIALS AND METHODS

As a starting point, it was established the place where cultivated and protected crop system technology was tried, Greceşti village, Dolj district, on an uncultivated land, with an argic cernoziom soil with spontaneous vegetation.

Preparing the soil: Dimensions of the parcel were determined - 100*100 m^2, surrounded by strips of land 6 m wide which will be processed through periodic disking and represents the protection area of neighbouring crops. The establishes area is cleaned by chopping vegetal residues and existing vegetation by using MTV

1.4 vegetal residues chopping machine by leaving the mince scattered on the surface of the soil on half of the established parcel. The other half is lightly raked 2-3 cm deep, vegetal residues are gathered and removed from the parcel.

Sowing: In order to set up crops on the surface with vegetal residues they are spread on the surface of the land where there are spread vegetal residues of a mixture formed of Aristolochia Clematises seeds and dry sand by using MIC-0,4, chemical fertiliser spreading Machine with spreading disk with blades oriented towards the negative angle and low speed, by using a quantity of 3.4 kg seeds mixed with dry sand for 5000 m^2.

For the raked surface, we used the same quantity of seeds mixed with dry sand of 2.2 kg for 5000 m^2, and sowing was carried out by using forage sowing equipment fitted with MSPFP-2.0 rollers. In this case, certain measurements were also made.

Attempts of the experimental model of the MSPFP-2.0 meadows forage sowing machine in order to sow Aristolochia Clematises seeds mixed with sand.

The sowing equipment presented in figure 1 is formed of: a seed box with two compartments, a compartment for small seeds of perennial leguminous plants with distribution boxes with small fluted cylinders and a compartment for perennial gramineae seeds with distribution boxes with spurs cylinders; seeds shaker on the perennial gramineae seeds compartment; collecting funnels; funnel-tray spreading seeds on the surface of the soil and transmission from the anterior roller to the Northon type gearbox, to the shaking axis and the axes of seeds distributors. **The sowing equipment** is placed on the machine and spreads seeds in the space between the two rollers.

Figure 1. MSPFP-2.0 meadows forage sowing Machine

These are the main technical characteristics of the machine: 2 m working width; 0,5-2 cm working depth; 42 dm^3 capacity of the boxes for small seeds.
The minimum norm of seeds obtained was 4,4 kg/ha per uniformity of distribution of approximately 98%. Sowing depth between 0,5-1 cm.
Setting up crop: whenever needed, we carry out the mechanic setting of the protection area between Aristolochia Clematitis harvested surface and the neighbouring crops, by using disks harrows, cultivators and combiner.
Aristolochia Clematitis crop can also be set up by chemical weed control works until the plant has 5-6-true leaves, considering the fact that it is a sensitive plant to MCPB-Na, oxyfluorfen, clopyralid, chlorsulfuron, tribenuron methyl, metosulam, acid 2,4-D+dicamba, glyphosate, etc. (Chirilă et al., 2012), which leads to warning by making an inscription in the ground not to use such substances.
Weed chemical control is done by using Erbicidator Wirax 200 l Sprayer, worn, equipped with anti-drip nozzles 6m working width.
Harvesting: It is carried out according to the proposed objective:
In order to obtain natural products – plants are cut by mowing during the period of blooming with the help of lawn mowers and vindrovers.
Plants are left in furrows for 1-2 days in order to wilt, then they are transported to shady areas in order to dry naturally on cloth frames. After drying, frames can be emptied in special boxes of depositing or they can be soaked directly and packaged for preservation.
- In besides harvesting, with the help of technology we establish that crop should be reset up naturally by auto seed spreading, taking into account that when ripen, capsules containing the seeds expand, then we will determine the medium distance of spreading and establish the width of the strip of plants which will be cut off, staking out rows which are to be left for self sowing.
- If the crop is set up in order to harvest seeds, the ripening period will be followed, as crops are close to the maturity phase at approximately 85%; plant capsules depend on phases.
First phase is represented by cutting plants and leaving them on the ground in furrows to dry, second phase consists of lifting plant furrows and threshed by combines, or stationary with threshers for experimental fields.
Note that during harvesting, it is recommended to use protection equipment which consists of gloves, protection glasses, respiratory protective mask.
It is recommended that during manual sowing on small field surfaces K2 group sowing machines be used, when sowing is done with the help of a distribution device vertical rotating disk type with spoons/cups, which change according to seed type and dimension.
The level of the seeds in the tank must be constant, so that seeds could be dosed by means of the spoons with every rotation, so that seeds should not be mistakenly thrown in the funnel or rod.

Figure 2. Small seed sowing machine in one row with mechanical distribution

Depth is adjusted between 0-7 cm with the help of the plough, and the channel is achieved by means of a wedge-type coulters, which, when appropriate, an additional weight can also be mounted.

CONCLUSIONS

Crop can also be set up on poor lands, in the first year of sowing, and in the following years by natural spreading.

Crop must be located so that seeds cannot be transmitted to other crops. It is recommended that after sowing, to produce a light subsidence or watering in order to fix the seeds in the soil.

Crop can be maintained either mechanically or chemically.

Harvesting: Since natural products are achieved in phases followed by shade drying, cutting, grinding and packaging the product.

Harvesting to obtain seeds is achieved in phases by cutting while leaving in the furrow until dry, followed by threshing by using the furrow combine or stationary by using the thresher for experimental field.

During the actions comprised in technology, protective equipment must be used.

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FUNGAL BIODIVERSITY AND CLIMATE CHANGE ON CORN: A KEY TOOL IN BUILDING AN INNOVATIVE AND SUSTAINABLE AGRICULTURE ON DOBROGEA AREA

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Abstract

Elaboration of biocontrol strategies to mycotoxins producing fungi and integration of beneficial microorganisms in protection systems of corn crops, involves in the initial phase, the development of methods for sampling and analysis of soil and plant debris samples and later, the analysis of cob corn for the purpose of differentiating toxigenic and atoxigenic fungi of Aspergillus and Fusarium group.
Risk factors on corn production specific for Dobrogea agricultural area are: the attack of fungal pathogens from primary inoculum that survive in the soil and on the plant debris: Aspergillus flavus (aspergillus or yellow mould); Giberella zeae/anamorph Fusarium graminearum (gibberella ear rot) and Giberella fujikuroi/anamorph F. verticilloides (fusarium ear rot); wrong conception of crop rotation (wheat – corn) and drought causing water stress in corn, as an indicator of climate change.
To bring together relevant knowledge and experience for Dobrogea farmers about improvements in fungi biodiversity, the research are focus on developing new methodologies for assessing toxigenic-pathogenic and beneficial fungi, leading to a quantitative risk-benefit assessment strategy.

Key words: *toxigenic-pathogenic fungi, beneficial fungi, climate change, drought.*

INTRODUCTION

In Romanian agricultural conditions, one of the most common rotation is wheat-corn. Plant debris left on the ground, favors the development of some microorganisms pest agents, including mycotoxin producing fungi of *Aspergillus* and *Fusarium* genus.
Conservation agriculture is being increasingly promoted as constituting a set of principles and practices that can make a contribution of sustainable production because it addresses to missing components in the intensive tillage based standardized seed-fertilizer-pesticide approach to agriculture intensification.
Suppressing soil-borne diseases with residue management and organic amendments is a relatively recent approach in agricultural practice to reduce the primary inoculum level of pathogens (Bailey and Lazarovits, 2003).
In Romanian conditions, the attack of *Giberella zeae (Fusarium graminearum)* on the corn cob produce 7-15% losses (Nagy et al., 2006; Zaberca and Borcean, 2010).
Reducing primary inoculum of *Fusarium graminearum*/*Giberella zeae* by using conservative technologies of biofumigation in the succession of wheat/corn crops, is so beneficial for corn, too.
The influence of *Fusarium* spp ear infection on production and mycotoxin content in maize is much more than that reported for Fusarium Head Blight in wheat, in case of favorable climatic conditions (Nagy et al., 2009).
Keeping pest and crop management records over time will allow farmers to evaluate the economics and environmental impact of pest control and determine the feasibility of using certain pest management strategies or growing particular crops.

MATERIALS AND METHODS

New methodologies to simulate *in vivo,* as initial stage in the drafting a method of sampling adapted to corn grower, offers the advantage that it processes for the identification of the toxigenic fungi in the soil and on plant debris, allow for an analysis of a large volume of data, which correspond to real-field, with a low cost and suggest the risk of corn contamination with mycotoxins in the following year of cultivation.

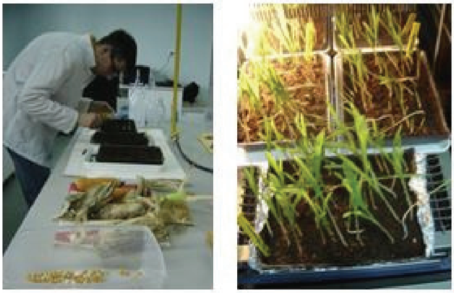

Figure 1. Research techniques and methods of artificial soil contamination by fungi spores

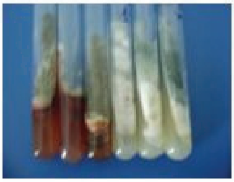

Figure 2. Selective culture medium of *Aspergillus*, *Fusarium* and *Trichoderma fungi* used in soil artificial inoculation

Research techniques and selective culture medium with dimethyl-β-cyclodextrin were used to studying the influence of soil contamination level on germination and emergence corn stage (Figure 1 and 2). The seeds were sowed in heat-treated soil and artificially infected with a concentration spores of $2.5x10^6$ spores/ml of *Fusarium* sp. and *Aspergillus flavus*, respectively $7,5x10^6$ spores/ml of *Trichoderma harzianum* (Tdh al12).

After 24 hours of inoculation with fungi, corn was sown, every 5 rows in each tray contains 10 seeds/row and incubated in a growth chamber for 2 weeks at 22^0 C.

The antagonism between pathogenic and beneficial fungi was assesed by using double culture method.

Experimental variants analyzed:

V_1 -untreated corn in heat-treated soil;

V_2-untreated corn in soil infected with *F. graminearum+F. oxysporum* and *Aspergillus flavus*;

V_3-untreated corn in soil infected with *F. graminearum+F. oxysporum*;

V_4-untreated corn in soil infected with *Aspergillus flavus*;

V_5-untreated corn in soil infected with *Trichoderma harzianum* (Tdh al12 strain);

V_6-untreated corn in soil infected with *A. flavus*, *F. graminearum+F. oxysporum* and *T. harzianum* (Tdh al12 strain);

V_7-corn treated with *Trichoderma pseudokoningii* (Td85 PTS-2 kg/t) in infected soil *A. flavus* and *F. graminearum+F. oxysporum*;

V_8- corn treated with Thiram (3 kg/t) in infected soil with *A. flavus* and *F. graminearum+ F. oxysporum*;

V_9-corn treated with Thiram (3 kg/t) in infected soil with *A. flavus*;

Biological material sampling were collected from agricultural Dobrogea crop with different meteorological and soil conditions (Figure 3). Location sampling points by GPS coordonates: Amzacea (N4358108; E02825026); Agigea Black Sea (N4404953; E02838050); Agigea Danube Canal (N4405113; E02832968); Oltina (N4407982; E02740820); Harsova (N 4442261; E02756012); Fantanele (N4438534; E02832161). The period analyzed in this study was 2011-2013.

Figure 3. Corn samples collected from Dobrogea agricultural area, 2012

RESULTS AND DISCUSSIONS

The objective of this research is to developing strategic solutions to reduce soil contamination by mycotoxin producing fungi (*Fusarium* and *Aspergillus* genus) and to predict risk level associated to corn crops in Dobrogea agricultural areas.

The use of novel methodologies based on research techniques and selective culture medium with dimethyl-β-cyclodextrin will allow to describe the contamination level of different crops and predict its value by simulate *in vivo* corn conditions (Based on our results published in Patent No 123355).

Climate change effects and Dobrogea agriculture

Risk factors for *A. flavus* are plant debris and contaminated soil, insect attack, hot and semi-arid regions. Corn plant affected by water stress are more susceptible to attack fusarium ear rot *Giberella fujikuroi/Fusarium verticilloides*.

The development of *Aspergillus* and *Fusarium* fungus on corn infection is associated with mycotoxin contamination. The causes of yellow mold and Giberella ear rot including: natural evolution of *Aspergillus* and *Fusarium* populations, climate change, conservative extension technologies.

Drought causing water stress in corn, as an indicator of climate change is characterized by frequency, duration and intensity increased especially in Dobrogea agricultural area. The effect of drought causing significant losses on corn cob by limiting growth potential of plants expressing, leaf wilting and drying, high frequency sterile plants and partial coverage of the ear with grains.

Climate change effects on Dobrogea agriculture will affect farmers by reducing the acreage in corn due to water stress caused by prolonged drought.

The novel methodologies using in this research are selective culture medium for differentiation between toxigenic and non-toxigenic species of *Aspergillus* and *Fusarium*. The results for culture medium for differentiation of aflatoxigenic and non-aflatoxigenic fungi are published in Patent no. RO 125071 and culture medium for differentiation of *Fusarium* toxigenic fungi are published in Patent no. RO 123 355. The research techniques of artificial soil contamination by fungi spores allow us to describe the contamination level of corn crops simulate in *vivo* conditions.

Culture medium for differentiating toxigenic and non-toxigenic fungi shows most differentiation capacity for *Aspergillus* and *Fusarium* non-toxigenic with 2.8-3.2 parts of dimethyl-ß-cyclodextrin. (Figure 4 and 5).

Culture medium for differentiation between toxigenic and non-toxigenic species.

The technical problem solved by selective culture medium with 2.8-3.2 parts of dimethyl-ß-cyclodextrin is rapid isolation and differentiation of phytopathogenic and toxigenic fungi of the genus Aspergillus and Fusarium.

Figure 4. Selective culture medium for differentiation between toxigenic and non-toxigenic species; corn samples, Oltina, 2011

Figure 5. Differentiation between *Aspergillus* and *Fusarium* pathogenic-toxigenic species on selectives culture medium; corn seeds, Oltina, 2011

Figure 6. Influence of *Aspergillus flavus* (on left) and *Trichoderma harzianum* Tdh al12 (on right) isolates on corn seed germination and emergence

Giberella zeae (Fusarium graminearum) on corn crop, cause disease in all stages of development, the seedlings, the stem and the seeds. Attacked seedlings rotting (Figure 7).

Figure 7. Pathogenicity of *Fusarium graminearum* fungus in germination–emergence stages

The level of soil contamination with mycotoxin producing fungi (*Aspergillus flavus; Fusarium oxysporum* and *F. graminearum*) has influenced *in vivo* conditions on germination–emergence corn stage (Figures 8 and 9).

Seeds corn treated with *Trichoderma pseudokoningii* (Td85 PTS-2 kg/t) in infected soil with *A. flavus* and *Fusarium graminearum+F. oxysporum* (V_7-variant) has presented the best influence of biological activity of *Trichoderma pseudokoningii* applied as bioproduct Td85, followed by variant 6. The results are compared with those obtained in V_1 (natural control) that there were only seven plants grown at both 10 days and 14 days.

Untreated corn in soil infected with *F. graminearum+F. oxysporum* and *Aspergillus flavus* (V_2) influenced negatively the germination and emergence of corn plants, followed by untreated corn in soil infected with *Aspergillus flavus* (V_4).

After 14 days of sowing, there were 19 plants emergence delayed (V_2), respectively, 15 plants springing delayed (V_4), the results were compared with untreated corn in soil infected with *Trichoderma harzianum* strain Tdh al12 (V_5) in the number of plants springing delayed was reduced to half (8 plants).

Number of plants with emergence delayed (8 plants) obtained in untreated corn in soil infected with *A. flavus, F. graminearum + F. oxysporum and T. harzianum*-Tdh strain al12 (V_6) was similar to that obtained in untreated corn variant in soil inoculated with Tdh strain al12 (V_5).

Untreated corn in soil infected with *F. graminearum+F. oxysporum* (V_3) did not affect the corn plants grown but was observed the pathogenicity of *Fusarium sp.*on corn seed (Figure 7).

The large number of plants with delayed emergence (11 plants) was obtained in corn treated with Thiram (3 kg/t) in soil infected with *A. flavus* (V9), after 14 days from sowing. This results is due to the inaction of fungicide against *Aspergillus flavus* and of the influence of the fungus on emerged corn plants (Figure 6).

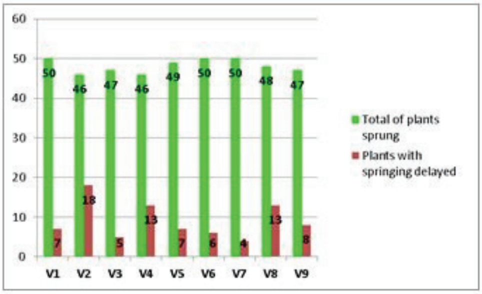

Figure 8. The influence of contamination level on germination–emergence corn stages after 10 days from sowing

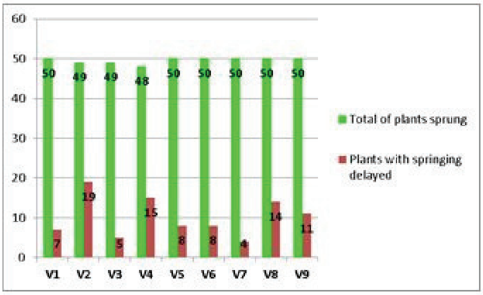

Figure 9. The influence of contamination level on germination-emergence corn stages after 14 days from sowing

In variant control untreated corn, sown in heat-treated soil (V_1), there were 50 plants sprung and a total of 7 plants springing delayed so after 10 and 14 days after sowing (Figure 8 and 9).

Number of plants springing delayed obtained in V7 (4 plants) was exceeded in control V1 (7 plants).

Comparative results has obtained in V7 and V8. *Trichoderma harzianum* Tdh al12 and *Trichoderma pseudokoningii Td 85* strains have the ability to colonize the roots of corn plants and to inhibit pathogens of *Aspergillus* and *Fusarium genus.*

Sustainable agriculture on Dobrogea corn crop by local beneficial microorganisms

New opportunities for Dobrogea agriculture had been identified. Beneficial microorganisms of *Trichoderma* genus, *Trichoderma harzianum* Tdh al12, isolated from corn seeds substrate, Dobrogea agricultural area, 2012 (Figure: 10). Tdh al12 strain could be identified to species level based on morphological and physiological characteristics, assigned to the species *Trichoderma harzianum.*

Figure 10. Pure culture of beneficial strain *Trichoderma harzianum* Tdh al12, isolated from corn seeds; Dobrogea samples, 2012

Trichoderma harzianum Tdh al12 strain has different action against microbiological agents showing strong antagonism *in vitro* against *Fusarium oxysporum* and *F. graminearum* pathogens and limiting development of toxigenic *Fusarium* fungi (Figure 11); using Tdh al12 strain as biocontrol agent to reduce mycotoxin producing fungi (*Aspergillus flavus*) (Figure 12) and to stimulate.

In vitro antagonism of *Fusarium oxysporum* assesed by double culture method mathematical coefficient were: x = 0.19 to 0.33 (4 days), x = 0.34 to 0.38 (8 days) and of *Fusarium graminearum* x = 0,30-0,37 (4 days); x = 0,32-0,44 (8 days). x < 1 antagonism (A) the stronger (PA) as the values are closer to the value 0.

Antagonistic strains of the genus *Trichoderma ssp* are able to produce various secondary metabolites that may play a role in the mechanism of action of their biological activity. *Trichoderma harzianum* strain 1295-22 (commercial product T-22 / TRIANUM-G) has currently the greatest ability to colonize plant roots and to inhibit pathogens like: *Pythium, Rhizoctonia, Fusarium*.

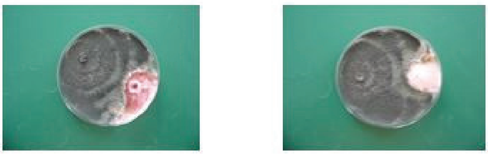

Figure 11. Tdh al12 strain antagonism against pathogens fungus *Fusarium graminearum* (on left) and F. oxysporum (on right)

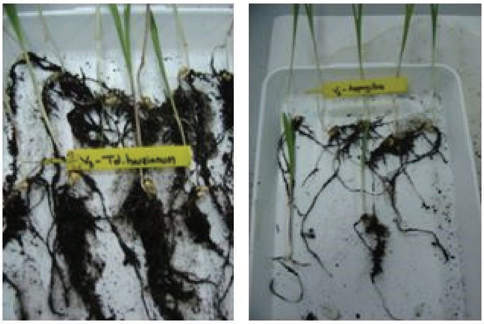

Figure 12. Biocontrol agent Tdh al12 to reduce *Aspergillus flavus* toxigenic fungi in corn

Figure 13. Stimulating corn root system development by Tdh al12 beneficial strain

CONCLUSIONS

Developing new methodologies for assessing toxigenic-pathogenic fungi of *Aspergillus and Fusarium* genus using culture medium with 2.8-3.2 parts of dimethyl-β-cyclodextrin and beneficial fungi (*Trichoderma pseudokoningii* Td 85 and *T. harzianum* al12) leading to a quantitative risk-benefit assessment strategy and bring together relevant knowledge and experience about improvements in Dobrogea agricultural area.

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MANAGEMENT OF BENEFICIAL MICROORGANISMS RESOURCES TO SUSTAINABLE AGRICULTURAL PRODUCTION

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Abstract

The sustainability and security of Romanian agricultural production is under threat from intensive production practices, global competition and climate change factors. Maintaining the sustainable production of land lies in striking a balance between socio-economic goals and responsible natural resource management. To rise to the challenge, an integrated approach making full use of all the major players involved – farmers, consumers, regulatory bodies and scientists – is necessary.
Trichoderma pseudokoningii Td85 *antagonistic fungus was isolated from wheat seeds, Baragan agricultural region. Td85 beneficial strain has the following properties: a wide spectrum of action towards pathogenic microbiological contaminants in cereal crops, due to complex activity expressed by antagonism and competition for food and space colonization. Td85 beneficial strain provide reducing development of primary inoculum that survive in the soil and on the plant debris, due to high capacity for colonization and degradation of plant substrates.*
Saccharomyces cerevisiae L30b *yeast strain was isolated from grapes Chasselas D'ore variety, RDIPP Bucharest vineyard. Research of L30b beneficial yeast was sidelined on strawberry crop, focusing on biological control of Botrytis cinerea fungus. The efficacy of L30b formulations was assessed on Favette (early), Cardinal (middle) and Pandora (late ripening) variety, achieving a reduced disease incidence and severity of grey mould on fruit and providing high efficacy against the pathogen.*

Key words: *sustainable production, beneficial fungi, Trichoderma pseudokoningii Td85, Saccharomyces cerevisae L30b.*

INTRODUCTION

Microorganisms of the genus *Trichoderma* are some of the most common naturally occurring fungi. Most strains are beneficial and have ability to colonize plant roots easily, without damage them. Close relationship between plants and *Trichoderma* fungi, gives an excellent biocontrol agent qualities. These microbial biofungicide may compete for food and space with pathogenic fungi, may stimulate plant host defenses and increased positive effect for root system. In addition, antagonistic fungi have capacity to attack and parazitize agents of agricultural plant pest in certain environmental conditions (Sesan et al., 2012).
Fungi of the genus *Trichoderma* ssp. possess innate resistance to to most agricultural chemicals, including fungicides, although individual strains of microorganisms differ in terms of their resistance to plant protection products (PPPs). Some strains of antagonistic fungi were selected or modified to achieve specific agricultural chemical resistance. Most owners of strains of the genus *Trichoderma* ssp, hold extensive lists of their sensitivity or resistance to a wide range of crop protection products, for biological control agents of pest.
In nature, some organisms favors the development of others, forming associations that allow coevolution in the agriculture system, while others are exclude each other by mechanisms of antagonism. Microorganisms with importance in biological control of of plant diseases have a complex action.
Antagonism of biological control agents against pathogens is due to the action of secondary metabolites and to direct destruction by micoparazitism.
Reducing *Botrytis cinerea* pathogens may be due to the mechanism that destroy microsclerotium or limit mycelium growth by antagonistic yeasts of *Saccharomyces* and *Metschnikowia* genus.

MATERIALS AND METHODS

***Trichoderma pseudokoningii* Td85 strain,** beneficial microorganism, isolated from wheat seeds collected from Baraganul de Sud (Figure 1).

Figure 1. Pure cultures of beneficial fungus *Trichoderma pseudokoningii* Td85

Identification of *Trichoderma* Td85 strain to the species level was based on morphological and physiological characteristics, assigned to the species *Trichoderma pseudokoningii*.
Td85 colony habitat: colony on oatflake-agar at 25^{0}C filling the Petri-dish within 4 days, mycelium hialine, sporulating areas tuffed, green. Colony reverse colour unchanged. No odour. No growth on PDA at 40^{0}C; 50mm radius at 40^{0}C.
Td85 morphology: conidiophores tree-like, branched at right angles; length of branches increasing to the basis; no sterile appendages. Phialides flask shaped, straight or bent, arranged mostly in groups of three of the end of branches. Conidia ellipsoidal, smooth-walled, 5x3 µm.
Lyophilized *Trichoderma pseudokoningii* Td85 strain Figure 2).

Figure 2. Vials of Td85 strain as lyophilized spores

Condition for storage of beneficial microorganisms Td85 are lyophilization (freeze-drying cell) and for cultivation PDA medium.
***Saccharomyces cerevisiae* L30b strain**, beneficial microorganism, isolated from *Chasselas D'ore* grapes variety, RDIPP vineyard (Figure 3, 4 and 5).

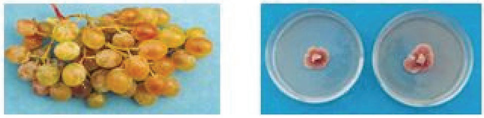

Figure 3. Habitat of L30b strain and yeast collony isolated from Chasselas d'ore grapes variety

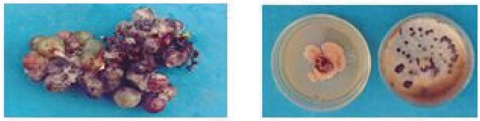

Figure 4. Cultures obtained on PDA medium of Saccharomyces cerevisie L30b and *Botrytis cinerea*-the target pathogen in strawberry experimental field

Figure 5. Pure cultures of beneficial yeast *Saccharomyces cerevisiae* L30b strain

The culture medium used for isolation: glucose 5%, 2% agar, 0.5% tartaric acid and pH 2.5 and for cultivation: YPGA medium (glucose 20g, peptone 10g, 5g yeast extract, 20g agar; sterile distilled water (1000 ml).
The criterion used for the proposed taxonomic designation for L30b yeast strain is the key to the species of *Saccharomyces* adapted from Stelling-Dekker.
Morphology of *Saccharomyces* L30b strain *surface on agar*: shiny; *texture on agar:* smooth.
Identification of L30b yeast at the species *Saccharomyces cerevisiae* was performed by sequence analysis of 26S rDNA D1/D2. Identification species: *Saccharomyces cerevisiae* (100% sequence D1/D2).
Conditions for storage are lyophilization and cryopreservation (storage in liquid nitrogen or mechanical freezing at temperatures between-80^{0}C and-135^{0}C).
Lyophilized *Saccharomyces cerevisiae* L30b strain stored into international collection of

microorganisms DSMZ Braunschweig – Germany, Figure 6).
Mineralization capacity of Td85 strain on plant debris was assessed by Strathox respirometer.
Pest incidence (% infected fruit) and pest severity (% infected area) of *Botrytis cinerea* was assessed on 100 fruit per plot. The results were interpreted statistically by ANOVA and Newman & Keuls 5% test.

Figure 6. Vials of L30b yeast strain as lyophilized spores

RESULTS AND DISCUSSIONS

Experiments conducted in this research allowed the definition of optimized conditions (composition of media, cultivation parameters-temperature, aeration) and conditioning formula that provides optimum performance in growing and multiplication replicates antagonistic strains to phytopathogenic microorganisms
Modern crop protection products must fulfill the requirements increasingly higher efficiency requirements in the field, but with minimal impact on the environment and the highest possible level of safety for both, the consumer and food products. Eliminate risks to health and environment of plant protection products is a major imperative for any company producing PPPs. Product behavior in soil, water and air and their effects on the fauna and flora are thorough tested in greenhouses and in the field, following international regulations for sustainable development.

BIOPRODUCTS BASED ON *Trichoderma Pseudokoningii* Td85 TO PROTECT CROPS

Different conditioning formulas and modes of actions: controlled release granules (F1 left) microgranules with curative action (F2 midl.) powder conditioning of seed treated with preventive actions (F3 left) (Figure 7). Active ingredient: *Trichoderma pseudokoningii* Td85 strain ($1x10^8$ spores/ml).

Figure 7. Bioproducts based on *Trichoderma pseudokoningii* Td85 strain with different conditioning formulas

Microgranules viability of Td85 spores was 100% after 12 months of conditioning and more than 90% viable spores, demonstrating the high level of conditioning formulas in yield (Figure 8 and 9).

Figure 8. Viable conidia of Td85 strain after 4 (left) and 8 (right) days from conditioning as controlled release granules (F1)

Figure 9. Viability of bioproducts based on Td85 strain embedded in alginic acid (F1) and sodium alginate (F2) after 12 month from conditioning

For testing the viability, embedded Td85 spores are transplanting on PDA medium and growned for 5 days at 22^0C. Alternatively, a pure fungal suspension from a tube is tested to quantify microscopic spore viability (hemacytometer+methylviolet/methylene blue), considering spores viable, if more than 90% of the spores is not colored.
Biological activity of strain Td85 is differentiated according to the formula of beneficial microencapsulation. (Figure 10 and 11). Our research publicated in Patent application a 2010 01161 demonstrated that controlled slowly releasing of Td85 spores (F1) are applicable in a conservative agriculture system.

Figure 10. Controlled slowly releasing of Td85 spores and the antagonism against *Fusarium graminearum*/ Td85 F1 (a) Td85 F2 (b) and control fungus (c)

Figure 11. Instant releasing spores and the antagonism of Td85 against *Fusarium graminearum* / Td85 F1 (a) F2 Td85 (b) control fungus (c)

The selection criteria of beneficial microorganism *Trichoderma pseudokoningii* Td85 are: antagonism towards different agents of damages; ensure reducing primary inoculum developed on plant debris from agricultural crops; high capacity for colonization and degradation of plant substrates; a complex action expressed by: antagonism, competition for food and space, high capacity of sporulation, submerged cultivation, in order to obtain biomass because it is an industrial profitable technique readily taken up.
To define optimal industrial parameters of *Trichoderma pseudokoningii* Td85 strain, the following composition was used: KH_2PO_4 5 g/l, $(NH_4)\ _2SO_4$ 5 g/l, yeast extract 2 g/l, $MgSO_4.7H_2O$ 0.3 g/l, $CaCl_2.2H_2O$ 0.3 g/l, whey powder 5 g/l, pulp corn to produce bioethanol by dry milling about 5 g/l, pH 5.6.
The results based on our research publicated in Patent application a 2010 01161 and 127293 demonstrated that *Trichoderma pseudokoningii* Td85 has antagonistic action against pathogens from *Fusarium, Botrytis* and *Sclerotinia* genus. Also, Td85 strain is producing hydrolases that degrades cellulose, chitinase and beta-glucanase; oxidase which degrade lignin and has high mineralization capacity of plant debris (Figure 12).

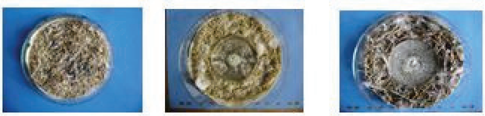

Figure 12. Determining of mineralizarion capacity of Td85 strain on wheat debris

BIOPRODUCTS BASED ON YEAST *Saccharomyces cerevisiae*L30b TO PROTECT CROPS:

Different conditioning formulas and modes of actions: soluble granulas into sodium alginate (F1); soluble granulas into sodium bicarbonate (F2); mixed bioproduct based on *Saccharomyces* and *Metschnikowia* yeasts (Figure 13).

Figure 13. Bioproducts based *on Saccharomyces cerevisiae* L30b strain with different conditioning formulas

To obtained biomass of L30b yeast, the following biosinthesys composition was used (all amounts are per litre) : 30 g of plasmolizate syrup, 5g yeast plasmolizates (supplemented with iron), 2g of $(NH_4)_2HPO_4$, 1g of $(NH_4)\ _2SO_4$, 0.5 g of $MgSO_4.7H_2O$ (Figure 14).

Figure 14. Biosynthesis of L30b yeast biomass used as cell suspension at different dilution rates

For the industrial parameters, plasmolizate syrup and yeast were determined following the optimum growing of L30b strain: 33°C temperature and an aeration rate of 0.75 l air/l medium/min (Oancea F. et. all., Patent 01382 and 01383, 2012).
Design, analysis and reporting of the strawberry trials in accordance with the European and Mediterranean Plant Protection Organization (*EPPO*) *guidelines 152 and 181,* regarding *q*uality assurance program for agricultural testing in the field, in greenhouses and in laboratories condition.

Protocol of research and reporting in accordance with Good Experimental Practice and Directive 93/71/EEC.
by preventive treatments included: tested Efficacy study of *Saccharomyces cerevisiae* L30b yeast against *Botrytis cinerea* (grey mold) bioproducts Saccharopulvin 25 PU with yeast cell at different dilution rates ($2x10^6$ and $6x10^6$ cell/ml); reference products (thiophanate methyl 0.07%) and an untreated control.
The efficacy of L30b formulation was assessed on Favette (early), Cardinal (middle) and *Pandora* (late ripening) variety on areas of 100 m^2/plot with 3 replicates.

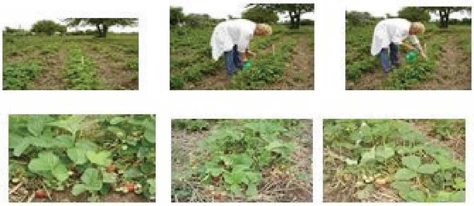

Figure 15. Biological experimental in strawberry field; Favette (early), Cardinal (middle) and Pandora (late ripening) varieties

During strawberry vegetation period, 2 treatments were applied in the following phenophases:
T_1 : After flowering fruit-binding (when there are a number of physical and chemical processes that lead to the creation of a favorable environment for the development B. cinerea fungus.
T_2 : with 2-3 weeks before harvest to protect the fruit from lately attack of *B. cinerea*.
Observations were made on strawberry fruit before harvest.
L30b strain used as biological control agent of preharvest strawberry diseases has protection activity against *Botrytis cinerea* pathogen, the causal agent of gray mould (Figure 16).
Saccharomyces cerevisiae L30b yeast was effective against gray mold (*Botrytis cinerea* during strawberry vegetation period, applied as Saccharopulvin 25 PU bioproduct with cell suspension at different dilution rates ($2x10^6$ cell/ ml and $6x10^6$ cell/ ml).

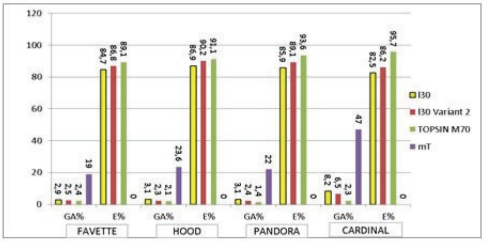

Figure 16. Efficacy of Saccharopulvin 25 PU bioproduct against Botrytis cinerea in strawberry experimental field

Bioproduct Saccharopulvin 25 PU ($6x10^6$ spores/ml), in field conditions, recorded highest efficacy (E = 86.8 to 90.2%) compared to the efficacy of chemical standard thiophanate methyl (E = 89.1 to 95.7%) for Favette, respectively, Pandora variety (ANOVA and Newman & Keuls 5% test).
The attack level during efficacy trial, ranged between 19.0 to 47.0% for Favette respectively, Pandora variety.
Bioproduct Saccharopulvin 25 PU maintain strawberry fruit quality properties and does not affect the organoleptic properties when applied two treatments in vegetation (Based on our research published in patent no. 125071).
The economic implications of bioproducts: an alternative to chemical treatments avoiding the formation of breeds resistant to fungicides, compatibility with integrated control systems, reducing quantitative and qualitative losses through high efficacy, not necessary breaks.

CONCLUSIONS

Trichoderma pseudokoningii Td85 strain is a solution applicable in a conservative agriculture system.

Td85 strain has high mineralization capacity of plant debris based on our reasearch published in patent no. 127293 and antagonistic properties against soil-borne pathogens, reducing the primary inoculum level of microbiological pest agents.

Saccharomyces cerevisiae strain has biological activity against *Botrytis cinerea* pathogen, achieving a reduced disease incidence and severity of grey mould on strawberry and providing high efficacy against the fungus.

The both beneficial microorganisms in agricultural crops, owned by RDIPP Bucharest are stored into International collection of microorganisms *Deutsche Sammlung von Mikroorganismen und Zellkulturen* (DSMZ) in Braunschweig, Germany.

Trichoderma pseudokoningii Td85 strain DSMZ access number 23661/2010, *Saccharomyces cerevisiae* L30b strain DSMZ access number 23648/2010.

ACKNOWLEDGEMENTS

This research work was carried out with the support of: Dr. Oancea Florin, project manager of MAKIS and BIOTECH 4630; Agricultural Research and Development Station Caracal, experimental field of Td85 strain; Research and Development Station for Fruit Tree Growing Baneasa, Bucharest, experimental field of L30b yeast.

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"HERBAL MEDNET" AN INNOVATIVE AND INTEGRATED E-LEARNING PROGRAMME ABOUT ORGANIC MEDICINAL AND AROMATIC PLANTS IN MEDITERRANEAN COUNTRIES

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Abstract

Organic farming of herbs, medicinal and aromatic plants is of major importance for rural economy due to their contribution to agricultural diversification and better use of land. Herbs have been used by local populations in traditional ways for many centuries. Their novelty is thus not related to their introduction to new areas but rather to the ways in which old and new uses are being re-addressed to meet today's needs.
In this sense, Herbal.Mednet is a transfer of innovation project under LLP Leonardo da Vinci Program (TOI) targeting to develop an e-learning training on organic herbs, medicinal and aromatic plants. Existing e-learning content in the topics of organic farming of herbs, medicinal and aromatic plants needs to be appropriately adapted, transferred and validated in relation to the needs of the farmers, so that this area of farming is further understood and adopted. To this end, there is a clear need for targeting agricultural advisors and extension officers, in order to further educate them and prepare them to effectively guide, train, and support farmers. The design and the development of the proposed Herbal.Mednet training program is based on the needed and required competences and requirements of trainers, as well as the production of Vocational Education and Training (VET) Scenarios for professionals from Mediterranean countries (Spain, Greece, Italy), who are involved in cultivation, production and processing procedure of organic herbs, medicinal and aromatic plants. Herbal.Mednet training process will be elaborated and deployed by a consortium of specialists from Spain, Italy, Greece, Belgium and Romania. The Romanian contribution will be crucial for the project progress and success, having in mind the own expertise in medicinal and aromatic species biology and cultivation as well as in education and training based on on-line and digital educational resources.

Key words: *e-learning, organic agriculture, herbs, medicinal plants.*

INTRODUCTION

Herbal, medicinal and aromatic plants have been an important resource for human healthcare from prehistoric times to the present day. According to the World Health Organization, the majority of the world's human population, especially in developing countries, depends on traditional medicine based on organic herbs. Between 50,000 and 70,000 plant species are known to be used in traditional and modern medicinal systems throughout the world (International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants, 2007).
These species are of major importance for rural economy due to their contribution to agricultural diversification and better use of land, their economic potential and the opportunities they provide for medicines' use diversification. They have been used by local populations in traditional ways for many centuries. Their novelty is thus not related to their introduction to new areas but rather to the ways in which old and new uses are being re-addressed to meet today's needs.
In this sense, "Herbal.Mednet" is a transfer of innovation project under LLP Leonardo da Vinci Program (TOI) targeting to develop an e-learning training on organic herbal, medicinal and aromatic plants. Existing e-learning content in the topics of organic farming of herbal, medicinal and aromatic plants needs to be appropriately adapted, transferred and validated in relation to the needs of the farmers, so that this area of farming is further understood and adopted. To this end, there is a clear need for targeting agricultural advisors and extension officers, in order to further educate them and prepare them to effectively guide, train, and support farmers. This project intends to give an original and efficient contribution to the agricultural sector promoting the specific focus

of organic herbal, medicinal and aromatic plants.

MATERIALS AND METHODS

„Herbal.Mednet"-"Enhancing the Vocational Education and Training of Innovative Farming Trainers/Advisors in Area of Herbal, Medicinal and Aromatic Plants" is an EU project funded under the Leonardo da Vinci Programme that will focus on the professional training of agricultural advisors in the area of organic farming of herbs, medicinal and aromatic plants subjects has been identified on an EU level in order enhance the Vocational Education and Training (VET) opportunities of agricultural advisors and improve the linkage between VET and labour market.

The consortium includes partners that have diverse backgrounds and expertises, so that they deal successfully with the complexities of the proposed project: Sociedad Española de Agricultura Ecologica (Spain), coordinator; Universidad de Alcalá (Spain); University of Agronomic Sciences and Veterinary Medicine of Bucharest (Romania); Eummena Professional Organization in ICT (Belgium); University of Thessaly (Greece); Società di Servizi Reali Ricerca e Formazione – Settori Agricolo, Agroalimentare, Rurale e Ambientale (Italy); Apivita Organisation on Pharmaceutical Products (Greece). The collaboration of partners among countries with (i) common interest in organic agricultural topics like the herbs, medicinal and aromatic plants from a specific geographical region-Mediterranean, (ii) different experience in applying methods and techniques in organic cultivation, production and processing of herbs and (iii) different expertise in the continuous training of professional on the topics of organic farming of herbs, medicinal and aromatic plants, indicates the benefits from this transnational approach that aims to transfer knowledge, existing training based in competences and long-term experience among participating countries in the Herbal.Mednet initiative.

RESULTS AND DISCUSSIONS

Conventional agriculture production has been applied through heavy reliance on non-renewable resources (mechanization, fertilizers, pesticides, etc.) resulting in numerous agricultural burdens such as soil degradation, water run-off, pollution, reduced biodiversity and landscape image, escalating production costs. Public awareness of the irreversible damage done to the environment has led to calls for a more responsible attitude towards our natural heritage (Toader et al., 2010). Against this background, herbs, medicinal and aromatic plants farming appear as an alternative agricultural approach that can not only produce valuable products but is environmentally sound too. The term "herbs" refers to the plants distributed from the ancient times until today in traditional stores and have, in a general sense, a beneficial effect in human health. These plants are known from the ancient years for their applications in pharmacy, cooking, distillery and perfumery. Their contribution to human is substantial because of specific components that defend the human health.

Europe holds the first position globally in Aromatic and Medicinal Plants imports with a percentage of 49%. The second place goes to Asia with 19%, Japan with 16%, and North America with 11% while the entire remaining regions together amount to 7% (Figure 1). The increase rate in Europe reaches 10% both because of the consumers turning towards healthy nutrition and alternative forms of therapy, as well as because of the fact that the financial benefit from the herbs, medicinal and aromatic plants farming has become tangible (FAO, 2011).

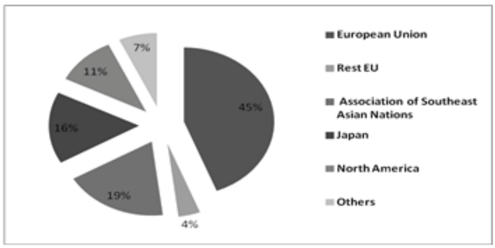

Figure 1. Global herbal markets
(source: FAO report, 2011)

The global commerce of these plants has a total value of 62 billion $, 28 billions of which is located in Europe (Figure 2).

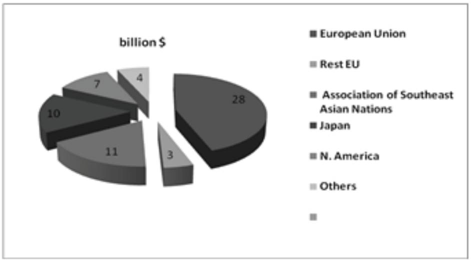

Figure 2. Value of global herbal markets
(source: FAO report, 2011)

In the context of the new globalised agriculture economy, a new agricultural environment is formed and a swift adoption of appropriate practices has to take place. In the next few years the traditional crops (grain, tobacco, cotton etc) are expected to be replaced by new. However, the herbs, medicinal and aromatic plants are still hampered by lack of clarity: both consumers and the agricultural professionals are not always sure what herbs, medicinal and aromatic plants are, what are it benefits, which products are covered by herbs, medicinal and aromatic plants farming, and which restrictions of these species implies (World Trade Organisation, 2009).

Agricultural universities around the world are slowly including related courses in their educational programs, aiming to prepare agricultural professionals so that they can appropriately support and guide farmers through a transition to herbal, medicinal and aromatic plants farming. Furthermore, various European and national efforts are now increasing the production of relevant e-learning content in a digital format. Such initiatives have various goals and are implemented in different socio-cultural and linguistic contexts. For instance, they may aim at promoting herbal, medicinal and aromatic plants farming and educating producers/farmers and consumers about its benefits, or at training agricultural professionals on the theory, methods and practices of this field. On the other hand, these constitute dispersed resources that are individually listed in separate sites, and their exploitation in actual training scenarios in European, national, regional, local and/or sectoral training systems and practices remains to be seen. Existing e-learning content needs to be appropriately adapted, transferred and validated in relation to the needs of the farmers, so that herbs, medicinal and aromatic plants farming is further understood and adopted. To this end, there is a clear need for targeting agricultural advisors and extension officers, in order to further educate them and prepare them to effectively guide, train, and support farmers in selecting and applying herbs, medicinal and aromatic plants farming products.

To address the above need, "Herbal.Mednet" project aims to achieve the following objectives: identifying and analyzing targeted needs and competences in order to prepare a set of highly-qualified agricultural advisors and extension officers, who can serve as trainers in adopting and applying organic herbal cultivations and producers/processors of extracts from medicinal and aromatic plants in Mediterranean countries; developing a training program that will particularly enhance and address the targeted competences for the advisors of organic herbs farmers and processors as well as specific case studies that apply for the specificities of the participating Mediterranean countries, Spain, Italy and Greece.

The Romanian contribution being crucial for the project progress and success, having in mind the own expertise in medicinal and aromatic species biology and cultivation as well as in education and training based on on-line and digital educational resources. University of Agronomic Sciences and Veterinary Medicine of Bucharest (USAMVB) will lead the work package on the design, development of the "Herbal.Mednet" curriculum and its appropriate localisation and adaptation in all user countries (Spain, Italy, and Greece) of Herbal.Mednet. Also, USAMVB will support the objectives of the Herbal.Mednet on the delivery of the training content in the field of organic herbs, medicinal and aromatic plants in the online course management platform. As part of the project, a training program will be designed and developed. This program will depart from a study on how experts-advisors in medicinal and aromatic plants (like agronomists) can train/support farmers, producers and processors of herbs, and will address all issues related to the use of new methods and techniques on organic farming of herbs, medicinal and aromatic plants through innovative training techniques (including online training and tutoring), participatory techniques and specific professional training scenarios. The innovation of the proposed program is (a) that it integrates components and best practices from previous successful initiatives and case studies, (b) includes pedagogical components on how advisors should approach and train farmers/producers and processors of organic herbs, (c) adopts a blended training approach, since it combines physical training and real-life examples with a variety of digital training resources that can be accessed online, and (d) provides candidate advisors with a suggested curriculum framework that they can appropriately adapt and specialize for approaching the farmers in their regions.

CONCLUSIONS

The "Herbal.Mednet" project intends to evaluate, implement and improve the current training methods and contents, included those coming from previous innovative initiatives, for the design of a on-line training program directed to the advisers of organic herb farmers and processors.

In conclusion, the selection and categorization of training content and identification of innovative training techniques through the Herbal.Mednet project will enhance the continuous training of agricultural advisors in topics of organic farming of herbs, medicinal and aromatic plants and improve the linkage between Vocational Education and Training opportunities and labour market for Spain, Italy and Greece (and with Romania in a second step) in an easy way that it could be easily transferred and adapted in all the EU countries with specific interest in herbs, medicinal and aromatic plants.

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ROLE OF THE ALLELOPATHY IN MIXED VEGETABLE CROPS IN THE ORGANIC FARMING

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Abstract

The main objective of organic farming is the preservation of natural resources and agricultural productivity with minimal negative impact on the environment.
Organic gardening differs from conventional vegetable production in the system, ways and peculiarities output fighting weeds, pests and diseases.
The allelopathy is identified as one of the factors that regulate the growth and distribution of plant communities in natural and cultural agrophytocenoses.
For the purpose of organic farming, allelopathy can be an important element in balancing the relationship between density and weeds, pests, diseases and cultivars.
Relationships among the vegetable species and varieties in particular mixed stand are not sufficiently explored, which is a sufficient reason to conduct such a study.

Key words: *organic farming, allelopathy, mixed vegetable crops.*

INTRODUCTION

Mutual interference between plant species in organic agrophytocenoses could be initiated by allelochemicals delivered by the plants in their mixed cropping.
Application of allelopathic interactions in crop protection for controlling populations of weeds, pests, phytopathogens are undeniable.
The allelochemicals applied as pesticides in the organic vegetable systems and their role are studied by Panayotov (1998, 2000), as alternatives for weed and pests control.
There is a little information on plants from different families, crops and weed populations, and on their effects on other plants that can be used for plant protection in organic farming.
There is a need to study and document the relationships among the vegetable species and varieties in a particular mixed vegetation stand.
Such study will enrich the information on the role of biodiversity and allelopathy in technology for organic cultivation of vegetables. The results will allow for drawing conclusions about the benefits of their combinations to provide crops clean from weeds, diseases and pests.
The study, which is described in this paper aims to answer some of these questions.

MATERIALS AND METHODS

The study to establish the relationship between allelopathic interactions among parsley, fennel, onions, carrots and peppers and tomatoes is done in the laboratory of the Department 'Agroecology' in the Agricultural University-Plovdiv during the period 2009-2011 year.
1. Study on effects of extracts from plants on mixed growth and development of seeds of pepper.
The plants select-sources allelochemicels-in the case of parsley, dill, carrots and onions.
In the laboratory of the Department 'Agroecology' in AU-Plovdiv plants were grown for preparation of extracts containing alelochemicals.
The soil (alluvial-meadow) vessels experience is dried to air-dry weight, screened through a sieve with a diameter of 0.5 cm were prepared 12 plastic cups with a volume of 0.5 l, as each of them 10 seeds sown in three repetitions of parsley, dill, onion and carrots. The glasses are placed in the vats, maintain soil moisture by capillary action with a cotton filter. Plants were grown at room temperature and daily cycle of light for twenty-eight days.
Extracts were prepared from roots and vegetation parts of the plants, taking an average sample of 0.5 g or 1 g of roots or mixed

vegetative mass (stems, leaves, flowers). The samples are ground in the mortar, then gradually pouring in 100 or 200 ml of distilled water. The extract were filtered.

Preparation of working concentrations: 1 g of fresh material in 100 ml-1% solution A-25 ml of solution A to 100 ml with H_2O-0.025%; 1 ml of solution A to 100 ml with HO-0.001%

The trials were included in duplicate in parallel with controls (untreated). They were put in a thermostat at 24^0C for 14 days-Petri dishes 6 cm in diameter with 10 number of seeds and 10 ml of extracts with the respective concentration. The parameters monitored were biometric indicators-number of germinated seeds per one Petri dish, root length, surface area and biomass.

2. The vascular trial to identify the effects of extracts of parsley, dill, onion and carrots grown under field conditions on growth of pepper seedlings test.

Extracts were prepared containing allelochemicals from parsley, dill, onion and carrots:

- Parsley-45 g chopped plant parts are flooded with 450 ml. distilled water;
- Carrots-45 g chopped plant parts flooded with 450 ml of distilled water;
- Onions-chopped 15 g plant parts flooded with 150 ml of distilled water;
- Dill-40 g chopped plant parts poured in 400 ml of distilled water.

On each plant pepper and tomato in duplicate and control, in vascular plastic pots having a capacity of 2 kg soil, 50 ml are added twice of the above extracts at the concentrations introduced above.

The biometric identifiers are been measured: plant root length, length of above-ground biomass and fresh and dry biomass in grams.

RESULTS AND DISCUSSIONS

1. Study the effects of extracts from plants on mixed cultivation on the growth and development of seeds of pepper.

The results on the effects of different concentrations of aqueous extracts of carrots, parsley, dill and onion on the growth and development of pepper seeds during the period 2009-2011 are presented in Figures 1 and 2.

The results (Figures 1 and 2) show that the effect of different concentrations on the key length of the root of the pepper seeds was statistically significant ($p < 0.001$). But the combined effect of the concentration and type of culture showed no statistically significant differences in root length ($p > 0.01$). However, it can be reported a decline of this indicator after treatment with 1% solution of carrots and parsley, and the remaining two cultures.

The results (Figure 3 and 4) show that there is significant effect of different concentrations on the length of pepper seedlings ($p < 0.01$), and lowest impact turns out to be the solution with the lowest concentration of allelochemicals. But the combined effect of the concentration and type of culture showed no statistically significant differences in the length of the surface part ($p > 0.01$). However, it can be reported a decline in this indicator after treatment with 1% solution of carrots and parsley, and the remaining two cultures.

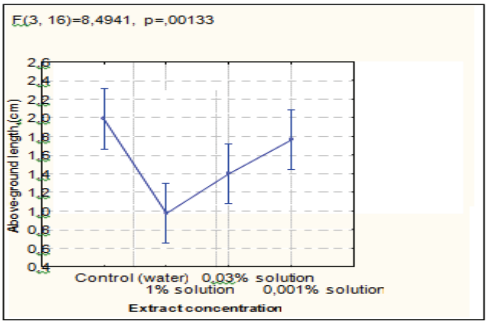

Figure 1. Effect of various concentration of extracts on above-ground length of pepper seeds 2009-2011

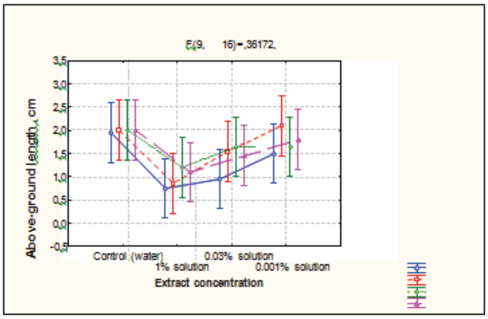

Figure 2. Interactions of extract concentration and type of crop on above-ground length of pepper seeds 2009-2011

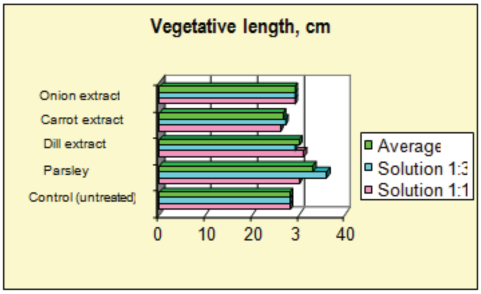

Figure 3. The Allelopathy effect on vegetation length in test plants of pepper

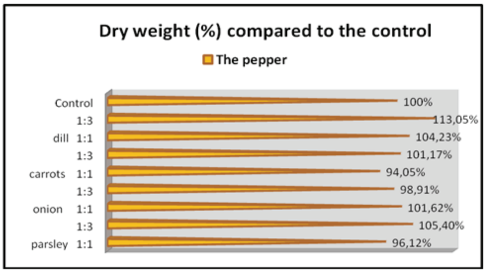

Figure 4. Proportion (%) of dry weight compared to the control dry weight for the vegetative part of the pepper

2. The vascular trial to identify the effects of extracts of parsley, dill, onion and carrots grown under field conditions on growth of pepper seedlings test.

The experiments produced seedlings of pepper plants and response to treatments with extracts of parsley, dill, onion and carrot. It showed the following results (Table 1, taking into account the effect 7 days after treatment with extracts):

Table 1. Vascular Trials – results measured on the 7-th day upon treatment

Pepper (test crop) Vegetative length (cm)			
	Solution 1:1	Solution 1:3	Average
Control (untreated)	28	28	28
Parsley extract	30	36	33
Dill extract	31	29	30
Carrot extract	26	27	26,5
Onion extract	29	29	29

From the results it can be concluded that in both concentrations (dilution 1:1 and 1:3) extracts of parsley impact positive the length of the vegetative part of the pepper (Figure 5). A similar effect was observed after treatment with extracts of fennel, but effect after carrot extract was not observed. The extracts of onion pronounced stimulation effect on pepper compared to the control.

Interesting is the fact that extracts of fennel and carrots, which showed inhibition of total growth and germination of seeds of pepper had a slight stimulation effect here. This could be due to different development environment, i.e. soil media against treatment with water solution that is applied directly to the seeds and that is a single development media).

The results show that variants treated with carrot extract in both solutions (diluted 1:1 and 1:3), the ratio of dry weight compared with the control is lower, respectively-94.05% and 98 91%. The highest percentage is in the treatment with dill extract in a 1:3 dilution-113.05%.

The study of allelopathic relationships and the significance of the results could clarify some expected effects on the interaction of certain vegetable species grown in mixed stands. For example, carrot crop (*Daucus carota* L.), pepper (*Capsicum annuum* L.), dill (*Anethum graveolens* L.) can be grown together to control populations of weeds, pests, phytopathogens so that higher yields could be expected.

The results put many questions concerning the nature and effect of allelochemicals in this experiment. These issues require further research.

CONCLUSIONS

From the study of allelopathic interactions between pepper and allelochemicals extracted from parsley, dill, carrots and onions the following conclusions can be formulated:

The results showed that different concentrations of the tested plant-allelochemicals, i.e. parsley, dill, carrots and onions, applied as extracts affected to a different degree the seed germination, root size and vegetative part for pepper.

The concentration of 1% allelochemicals (seed extract), suppresses in a highest extent the development of the root and stem system.

The inhibitory effect was shown by allelochemicals from onion on the root system on pepper. A positive impact on growth and development of pepper was shown by the extracts of fennel and carrots.

Allelochemicals applied by watering pot experiments with extract solutions had distinct stimulation effect on the development of the pepper.

It was a stimulation effect shown by the allelochemicals from dill on biometric parameters (fresh and dry weight) of pepper.

ACKNOWLEDGEMENTS

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RESEARCH ON *CYNARA CARDUNCULUS* L. SPECIES UNDER THE CONDITIONS OF SOUTHEASTERN ROMANIA AREA

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Abstract

Cynara cardunculus L. (cardon) is an alternative crop with multiple use (energy biomass, oil extraction, pharmaceuticals, food, honey plant, and others). Research conducted on three varieties of Cynara cardunculus L. (Gobbo di Nizza, C 816, Porto spineless) grown under the climatic conditions of Moara Domneasca Didactic Farm in 2012, shows the good ecological adaptability of the plant. By the end of the growing season (November), the average biomass production was 40,554.1 kg/ha^{-1} fresh matter and 7,192.0 kg/ha^{-1} dry matter, the maximum biomass production was recorded in the variety Porto Spineless (46,600.8 kg/ha^{-1} fresh matter, and 7,636.4 kg/ha^{-1} dry matter).

Key words: *alternative crop, Cynara cardunculus L., dry matter, fresh matter.*

INTRODUCTION

Cynara Cardunclus L. (cardon) is a perennial herbaceous plant of Mediterranean origin (Franco, 1984), with a period of about 10 years of life (Archontoulis et al., 2009). It grows naturally in Europe, North Africa and South America (Gominho, 2001), generally in areas that are characterized by less favorable conditions like: high temperatures in summer, water deficit, thin, rocky and poorly productive soils (Abeliotis et al., 2009).

The interest in growing this species interferes with the increasing development of concepts related to the need to protect the environment, primarily through the increased production of renewable energy. Considering the high performance of the overall biomass production, especially in the Mediterranean climate area (Fernández and Manzanares, 1990, Fernandez et al., 2006; Archontoulis et al., 2009; Angelini et al., 2009), and the rich oil seed production, Cynara carduncululus L. is a plant of interest as feedstock for biofuels and bioenergy (Sengo et al., 2010).

Biomass production can vary between 14 and 20 t/ ha^{-1} in the first year of vegetation, and 30-35 year t/ha-1 in the second year of vegetation Dalianis et al., 1996, Fernandez 1998, Gherbin and col., 2001, Mantineo et al., 2009).

The vegetation period of the species *Cynara cardunculus* L. comprises nine main stages of growth and development, subdivided into secondary growth stages. Growth begins with seed germination (first year) or sprouting / bud development (in the second year and the following years of vegetation) - stage 0, and ends with the installation of senescence - stage 9 (Archontoulis et al., 2009). Characteristic for the cycle of vegetation of *Cynara cardunculus* is that several growth stages overlap or take place simultaneously; thus, the phenological description takes into account either the code for more advanced stages or both stages are indicated separately (Archontoulis et al., 2009).

MATERIALS AND METHODS

Research was conducted on the reddish preluvosoil of the Moara Domneasca Didactic Farm belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest (44°29′33″ N, 26°15′20″ E).

The field was organized by the method of subdivided lots in three replications. Three cultivars of the *Cynara cardunculus* L. were analyzed:

V_1 - Gobbo di Nizza
V_2 - Cynara carduncululus C 816
V_3 - Porto spineless

Research was also aimed at observing the influence of the fertilization type (unfertilized, fertilized with chemical fertilizers, organic fertilizers).

Dynamic biometric measurements were made during the growing season. Production results were analyzed, both as fresh matter (FM) and as production of dry matter (DM).

Sowing was carried out with the seed drill SPC-6 on 10 April 2012, at a density of 40,000 seeds/ha, with 70 cm in spacing and 4 cm in depth. Under laboratory conditions, seeds had a germination of 94% for the C 816 and Porto spineless varieties and 97% for the Gobbo di Nizza variety.

During the vegetation season of *Cynara cardunculus* L. plants (April-November), the climatic conditions of 2012 were characterized by an average temperature of 19.28°C and a total rainfalls amount of 342.2 mm. Temperature was 2.09°C higher than the average temperature of the area and rainfalls 43.3 mm lower than the multi annual average for this period.

Table 1. Climatic conditions during April-October 2012 - Weather Station - Afumaţi

Month	Temperature (t°C)		Rainfalls (mm)	
	2012	Normal	2012	Normal
April	14.1	11.2	32.4	48.1
May	18	16.5	180.6	67.7
June	22.9	20.3	14.2	86.7
July	27.0	22.1	9.2	63.1
August	24.4	21.7	47.0	50.5
September	19.4	17.5	42.2	33.6
October	13.7	17.5	16.6	35.8
Average(°C) / Sum (mm)	19.28	17.19	342.2	385.5

RESULTS AND DISCUSSIONS

Results of the research conducted on *Cynara cardunculus* L. species in 2012, the first year of life, show the following aspects:

The sprouting degree of Cynara cardunculus L. seeds.

The data presented in Table 2 shows that there are differences between the three *Cynara cardunculus* L. cultivars in their power of germination under field conditions. 63.1% of the sown seeds sprung in the variety Porto Spinelles, 66.45% in C 816, and 68.8% in Gobbo di Nizza.

Table 2. Sprouting degree of *Cynara cardunculus* L. seeds

Variety	Density		%
	No Seed ha^{-1} 04/10/2012	Plants sprung No ha^{-1} 05/15/2012	
V_1	40,000	27,531	68.8
V_2	40,000	26,580	66.5
V_3	40,000	25,236	63.1
Average	40,000	26,449	66.1

V_1 - Gobbo di Nizza; V_2 – C 816; V_3 - Porto spineless.

Crop plants development and biomass production.

The data in Table 3 regarding the development stage of *Cynara cardunulus* L. plants on 07/14/2012, shows that their height ranged from 22.63 cm in V_1 (Gobbo di Nizza) to 25.15 cm in V_3 (Porto spineless). The number of leaves per plant varied between 8.4 and 10.3, and leaf length recorded a minimum in the Gobbo di Nizza variety and a maximum in C 816.

The fresh matter production of *Cynara cardunculus* L. plants in the first year of life, as seen in the determinations made in September (Table 4) ranged from 923.5 g/plant in the Gobbo di Nizza variety to 1,333.0 g/plant in Porto spineless, which means an addition of 22.4% to the average production of the three varieties. Fresh matter production per hectare (Table 5) varied between 25,419.3 kg.ha^{-1} in V1 (Gobbo di Nizza), i.e. 88.7% of the average yield for the three varieties, and 3,3647.2 kg.ha^{-1} at V_3 (Porto spineless), i.e. 117.4% of the average of for three varieties.

In November 2012, the fresh matter and dry matter production of a plant (Table 6) ranged between 1,327.3 g/plant n V_1 (Gobbo di Nizza) and 1,846.8 g/plant in V_3 (Porto spineless). The highest dry matter content was registered in the Gobbo di Nizza variety (17.4% in leaves and 28.3% in root).

The average biomass production per ha (Table 7) was 40,554.1 kg.ha^{-1}, the maximum being recorded in V_3 - 46,600.8 kg.ha^{-1}. This variety also developed a maximum foliar biomass of 41,033.7 kg.ha^{-1}. The maximum root recorded was 6,036.3 kg.ha^{-1} in the variety C 816.

Table 3. Development of crop plants on July 14, 2012

Variety	Plants height (cm)	%	Leaf number plant	%	Leaf length min-max (cm)	%
V_1 - Gobbo di Nizza	22.63	95.5	9.3	100	17.1 - 52.5	91 - 98
V_2 - C 816	23.30	98.3	8.4	90.3	18.5 - 55.9	99 – 104.3
V_3 - Porto spineless	25. 15	106.1	10.3	110.7	20.5 – 52.5	109.6 - 98
Average	23.70	100	9.3	100	18.7 – 53.6	100

Table 4. Fresh matter production (g/plant) of *Cynara cardunculus* L. on September 15, 2012

Variety	Total biomass (TB) g/pl	%	Leafes biomass (LB) g/pl	%	Root biomass (RB) g/pl	%
V_1	923.5	84.8	798.6	84.9	124.7	83.9
V_2	1,012.0	92.9	864.2	91.9	147.8	99.4
V_3	1,333.0	122.4	1,159.7	123.3	173.6	116.7
Average	1,089.6	100	940.8	100	148.7	100
V_1 - Gobbo di Nizza; V_2- C 816; V_3 - Porto spineless						

Table 5. Fresh matter production (kg/ha-1) of *Cynara cardunculus* L. on September 15, 2012

Variety	Total biomass (TB) kg/ha^{-1}	%	Leafes biomass (LB) kg/ha^{-1}	%	Root biomass (RB) $kg.ha^{-1}$	%
V_1	25,419.3	88.7	21,986.2	88.9	3,433.1	87.7
V_2	26,898.9	93.9	22,970.4	92.84	3,928.5	100.4
V_3 -	33,647.2	117.4	29,266.2	118.3	4,381.0	112
Average	28,655.0	100	24,740.9	100	3,914.2	100
V_1 - Gobbo di Nizza; V_2- C 816; V_3 - Porto spineless						

Table 6. Fresh matter and dry matter in plant of *Cynara cardunculus* L. on November 15, 2012

Variety	Total Biomass (TB) g/pl	%	Leaf Biomass (LB) g/pl	%	Dry Matter %	%	Root Biomass (RB) g/pl	%	Dry Matter %	%
V_1	1,327.3	86.1	1,153.4	86.8	17.4	106.5	173.9	84	28.3	103
V_2	1,449.2	94	1,222.1	91.6	16.5	101	227.1	109.6	28.2	102.7
V_3	1,846.6	119.8	1,626.0	122	15.1	92.5	220.6	106.5	25.9	94.3
Average	1,541.0	100	1,333.8	100	16.3	100	207.2	100	27.5	100

V_1 -Gobbo di Nizza; V_2 -C 816; V_3 -Porto spineless

Table 7. Fresh matter production (FM $kg.ha^{-1}$), on November 15, 2012

Variety	Total Biomass (TB) kg/ha^{-1}	%	Leafs Biomass (LB) kg/ha^{-1}	%	Root Biomass (RB) kg/ha^{-1}	%
V_1	36,541.8	90.1	31,754.2	90.5	4787.6	87.6
V_2	38,519.7	94.98	32,483.4	92.57	6036.3	110.5
V_3	46,600.8	114.9	41,033.7	116.93	5567.1	101.9
Average	40,554.1	100	35,090.4	100	5,463.7	100
LSD 5%=3,320 LSD 1%=5,959.4 LSD 0.1%= 7,162.5 kg TB/ha^{-1}						
V_1 – Gobo di Nizza; V_2 - C 816; V_3 - Porto spineless						

Dry matter production per plant in November (Table 8) showes the average of the three varieties was 272.7 g/plant.

Leaves accumulated 215.9 DM g/plant and roots 56.8 DM g/plant on average.

Dry matter production per hectare (Table 9) was 7,192.0 $kg.ha^{-1}$ on average and the lowest amount of dry matter was registered in V_1, i.e. 6,880.0 DM $kg.ha^{-1}$ while the highest amount, 7,636.4 DM $kg.ha^{-1}$ was recorded in V_3.

Table 8. Dry matter production per plant of *Cynara cardunculus* L. on November 15, 2012

Variety	Total Biomass (TB) g/pl	%	Leafs Biomass (LB) g/pl	%	Root Biomass (RB) g/pl	%
V_1	249.9	91.6	200.7	93	49.21	86.6
V_2	265.6	97.4	201.6	92.7	64.04	113
V_3	302.6	111	245.5	113.7	57.14	101.8
Average	272.7	100	215.9	100	56.8	100
LSD 5%= 23.5 LSD 1%= 37.2 LSD 0.1%= 43.9 g TB/pl						
V_1 - Gobbo di Nizza; V_2 - C 816; V_3 - Porto spineless						

Table 9. Dry matter production (DM $kg.ha^{-1}$) on November 15, 2012

Variety	Total Biomass (TB) kg/ha^{-1}	%	Leaf Biomass (LB) $kg.ha^{-1}$	%	Root Biomass (RB) $kg.ha^{-1}$	%
V_1	6,880.0	95.66	5525.5	97.1	1,354.5	90.3
V_2	7,059.6	98.16	5358.5	94.1	1,701.1	113.5
V_3	7,636.4	106.2	6195.4	108.8	1,441.0	96.1
Average	7,192.0	100	5,693.1	100	1,498.9	100
LSD 5%=465.2 LSD 1%= 796.3 LSD 0.1%= 1,022.6 kg TB/ha^{-1}						
V_1 - Gobbo di Nizza; V_{2-} C 816; V_3 - Porto spineless						

Leaf production of dry matter per hectare was 5,693.1 kg ha^{-1} and root biomass 1,498.9 kgha^{-1} on average, with the highest production recorded in the variety C 816 (1,701.1 kg ha^{-1}).

Figure 1. *Cynara carduncULUS* L. on 15 November, 2012 - Moara Domnească Experimental Field (original photo)

Figure 2. *Cynara cardunculus* L. root on November 15, 2012 – Moara Domnească Experimental Field (original photo)

CONCLUSIONS

Results of the research conducted in 2012 on the *Cynara cardunculus* L. species show the following:

- Seed germination was 66.1% on average, this aspects is important for seeding density determination.
- Plant development was generally good, accumulating a significant amount of biomass even in a year with water deficit, which shows the good adaptability of the species to different ecological conditions.
- The maximum level of biomass at the end of the growing season was achieved at Porto spineless variety (46,600.8 FM kg.ha^{-1} and 7,636.4 DM kg.ha^{-1}).

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DETERMINE THE EFFECT OF SOME CULTIVATION PARAMETERS IN THE DEVELOPMENT OF MICROALGAE FOR BIODIESEL PRODUCTION

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Abstract

The research studies in the past focusing on finding new energy sources, were based on biodiesels which reduce the greenhouse effect by 41% when compared with diesels. Due to this fact, many contries in the world have exempted biodiesel from taxes and encouraged their production and consumption. However, in Turkey, increase in production taxes, and because the producers can only sell their products to distribution firms, the attractiveness of biodiesel has decreased tremendously and could only been developed to the limits provided by the studies of related departments of the univercities.
Microalgae carbon dioxide and sunlight through photosynthesis converts it to energy very efficiently, and in this process the oil-producing single-cell biological organisms. Just like any other plant-based oils such as algae oil biodiesel converted directly used as a fuel for diesel engines. Today, experienced negative effects due to oil and oil to eliminate the negative effects to the environment is given a new, clean and cheap energy resources, and these resources have to be used effectively. With a high fat binding properties of micro-organisms, especially microalgae energy crisis on behalf of the resort, be worth studying.
The recent research studies focused on alga cultures which are blue, red, green in color and are transforming CO_2 to O_2 in the ecosystem. The research studies on algs are implemented under two topics which are namely alg production and possibilities of using algs as fuel.
In this study, species of Dunaliella salina, Palmellopsis muralis and colored light sources with different wavelengths using the 24-hour period of enlightenment, subjected to constant light intensity of cultivation under the analyzed parameters. The second experiment using white light illumination of different periods of growth parameters, cell number, pH, salinity and conductivity values were measured and analyzed. The third attempt, the temperature in the same way using white light and under constant light intensity, respectively, 21°C, 28°C and 35°C growth parameters were investigated. Finally, using white light source and 12 hours light and dark periods within 12 hours, applying a different light intensity, cell numbers, pH, salinity and conductivity values were analyzed and compared.

Key words: *Renewable energy sources, microalgae, biodiesel, algae.*

INTRODUCTION

Microalgae are sunlight-driven cell factories that convert carbon dioxide to potential biofuels, foods, feeds and high-value bioactives. In addition, these photosynthetic microorganisms are useful in bioremediation application sand as nitrogen fixing biofertilizers (Figure 2). This article focuses on microalgae as a potential source of biodiesel (Chisti, 2007).
Microalgae can provide several different types of renewable biofuels. These include methane produced by anaerobic digestion of the algal biomass biodiesel derived from microalgal oil and photobiologically produced biohydrogen (Demir et al., 2007). The idea of using microalgae as a source of fuel is not new but it is now being taken seriously because of the escalating price of petroleum and, more significantly, the emerging concern about global warming that is associated with burning fossil fuels.
Biodiesel is produced currently from plant and animal oils, but not from microalgae. This is likely to change as several companies are attempting to commercialize microalgal biodiesel. Biodiesel is a proven fuel. Other sources of commercial biodiesel include canola oil, animal fat, palm oil, corn oil, waste

cooking oil and jatropha oil (Vonshak, 1997; Gökpınar and Cirik, 1991).

Especially, the latest biotechnical and technical studies on microalgae seek to increase their use in food, agriculture, animal feed, environment and cosmetics (Figure 2). Therefore, it is important to base microalgae production upon some biotechnical basis because of its future contributions to the fields mentioned above (Naz ve Gökçek, 2006).

Figure 1. The explosion of microalgae

Figure 2. Microalgae used in food and cosmetics industries

Although there have been many different classifications, algae can be classified simply in two categories as prokaryotic and eukaryotic (Figure 3). They are also separated into two as micro (one-year and unicellular, microscopic) and macro (perennial and cellulosic). Microalgae contain a higher rate of fat.

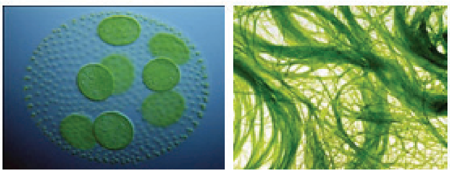

Figure 3. Microalgae cell

Microalgae are known as Cholophyceae (green algae), Rhodophyceae (red algae), Cyanophyceae (blue green algae) and Pheophyceae (brown algae). Important pigments produced are chlorophyll a and b, Carotene, Astaxanthin, Fitosiyanin, Xanthophyll, fito erythrosine. These pigments are frequently used in food, medicine, textile and cosmetics (Vonshak, 1997).

In microalgae production, the purpose of mass-production is to obtain efficient product for a minimal cost (Figure 4). In high scale cultivation systems, effective usage of light, temperature, hydrodynamic balance in cultivation, providing the longevity of culture must be compared.

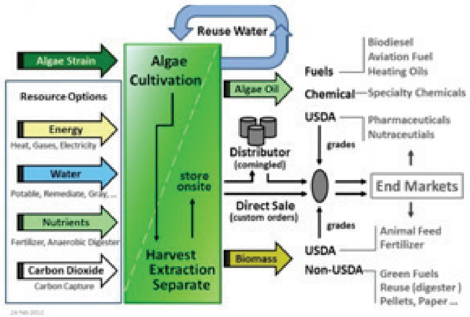

Figure 4. Microalgae production system

The ideal development of any microalgae type occurs in cultivation environments in which distinctive conditions are met. Accordingly, while *Spirulina* achieves most growth in high Ph and bicarbonate density, *Chlorella* seeks highly nutritive environments and *Dunaliella salina* fosters in high salinity. On Table 1, oil content of some microalgae species can be seen.

Open pool systems vary greatly (Figure 5). The main reason of this is that these systems are economical, while indoor production systems require technology which is not cost effective. However fewer kinds of microalgae can be cultivated outdoors (Gökpınar and Cirik, 1991). Outdoor microalgae production systems based on the interior of the significant difference in production systems, the direct environmental impacts of microalgae cultures were exposed. *Palmelopsis muralis*, *Chlorella* and *Spirulina* without any artificial mixture of open-top, shallow, and can be produced by providing a mixture of large circular pools. Microalgae in Table 2 are the average production conditions.

Table 1. Fat content of some microalgae species

Microalgae	Fat Content (dry weight %)
Botrycoccus braunii	25-75
Chlorella sp.	28-32
Crypthecodinium cohnii	20
Cylindrotheca sp.	16-37
Dunaliella primolecta	23
Isochrysis sp.	25-33
Monallanthus salina	›20
Nannochloris sp.	20-35
Nannochloropsis sp.	31-68
Neochloris oleoabundans	35-54
Nitzschia sp.	54-47
Phaeodactylum tricornutum	20-30
Schizochytrium sp.	50-77
Tetraselmis sueica	15-23

Figure 5. Tubular photobioreactor and growing pool

Table 2. Production conditions of microalgae

Parameters	Limit Values	Optimum Conditions
Temperature (^oC)	16-27	18-24
Salinity (g/*l*)	12-40	20-24
Light Density (lux)	1000-10000	2500-5000
Light Exposure time (Day:Night h)		16:8 minimum 24:0 maximum
pH	7-9	8,2-8,7

Also in outdoor environment, the cultivation is susceptible to contamination. The losses resulting from continuous evaporation, CO_2 emission and contamination risk are the other disadvantages of outdoor systems (Table 3).

Considering indoor systems, it is quite costly to maintain and install. However these systems should be applied for only one kind. Indoor systems have many advantages such as preventing contamination, effective usage of light, high effectiveness, controlling temperature and using the sunlight from reactors installed outdoors. In indoor reactors, it is easy to control the cultivation environment as well as the product is satisfactory in quality and effectiveness.

Table 3. The comparison of open and closed systems

	Outdoor Systems	Indoor Systems
Contamination Risk	Very High	Low
Space Requirement	High	Low
Water Loss	Very High	None
CO_2 Loss	High	None
Variety of Types	Limited	All kinds
Standardization	Not possible	Possible
Dependence on Weather Conditions	No production in Rain	No dependence
Production Concentration	Low 0.1-0.2 g/*l*	High 2-8 g/*l*
Effectiveness	Low	High

To determine the most efficient types of universities in particular, experiments have established direct from production. Finally, Ankara University, Faculty of Agriculture, Department of Agricultural Machinery and University of the Dicle, Faculty of Agriculture the Department of Agricultural Machinery grown *Palmollopsis muralis* and *Dunaliella salina* species. The reason is easy availability of the training of these two species in nature and more influenced by external factors, unless otherwise indicated. (Eliçin et *al*., 2009) (Figure 6).

First of all, a microalgae cell count is conducted to determine the number of mature microalgae cells. Microalgae reaching an adequate cell number (which depends on the type of microalgae) are moved into another tank before the “stress” process. A high amount of catalyst is released from nutritive tank in order to expose the algae to stress. Specific parameters are to be modified unless the catalyst is not applied. Stress process forces the microalgae to produce fat quickly before the extraction process. After the stress process, extraction begins. The first phase of fat extraction is the dehydration of microalgae in Microalgae Harvest Unit (Figure 7). With the air inside Microalgae Harvest Unit and a belt rotating continually, water is removed from microalgae.

Microalgae retrieved out of microalgae harvest unit are completely dehydrated. Dehydrated microalgae are also called scales. These scales are sent to pressure machines to extract fat. Custom fat extraction machines are present in many companies producing in small scales. In enterprises without these custom fat extraction machines, many different fat extractors are used as well (Tawfig et al., 2004).

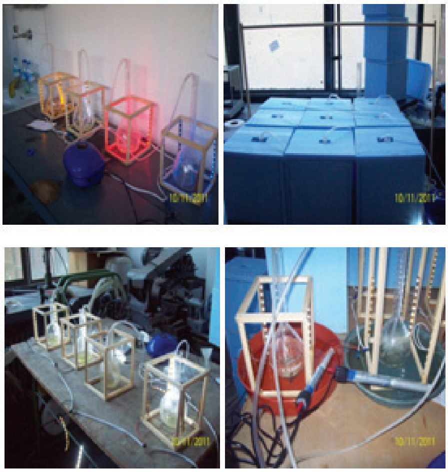

Figure 6. Ankara University Faculty of Agriculture established microalgae cultivation of agricultural machinery in the experimental setup

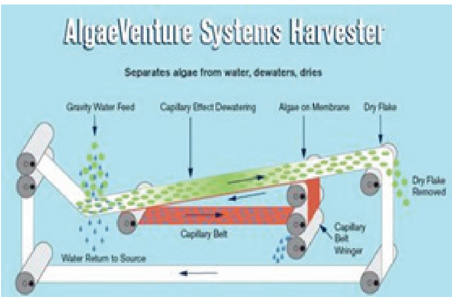

Figure 7. Microalgae harvesting unit operation diagram

Microalgae have high potentials in biodiesel production compared to other oil crops. First, the cultivation of microalgae dose not need much land as compared to that of terraneous plants. Biodiesel produced from microalgae will not compromise the production of food and other products derived from crops. Second, microalgae grows extremely rapidly and many algal species are rich in oils. In order to obtain oil from microalgae culture microalgae and it is expected to reach maturity for the detection of a specific cell count is done. Certain populations as a result of mature cell counts (varies by type) in a separate tank on the stressful applied (Eliçin et al., 2009). Stressful is a catalyst to expose intensive nutrient tank. Some of the parameters given in Table 2 by changing the applied stressful be executed catalyst. Stressful microalgae oil extraction process prior to application of the oil binding will provide a fast and intense. Stressful oil extraction process begins after the application. Oil extraction process can be accomplished by various methods. Oil extraction process, moving through the air thanks to the free and infinite in the harvest unit with the help of a rotating band enables to water and dried microalgae (Figure 8). Harvest units were extracted from microalgae in the water completely. Microalgae are also known as dehydrated flakes. To be sent to the printing machines have become stamps microalgae oil.

Figure 8. Take the form of flakes harvest microalgae

For the methods of transforming microalgae into biodiesel; Pyrolysis, gasification and transesterification methods can be given as examples (Eliçin et al., 2009). Pyrolysis method; this is the method of transformation in which the biomass is dissolved into liquid (bio-petrol), solid (charcoal) and gas state. Gasification method; "gasification" is the process in which a secondary gas fuel is obtained predominantly during Pyrolysis. Gasification transforms the bio-mass into a flammable gas consisting of carbon monoxide, hydrogen and methane. Transesterification method; ın the transesterification method, oils, re-esterification process by reaction with alcohol by means of a catalyst. This method is most effective in reducing viscosity (Demir et al., 2007).

A method of transesterification reaction is balanced, complete mixing of the catalyst used in the reaction occurs in particular. The presence of the catalyst is a catalyst of the reaction to equilibrate. Nevertheless, a high proportion of the alcohol to be used to obtain the ester. Triglycerides transesterification process with an alcohol is reacted with a strong acid or base catalyst, alkyl ester, and glycerin is obtained by reaction of saturated. The entire process is analyzed, the reaction to a chain di- and monoglycerides formed as an intermediate product consecutive two-way and 3-stage appears to be a reaction.

Similarly oil from microalgae, an alcohol (ethanol, methanol), the catalyst (acidic, basic and enzyme) in the presence of methyl esters of fatty acids and glycerol are formed. During the transesterification reaction variables affecting the efficiency of microalgae oil, algae oil, the quality of the alcohol by microalgae oil molar ratio, reaction temperature, reaction time, catalyst type and amount. The amount of conversion occurred as a result of the reaction, the upper phase can be found by the analysis of gas chromatography or thin layer chromatography (Eliçin et al., 2009).

MATERIALS AND METHODS

As plant materials, is more than the amount of fat, easily available, taking into account lifestyle factors such as contamination and temperature resistance, belong to the class *Chlorophyceae*, *Palmellopsis muralis* and still belong to the class *Chlorophyceae*, *Dunaliella salina sp.* types were selected (Figure 9 and Figure 10).

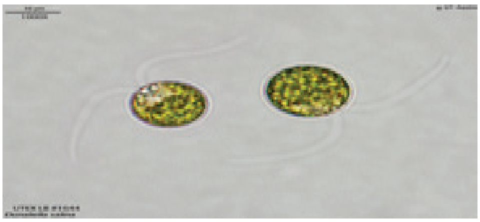

Figure 9. *Dunaliella salina* sp. microscope image

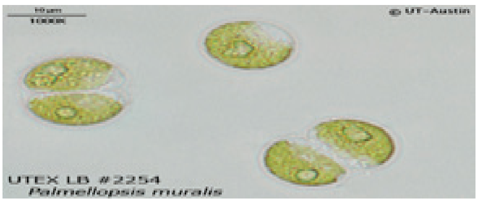

Figure 10. *Palmellopsis muralis* microscope image

Algae are grown right after the planned experiments in 4 different section. Also examined the effects of light intensity and duration of light exposure due to the algae grown in a light-proof box for each volumetric flask made of styrofoam material (Figure 11).

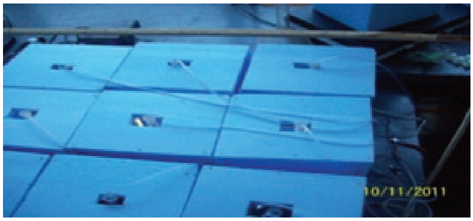

Figure 11. The protective boxes

Algae at the beginning of the experiment, using the resources of colored light of different wavelengths subjected to a 24-hour light period, the number of cells under constant light intensity, measured were pH and conductivity (Demirbaş, 2010; Tapan, 2006) (Figure 12).

The first experiment, the light source through the 4 different colors with the high intensity white light source that creates a positive impact on the parameters of the cultivation of selected white light source used in the other trials.

Using white light again in the second part algae exposed to constant light intensity, 24 hours light, 18 hours of light - 6 hours darkness, 18 hours darkness - 6 hours of light and 12 h light - 12 h darkness, the same parameters were determined in intervals.

In the third chapter the use of white light and algae under constant light intensity, respectively, 21^{o}C, 28^{o}C and 35^{o}C daki changes in the number of cells with values of were investigated pH and conductivity (Ilgaz 2003; Tapan 2006).

In the last part of the experiment, the white light source is used, and 12 hours of light and 12 hours dark periods algae exposed to applied light in a different light intensity. Respectively, 6V, 9V and 12V adapters 60 cm led light source, light intensity provided by the exchanges were determined on the same parameters.

Nutrients of mixing ratios and algae are given in Table 4. This stock solution was prepared in the Department of Fisheries Engineering, Faculty of Agriculture, University of Ankara, Turkey. Attempts to do such, flasks were produced before it is deployed in a large vase. Here, after performing the production of a sufficient amount of the same volume of volumetric flask (300 ml) were distributed.

Table 4. The nutrient content

Content	Amount	Amount
$NaNO_3$	30 ml / l	10 g / 400ml
$CaCl_2 \cdot 2H_2O$	10 ml / l	1 g / 400ml
$MgSO_4 \cdot 7H_2O$	10 ml / l	3 g / 400ml
K_2HPO_4	10 ml / l	3 g / 400ml
KH_2PO_4	10 ml / l	7 g / 400ml
NaCl	10 ml / l	0.4 g / 400ml
P-IV Metal Solution	6 ml / l	0.1 g / 400ml
Soil water: GR + Medium	40 ml / l	1.5 g / 400ml
Vitamin B_{12}	1 ml / l	2 g / 400ml
Biotin Vitamin Solution	1 ml /l	0.9 g / 400ml
Thiamine Vitamin Solution	1 ml / l	0.1 g / 400ml

RESULTS AND DISCUSSIONS

The first part of experiments investigated the development of algae led of different colors (Figure 12). Boxes made in the measurement of light intensity, the yellow light 117 lux, 194 lux blue light, red light 224 lux and 265 lux have been obtained of white light results (Demir et al., 2007) .

Figure 12. Color experiments

Colorful led trials, *Dunaliella salina* sp. when white light is the best for the type of growth observed in the number of cells. The highest light intensity, blue, red, yellow and white color leds White leds with 265 luxury reserved (Agra et al., 2004) (Figure 13).

Conductivity is directly proportional to the light is increased intensity (Figure 14).

On the contrary, the light intensity increases, ie, the pH value of the conductivity is observed decline in the use of white leds (Figure 15).

Palmellopsis muralis to the color of the cell growth experiments, the best has been reached white leds (Figure 16). Showed the lowest cell count and 13 yellow leds determined at the end of day living cell (Demir et al., 2007; Eliçin et al., 2009).

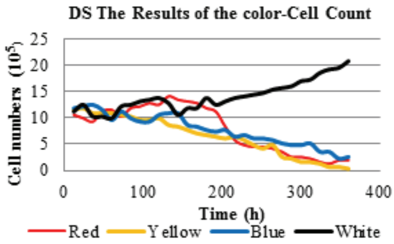

Figure 13. *Dunaliella salina* sp. species, using different colored light sources, which was time-dependent changes in the number of cells

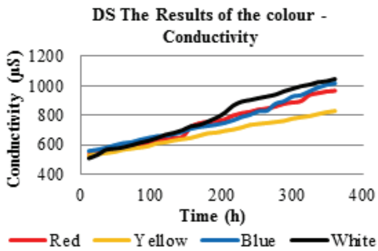

Figure 14. *Dunaliella salina* sp. species, using different colored light sources, which was time-dependent changes in the conductivity values

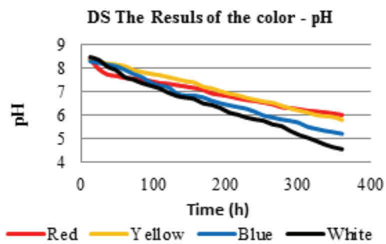

Figure 15. *Dunaliella salina* sp. species, using different colored light sources, which was time-dependent changes in pH values

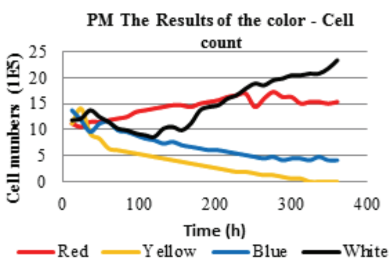

Figure 16. *Palmellopsis muralis* species, using different colored light sources, which was time-dependent changes in the number of cells

Conductivity at the first blue leds *Dunaliella salina* sp. determined to increase up to 2 times (Figure 17).

Evaluation of the data fall in pH in the first 7 days was observed rise in the values of the first day of the next 8 days (Figure 18).

Duration of the light exposure trials, *Dunaliella salina* sp. for the type of environment light of the high number was determined of cells 24 hours (Figure 19). 18 hours dark/6 hours in the light is observed of the low number of cells (Demir et al., 2007; Eliçin et al., 2009).

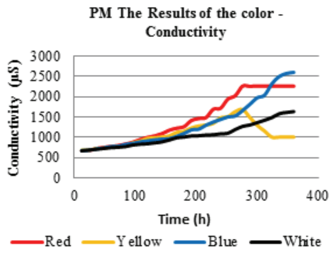

Figure 17. *Palmellopsis muralis* species, using different colored light sources, which was time-dependent changes in the conductivity values

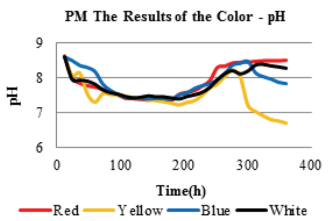

Figure 18. *Palmellopsis muralis* species, using different colored light sources, which was time-dependent changes in pH values

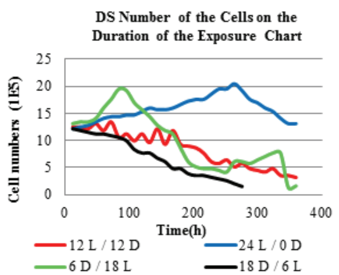

Figure 19. *Dunaliella salina* sp. different times, depending on the type of light can change the number of cells

18-hours darkness/6 hours light environment were increasing conductivity (Figure 20).

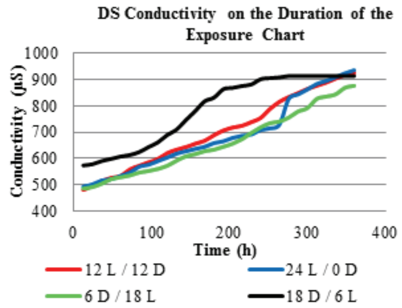

Figure 20. Different light exposure times, depending on the type of *Dunaliella salina* conductivity changes

From a darkness time, the increase in pH values decrease in pH value decreased, but in general there is a decrease in pH values (Figure 21). Looking at the data of the light of life *Palmellopsis muralis* showed the highest number of cells a 24-hours illumination (Figure 22) Lowest showed that the number of cells in the 18 - hours darkness/6 - hours light (Vonshak 1997; Gökpınar and Cirik 1991).

Increase in conductivity is observed values in the 24 hours of light (Figure 23).

The best results were obtained from the pH 24-hour periods (Figure 24).

The third section of the white light in the same are used way trials. 268 lux light intensity is below 12 V adapters provided by the algae, respectively, 21 °C, 28 °C and 35 °C changes in cell numbers, pH, salinity and conductivity changes were investigated of the 12 hours light - dark periods of 12 hours based on a measurement in 12 hours the same parameters (Brown et al., 1989; Agra et al., 2004). Temperature experiments, *Dunaliella salina* sp. type the maximum number of cells reaching 35°C showed that a type of heat-loving. Lowest was reached number of cells at 21°C (Figure 25).

Increased in direct proportion to the temperature were evaluated conductivity data (Figure 26).

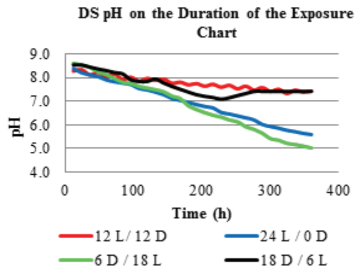

Figure 21. *Dunaliella salina* sp. changes in pH values of different light exposure times, depending on the type

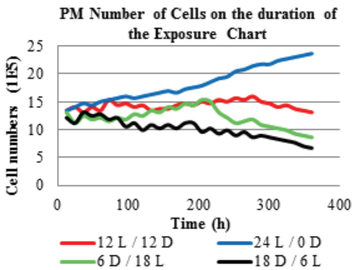

Figure 22. Different times, depending on the type of light can *Palmelopsis muralis* changes in the number of cells

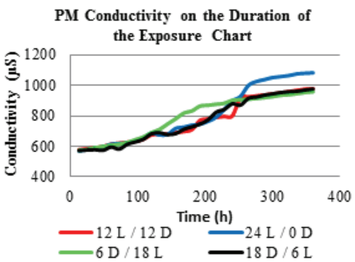

Figure 23. Different times, depending on the type of light can *Palmelopsis muralis* conductivity changes

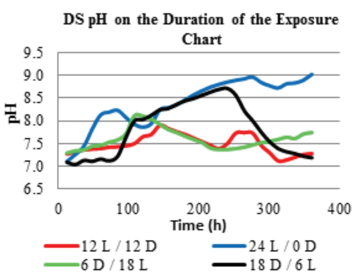

Figure 24. Different times, depending on the type of light *Palmelopsis muralis* changes in pH values

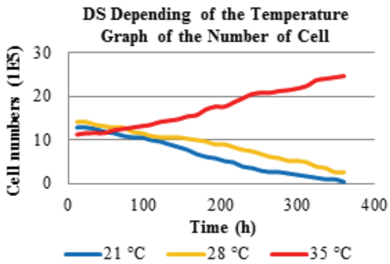

Figure 25. Depending on the temperature variations in the number of species *Dunaliella salina* cells

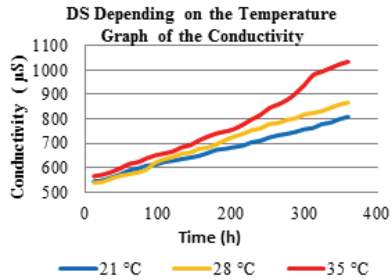

Figure 26. Changes in the value depending on the temperature conductivity type *Dunaliella salina*

Such as pH and conductivity increases with temperature (Brown *et al*., 1989; Agra *et al*., 2004) (Figure 27).

In experiments, the temperature for the type of *Palmellopsis muralis*, the highest number was reached cells at 21°C. The high temperature was 35°C, a significant reduction in cell numbers.

Considering the value of conductivity increases as the temperature increases were determined conductivity values (Figure 28).

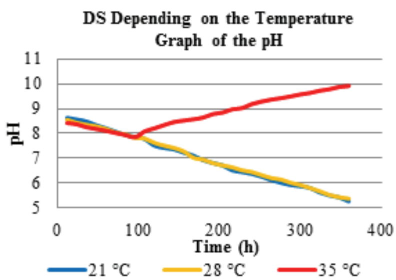

Figure 27. Changes in temperature, pH values, depending on the type of *Dunaliella salina*

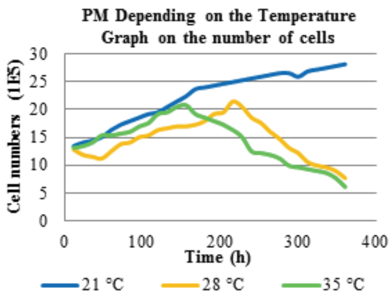

Figure 28. Depending on the temperature variations in the number of cell types *Palmelopsis muralis*

The conductivity is inversely proportional to the pH data (Figure 29). High pH values were measured at low temperatures (Vonshak, 1997; Gökpınar and Cirik, 1991) (Figure 30).
Light on the severity of the experiment, the *Dunaliella salina sp.* 265 lux 12 V, the highest has been reached number of cell types (Figure 31) Figure 33 appearance of decline in 12-hours light 12-hours dark period of the reason is intended to trials (Tawfig et al., 2004; Ilgaz, 2003).

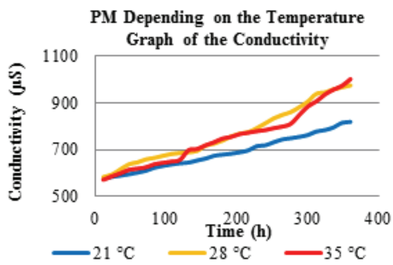

Figure 29. Changes in the value type conductivity depending on the temperature *Palmelopsis muralis*

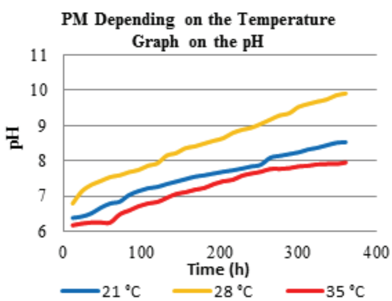

Figure 30. Changes in temperature, pH values, depending on the type of *Palmelopsis muralis*

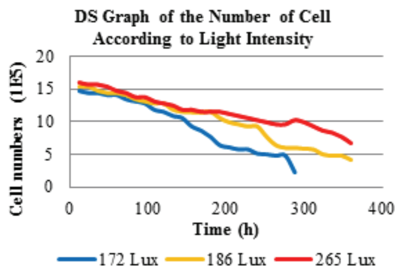

Figure 31. *Dunaliella salina* sp. changes in light intensity, depending on the type of values of the number of cells

Conductivity values, the number of cells as in the case of an increase in conductivity, with the increase was determined of light intensity (Figure 32)

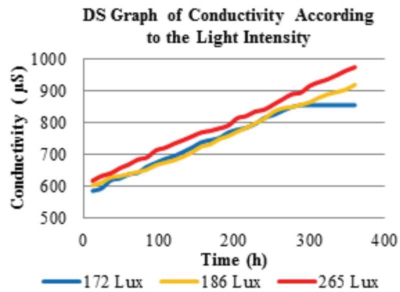

Figure 32. *Dunaliella salina* sp. changes in conductivity, depending on the type of light intensity values

In general sense, there is a decrease in pH data (Figure 33) Light intensity decreases with the increase of pH value decreases (Tawfig et al., 2004; Brown et al., 1989).

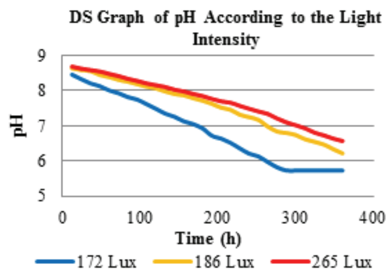

Figure 33. *Dunaliella salina* sp. changes in light intensity, depending on the type of pH values

Light intensity values for the type of *Palmellopsis muralis*, the highest was reached cell number at 265 lux. Figure 34 is the reason for the decline is the growing number of period due to of 12 hours darkness /12 bright.

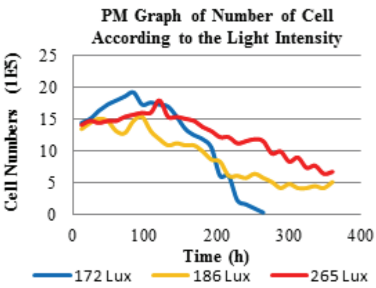

Figure 34. Depending on the type of intensity values *Palmellopsis muralis* changes in the number of cells

Conductivity analysis of the data of the light intensity, as well as the influence on the number of cells is the effect on conductivity and conductivity increased with increasing light intensity (Figure 35) (Demirbaş, 2010; Demir et al., 2007; Eliçin at al., 2009).
Palmellopsis muralis light intensity for the type of experiment, the effects of light intensity were not detected significant in pH changes value (Gökpınar 1983; Scragg et al., 2002) (Figure 36).

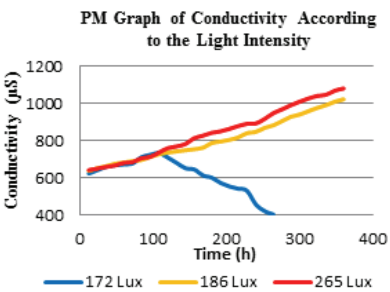

Figure 35. *Palmellopsis muralis* changes in conductivity, depending of the light intensity

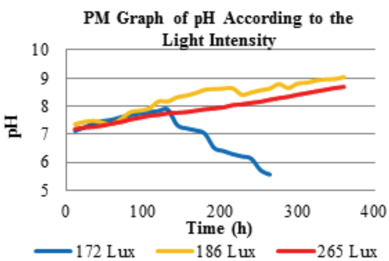

Figure 36. *Palmellopsis muralis* changes in light intensity, depending on the type of pH values

CONCLUSIONS

To optain the highest cell density culture of microalgea in per unit is objective of the operation. Culture technique used for production process of determining in addition to many factors limiting the process, the culture economy should be noted that an important factor as well. Different production techniques are applied depending on ecologic and economic conditions. For his reason, production enterprises must choose the best methods according to culture purposes.

As a result, *Dunaliella salina* sp. species at relatively high temperatures, salinity, loving and very susceptible to ambient conditions and the external environment, rather than rapidly in closed environments need to be raised because it is contaminated. Show the best growth in the low tempered *Palmellopsis muralis* type and ambient conditions *Dunaliella salina* sp. To be less affected by the contaminated due to the low risk were grown outdoors more comfortable.

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THE EVOLUTION OF MECHANISED FARMING IN THE WEST LANCASHIRE REGION OF THE UNITED KINGDOM SINCE 1945

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Abstract

This paper critically examines the effects mechanised operations, in particular the replacement of the horse with the introduction of the tractor, had on the socio economic position of the rural population of West Lancashire. This study investigates how the history of West Lancashire made a significant contribution to understanding the transition from horse to tractor, in the post Second World War period; a period of time where the experiences of farming with both horses and tractors were common place. This academic piece of work draws on the personal experiences of farmers in conjunction with documented evidence, and critically examines the effects on both rural life and the farming industry. The data processed included the relationship of new tractor sales in comparison with the decline in working horses; an increase of 350,000 from 100,000 to 400,000 tractors nationwide in the 17 years following the war, during the same period the number of working horses declined to virtually zero; productivity increased and at the same time labour requirement on farms declined and it was during this period that the population nearly doubled.
Lancashire, situated in the North West of England, lends itself to a wide diversification in crops and land use with large urban populations to the south and east of the county providing a clear market for produce. The most productive land, located in the West Lancashire plain, comprises of light easily cultivated peat mosses, light alluvial and sandy soils (Grade 1 listed soil) which are ideal for intensive arable cropping. Fifteen per cent of the UK soil is categorised as grade 1; ninety four per cent of this fifteen per cent is located in North West Lancashire.
This report critically reviews the increase in tractor numbers and their role in the regions agriculture in comparison to the decline of manual labour, the decline in the use of horses and trends in farm size.

Key words: *mechanised operations, horses, tractors, urban population, intensive arable cropping, social trends, West Lancashire.*

INTRODUCTION

During the 1950's British farming practices became much more intensive as farmers shifted decisively and irrevocably away from the use of horses to tractors (Robinson, 2002). Post War agriculture needed to undergo a process of profound change. This progressive change became the extension of technological, organisational and economic rationality (Ilbery, 1986). This investigation aims to contribute to the understanding of this significant and remarkable nation-wide change through studying part of West Lancashire, establishing the chronology of the process and how and why it occurred. For the basic economic analysis of this study, farming has been looked at purely as a business activity, setting aside the romantic view of the countryside that ignores the realities of earning a living. However, it also considers the social consequences.

The change from horses to tractors was the fastest change, in farming practice, to occur in the history of agriculture. We, the investigators already knew the outcome of the challenge facing an industry using dated practices; the reasons behind the change and the impact on communities of British farmers remain obscure. Factors such as financial constraints and inducements, farm size and the existence of a rigid or dated attitude will all be considered in this study of decision making, as well as the effect the changeover had on the lives of West Lancashire farmers.
With the food crisis of the war years continuing, due to the lack of foreign exchange to pay for imports; during 1951 and 1952 British agriculture was being called on to produce £100,000,000 worth of extra food. This was a vital contribution to the nation's economic recovery after a devastating war that left the country nearly bankrupt. The

Government, of the day, felt the achievement of this target depended on the introduction of total mechanisation on British farms (Turner, 1948). It was expected, that by 1959, £60,000,000 annually would be spent on mechanising agriculture across Britain. This would represent up to £2.00 for every acre of cultivated farm land (Culpin, 1959). The critical state of the British economy justified this vast investment.

MATERIALS AND METHODS

According to Denscombe (2010), social researchers must always ask at the outset if the research is suitable, feasible and ethical. The obvious sources for agricultural statistics have been used to the full, however notoriously farmers have a very powerful inclination to reminisce suggesting that the best method of data collection would be oral testimony. Testimonials have been collected from 67 men and women with farming backgrounds and lifestyles this formed the backbone of the investigation; the suitability and ethical aspects of this approach must be considered here. Dr Stephen Caunce (1994) in his book Oral History and the Local Historian, stresses the importance of accurate depiction of working family life and states that 'many memories of small groups of people had been previously considered too unimportant to merit much attention'. The people interviewed, for this study, contributed a real life perspective of working farmland using horses and tractors in 1950's West Lancashire; this information could have not been gained in any other way and these memories are unique and personal and have been treated as such, and are becoming increasingly difficult to collect as time passes. Since this investigation one contributor has passed way.

All interviewees signed a declaration to express that they are happy for their conversations to be used in this way, anonymity has been respected where quotes have been included. Five interviewees provided particularly valuable testimony, and their words appear regularly in this document. Brief conversations with the interviewee's immediate family members and the public have been included even when not recorded. All the individuals, once established they had lived throughout the farming change were asked six key questions. This has allowed the creation of statistical graphs and charts to generate a picture of their lifestyles throughout the 1950s.

External reading around the subject and interpretation of memoirs and cross referencing the interviews with each other indicated that the information collected is factually accurate. Photographs and postcards from interviewees have also been used, with information as to the content added in captions with the correct accreditation. Maps, diagrams and tables are also used to assist the reader with the understanding and reasoning for this project. Articles from newspapers have been referred to throughout, the Preston Guardian now the Farmers Guardian was particularly useful as an additional source for pricing and local life stories.

RESULTS AND DISCUSSIONS

Why West Lancashire needed to change

The expense of the war left the country with severe economic problems. James Turner, National Farmers Union (NFU) President said in 1950 that recovery depended on the progress in agriculture. These problems were centred on the output per man hour which would lower the cost of stocks (ESSO 1948), and a nation-wide mechanisation was vital for that (Culpin 1959). The prime reason being the long standing dependence on the importation of a large percentage of the nation's food, hence the government pressure to reduce this import bill by £100,000,000. In addition, the population was growing, and extra food and jobs were needed every year. Between 1946 and January 1960 a labourer's standard working week was reduced from 48 to 45 hours before overtime rates had to be paid. As horsemen had to work a longer day on full pay to prepare their horses, employers faced a rise in the cost of caring for horses.

Lancashire's traditional commitment to cotton mills, mines and engineering had been revitalised by the war, but food production still required a long term solution. In Lancashire alone the population rose from 4.8 million to 5.1 million, and a good deal of the food production from West Lancashire was consumed locally.

Tractor power seemed the obvious way to increase productivity. The working rate of a machine is determined in order to enable the farmer to estimate probable work output comparable to the horse; this idea originated by manufactures to ascertain machine productivity The problems of using horses had previously been accepted as inevitable, but a dramatic decline in numbers began after 1945. In 1900 there were 3.3 million horses in Britain; 2.6 million of these were working in agriculture with around 4% of this figure working in and around the Lancashire County. At the end of the 20th century the number of farm horses used in England was almost unaccountably low.

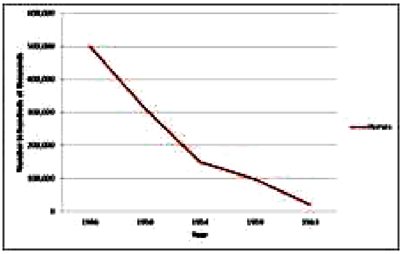

Figure . 1. Graph showing the post-war decline of horses used in British Agriculture

The distinct fall of working horses during 1950, 1954 and 1959 can be attributed to new developments in tractors, government subsidies and local people gaining an interest in tractors (Turner, 1948).

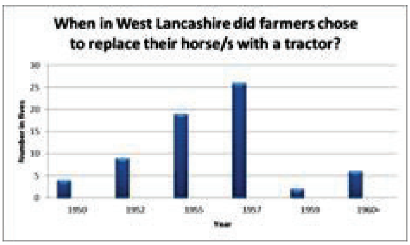

Figure 2. Graph showing when tractors replaced horses

The peak of change, evident in 1957 could be attributed to the governments' introduction of the Farm Improvement Scheme which encouraged new intensive methods, including land drainage, particularly vital to the farmers who worked the Longton Moss. They could also apply for new buildings, which helped them replace the stable and storage barns with workshops that had ramps and built in tool storage facilities.

Incentives for Farmers to Change

Change can be very difficult to implement in close-knit communities engaged in traditional work like farming, also, changes that require capital investment will inevitably strike a general reluctance to adapt, unless the gains are clear. It was easiest where it used and adapted skills that have been passed on from generation to generation (Kruger, 2011). Manufacturers and government officials had to create a general sense among farmers that the tractor really would make life easier, rather than something forced on them. A safety net such as payment plans that could be frozen to prevent them from going bankrupt made people more likely to change since they knew that 'they are not sentenced to something that may not work (Kruger, 2011)'. The management of this process required the government to commit to protecting farmers with substantial subsidies. Until 1939 farming received little support, and had little confidence. There was no direct attempt to assist them to purchase machinery. After the war, the experience of such severe food supply problems prompted the Labour government to promise that agriculture would see no return to such conditions, and that the British people would not experience rationing in the future (Labour Party, 1945). At the most basic level, farmers could effectively 'write off' the amount they paid for new machinery against tax as a justifiable business expense extremely quickly, as long as it was genuinely made use of. This was never a scheme in its own right, but that informality helped make it extremely effective (Tichetar, 1945). Formal grants and schemes were first set out in the Agriculture Act of 1947 to help farmers make a good living, but they depended on changing from horses to tractors. The National Agricultural Advisory Service (NAAS) was to encourage agricultural improvement and more productive mechanised methods, and operated without charge (DEFRA, 2006).

The New Food Services Scheme (NFSS) meant that all industry canteens, schools and British restaurants had to serve British produce, and this was promised to be in place by 1954 (Labour Party, 1945). This was good news for

West Lancashire farmers as Leyland Motors was then expanding rapidly to become one of the biggest wagon, bus and engine manufacturers in the UK, taking on 700-800 extra workers and contractors in the process (Leyland Trucks, 2011). Total staff numbers eventually rose from 10,000 to 25,000 people.

When diesel was first introduced (known as derv), fuel for agricultural tractors was subject to the same duty as that on petrol. In 1950-51 the Ministry of Agriculture operated a scheme of grants to farmers to offset the increase in petrol duty made in that financial year, providing flat rate payments according to the number of tractors used. Farmers were permitted to use diesel that was given a red colouring at the lower heavy oil rate for agricultural operations (Hylto-Foster, 1961).

A ploughing grant formed a large part of the Agriculture Act subsidy scheme introduced in 1952 (Dugdale, 1952). This set grant rates for ploughing up grassland to grow arable crops for human consumption (Nugent, 1952). £5.00 per acre was paid for grass land of up to four years old and a higher rate up to £30.00 for 2.5 acres of grassland that was up to 12 years old (Pretty, 1998). Governments prioritised the conversion of land over a certain age. West Lancashire was primarily an area of flat, good soils that had been extensively used for grazing beef cattle. The ploughing grant did not require the use of tractors but farmers wishing to purchase one could do so knowing they had a reliable top up on their gross income. Tractors also performed the ploughing quicker and once the government reached its target of 500,000 more arable acres, the ploughing grants would cease. South western counties had the greatest uptake of this scheme, but farmers in West Lancashire also seized this chance to gain extra money. The increase in the removal of horses shown in Figure 2, 1952 could be attributed to the ploughing grant.

The Introduction of the tractor.

The tractor was not a new invention in the 1950s. Attempts to use steam power dated back many decades, but always proved a costly and often an inappropriate, source of draught power in fields. Internal combustion engines were used more successfully in North America, and some of the newly manufactured machinery was shipped to the UK especially during the food crisis of the two World Wars; tractors could be used with horse adapted machinery for almost any powered task on the farm, thus providing a direct replacement for the horse.

Table 1. Table showing the comparison of tractors with horses

Positive Attributes of the Tractor	Negative Attributes of the Tractor
They were faster than the horse. Field work took less time and basic applications were completed quicker.	There was no standardisation of parts. Parts were machine specific and could be costly.
Tractors were less labour intensive. Labourers/farmers were able to sit down during an entire task. New systems that were being tested meant that they could adjust machinery from the seat thus saving on time and motion exercises.	They required regular maintenance such as servicing. They also required fuel and oil to run on a regular basis and this was both an expense and required cash at hand.
If work slowed down on a farm a tractor would not require any upkeep unlike the horse which the worker would have to continue feeding and require looking after.	Tractors had zero intelligence. They were machines. They could not be trusted or left while running in the fields if the labourer chose to look at another task.
To help farmers purchase tractors incentives were put in place, in the form of Government Grant Schemes and tax benefits.	They were not sustainable, or environmentally friendly. Not an issue in the 1950s, but after the war it could become a concern as fuel reserves were low.
The machinery previously used for horses could be adapted and modified for use with the tractor. Some modifications could be crude, but they were effective and provided a short term solution to purchasing new implements.	Tractors were much more expensive to acquire
Different tractor makes and models could change, improve and gain new developments to suit the operator's needs. A horse had to stay the same.	
Ferguson and Brown tractors had a system in place called the Power Take Off (PTO). This meant powered machinery could be powered at the rear of the tractor.	

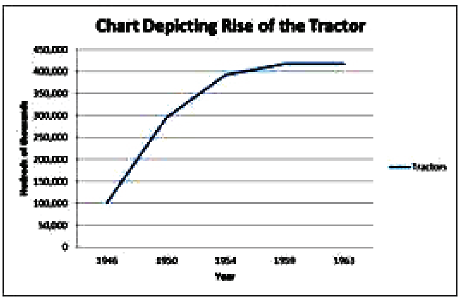

Figure 3. Graph showing rise in tractor sales

Figure 4 shows that in 17 post war years, the tractor had risen from a mere 100,000 across Britain to just less than 450,000 (HMSO, 1968). We must recognise that one tractor was the equivalent in power terms to several horses, as well as being the least expensive. When horse numbers had fallen to around 300,000, the number of tractors increased dramatically (HMSO, 1968).

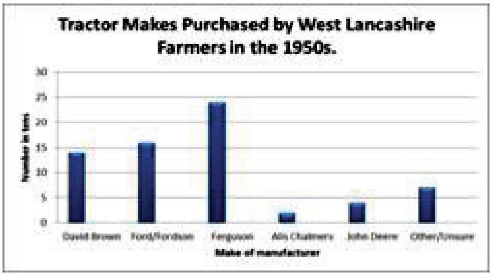

Figure 4. Chart showing tractor sales by make

The Three Point Linkage and Draught Control System, developed by Harry Ferguson and adopted by all other manufacturers, meant that the plough, cultivator or other implement, could be linked directly to the back of the tractor, and the working depth of the device be set at a certain range by hydraulic control, which could also be adjusted whilst on the tractor. The system transfers a proportion of the draught weight of the attachment onto the rear wheels of the tractor, thus allowing the tractor to take more weight than the horse. Old implements designed for horses were increasingly scrapped rather an adapted, a sign of a genuine new era (Melloy, 1984).

Between 1956 and 1958 tractors and self-propelled machines were the causes of 45.3% of agricultural fatalities in the UK (Matthews, 1986). Compulsory protective and preventative measures for tractors were slow to be introduced, starting as late as 1969, which may explain a lack of data on accidents before the 1974 Health and Safety at Work Act (Agricultural Safety, 1974).

As with motor vehicles, however, extra rules and regulations applied to operating tractors, though at first they were possibly not taken seriously and were of little concern to farmers and even college institutions. All tractor operators were required to update their skills especially if they were trying to gain an overall qualification in agriculture and legislation forced action to be taken.

Table 2 Table showing accident rates involving tractors in 1974

January	4%
February	8%
March	7%
April	13%
May	16%
June	10%
July	10%
August	7%
September	6%
October	9%
November	5%
December	5%

Table 3. Chart outlining the development of safety legislation

Risks	Preventative Measures
Power Take Off Injuries (near fatal, severe injury, amputation)	PTO guards became compulsory and required on every tractor. PTO injuries and fatalities 78% of the time involve the sole operator In 1985 PTO guards became interchangeable and allowed the attachment of the implement without fully removing the guards.
Running Over	Ensuring operators had adequate training and driving skills would prevent running over tractor driving qualifications could help by providing the training needed for safe vehicle operation.
Crush Injuries	Making sure that operator had adequate training and understood the moving parts on the tractor could prevent injury as a result of crushing.
Roll Over Injuries (fatal, severe injury)	In 1976 it was made compulsory to have a roll over protection system (ROPS) for hired employees. Statistics have proven that one in 10 operators will roll over a tractor in their career. From 1967 all tractors over 20 horsepower were sold with ROPS in place.
Falling Objects Injuries (fatal severe injury)	Falling object protection FOPS is aimed at protecting the operator from any falling objects. FOPS protection means that there either has to be a canopy or a frame over the operator for cables tractors. It was only made compulsory in 1989

The 1950s and 1960s proved to be a good time for the manual worker, substantial rises in wages were leading to unprecedented improvements, in standards of living and there was work for everyone who wanted it.

Casual workers were crucial to British agriculture, as work was primarily seasonal and in West Lancashire family members who helped out might not appear in either category. At the same time the number of full time male workers is in decline coinciding with a rise in the expansion of the manufacturing sector, Leyland Trucks being a good example. However, female employment shows a rise, which can be contributed to changing roles within the agricultural sector.

Table 4. Table showing workers employed in agriculture in Britain

Year	Regular Male	Regular Female	Casual Male	Casual Female
1931	510,158	51,616	65,463	26,883
1940	427,830	40,092	58,362	42,119
1950	490,521	53,267	97,589	46,340
1960	393,402	52,667	42,295	35,071

After tractors arrived, staff inevitability had to change roles. The younger generation found this easier, and some older workers struggled, and possibly failed to adapt. If a worker failed to adapt or learn new skills they could be left surplus to requirements.

Overall, agricultural workers' numbers dropped throughout the 1950s. Most were aged between 20 and 65, and it was also this group that shrank most, dropping by 24,093 between the years 1955 to 1958. The 65's and overs dropped by nearly 5000. It is safe to assume that all the agricultural skills of staff above the age of 35 would relate to horsepower whereas younger people might have some familiarity with tractors. Horsemen were becoming redundant and refusal to adapt meant an increasingly difficult task of finding another un-mechanised employer. Around 10,000 horsemen were made redundant in the years 1956-57, replaced by 'skilled' individuals who had additional recognised qualifications, and the process could be a very callous one for man and horse (Landers, 2000).

In Lancashire the rates of pay were comparable to the rest of the country, basic pay for 45 hours/week would be enhanced by over time and weekend work; workers in the manufacturing sector were often paid at a slightly higher rate (Agriculture Wages Act, 1948).

The cost of purchasing a tractor was similar to the cost of employing a worker for a year and by replacing the horse, the "knock-on" effect meant less labour required and greater productivity thus reducing costs and at the same time increasing output.

Table .5 Table showing average agricultural rate of pay throughout Lancashire in the 1950s

Year	Wage per week
	£
1949/50	4.70
1950/51	4.96
1951/52	5,40
1952/53	5.68
1953/54	6.00
1954/55	6.24
1955/56	6.64
1956/57	7.05
1957/58	7.45
1958/59	7.78
1959/60	7.92

Table 6. Costs of purchasing a tractor

Tractor Make and Model	1945	1950	1955	1959	1965
Ferguson Petrol	£235.00	£325.00	£395.00	£460.00	£525.00
Ferguson Diesel	£310.00	£480.00	£525.00	£610.00	£675.00
Fordson Diesel	£310.00	£380.00	£425.00	£465.00	£535.00

There was also depreciation to contemplate when a farmer purchased a new machine. It is not clear whether farmers were aware of depreciation when they purchased tractors or realised the loss in value a tractor can have from the minute it is purchased, this led to a change in managerial skills, operational costs and the value of assets.

Once West Lancashire farmers accepted the realisation for change they had to decide what precisely needed to be done. According to Cooke and Slack we must ask if farmers were actually making plans or were they problem solving? Herein lies the problem that there are many steps into decision making which will ultimately solve the problem that has occurred in the first place.

West Lancashire farmers were not compelled to mechanise, even though the country would struggle if they opted out, so they felt they controlled their own destiny and survival. This means that the theory of empowerment provides a very useful mechanism for understanding farmers' actions. The government made mechanisation easy and rewarding, which meant farmers did not see giving up the older ways as failure. Official training schemes were implemented to maintain support with the National Proficiency Tests Council (NPTC) formed in the 1930s and taking responsibility for education, training and safety standards in agriculture. Workers were offered many recognised qualifications to boost their employability, help raise their wages and earn respect. Traditionally if a person was taking part in a qualification such as a degree the educational establishment would pay for their additional qualification. However, if the person was already employed it would be up to them to pay for their training and tests. If they were fortunate enough employers would offer to pay for them, but in many cases as there was no way of ensuring a worker, employment out of season it seemed pointless for them to pay for it.

CONCLUSIONS

This period of study has proved to have been one of the important eras in the history of agriculture in North West Lancashire and the United Kingdom:

- A major change had been successfully implemented.
- Tractor power raised productivity by a factor of four.
- Tractor power reduced labour costs.
- Engineering skills replaced horsemanship.
- Industrial development absorbed the majority of redundancies on farms.
- The introduction of mechanisation led to a different strategy for farm business management.
- Financial reward proved to be the main motivating agent behind the change.
- An increase in female and part-time labour as male workers sought better job opportunities in the expanding industrial sector.
- Farm workers' wages and working hours underwent a change in order to attempt to stem the drift of farm workers into the industrial sector.
- The tractor and mechanised agriculture led to the development of formal training courses.
- The National Proficiency Test, povided nationally recognised skills awards for a whole range of agricultural tasks.
- A rise in machinery related accidents led to a rise in legislation.

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RESEARCH REGARDING THE UNIFORMITY OF SPRINKLER IRRIGATION IN FORESTRY NURSERY

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Abstract

The research was carried out in the Iarac forestry nursery in the O.S. Iuliu Moldovan during 2010-2012, on an alluvial soil (the vertical-gleyed subtype). The placement of the sample markets was carried out according to the "divided parcels method" in two repetitions, and the surface of a parcel was 450 m^2.
The present paper displays the results obtained after the sprinkler irrigation, when we determined the quantity of water spread by the 6 sprinklers on a 15 m-radius, placed on the direction of the cardinal points.
The purpose of the research was to observe the correlation between the qualitative work indexes of the sprinkling devices, by spreading a uniform quantity of water on the entire surface and the maintenance of an ecological balance of cultivation of the saplings in the forestry nursery.
In a close connection with the purpose stated, the paper also focuses on the study of the work indexes of the sprinklers used in forestry nurseries, among which the most important is the uniformity of sprinkling.
The uniformity of sprinkling, the intensity of watering, the fineness of the rain, and the energy of the drops are also called qualitative indexes or the sprinkling's characteristics - key elements for the assessment of the sprinkling irrigation devices. Sprinklers are active organs of the watering devices. They can transform the water pumped out into drops which can be spread on the surface that needs irrigation.
The main means used for the improvement of sprinkling uniformity are the following: the usage of sprinklers with a small radius of sprinkling, having correct pluviometric curves; the correct placement of sprinklers on the terrain, according to the schemes of work recommended; avoiding to water when the speed of the wind surpasses the speed limit established for the sprinklers used.

Key words: *sprinkler, sprinkler irrigation, uniformity of sprinkling, qualitative indexes of the sprinkling.*

INTRODUCTION

The condition of a uniform distribution of the water on the terrain is determined with the aid of an index of sprinkling uniformity. The condition of a minimum loss of water through surface leaking and the condition that the watering does not worsen the properties of fertility of the soils, through the deterioration of the soil (the formation of the crust) or through erosion are determined with the aid of an index of uniformity.
The condition of a minimum loss of water through evaporation during watering is determined through the index of the fineness of the rain. The same index serves together with the index of intensity for the appreciation of watering from the point of view of the formation of the crust and of the mechanical effects of the water on the tissues of the irrigated plants (Nedelcu, 2004).
In order to diminish the negative effect of the wind and to improve the uniformity of the sprinkling, it would be good to reduce the distance between sprinklers on the wing of sprinkling according to the speed of the wind (Grumezea and Kleps, 2005).
The height of the sprinkler at 0.50 m when the wind blows is more favourable than at 1.50 and the stability to wind of the jet increases together with the size of the nozzle. Uniformity of watering depends on the speed of the wind and its direction, and also on some technical characteristics of the sprinklers, height of placement, etc. (Cazacu et al., 1989).
While modifying the schemes, we must take into consideration the speed of the wind at the height of the sprinkler. The wings are placed as

possible perpendicularly on the dominant wind and the sprinklers at the height of 40-60 cm above the soil in order to avoid the turbulence of the wind which is formed immediately on the soil (Vlad et all., 1982).
On the basis of the different indexes found in the specialty literature, we acknowledge the limit speed of the wind at 5 m/s, bigger speeds being prohibitive for the sprinkling. At a wind speed of 1.5-5 m/s, one needs special schemes of placement of the sprinklers. At wind speeds less than 1.5 m/s, the influence of the wind is considered to be insignificant for the uniformity of the sparkling (Mihai, 1970); (Siseşti, 1971).
Knowing the technical elements of the watering (schemes of watering, intensity of the rain, duration of watering, fineness of the rain, uniformity of the sprinkling) creates the premises necessary for the application of a uniform watering, the correlation of the intensity of the rain with the speed of infiltration of the water in the soil, but also possibility of appreciation of the quality of watering (Mihai, 1970); (Popescu and Popescu, 2000).
An ideal sprinkler must accomplish an intensity whose value grows continuously, with smaller values from the periphery of the jet towards the sprinkler. These types of sprinklers ensure a good uniformity of watering when the work schemes are established judiciously, according to the distribution of the intensity on the radius (Chiru and Mihai, 1972).
The intensity and the uniformity of watering are in a large extent influenced by the work pressure and the nozzle used. Thus, when the sprinkler functions at a too low pressure, it produces too big drops and an un-uniform distribution of the water. When the pressure is too high, the jet of the sprinkler is pulverized in smaller drops which are distributed around the sprinkler (Plesa and Burchiu, 1986).
Thus, the present research had as a purpose the study of the possibility of introducing in the exploitation other types of sprinklers, adaptable to the requirements of the cultures and soils in question.

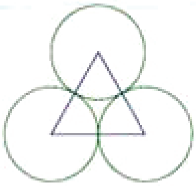
MATERIALS AND METHODS

The research was carried out in the Iarac forestry nursery in the O.S. Iuliu Moldovan during 2010-2012, on an alluvial soil (the vertical-gleyed subtype). At the time when the measurements were taken, the meteorological conditions were: temperature of 24^o C; wind speed of 2 m/s; total nebulosity: 4; and relative humidity 49. The placement of the sample markets was carried out according to the “divided parcels method” in two repetitions, and the surface of a parcel was 450 m^2.
The present paper displays the results obtained after the sprinkler irrigation, when we determined the quantity of water spread by the 6 sprinklers on a 15 m-radius, placed on the direction of the cardinal points.
The determination of the uniformity of sparkling by measuring the quantity of water sprinkled, which is collected in pluviometers, placed after a certain rule on the watered surface.
In the case of the determination of the uniformity of sprinkling of an isolated sprinkler, the pluviometers are placed at equal distances of 1-2 m, on a radius, in conditions of atmospheric calmness or on four radiuses, in a cross, if windy.
In the case of the determination of the uniformity of sprinkling under a wing of rain, it is necessary to use a greater number of pluviometers, placed on two perpendicular directions, under the form of a grid.
Thus, we can produce a regular geometrical platform, having the width equal with the distance between two neighbouring sprinklers, and the length equal with the distance between the two neighbouring wings of rain.
The graphic of the isohyets is made by uniting the points which have the same collected quantity of water in the pluviometers. With the circle watering, the isohyets appear under the form of a concentric curve.
In order to determine the quantity of water distributed from the sprinkler to the surface of the soil, we placed pluviometers at each meter on two diagonals (cardinal points), until the distance of 15 m, thus registering the quantity of water distributed, in mm or l/m^2.
Thus, we established two surfaces for the sampling of the observational data, in a rectangular form, with a 450 m^2 (30 x 15 m) surface, among which one was the witness sample – the un-irrigated soil, and the other surface suffered successive modifications

through the sprinkler irrigation. At each surface, we sampled 60 primary data, placed on the direction of the cardinal points (N, S, E, W) for each of the six sprinklers henceforth abbreviated (A1…A6).

The distribution scheme of the sprinklers and pluviometers for the determination of sprinkling uniformity is given in Figure 1 and Figure 2.

The equilateral triangle



$$C_T = \frac{S_C}{S_T},\ S_C = \frac{1}{2}\pi \cdot r^2$$

$$C_T = \frac{S_C}{S_T} = \frac{\frac{1}{2}\pi \cdot r^2}{\frac{1}{2}(2r)^2 \cdot \sin 60^o} = \frac{\pi}{2\sqrt{3}}$$

where:

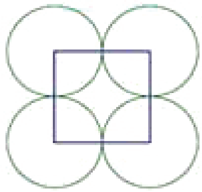
C_T is coverage

S_c - surface parts covered

S_T - surface unit triangle

r – radius

The square



$$C_S = \frac{S_C}{S_S},\ S_C = \pi \cdot r^2\ C_S = \frac{S_C}{S_S} = \frac{\pi \cdot r^2}{(2r)^2} = \frac{\pi}{4}$$

where:

C_S coverage;

S_c - the area covered parts;

S_s - square unit area,

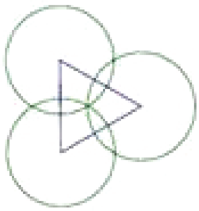
r – radius

Calculation of the surface irrigated (S_N):

$$S_N = 4r^2 - \pi \cdot r^2 = r^2(4-\pi) \approx 0.86 \cdot r^2$$

Figure 1. The arrangement reciprocal of coverage area without sprinklers

The equilateral triangle



$$O_T = \frac{S_O}{S_T},$$

$$S_O = \frac{3}{2}\left(\frac{2}{6}\pi \cdot r^2 - r^2 \sin 60^o\right) = \left(\frac{\pi}{2} - \frac{3\sqrt{3}}{4}\right)r^2$$

$$O_T = \frac{S_O}{S_T} = \frac{\left(\frac{\pi}{2} - \frac{3\sqrt{3}}{4}\right)r^2}{\frac{1}{2}\left(2 \cdot \frac{\sqrt{3}}{2}r\right)^2 \sin 60^o} = \frac{\frac{\pi}{2} - \frac{3\sqrt{3}}{4}}{\frac{3\sqrt{3}}{4}} = \frac{2\sqrt{3}\pi}{9} - 1$$

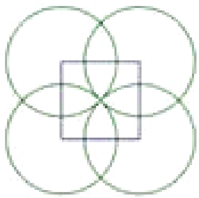
where:

O_T is the rate of overlap;

So - surface parts that overlap;

S_T - surface unit triangle.

The square



$$O_S = \frac{S_O}{S_S},$$

$$S_O = 2\left(\frac{2}{4}\pi \cdot r^2 - r^2\right) = (\pi - 2)r^2$$

$$O_S = \frac{S_O}{S_S} = \frac{(\pi - 2)r^2}{(\sqrt{2}r)^2} = \frac{\pi}{2} - 1$$

where:

O_S is the rate of overlap;

So - That surface overlap shares;

S_S - surface unit triangle.

Figure 2. The arrangement sprinklers in areas of reciprocal coverage

RESULTS AND DISCUSSIONS

The quantity of water distributed by the six sprinklers included in the experiment is presented through average values in Table 1, at distances from m to m on a 15 m - radius, placed on the direction of the cardinal points.

Analysing the average values from the table below, we could observe the presence of some optimal values of the water accumulated in pluviometers, after the sprinkling, up to an 8 m distance; on this radius, the quantity of water accumulated presents quite big variances because of the speed of the wind or the functioning of the sprinkler.

Table 1. Average values of the sprinkling uniformity in connection with the cardinal points

Distance from the sprinkler, m	Average values in connection with the cardinal points, mm			
	North	East	South	West
1	7.50	7.00	6.88	7.40
2	5.75	6.43	5.28	5.77
3	5.48	5.48	5.57	5.90
4	5.52	6.22	4.75	4.32
5	5.13	5.62	4.45	3.73
6	5.30	5.38	4.77	3.43
7	6.00	4.63	4.55	3.53
8	5.12	3.63	4.22	3.63
9	4.30	2.40	3.38	2.77
10	4.15	1.58	2.05	2.40
11	2.12	0.88	1.35	2.03
12	1.52	0.40	0.92	1.47
13	0.68	0.28	0.52	0.90
14	0.32	0.15	0.28	0.35
15	0.23	0.12	0.20	0.27

In the specialized literature is referred to minimum amount of water sprayed crop's needs, ranging from 2-6 mm / h depending on soil texture and crop species. (Trifu, 1973)

Analyzing information collected from our research these values are obtained and 10-11 m from the sprinklers.

This is particularly important because it provides information about the optimal distance between sprinklers in order to comply with the initial condition that the entire surface to distribute the same amount of water.

In order to synthetize more efficiently the data and to describe more accurately the intrinsic characteristics of the sample, we proceeded to the statistical processing with the aid of the KyPlot program.

The results obtained are given in Table 2 for the average values of uniformity of the sprinkling in connection with the cardinal points, so that we could emphasize the variance of the quantity of water distributed by the sprinkler and accumulated in pluviometers at the surface of the soil.

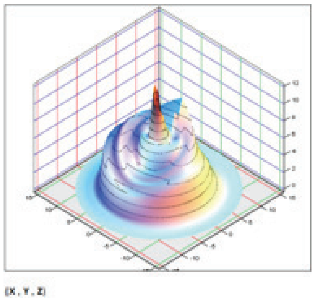


Figure 3. The uniformity variation around the sprinkler spray 2

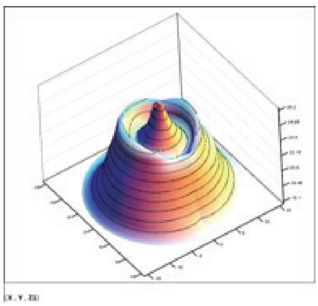


Figure 4. The uniformity variation around the sprinkler spray 3

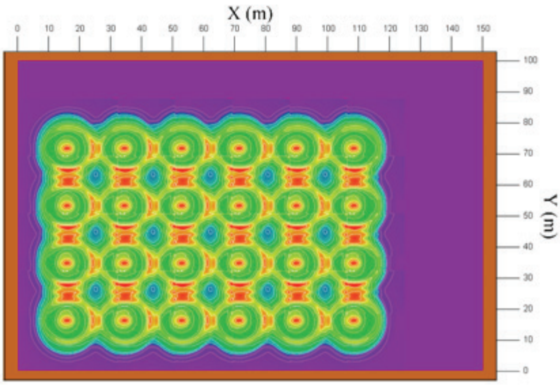


Figure 5. Overlapping sprinklers wings (7m/7m) to a minimum quantity of water 2l/mm^2 the square display

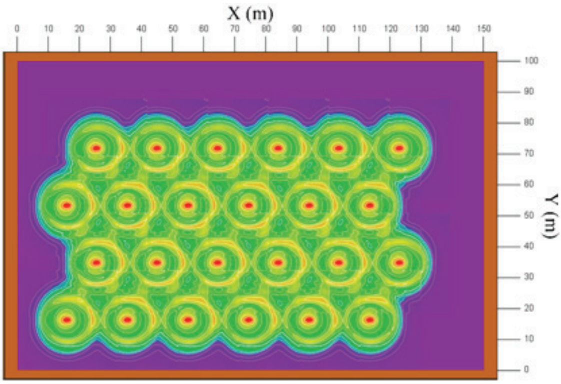


Figure 6. Overlapping sprinklers wings (6.5 m/6.5 m) to a minimum quantity of water 2l/mm^2 the equilateral triangle display

Table 2. Variance of some statistical indexes of the average values of sprinkling uniformity in connection with the cardinal points

Cardinal points / Statistical indexes	North	East	South	West
Mean	3.94	3.35	3.28	3.19
S.E.M. (Average standard error)	0.60	0.67	0.57	0.54
Standard deviation	2.34	2.61	2.19	2.08
Coefficient of variation	0.59	0.78	0.67	0.65
Minimum	0.23	0.12	0.20	0.27
Maximum	7.50	7.00	6.88	7.40
The number of feature values (N)	15	15	15	15
Skewness	-0.46	-0.03	-0.15	0.38
Curtosis	-1.14	-1.64	-1.34	-0.59
Mean Deviation	2.12	2.52	2.05	1.74
Median	5.12	3.63	4.22	3.43
Range	7.27	6.88	6.68	7.13
Confidence Level(0,95)	1.29	1.45	1.21	1.15
Lower Confidence Limit	3.34	2.67	2.71	2.66
Upper Confidence Limit	4.55	4.02	3.84	3.73

CONCLUSIONS

When watering through aspersion, the uniformity of distribution of the water for irrigation is rather reduced because of some definite causes. One of the causes for the lack of uniformity of the water on the irrigated terrain through sprinkling is the watering of the sprinklers on circular surfaces. For the integral coverage with rain of the terrain, the circular surfaces must overlap in a smaller or greater extent according to the distribution scheme of the sprinklers. In conditions of correct placement of sprinklers on the terrain, the surface watered twice varies between 15 and 33%.

Another cause which influences the uniformity of sprinkling is the functioning of a sprinkler. It is obvious that the water jet, even at the improved sprinklers cannot be distributed in an absolute uniformity on all its length. That is why the circular surface watered by a sprinkler appears, from the point of view of the uniformity of sprinkling, under some concentric zones, more or less differentiated according to the characteristics and functioning state of the sprinkler used.

At the improved sprinklers, small quantities of water are distributed at the periphery of the circular surfaces. Thus, by overlapping the circular surfaces, we could ameliorate the uniformity of sprinkling.

The uniformity of distribution of the sprinkler is best given with the aid of a pluviometric curve.

Another major source of non-uniformity of the watering through sprinkling is represented by the influence of the wind. The wind deforms the circular form of the surface sprinkled, which becomes a more or less normal ellipsis and a more or less flattened ellipsis, according to the uniformity and intensity of the wind.

Among the main means used for the improvement of sprinkling uniformity are the following:

The usage of sprinklers with a small radius of sprinkling, having correct pluviometric curves;

The correct placement of sprinklers on the terrain, according to the schemes of work recommended;

Avoiding to water when the speed of the wind surpasses the speed limit established for the sprinklers used;

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CLIMATE CHANGE AND AGROMETEOROLOGICAL CONDITIONS FOR GROWING WINTER CROPS IN BULGARIA

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Abstract

During the last decade climate variability and anomalies become more evident and their impact is more expressive. Appearances are different - sudden changes in weather conditions transitional seasons are becoming shorter with fuzzy borders, dry spells and droughts in combination with forest and field fires. Simultaneously, there are torrential rains accompanied by devastating floods that caused significant damage to agriculture. These anomalies affect on the conditions for grow of crops because 90% of the yields depend from weather conditions. The winter wheat has a long vegetation period. Development of wheat crops depends of different combinations from state of basic meteorological elements.

Main purpose of this paper is to assess the agro-climatic conditions in major grain producing regions of Bulgaria to the use of agroclimatic potential of each. This investigation covers the period 1981-2010, and refers to occupied territories with winter wheat and barley. Data were analyzed for fundamental values of weather elements - maximum, minimum and average daily air temperature (°C), rainfall sum (mm). An assessment of agro-meteorological conditions during critical phases of crop values on the main weather elements - sowing winter conditions, water saving, tillering, stem elongation, earing and milk ripening. It is traced as the dynamics of the main meteorological elements and their complex effects on growth and development of crops from the calculation of some indices characterizing hydrothermal conditions.

Key words: *climate change, agrometeorological resources, winter crops.*

INTRODUCTION

Winter crops in Bulgaria are growing on three basic regions - Danubian Plain, Northeastern Bulgaria and Thracian Lowland. Productivity depends on the maximum use of agro-climatic resources in these areas. The climatic zoning (The climate of Bulgaria, 1991) of the country shows that they are in two climatic regions and four sub regions, with typical manifestations of basic meteorological elements forming agro-climatic conditions. The temperature conditions in the production areas of winter crops are suitable, but the humidity conditions of the majority of these areas characterized with drought different level (Hershkovich, 1984; Kazandjiev et al., 2011).

Analysis of multi annual data of basic meteorological elements in Bulgaria tends to rise in temperature and decrease or change in the distribution of rainfall seasons (Kazandjiev, 2008, E. Koleva et al., 2008). The average annual temperature in these areas during 1971-2000 compare with the period to the contemporary climate has risen by 1.5°C. The increase is greater in Northern Bulgaria, but in South this trend was not observed. (Kazandjiev C. 2008; Eitzinger et al., 2008; Kazandjiev et al., 2009). As a result, the duration of the period with temperatures above 5°C is extended by 6-10 days for the two periods being compared. Humidity conditions are directly related to the amount of rainfall. E. Koleva at all, 2008, found that the annual amount of precipitation decrease in the Danubian Plain and the Thracian Lowland and the increased frequency of dry years in the last century. For the period 1971-2000, the trend is towards a decrease, compared to 1961-1990, the annual rainfall sum on the territories of agricultural production decreased by 40 mm, with the exception of the district of northeastern Bulgaria (Kazandjiev et al., 2011). It should be noted that the area of eastern Dobrudja is characterized by the lowest annual rainfall (The climate of Bulgaria, 1991).

Increasing the number and frequency of extreme events - sudden changes in weather conditions transitional seasons are becoming shorter, dry spells and droughts in combination with forest fires increasingly large areas in Europe. Gocheva et al. (2010) found that during the period from 1961 to 2000 the most frequently dry winds occur in July and August, with duration 3-4 days in Northern Bulgaria is happening 25% of these phenomena, and in South 40%, the trend is an increase over the last ten years (1991-2000).

The studies on the frequency of dry periods with different duration have special interest in view of driest character of climatic conditions in the agricultural regions. The driest periods occur most frequently in the period from August to October, and the areas with the highest number of droughts are Seaside and Southern parts of the lowland of Tundja, Maritsa and Struma (Drought in Bulgaria, 2003). A similar trend is observed in the last 20 years - increased frequency and the dry period compared to the modern climate, especially in the Thracian Lowland and Northeastern Bulgaria (Alexandrov et al., 2011). For the period 1971-2000, the country has been a total of 4,536 cases where the maximum temperature was ≥ 35°C, 2,185 of them are Tmax≥36°C, 225 case Tmax≥40°C and 18 times was measured maximum temperature ≥ 43°C. The distribution of maximum temperatures during the period was almost evenly with the exception of 1975 and 1976 when no product temperatures ≥ 35°C. The highest number of days with maximum temperature above 35°C is observed during 2000. These days are concentrated in July and August. The most often observed from 3 to 5 consecutive days with maximum temperature ≥ 35°C. In some cases, this number is reached, and up to 7-10 days (Kazandjiev, 2008).

Frequency cases and duration of retention of temperatures below critical plants levels and the presence of snow cover characterized of conditions for winter. The contemporary bulgarian wheat varieties have high resistance to cold (Dochev et al.. 2009). Barley, which is grown mainly in areas of unstable snow with a small depth have lower cold resistance. According to research Petkova at all, 2010, snow cover in the flat part of Bulgaria is unstable and thin. It stays longer in Northern Bulgaria, the Western and Central Danubian Plain 42 to 48 days, and in the Eastern Danubian Plain, 32 to 42 days. In the Thracian lowland snow cover is retention 20 to 30 days, in the central part and 26÷28 days. The maximum height of snow in Northern Bulgaria is changed in the range 30÷40 cm, and in the Thracian Lowland 20÷30 cm.

Agroclimatic indices - Selyaninov hydrothermal coefficient, an index of De Marton, coefficient of atmospheric humidity, evaporability-precipitation balance etc, are used for a comprehensive assessment of temperature and humidity conditions in the area under consideration. The most commonly used is evaporability-precipitation balance because it gives an idea of the real water deficit for a certain period. Dilkov, 1960 found that the period of spring wheat growth evaporability-precipitation balance values are exceeding -200 mm in each 2 to 4 years i of 10 years. More recent studies (Moteva et al., 2009; Kazandjiev et al., 2010) that the evaporability-precipitation balance in the spring growing season for the period 1971-2000, the range between -223 mm and +15 mm, the largest deficit of water resources is observed in some areas of the Thracian lowland and especially in Svilengrad, Ivaylo, Plovdiv (-180 mm). The values of De Marton in agricultural areas ranged from 20-40 mm $^{o}C^{-1}$, (Moteva et al., 2010) which defines the terms as moderately moist, HTK Selyaninov of about 1, and wheat yields are obtained when values of the De Marton than 30 mm $^{o}C^{-1}$. Comprehensive assessment of conditions in the areas of agricultural production shows that in the region of Thracian lowland and Dobrudja to obtain high yields of wheat is necessary to compensate the water deficit, is to conduct additional irrigation at critical growth and yield formation of cultivations.

The results of climatic scenarios for the values of the basic meteorological elements during 2050 and 2070, shows a tendency toward deterioration in agro-meteorological conditions. From insufficient when using HTK to Selyaninov the conditions are characterized as deficient. According to the index in De Marton - moderately moist become dry and will not be able to rely on economical effective values yields without irrigation in some areas

The main goal of this paper is to assess the climatic changes and the agro-climatic conditions in major grain producing regions of

Bulgaria to the use of agroclimatic potential of each.

MATERIALS AND METHODS

Traditional areas for growing winter cereals include lowland areas, plains and low undulating character with altitude up to 1000 m - lowland areas of Northern Bulgaria, Thracian lowland, southeastern Bulgaria and the Sofia field. According to climatic zoning of Bulgaria (The climate of Bulgaria, 1991), they are located in two climatic regions and four subregions, with typical manifestations of basic meteorological elements forming agro-climatic conditions.

Long-term 1971-2010 daily and monthly meteorological data from 40 agrometeorological and 20 agrometeorological stations, evenly spread over the agricultural territory of the country, have been processed (Figure 1). Basic period of investigation is 1981-2010. Comparison is made with period 1971-2000.

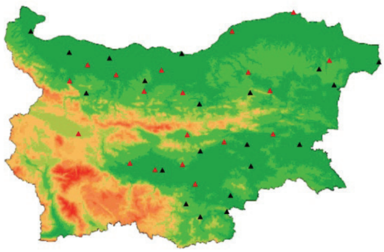

Figure 1. Spatial distribution of meteorological and agrometeorological stations

RESULTS AND DISCUSSIONS

Bulgaria is situated in a zone with insufficient soil water supply. Soil water resources at many regions of the country during the some phases of development stages are insufficient for growing winter wheat. Soil water supply during sowing and beginning of spring vegetation is related with the rest soil water supply. In the end of the summer available soil water supplies in the top 100 cm soil layer varied between 10 and 80 mm. The lowest supply have station Haskovo (10 mm) and the biggest Pavlikeni and Kneja (82 mm). The spatial distribution describes the regions with different AWC deficit on the territory of the country (Figure 2). With bigger deficit are characterized the regions of Central and Eastern part of South Bulgaria, and the Danubian Plain on the Russe region-more than 100 mm. The maximum value is 146 mm in Haskovo.

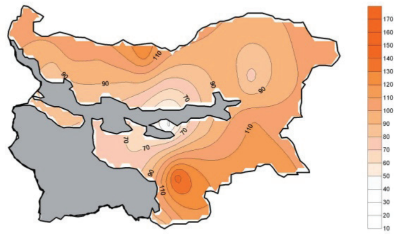

Figure 2. Soil water deficit (in mm) in the top 100 cm in the beginning of autumn growing season

The comparison between two periods 1971-2000 and 1981-2010 shows that in the regions of Thracian Lowland and North Western Danubian Plain soil water deficit increase. To assess the differences between mains for two periods with t-test is established that no statistically significant differences, with except the region of Haskovo. The biggest deviation (Figure 3) are observed in Haskovo (33mm) and lower they are in Plovdiv (-17mm).

Considering the critical values of available water supply in the end of vegetation season the decreasing tendency would lead to their depletion.

The sowing date depends mostly from soil water supply on the top 20 cm depth. Average sowing date varies between 13 and 30 October. Earlier date – second decade of October on North-Western Bulgaria, during the third decade on the Danube plain, and latest on the Thracian lowland (Figure 4).

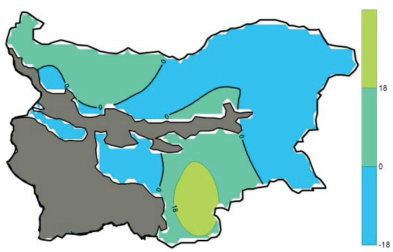

Figure 3. Deviation of deficit soil water supply (in mm) in the top 100 cm in the beginning of autumn growing season

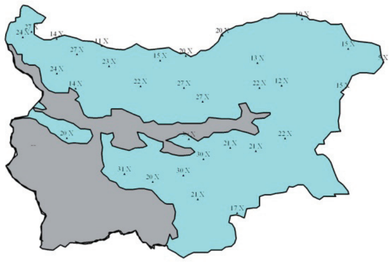

Figure 4. Average sowing date

The soil water availability (SWA) during the sowing period on the top 20 cm depth show that they are sufficiently on the central part of Danubian Plain and Eastern Bulgaria Thracian Lowland and western and eastern part of Danubian Plain they bellow optimal values (> 70% FC) (Figure 5).

Figure 5. SWA (% FC) of winter wheat during the sowing on top 20 cm layer depth

The deviation of SWA on the top 20 cm for the period 1981-2010 in relation to 1971-2000 varies between-10 to 8% FC. They are increase only on Eastern Thracian Lowland and region of Sliven (Figure 6). For the rest territory of the arable land is observed the decreasing. The differences between means of two data series (rainfall sum for two comparing periods) are not statistically significant except the eastern part of Thracian Lowland (Chirpan, Haskovo).
The rainfall sum 20 days before the sowing is related with duration the emergency period. This sum is more than 30 mm (Figure 7) and varies between 33 and 57 mm, which ensure the top 20 cm layer with water resources necessary for emergency in most of the concerned regions. Greater rainfall sum are measured in South Eastern Bulgaria and Thracian Lowland, where the soil water supplies are insufficient.

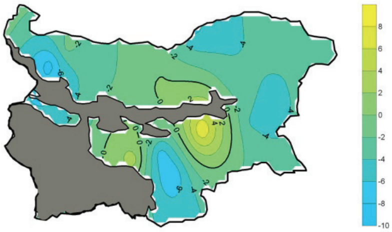

Figure 6. Deviation of SWA (% FC) of winter wheat during the sowing on top 20 cm layer depth

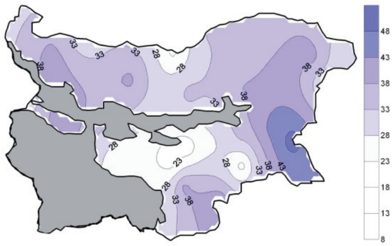

Figure 7. Rainfall sum [mm] in October

In the Eastern Bulgaria, western part of Forebalkan and Thracian Lowland the deviation of rainfall sum in October are increased, but in the regions with the insufficient soil water supply during the sowing they decrease (Figure 8). The differences vary between 19 mm (Burgas) and-14 mm (Svishtov), but they are no statistically significant.

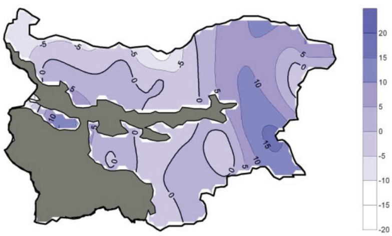

Figure 8. Deviation of the rainfall sum [mm] in October

The duration of the period sowing-emergency is in depending from the quantity of soil water supply (Figure 9). They vary between 17 (Dobrich) and 33 days in the North-Western Bulgaria and central part of Danube plain. The duration of the period of sowing-emergency is longer in the regions with biggest soil moisture deficit and at the latest sowing date.

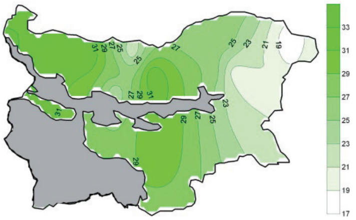

Figure 9. Duration of the period sowing-emergency

The end of the early vegetative stage at the date of air temperature falling below 5^{o}C in the autumn for the largest part of agricultural regions occurred in late November (Figure 10). Exceptions are the southernmost areas where transition is observed in 5^{o}C in early December. No change in the termination date of vegetation compared to the rate for the period 1971-2000. Because of our climatic conditions that limit is relative after the termination the vegetation are observed the cold and warm periods with different duration.

The frequency and duration of retention of extreme minimum air temperature and availability and snow depth are limited during the winter dormancy. Number of years in which the air temperature in January was lower than-15^{o}C, expressed in percentage is shown in Figure 11. It varies between 3% (Shabla), 60% (Chirpan) and 63% (Kneja). There are two regions which more than 50% from the period of investigation the temperature are bellow-15^{o}C – central part of Danubian Plain (Kneja, Pavlikeni) and central part of Thracian Lowland (Chirpan, Sadovo).

Single decrease the air temperature below-15^{o}C is not always occur damages and dead of plants. The shortages of snow cover and duration of influence of low temperature are precondition for partial or seriously damages of winter wheat. Figure 12 shows the number of cases with minimum air temperature below-15^{o}C more than 3 days during January. Most of such cases are occurred in North and Medium climatic region of Danubian Plain and in central part of Thracian Lowland. Greatest duration is occurred in these regions (Kneja – 12 and Chirpan-9 days).

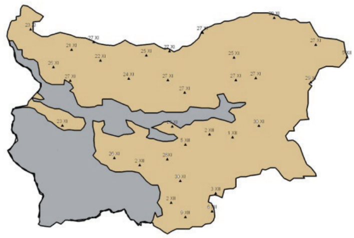

Figure 10. End early vegetative stage at the date if air temperature falling bellow 5^{oC}

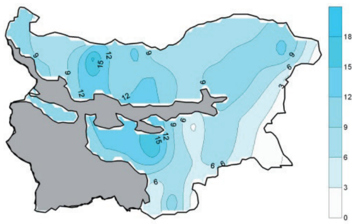

Figure 11. Number of years where the minimum air temperature is lower than-15^{o}C during January

Table 1. Multi annual mean values of snow cover depth, number of days withaut, partial and snow cover bellow 10 cm depth and number days with temperature bellow -15^{o}C

Station	Snow cover depth (cm)		Days without snow cover (%)	Days with partial snow cover (%)	Days with snow cover depth bellow 10 cm (%)	Number of days with air temperature bellow -15^{o}C
	Maximum	Minimum				
Vidin	2	53	6	-	20	87
Bazovetz	2	51		-	14	58
Montana	5	50	2	-	16	51
Kneja	1	58	5	-	20	117
Pavlikeni	2	49		-	29	45
Razgrad	1	41	3	-	48	41
Shunen	1	45	16	3	32	38
Silistra	1	38		-	19	26
Dobrich	1	30	2	19	24	43
Siven	-	-	100	-	-	3
Plovdiv	2	56	-	2	32	62
Chirpan	2	55	2	7	15	109
Sofia	4	50	4		24	49

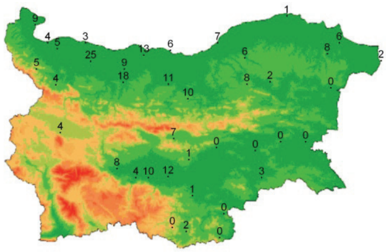

Figure 12. Cases with minimal air temperature below-15oC for more than 3 days during the dormancy

Figure 13. Beginning of the late vegetative stage at the date of air temperature proof rising above 5^{o}C

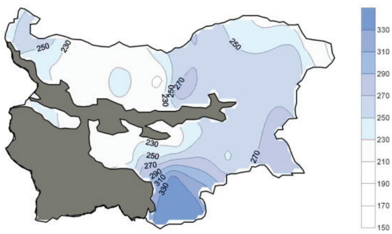

Figure 14. Rainfall sum for the period October-March

Probability of happen of such precipitations in these areas varies between 27% in the region of Silistra and Shabla (in extreme eastern districts) and 72% in the region of Veliko Tarnovo, Targovishte (67%) and Rouse (63%). Approve the tendency of increasing of the winter rainfalls as show the deviations for two periods of investigation. They are not statistical significant (Figure 15).
In early spring growing season in Northwestern Bulgaria, part of the Central Danube Plain and Dobrudja region in Northern Bulgaria SWA are between 90 and 95% of the FC (Figure 16). In Southeast Bulgaria (Haskovo, Sliven and Karnobat) precipitations for the period from October to March are no sufficient to compensate the water deficit in the soil in early spring vegetation. SWA varies between 85-90% of FC.

Figure 15. Deviation of rainfall sum during the period October-March

On the all over the arable land the SWA are decrease, except the western part of Thracian Lowland (Figure 17). The biggest decreasing in the northern part of Danubian Plain and the rest part of Thracian Lowland (stations Haskovo, Chirpan and Sliven), where are observed statistical significance difference between SWA during two periods of investigation.
In the early stages of spring vegetation soil water supply is usually sufficient, but in the process of developing their consumption increases.

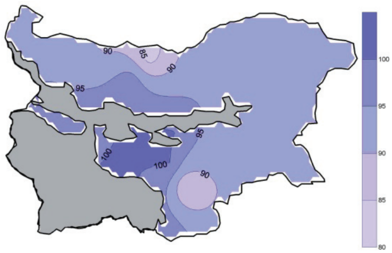

Figure 16. SWA in the beginning of wheat's spring vegetation for the top 100 cm

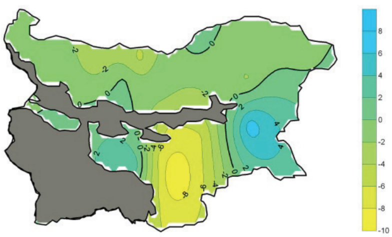

Figure 17. Deviation of SWA in the beginning of wheat's spring vegetation for the top 100 cm

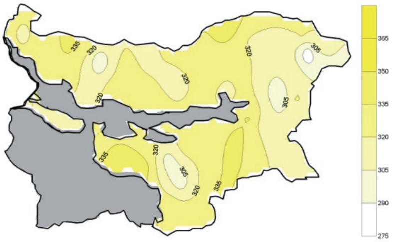

Figure 18. Evapotranspiration of winter wheat for April – June

CONCLUSIONS

During the autumn growing season SWA in layers 0-20 cm is sufficient Eastern Bulgaria and the central part of the Danubian Plain. During the sowing soil water supply in layer 0-20 cm ranges from 61% to 82% FC. The deviation of SWA on the top 20 cm for the period 1981-2010 in relation to 1971-2000 varies between -10 to 8% FC. They are increase only on Eastern Thracian Lowland and region of Sliven. Significant difference is established on the eastern part of Thracian Lowland (Chirpan, Haskovo).

Analysis of winter conditions shows that there are two areas in which more than 50% of the period temperatures remain below -15°C for more than three days - Central part of the Danubian Plain and the Central part of the Thracian Lowland. Analysis of cases with temperatures below -15°C, compared with the availability and snow cover depth shows that the largest percentage of days with snow cover less than 10 cm in Razgrad (48%), lowest in Buzovets (14%) and between 2-16% of cases there is no snow cover. The greatest risk of damage is in Northeastern Bulgaria and the North-Western regions;

In early spring growing season in Northwestern Bulgaria, part of the Central Danubian Plain and Dobrudja region in northern Bulgaria SWA are between 90 and 95% FC. Decreasing is observed in Thracian Lowland. The comparison between means for two periods 1971-2000 and 1981-2010 shows that statistically significant is the difference only in Haskovo.

Precipitation sum for October-March varied between 203 mm and 339 mm. Smaller are rainfall sums in Central part of Danubian Plain and Northern part of Thracian Lowland and greatest they are in Southern Bulgaria. Approve the tendency of increasing of the winter rainfalls as show the deviations for two periods of investigation. They are not statistically significant.

Water consumption of wheat during the period after the restoration of vegetation varies between 348 mm (Brashlyan) and 275 mm (Dobrich), the highest values are in the Thracian Lowland and the northern part of the Danubian Plain and Dobrudja in the Black Sea region wheat evapotranspiration is least.

The rainfall sum for the period April - June is the highest values in the regions of the Danube Plain and the Forebalkan. The Black Sea region, Dobrodja and the Thracian Lowland is characterized by the lowest values of the rainfall sum during this period. The comparison of two periods of investigation shows that the deviation varies between 0-30 mm, but on the bigger part is decrease with 10-20 mm. The t-test shows that no statistically significant differences between two periods of investigation.

Soil water availability during the earing ranges from 58 to 92% FC but in the majority of regions of investigation is 70-80% of FC. They are lower only in extreme eastern and part of northern regions. The difference between SWA during two thirty-year periods varies from - 9 to 5% and they are decrease on almost all arable land, except western part of Thracian Lowland. Bigger decreasing is observed in central part of Thracian Lowland and northern part of Danubian Plain where statistically significant differences (Haskovo, Novachene and Bazovetz) have.

In 50% of the years the rainfall sum during ear formation of watary ripe are sufficient to provide water for most of the agricultural areas, with the exception of some of the Northern areas of the Danube Plain, where the soil is more assured than optimal boundary during ear formation. There has been found correlation between the yield and the rainfall sum for the period of earing-watery ripe.

The values precipitation evaporation balance larger than 160-170 mm for the period April-June leads to depletion of soil water supply below optimal boundary. These include the region of Thracian Lowland, part of Dobrudja and the Northern part of the Central Danubian Plain. In areas with less water deficit can ensure normal growth and development and obtaining higher yields - Black Sea region, part of Ludogorie Balkan and northwestern Bulgaria.

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IMBIBITION OPPORTUNITIES OF FOREST SEEDS SPECIES TO REDUCE PROFOUND DORMANCY

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Abstract

The fact that the seeds of some forest species after maturation become profoundly dormant, leading to germination and emergence in the second year after planting, requires some investigation undertaken in order to reduce profound dormancy, considering that mechanical degrading of seminal coatings is a difficult operation which can lead to injuring the endosperm. In their turn, mechanical treatments can provide fast germination imbibitions, but done incorrectly, they can reduce germination potency.
This paper presents a mechanical method for reducing profound dormancy by degradation of the per carp and seed coat permeability for rapid penetration of water into the seed, the method to apply the mechanical treatments under various conditions of time, temperature and humidity.

Key words: *Ceratonia siliqua; dormans; forest seed; scarification.*

INTRODUCTION

Ceratonia siliqua (carob) seeds have been studied, which have been harvested from isolated trees which have been grown in the Southern area of Craiova, i.e. in the sandy area on the left side of river Jiu. Multiple qualities of the species: content of simple and complex carbohydrates, mucilage, pectin, starch and vitamins, using powders against diarrhoea, dysentery, gastritis and enterocolitis, as well as the importance of wood for furniture, constructions and fire, and also for harnessing sandy soils by harvesting it, increased requests of seedlings.
Since it is a tree which originates from the Mediterranean basin from the family of Fabaceae, it has adapted very well to geographic conditions and climate of our South-West part of the country in terms of climate and humidity.
Practical difficulties to obtain seedlings of this species have lead to conducting certain studies and research in order to find possibilities of seeds imbibitions until ensuring the necessary level of humidity in order to germinate and undergo attempts to interrupt deep sleep (Dormans) in various conditions of temperature and humidity. Actually the two represent the proposed objectives in order to achieve the paper.

MATERIALS AND METHODS

In terms of material, we used Ceratonia siliqua pods, harvested at full maturity. Harvesting included the following organisational measures:
- the number of seeds was established;
- the source of seeds was established;
- the phonological chart was drawn in order to establish correctly the date of beginning harvesting.

After harvesting: pods were weighted and humidity was determined. Dehiscent dry fruit, glad pods after dry were treated by mechanical crushing with the help of certain equipment which also separated seeds from pods by fanning. MMB was determined by obtaining the value of 206,7 grams.
In order to assess changing humidity under mechanical action (pericarp degradation) the studied mass of seeds was weighted, before the mechanical action of scarification, followed by placing it into water at room temperature of 22-24^{0}C, then they were weighted every 12-24-36-48 hours. Scarification was carried out with the help of a machine of selecting, removing and sensitising seeds pericarp from forest species.

Figure 1. Sample preparation for work

Table 1. Seed rating in processing pods

Sample	Total weight (g)	The Yield (g)		Nr. seeds
		Seeds	Peabody	
P1	15.77	3.94	11.84	20
P2	14.93	3.73	11.20	18
P3	16.15	4.03	12.11	21
P4	19.57	4.89	14.68	24
P5	16.83	4.20	12.62	22
P6	16.61	4.15	12.46	21
P7	17.45	4.36	13.09	22
P8	14.45	3.61	10.84	17

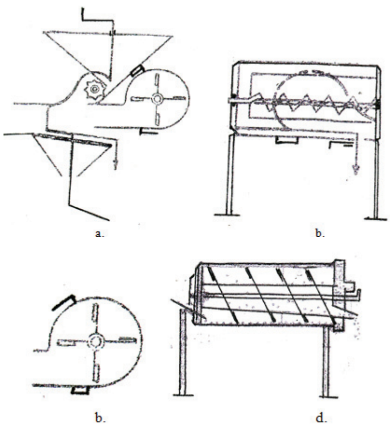

Figure 2. For the selected machine, dezaripat and pericarp of the seeds of sensitized species forestry. a. power supply system and the air flow separation; b. decorticator; c. radial-axial fan; d. conveyor with metal mesh trays for sorting and destruction of seed pericarp

RESULTS AND DISCUSSIONS

After scarification, seeds are under supervision and determination which are meant to establish their influence on seminal coatings and viability. In order to achieve this, 100 grams of seeds were put in small bags and placed in glass cylinders with 200 ml of water at room temperature.

Table 2. Tegument permeability according to the level of humidity after scarification

Initial state %	Humidity % at the time of immersion in water (h)			
	12	24	36	48
10.21 – 13.70	21.64 – 29.04	35.63 – 47.81	57.89- 77.68	67.60 – 90.70

Laboratory determination of the level of imbibitions with scarified seeds established that generally, while germinating, their humidity is 5-6 higher than their humidity while harvesting. Moreover, laboratory determinations performed with seeds in natural state (not scarified seeds) showed the fact that after a long period of time of approximately 120 hours, their initial state did not change, and with certain seeds the process of alteration was observed.

CONCLUSIONS

Degradation of the pericarp and tegument, drop resistance shall be carried out for the purposes of ingress of water into the seed and shortening the period of rest.

Degradation of the pericarp will appreciate after his resistance to mechanical crushing action (compression) measured in the Laboratory for Mechanics and Strength of Materials.

Drop resistance skin will be determined in the laboratory, depending on the degree of humidity of the seeds after a period of immersion in water.

The proposed Car can achieve separation of seeds by setting afloat speed, desariparea, selection and destruction of the pericarp.

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PROPOSALS TO REDUCE THE NEGATIVE EFFECTS OF RESTITUTION AND DEFORESTATION ON AGRICULTURAL LAND IN THE SOUTH OF OLTENIA

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Abstract

To achieve the establishment and maintenance technology of forest belts for crops and combating drought and desertification phenomena, activities of technology development, design, construction, testing of experimental models, demonstration of the functionality and utility of the technology developed and wide dissemination of results are carried out.
The paper was realised having as departure point the map of soils from the South of Oltenia, processed with the aid of SIG. The South area of district Dolj, though its geographical position it is situated under the influence of an excessive natural ground with annual average temperatures that are high enough, average annual precipitation of 400-500 mm and the value of the small aridity index is considered to be one of the most predisposed areas at the process of soil degradation due to drought phenomenon of drought – aridity – desert. Work of improvement and preservation of the soils must be advisable realised.

Key words: *erosion; management; protection curtains; retention of nutrients; structure.*

INTRODUCTION

The evaluation of the management of the soil quality represents the process of measuring the changes that took place in the quality of the soil, as a result of the agricultural practices adopted for the improvement of the economical performances obtained for the same field surface.
And the value of the small aridity index is considered to be one of the most predisposed areas at the process of soil degradation due to drought phenomenon of drought – aridity – desert.
The process of degradation of the soil, due to this phenomenon is defined as the actual or potential loss of productivity or the utility of the soil of the natural and atrophic factors.
The main processes that can aid the development of the phenomenon of degradation – desert can be identified in:
- biological degradation through the loss of organic substance;
- physical degradation due to structure.

Figure 1. Deconstruction of the soil through improper tillage

The influence of the texture on the processed of soil degradation is presented through at least two reasons:
the size and the modalities of disposure of the soil particles that at vulnerable at the action of the wind and water;
- the modification of the potential of retention of the water, making possible surface drainages.

Soil represents the main source of herbs in the cultures, due to the reserve of herbs seeds from the soil, reserve that can be used for the realization of the green areas, of protection of the cultures through Aeolian deflation, by application of some specific technologies in that area and leaving some unprocessed surfaces in which high herbs will be developed up to the blossom period, when will be destroyed.

The massive content of organic matter can be associated with some activities carried out by man the intensive usage of the tillage, of leaving the uncultivated field during summer time, burning the stubble filed, etc.

a.

b.

c.

Figure 2. Uuncultivated field during summer time

MATERIALS AND METHODS

The land that belonged to SCCCPN and which were Dăbuleni returned to the population in the area.

Work of improvement and preservation of the soils must be advisable realised. It is imposed that a part of these fields, with reduced fertility capacity be passed in the forester filed and to facilitate the foundation of protection curtains.

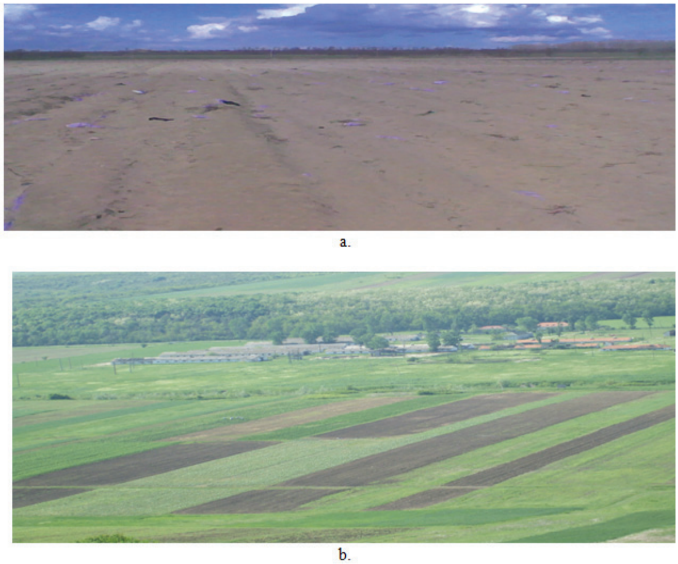

Figure 3. The land that belonged to SCCCPN and which were Dăbuleni returned to the population in the area.

Figure 4. Foundation of protection bands trip, in the autumn, with sowing

Figure 5. With mulch foil ready for planting

Figure 6. Area of land planted with mulch, to be covered with shrink tunnel

RESULTS AND DISCUSSIONS

The impact of mechanization on the environment and the soil should be highlighted by the fact that any agricultural aggregate is part of a context which does not only refer to the technique or technology is adopted but also functional issues related to technology and to the choice of the best periods for carrying out agricultural works.

These two factors are of great importance both for the purposes of reducing the cost and over the land. Climate change in the South-western part of compaction and not only the physical characteristics and chemical modification of land leading to the realization of a concept in the case of processing land especially the sand from this area.

The use of agronomic practices and soil management systems and environmental protection are responsible for the main effects on a specific type of farming area and can be valid and timely solutions to achieve high yields by using effective natural resources and manpower in the area. This type of agriculture must transform as little soil and organic substance composition, fertility, structure and natural biodiversity to avoid such degradation, erosion of any kind but also compact.

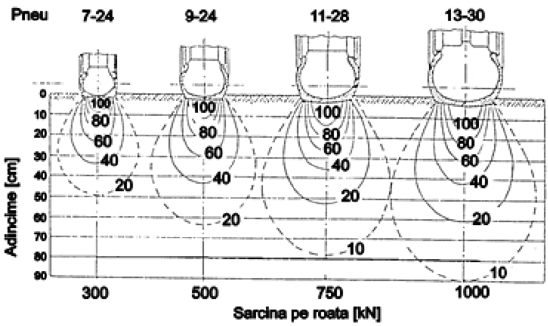

Figure 7. Influence of air-whel load about on izostatics curves in vertical-transversal plain at filled interior presure pi=82 Kpa

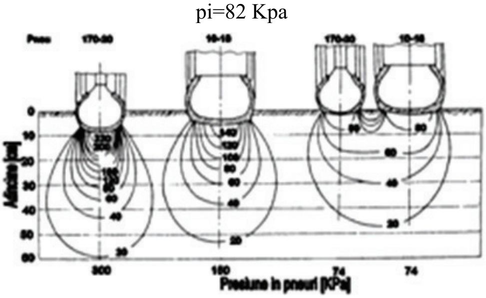

Figure 8. Influence of wheel air-pressure about on curves repartition in soil

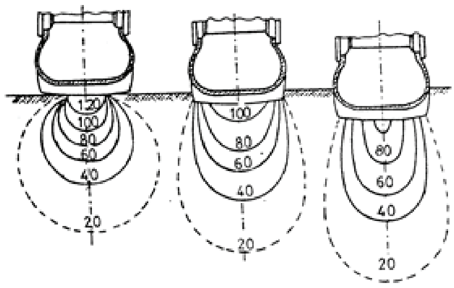

Figure 9. Repartition of izostatics curves pressure pi=90Kpa and load of 10 KN: a-hard soil; b-average soil; c-wet and low soil

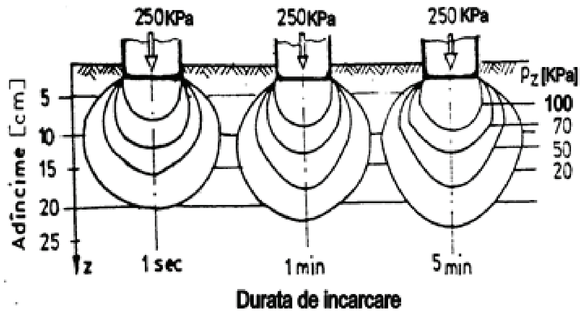

Figure 10. Influence of time charge of wheels about on izostatics curves repartition in case of a constant require on wheel

Agriculture includes such techniques as: no tillage, direct sowing or minimum tillage reduced processing. Also, the use of protected crops, especially with foil mulches or establishing protective curtains from cultures with high waist (rye) or curtains.

CONCLUSIONS

- Reduction of traffic on the ground;
- Traffic Control area cultivated by use of plant life;
- Reducing the number of works by applying non-till system;
- Using light equipment;
- Agricultural equipment with wheels in tandem;
- Practicing crop rotations that include plants with deep roots and penetrating power.

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STRUCTURE, DYNAMICS AND ABUNDANCE OF CARABID SPECIES COLLECTED IN CORN FIELDS

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Abstract

Corn agricultural agroecosystems is considered unstable ecosystems, with specific interdependencies between different food chains that natural factors play a role. A large number of insects are living in the maize agroecosystem, being a species community and each species has a particular place in the food chains. If a lot of studies were done, in Romania about biology, ecology and control of corn insect pest, there are little knowledge aboutepigeal fauna captured fauna in pitfall traps (Barber).Experiences from 2011-2012 had the main objective to observe the potential impact of GMO-maize on the epigeal fauna. (39.7%), Pterostichus vulgaris L. 1758 = [P. (Morphnosoma) melanarius Illiger 1798] (32.5%), Carabus coriaceus L.1758 (18.3%), Pterostichus melas Creutzer 1799 (5.3%), Pseudoophonus (Harpalus) rufipes De Geer 1774 (2.2%) and Pterostichus cupreus L. 1758 (2.0%). Cultivation of genetically modified corn, has no influence on epigeal fauna, field cultivated with this type of plants has no observed differences regarding fauna biodiversity. Data obtained regarding resemblance of whole insect fauna from those cultural variant, taken into consideration, represented by value of Sorensen index, confirm idea that corn hybrids containing transformation event has no evident influence on epigeal carabid insect fauna from corn field.

Key words: *Transgenic corn hybrids, epigeal fauna, Carabidae.*

INTRODUCTION

In recent years concerns have been supported to identify animal species existing in different cultures (Baicu, 1980; Barbulescu et al., 1993; Muresan et al., 1973; Voicu et al., 1993). Corn agricultural agroecosystems is considered unstable ecosystems, with specific interdependencies between different food chains. If a lot of studies were done, in Romania about biology, ecology and control of corn insect pest (Barbulescu et al., 2000; Costea et all., 2011 a, b), Few data are known about, generally on useful fauna, especially on predatory fauna existing in corn fields in Romania (Perju et al., 1988; Rosca, 2004; Rosca and Istrate, 2004). After the Ionescu (1962) family Carabidae beetles includes only land insects with rapid movement, which live generally at the soil surface, rarely climb on trees (Calosoma). In the world are over 40,000 species known, of which 2,700 are reported in Europe (www.en.wikipedia.org / wiki / Ground_beetle). In Europe 328 genera are known and in Romania 125 (www.faunaeur.org/). Their systematic is complicated, but in general allowed the existing website Iowa State University (http://bugguide.net), which includes 14 subfamilies and 47 tribes. Almost all Carabidae are predatory to invertebrates, some are specialized for a particular type of food, some are phytophagous other ommnivore. Carabidae density in ecocenosis, varies from 1 to 1000/m^2 depending on ecosystem and wintering place. Most are nocturnal carabid species (60%) than diurnal (20%), nocturnal populations, are in general more numerous having a darknes coloration of the body, in the meantime those diurnl have iridescent colors. *Pterostichus cupreus*, species that runs on the ground in search of food, has two characteristic ways of looking for food (aphids fallen from the plant), and when he finds them change their behavior climbing on plant for food (Matalin, 2008). Structure and size of populations of different species of Carabidae analyzed ecosystem depends of course but also analyzed period (years and/or period) (Carlan and Varvara, 1999; Donescu and Varvara, 1999; Talmaciu, 1996; Varvara and Brudea, 1983; Varvara et all., 1989, 1991 Bažok et al., 2007).

MATERIALS AND METHODS

Researches were made during two years (2011 and 2012), each year starting from May to October. The entomologic material for the study was collected in centre for variety testing and registration Troian, where were 14 corn cultivars [7 conventional corn hybrids and 7 hybrids containing transformation events (glyphosate-tolerant, corn rootworm protected, resistant to Lepidopteran and with two of transformation events)]. Variants were in 4 replications, each corn plot had 4 rows and plot's area was 20.3 m^2. Sowing time was 16 May in 2011 and 22 May in 2012. Specimens of epigeal fauna were collected with 16 Barber soil traps (Figure 1), 4/replication (2 in area of conventional corn hybrids and 2 in area of corn hybrids containing transformation events). There were used yogurt plastic jars protected by lid, with a 1000 ml volume, 12.5 cm width and 13.0 cm height. Diluted acetic acid 50% was used as fixing and preserving liquid, a few drops of detergent were put in the traps to reduce surface tension. The traps were opened for 48 hours and specimens captured there were collected and labeled. The samples labeled were protected from sunlight and transported to the laboratory for analysis and determination. Soil Barber traps were installed at the emergence of corn seedlings (middle of May), harvested and replaced, the material was collected biweekly (in 2011 on 31 May; 14, 28 June; 12, 26 July; 9, 23 August; 6 September, in 2012 on 29 May; 12, 26 June; 10, 24, July; 7, 21 August; 4 September).

Figure 1. Soil traps Barber type

Samples of biological material collected were taken to the laboratory where they were subject to inventory and were cleaned and then collected insects were determined. Determination of the material was performed using entomological key books, with a stereomicroscope, a binocular magnifier and using inventory provided by the discipline of Entomology of the USAMV-Bucharest.

RESULTS AND DISCUSSIONS

There are collected in total 626 Carabid specimens, 11 species were determinate, from those we consider that only those over 10 specimens are representative, thus only 6 Carabid specimens collected belong to this category (457 specimens), most common being *Harpalus distinguendus*http://eol.org/ and www.faunaeur.org/. Taking into consideration the number of Carabid specimens captured in conventional corn field versus those from fields cultivated with corn hybrids containing transformation events it was the remark that there is no significant differrences (295 respective 331 specimens). A comparison was made in terms of animal community structure obtained by similarity index 'Sörensen' by comparing two different fauna by the formula: Is=2c/a+b x 100. Where: Is = Sörensen index c = number of species common to the two faunas compared, a = number of fauna species existing only in first evaluated by comparison, b = number of species existing only in the second fauna evaluated by comparison. 100% means that there are no differences between fauna and 1% means that the two are completely different fauna. Sörensen index value (96.55%), obtained on whole insect fauna of Carabidae from these two variables investigated (fauna observed in maize fields with conventional and with genetic transformation elements) confirming the idea that fauna is not significantly different in plots with conventional corn from the GM.

CONCLUSIONS

Our data confirm generally supposition that predator Carabid fauna from corn fields has no so many species than other ecosystems.

There are no differences on the structure and quantity of wildlife common Carabidae between different types of corn hybrids [conventional and those containing transformation events (glyphosate-tolerant, corn rootworm protected, resistant to Lepidopteran and with two of transformation events)].

Table 1. Structure of Carabid species captured in Barber soil traps

Nr. crt.	Corn hybrids Species and classification	Conventional corn hybrids	Corn hybrids containing transformation events*
	Order Coleoptera		
	Superfamily CARABOIDEA		
	Subfamily CARABINAE		
	Tribe CARABINI		
1	*Calosoma* (Weber 1801) spp.	8	12
2	*Carabus glabratus Paykull, 1790*	1	
3	*Carabus coriaceus* L.1758	36	47
	Tribe CICINDELINI		
4	*Cicindela campestris* L. 1758	3	1
	Subfamily HARPALINAE		
	Tribe HARPALINI		
5	*Harpalus distinguendus* Duftschmidt 1812	85	96
6	*Pseudoophonus griseus* Panzer 1797	1	2
7	*Pseudoophonus* (Harpalus) *rufipes* De Geer 1774	4	7
	Subfamily PLATYNINAE		
	Tribe SPHODRINI		
8	*Dolichus halensis* Schaller 1783	1	4
	Subfamily PTEROSTICHINAE		
	Tribe PTEROSTICHINI		
9	*Abax* (Bonelli 1810) spp.	16	14
10	*Pterostichus vulgaris* L. 1758 = [P. (Morphnosoma) melanarius Illiger 1798	77	71
11	*Pterostichus* (Poecilus) *cupreus* L 1758	5	5
12	*Pterostichus melas* Creutzer 1799	9	15
	Tribe ZABRINI		
13	*Amara* (Bonelli 1810) spp.	20	24
	Subfamily SCARITINAE		
	Tribe CLIVININI		
14	*Clivina fossor* L. 1761	1	4
	Subfamily TRECHINAE		
	Tribe BEMBIDIINI		
15	*Bembidion* Latreille 1802	5	3
	Total specimens	**295**	**331**

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RESEARCHES REGARDING EVOLUTION OF SPECIAE *Chrysoperla carnea* - *Neuroptera* FAUNA IN CORN AGRO ECOSYSTEM

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Abstract

Corn agricultural agroecosystems is considered unstable ecosystems, with specific interdependencies between different food chains that natural factors play a role. A large number of insects are living in the maize agroecosystem, being a species community and each species has a particular place in the food chains. If a lot of studies were done, in Romania about biology, ecology and control of corn insect pest, there are little knowledge about beneficial fauna especially on the correlation between presences of Chrysoperla carnea species during different phases of corn vegetation. Evolution of Chrysoperla carnea population was assessed using yellow sticky traps, type Pherocone AM trap, which were installed, harvested and replaced, biweekly. Experiences from 2011-2012 had the main objective to observe the potential impact of GMO-maize on Chrysoperla carnea for Neuropteran fauna existing on 14 corn cultivars (7 conventional corn hybrids and 7 hybrids containing transformation events (glyphosate-tolerant, corn rootworm protected, resistant to Lepidopteran and with two of transformation events).Variants were in 4 replications, each corn plot had 4 rows and plot's area was 20.3 m^2. the flowering stage in corn, which involves pollen shed and silking, then this reduces their agroecosystem easy (their presence will continue to be significant) and their number gradually reduce towards the end of vegetation maize. There are no differences on the structure and quantity of wildlife Neuropterans between different hybrids.

Key words: *Transgenic corn hybrids, yellow sticky traps, Chrysoperla carnea.*

INTRODUCTION

In recent years concerns have been supported to identify animal species existing in different cultures (Baicu, 1990; Barbulescu et al., 1993; Muresan et al., 1973; Voicu et al., 1993). Corn agricultural agroecosystems is considered unstable ecosystems, with specific interdependencies between different food chains. If a lot of studies were done, in Romania about biology, ecology and control of corn insect pest (Barbulescu et al., 2000; Costea et al., 2011 a,b), Few data are known about, generally on useful fauna, especially on predatory fauna existing in corn fields in Romania (Perju et al., 1988; Rosca et al., 2007; Rosca and Istrate, 2008). *Chrysoperla carnea*, known as the common green lacewing, is an insect from the Chrysopidae family. The adults feed on nectar, pollen and aphid honeydew but the larvae are active predators and feed on aphids and other small insects. It has been used in the biological control of insect pests on crops (Henry et al., 2002). Polyphagous species *Chrysoperla carnea* is a common representative of useful fauna in respect with their larval stage, taking into consideration that larvae are mobile, voracious searching all the plant for pray, generally small animals (adults, larvae and eggs) with soft bodies. Prey is mostly from the order Homopterous and is predominantly aphids on low growing vegetation (Bellows and Fisher, 1999). Of course there are adults of common green lacewing in corn fields especially when on corn plants are aphid colonies. On crops, the larvae have been reported as attacking several species of aphids, red spider mites, thrips, whitefly, the eggs of leafhoppers, leaf miners, psyllids, small moths and caterpillars, beetle larvae and the tobacco budworm. (Hoffmann and Frodsham, 1993). The present investigation was carried out to study the biology of common green lacewing, related with the presence of *C. carnea* (Figure 1) adults in corn field in correlation with corn flowering, in condition of Romania.

Figure 1. Adult *Chrysoperla carnea*

Figure2. Yelow sticky trap (ICCN type)

MATERIALS AND METHODS

The experiment was done in centre for variety testing and registration Troian, where were *14 corn cultivars* [7 conventional corn hybrids and 7 hybrids containing transformation events (glyphosate-tolerant, corn rootworm protected, resistant to Lepidopteran and with two of transformation events)]. Variants were in 4 replications, each corn plot had 4 rows and plot's area was 20.3 m^2. Sowing time was 16 May in 2011 and 22 May in 2012. Dynamic of *Chrysoperla carnea* adult flight in corn field was assessed using yellow sticky traps, type Pherocone AM trap, in 2011 and ICCN in 2012 (Figure 2), 6/replication (3 in area of conventional corn hybrids and 3 in area of corn hybrids containing transformation events). Yellow sticky traps were installed at the emergence of corn seedlings (middle of May), harvested and replaced, weekly (in 2011 on 31 May; 7, 14, 21, 28 June; 5, 12, 19, 26 July; 2, 9, 16, 23 and 30 August; 6 September, in 2012 on 22 and 29 May; 5, 12, 19, 26 June; 3, 10, 17, 24, 31 July; 7, 14, 21 and 28 August). Yellow sticky traps were maintained till transportation and analysing at +4^{0}C, as soon was possible were analysed by taking out (with glue) and counting *Chrysoperla carnea* specimens. It was correlated the flowering stage in corn, which involves pollen shed and silking, (the most critical period in the development of a corn plant) with the presence of common green lacewing adults feeding with nectar, pollen and aphid honeydew, because in this period it seems that aphid population reched a peak in it's development (Figure 3).

Figure 3. Aphid colony on corn

RESULTS AND DISCUSSIONS

The order Neuroptera, or net-winged insects, include the *Chrysoperla carnea*, known as the common green lacewing between other predatory species (Brooks and Barnard, 1990; Grimaldi and Engel, 2005). The importance of Neuroptera for different agrocoenoses was discussed previously (New, 1975; McEwen, et all., 2001; Paulian, 2001). A lot of insect groups were captured on yellow sticky traps and comparison of proportion, it is noted that the most numerous are in 2011 Coccinellidae, in 2012 the most numerous are in Syrphid. The most widespread neuropteran species is *Chrysopa carnea*. In Romanian' conditions there are 1-2 generations of common green lacewing (*Chrysopa carnea*), adults generally live from 1-3 months depending on temperature, humidity and quality of food sources. In Europe, in areas cultivated with corn, Neuropteran populations is developed numerous in late July, when numbers reach a peak of development, then this reduces their agroecosystem easy (their presence will continue to be significant) and their number gradually reduce towards the end of vegetation maize. The biology' of various species of chrysopids has been studied on different hosts by several authors. Tassel emerges and pollen shed begins 2-3 days prior to silk emergence and in the next period continue to elongate until fertilized. In this period of time is necessary to scout for corn leaf aphids, corn rootworm adults and symptoms (goose neck) caused by rootworm larva. From figures 1 and 2 we can see that the common green lacewing (*Chrysoperla carnea*) total was 141 specimens, in 2011, of which 73 specimens were captured in the plots with conventional hybrids and 68 specimens were captured in the plots with hybrids containing transformation events and 148 specimens, in 2012, of which 71 specimens were captured in the plots with conventional hybrids and 77 specimens were captured in the plots with hybrids containing transformation events.

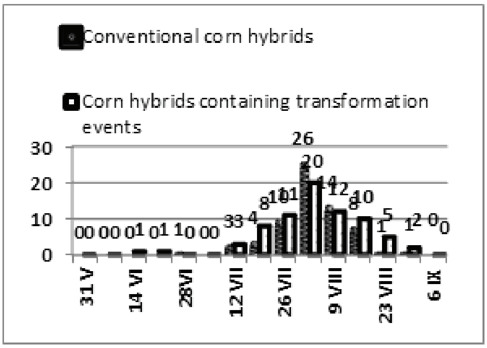

Figure 4. Evolution of specimens of *Chrysoperla carnea* captured on yellow sticky traps in 2011

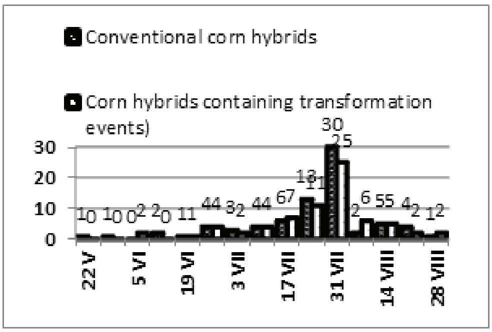

Figure 5. Evolution of specimens of *Chrysoperla carnea* captured on yellow sticky traps in 2012

In this respect our data confirm generally supposition that this predator is coming in corn fields only for food, after panicle appearance at beginning fall corn pollen and silk emergence, because the adults feed on nectar, pollen and aphid honeydew but the larvae are active predators and feed on aphids and other small insects, which started, in this period, to develop aphid colony on corn. Thus from the total of 141 specimens captured throughout the period in which observations were made, 129 (91.5%) were captured during July 12 - 16 August, in 2011, and respectively 118 (79.7) during 10 July - 14 August, in 2012, when corn began to form pollen and silks and continue to remain on corn until the plants remain relatively green, allowing the development of colonies of aphids and larvae feeding predator default. There are no differences on the structure and quantity of wildlife Neuropterans between different types of corn hybrids.

CONCLUSIONS

Our data confirm generally supposition that this predator is coming in corn fields only for food, after panicle appearance at beginning fall corn pollen and silk emergence.

There are no differences on the structure and quantity of wildlife common green lacewing (*Chrysoperla carnea*) between different types of corn hybrids [conventional and those containing transformation events (glyphosate-tolerant, corn rootworm protected, resistant to Lepidopteran and with two of transformation events)]..

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CONTRIBUTION TO THE SCIENTIFIC FUNDAMENTATION OF DIVERSIFYING THE BIOLOGICAL FUND WITHIN SPECIES WITH SANOGENIC PROPERTIES *Ribes nigrum* AND *Ribes Rubrum*

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Abstract

In the context of development the concept with regard to the role of diversification the plant species with sanogenic properties about increasing the quality of life, they were initiated at the University of Agricultural Sciences and Veterinary Medicine Bucharest, Romania, researches on diversity of biological fund at the species Ribes nigrum and Ribes rubrum.
This paper emphasize in synthesis, the results of the research developed during 2010 - 2012, with regard to the particularities of biological, agronomic and adaptability characteristics of varieties Roxia, Kzvana, Deea, Elita 124, Tinker, Triton, Abanos, Tenah of the Ribes nigrum species and Tatran, Elite, Rolan, Detwar, Jonkheer van Tets of the Ribes rubrum species.
The plants of the varieties studied are in the juvenile period, the main characteristic being the alert rhythm of growth and the balance between growth and development. Under this aspect, were detached the varieties Roxia, Elita 124, Kzvana, Deea of the Ribes nigrum species and Jonkheer van Tets, Rolan, Detwar of the Ribes rubrum species.
In terms of productivity have been remarked the varieties Deea, Roxia, Kzvana of the Ribes nigrum species and Rolan and Jonkheer van Tets of the Ribes rubrum species.

Key words: *evolution,milk production, NW Region, Romania, trends.*

INTRODUCTION

Biodiversity, as a concept, was introduced by biologists for the first time in the middle of the 1980's. After this concept was elaborated, the diversity of living systems started to be studied intensively, with regard to the diversity of the species belonging to the plant and animal world and some intrinsic properties of the studied ecosystems and communities were identified. (Vasilevich, 2009). In this context, lately, the scientific interest has raised towards the plant species with health promoting properties, the genus *Ribes* being one of them. During the recent years the scientific interest has raised towards the species belonging to this genus and also towards the varieties of these species. This happened, due to the taste of the fruit as well as the health benefits generated by their consumption. To these benefits, there can be added the possibility of therapeutically exploiting the plant components (Oprea, 2008; Liobicas, 2008; Ikuta, 2012; Mitchell et al., 2011).

The blackcurrant (*Ribes nigrum* L.) represents a very important culture in Poland, Central Europe and Northern Europe as well as in all the slightly temperate areas of the world. The most important attributes that show phenotypic diversity between the varieties of currants are: the size and the development stage of the fruit, the number of shots, the fruiting yield and the susceptibility of pests and diseases (Madry, 2010). Therefore, the varieties of *Ribes nigrum* and *Ribes rubrum* species are cultivated or their economically importance on one hand, and on the other hand for their health promoting and nutraceutical properties (M.E.Arena, 2008) which makes that the interest towards the spread of their cultivation to growth all over the world, including United States of America (Hummer and Dale, 2010).
The aim of this study is to make a contribution to the biological fund diversity within species *Ribes nigrum* and *Ribes rubrum*, by identifying superior varieties in terms of growth and development characteristics, fructification and

productivity as an indicator of their adaptability to the study area.

MATERIALS AND METHODS

The research has been conducted in the orchard of the Experimental Teaching Field, University of Agronomic Sciences and Veterinary Medicine of Bucharest, as well as the experimental field of Faculty of Agriculture, part of the specialization Biology. The experiments were done during the year 2012, on a currants plantation which includes the species *Ribes nigrum* and *Ribes rubrum* with the following varieties: Deea, Roxia, Elita 124, Abanos, Triton, Tenah, Kzvana, Tinker and Rolan, Jonkheer van Tets, Detwar, Tatran, Elite.

The collected data from the field and laboratory were summarized and statistically analyzed applying Student's t test considering the average values of the characteristics of each variety analyzed. For each characteristic analyzed were calculated standard deviation of the arithmetic mean, coefficient of variation and the t value.

RESULTS AND DISCUSSIONS

The growth of the length of shoots during the annual cycle, represents growth and development characteristic for *Ribesnigrum* and *Ribes rubrum* varieties which can aide in determining the growth rhythm of the plants.

Based on the measurements, determinations and statistical analysis a few observations have been emphasized the following: the growth limits, the variability of the characteristics expressed by the variability coefficient and the significance of the growth differences varieties and species.

The determinations in the length of shoots during the intensive growth period April – May, showed a big variability of this characteristic for the varieties of *Ribes nigrum* as well as for the varieties of *Ribes rubrum*. For the varieties of *Ribes nigrum*, the variability coefficient S% had values between 26.96 and 46.96 (Table 1). With regard to the variability in the length of the shoots, the varieties Abanos and Elita 124 showed the best results, with the limits for their groups 3.60 – 84.5 and 12.50 – 82.00 cm, respectively.

Table 1. The length of shoots variation of *Ribes nigrum* varieties

Length of shoots of blackcurrant varieties in the third year after planting				
No. crt.	Variety	Class limits (cm)	Centers of class (cm)	S%
1	Kzvana	14.5-77.5	19-73.00	35.9
2	Deea	14.00-68.00	17.56-64.14	35.6
3	Roxia	14.50-73	18.68-68.82	26.96
4	Elita 124	12.50-82.00	17.46-77.04	43.08
5	Abanos	3.60-84.5	9.38-78.72	46.96
6	Triton	12.60-53.70	15.54-50.76	38.33
7	Tenach	17.30-43.50	19.17-41.63	29.27
8	Tinker	2.00-46.70	5.19-43.51	39.94

Following the same example, the determinations for the length of shoots during the intensive growth period for the varieties of the *Ribes rubrum* species showed a high variability, S% coefficient having values between 27.01 and 76.6 cm (Table 2).

Table 2. The length of shoots variation of *Ribes nigrum* varieties

Length of shoots of redcurrant varieties in the third year after planting				
No. crt	Variety	Class limits (cm)	Centers of class (cm)	S%
1	Elite	1.00-59.00	5.14-54.86	76.6
2	Rolan	12.20-34.50	13.79-32.91	42.65
3	J van Tets	2.70-40.60	5.41-37.89	27.1
4	Tatran	4.70-38.80	7.14-36.36	33.27
5	Detwar	13.70-41.80	15.71-39.79	25.04

Amongst the species *Ribes rubrum* the best varieties were Elite and Detwar with class limits between 1.00 – 59.00 cm and 13.70 – 41.80 cm, respectively.

Third year after planting, 50% of the varieties in the *Ribes nigrum* species can be found distributed between the class limits of variation of the length of shoots with values between 33.35 and 35.21 cm (Figure 1). With regard to this aspect, the varieties Abanos, Elita 124, Roxia and Kzvana showed the highest levels.

A 40% of the varieties of the *Ribes rubrum* species can be found between the class limits of variation for the length of the shoots with maximum values between 20.66 and 21.09 cm (Figure 2). According to this aspect, the varieties Rolan and Jonkheer van Tets showed the highest levels.

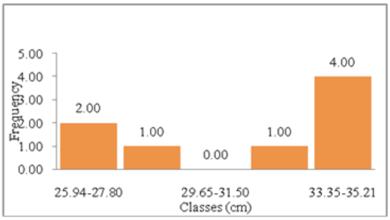

Figure 1. Length histogram varieties of *Ribes nigrum* shoots

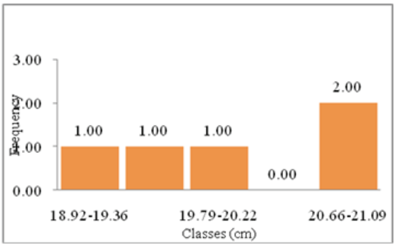

Figure 2. Length histogram varieties of *Ribes rubrum* shoots

The highest value for the growth of the shoots was identified for the *Ribes rubrum* variety, Elite with 59 cm, nonetheless, the Abanos variety showed superior values (84.5 cm) belonging to the *Ribes nigrum* species, being with almost 50% bigger than the Elite variety.

With regard to the aspect of the significance of the differences of the means for the growth of the shoots for *Ribes nigrum* species, the t value was compared with the t values for the 3 transgression probabilities. Therefore, there could be shown that the determined t value for the Tinker variety is higher than each one of the other t values which means that the difference is very significant (Table 3).

Regarding to the aspect of the significance of the differences between the means of the growth of the shoots for the Ribes rubrum species, the difference between the means length of the shoots was insignificant (Table 4).

With regard to the production characteristics of the currants during June -July 2012, the following characteristics have been analyzed: the weight of bunches, berries and raceme. Also, the production per shrub and per hectare. Therefore, the determination for the weight of bunches showed a very high variability for the both species. The variability coefficient S% had values between 46.88 and 54.41 for the varieties of the *Ribes nigrum* species (Table 5).

According to that, the aspect of the variability of the weight of the bunches, the best varieties were Deea and Roxia with their class limits between 1.03 – 15.87 g and 1.42 – 13.14 g, respectively.

Table 3. The significance of differences between the growth means of shoots of *Ribes nigrum* varieties

Variety	t calculated	Degrees of freedom	t 5%	t 1%	t 0.5%	Significance*
Kzvana	-1.42	33.02	2.035	2.733	3.008	○○○
Deea	1.01	30.62	2.04	2.744	3.022	xx
Roxia	-1.04	32.78	2.035	2.733	3.008	○○○
Elita 124	-1.40	33.40	2.032	2.728	3.002	○○○
Abanos	-1.23	33.04	2.035	2.733	3.008	○○○
Triton	2.11	29.42	2.042	2.75	3.03	xx
Tenach	-0.49	32.12	2.037	2.738	3.015	○
Tinker	2.68	28.89	2.045	2.756	3.038	xxx

High significant - xxx, significant - xx, insignificant – x (positive values);
High significant - ○○○, significant - ○○, insignificant – ○ (negative values).

Table 4. The significance of differences between the growth means of shoots of *Ribes rubrum* varieties

Variety	t calculated	Degrees of freedom	t 5%	t 1%	t 0.5%	Significance*
Elite	0.15	20.04	2.086	2.845	3.153	x
Rolan	0.10	20.07	2.086	2.845	3.153	x
J van Tets	0.35	19.53	2.086	2.845	3.153	x
Tatran	-0.33	20.46	2.08	2.831	3.135	○
Detwar	-0.79	20.61	2.08	2.831	3.135	○

Table 5. Bunch weight variation for *Ribes nigrum* varieties

Greutatea ciorchinilor la soiurile de *Ribes nigrum* in anul III de la plantare				
No. crt.	Variety	Class limits (cm)	Centers of class (cm)	S%
1	Kzvana	0.4-11.00	1.16-10.24	54.41
2	Deea	1.03-15.87	2.09-14.81	52.62
3	Roxia	1.42-13.14	2.26-12.30	46.88
4	Tinker	0.85-10.51	1.54-9.82	48.91

Following the same pattern, in the case of *Ribes rubrum* species, the determinations for the weight of the bunches being in the mature stage, showed a high variability, S% coefficient having values between 43.47 and 69.18 g (Table 6).

The *Ribes rubrum* species shows two parts equal to 40% amongst the varieties that are distributed between 2 limits of the class variation for the weight of the bunches with minimum values between 2.42 g and 2.55 g and maximum values between 2.94 g and 3.97 g (Figure 4). Regarding to the highest weight reached, have been highlighted varieties Rolan and Jonkheer van Tets.

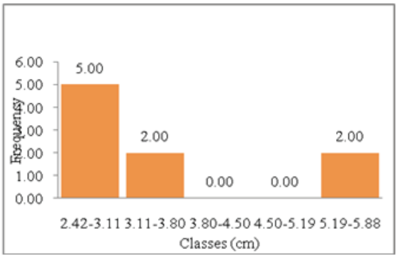

Figure 3. Weight of bunches histogram for *Ribes nigrum* varieties

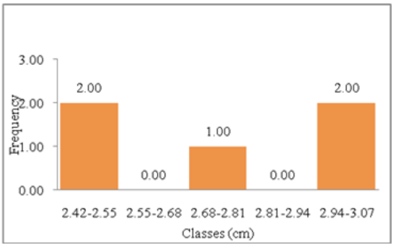

Figure 4. Weight of bunches histogram for *Ribes rubrum* varieties

Table 6. The significance of differences between the growth means of bunches of *Ribes nigrum* varieties

Variety	t calculated	Degrees of freedom	t 5%	t 1%	t 0.5%	Significance*
Kzvana	0.35	4.03	2.776	4.604	5.598	X
Deea	-0.33	5.17	2.571	4.032	4.773	○
Roxia	-0.27	4.92	2.571	4.032	4.773	○
Tinker	0.48	3.99	2.776	4.604	5.598	X

High significant - xxx, significant - xx, insignificant – x (positive values);
High significant - ○○○, significant - ○○, insignificant – ○ (negative values).

In terms of significance of differences between the average of *Ribes nigrum* bunches, comparing determined t value with the t value belonging to the 3 probabilities of transgression, the positive and negative differences are both insignificant (Table 7).
Under the aspect of significance of the differences between the weight means of bunches for the *Ribes rubrum* varieties, the difference of the means is insignificant (Table 8).

Table 7. The significance of differences between the growth means of bunches of *Ribes rubrum* varieties

Variety	t calculated	Degrees of freedom	t 5%	t 1%	t 0.5%	Significance*
Detwar	-0.24	6.73	2.365	3.499	4.029	○
Tatran	0.35	8.28	2.306	3.355	3.833	X
Elite	-0.24	8.34	2.262	3.25	3.69	○
Rolan	-0.20	6.78	2.365	3.499	4.029	○
J. van. Tets	0.47	8.53	2.262	3.25	3.69	x

High significant - xxx, significant - xx, insignificant – x (positive values);
High significant - ○○○, significant - ○○, insignificant – ○ (negative values).

Table 8. Berries weight variation for *Ribes nigrum* varieties

No. crt.	Variety	Class limits (cm)	Centers of class (cm)	S%
1	Kzvana	0.39-10.90	1.14-10.15	52.87
2	Deea	1.02-15.73	2.07-14.68	52.63
3	Roxia	1.41-13.06	2.24-12.23	47.4
4	Tinker	0.82-10.44	1.51-9.75	49.41

Another characteristic of production studied was the weight of berries. Therefore, the determination of the weight of berries showed a high variability, which was similar in the case of bunches weight variability analyzed. The coefficient of variation S% ranged between 47.4 - 52.87 in varieties of *Ribes nigrum* species (Table 9). In terms of berries weight variability characteristic, varieties detached have been Deea and Roxia class limits 1.02 - 15.73 g and 1.41 - 13.06 g.
Also, varieties of *Ribes rubrum* showed a high variability S% ranging from 44.51 to 70.3. In this regard have been remarked varieties Elite and Rolan, with class limits were between 0.66 - 13.14 and 0.22 - 10.38.

Table 9. Berries weight variation for *Ribes rubrum* varieties

No. crt.	Variety	Class limits (cm)	Centers of class (cm)	S%
1	Detwar	0.49-5.54	0.85-5.18	58.34
2	Tatran	0.41-8.05	0.96-7.50	70.3
3	Elite	0.66-13.14	1.55-12.25	66.99
4	Rolan	0.22-10.38	0.95-9.65	61.18
5	J. van. Tets	0.76-6.29	1.16-5.90	44.51

Following the calculations performed on the varieties of the *Ribes nigrum* species, a percentage of 25% of berries was distributed between classes of variation with maximum values being in the ranges of 5.36 - 5.83 g (Figure 5). On this aspect was highlighted Deea variety.

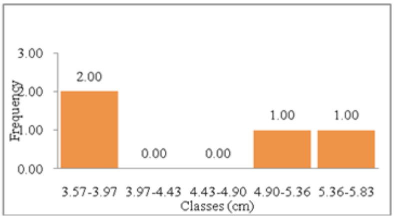

Figure 5. Weight of bunches histogram for *Ribes nigrum* varieties

About the weight of berries we can say that according to Figure 6, *Ribes rubrum* varieties have a 60% of berries distributed between class of variation with maximum values located between ranges 2.89 - 3.02. Therefore, Tatran, Elite and Jonkheer van Tets varieties were revealed.

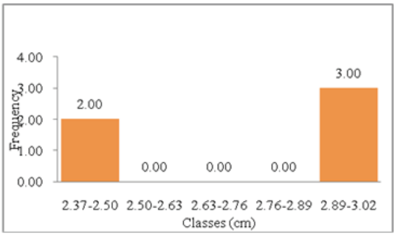

Figure 6. Weight of bunches histogram for *Ribes rubrum* varieties

Under the aspect of meaning, the differences of the means of berries weight of *Ribes nigrum* species, the difference of the means is insignificant (Table 10).
With regard to the weight of berries was emphasized being a slight weight difference between the averages of the *Ribes rubrum varieties* (Table 11).
The production of currants was expressed in tone per hectare and represents the biological production for the June - July period. The average production of bunches, berries and raceme/shrub was expressed in grams (Table 13). Also has been calculated the production for the shrub expressed in kilograms and tone per ha.

Table 10. Berries weight variation of *Ribes nigrum* varieties

Variety	t calculated	Degrees of freedom	t 5%	t 1%	t 0.5%	Significance*
Kzvana	0.54	3.98	2.776	4.604	5.598	○
Deea	-0.33	5.13	2.571	4.032	4.773	X
Roxia	-0.27	4.88	2.571	4.032	4.773	○
Tinker	0.48	3.95	2.776	4.604	5.598	○

High significant - xxx, significant - xx, insignificant – x (positive values);
High significant - ○○○, significant - ○○, insignificant – ○ (negative values).

Table 11. Berries weight variation of *Ribes nigrum* varieties

Variety	t calculated	Degrees of freedom	t 5%	t 1%	t 0.5%	Significance*
Detwar	-0.23	6.47	2.365	3.499	4.029	○
Tatran	0.34	8.00	2.306	3.355	3.833	X
Elite	-0.25	8.03	2.306	3.355	3.833	○
Rolan	-0.21	6.52	2.365	3.499	4.029	○
J. van Tets	0.46	8.24	2.262	3.25	3.69	X

High significant - xxx, significant - xx, insignificant – x (positive values);
High significant - ○○○, significant - ○○, insignificant – ○ (negative values).

The planting distances are 1.0 m per row and 2.5 m between the rows, which results a number of 4000 shrubs per ha. The production per ha (P) was determined using the following formula: P./ha (t/ha)= P./shrub (kg) x 4000 shrubs/ha.
After calculations, in terms of production, have been highlighted Roxie and Deea varieties, the latter having a production of 403.65 g bunches/shrub. The polar opposite was Tinker variety with a production of 56.69 g/shrub. Also, in terms of production per hectare was posted with Deea variety was dettached with over 50% more bunches compared to Roxia varieties, Kzvana and Tinker.
The most productive varieties of *Ribes rubrum* species were Rolan and Joankheer van Tets with an estimated production of 235.01g/shrub and 77.53 g/shrub.

Table 12. The production of *Ribe nigrum* species in the third year after planting

Variety	No. of shrubs	Bunches/ shrub (g)	Berries/ shrub (g)	Raceme/ shrub (g)	Bunches/ variety (kg)	Bunches (t/ha)	Berries (kg)	Berries (t/ha)	Raceme (kg)	Raceme (t/ha)
Kzvana	5	114.34	111.95	2.39	0.572	457.36	0.560	447.8	0.010	9.56
Deea	12	403.65	398.5	5.15	4.844	1614.6	4.782	1594	0.062	20.60
Roxia	14	268.29	265.62	2.67	3.756	1073.16	3.71868	1062.48	0.037	10.68
Tinker	16	56.69	56.24	0.45	0.907	226.760	0.900	224.960	0.007	1.80

Table 13. The production of *Ribe rubrum* species in the third year after planting

Variety	No. of shrubs	Bunches/ shrub (g)	Berries/ shrub (g)	Raceme/ shrub (g)	Bunches/ variety (kg)	Bunches (t/ha)	Berries (kg)	Berries (t/ha)	Raceme (kg)	Raceme (t/ha)
Detwar	4	33.9	33.23	0.67	0.136	135.6	0.133	132.92	0.003	2.68
Tatran	7	47.61	46.9	0.71	0.333	190.44	0.3283	187.6	0.005	2.84
Elite	16	25.32	24.55	0.77	0.405	101.28	0.3928	98.2	0.012	3.08
Rolan	10	235.01	230.67	4.34	2.350	940.040	2.307	922.680	0.043	17.36
J. van Tets	7	77.53	76.46	1.07	0.54	310.12	0.5352	305.84	0.01	4.28

CONCLUSIONS

With regard to the variability of the characteristic length of shoots, the Ribes nigrum varieties Abanos and Elita 124 had the maximum length of 84.5 cm or 82.00 cm. Ribes rubrum varieties Elite and Detwar had increases of up to 59.00 cm and 41.80 cm. Both species had a high variability of the length of shoots, which reflects the importance of the environment conditions on this phenotypic characteristic as well as for the biological diversity of the varieties taken into study.

The highest weight of the bunches was determined for the *Ribes nigrum* varieties Deea and Roxia, with 15.87 g and 13.14 g/bunch respectively, and for the Ribes rubrum species, emphasizing Rolan and Jonkheer van Tets varieties.

The S% variability coefficient for the weight of bunches showed values between 47.4 and 52.87, for *Ribes nigrum*, and for *Ribes rubrum* even higher, up to 70.3.

The calculated production per varieties showed that the highly productive variety of blackcurrant is Deea, with a production of 1614.16 t bunches/ha, followed by the redcurrant variety Rolan, with a production of 940 t bunches/ha.

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GROWTH AND DEVELOPMENT CHARACTERISTICS OF PLANT INDIVIDUALS FROM TWO *LYCIUM BARBARUM* L. VARIETIES

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Abstract

This study is the result of the interpretation and synthesis of the observations, measurements and calculations performed with regard to the biological characteristics of growth and development dynamics of the vegetative and reproductive organs of Lycium barbarum L. plants. Two varieties of this species were studied. Research has been conducted between the years 2010 and 2012. Some of the biological characteristics, that have been measured or observed, were: plant height, number and length of shoots, number of leaves, flowering and fructifying dates, fruit yield, soluble dry substance in fruit (SU%) and fruit weight. Also, the volume and shape of the two years old goji shrubs were determined. The plants' shapes were either truncated cones or inverted (reversed) truncated cones. Our work highlights some of the differences between the two studied Lycium barbarum L. varieties. These differences refer to adaptability potentials as well as biological characteristics. The significance of our contribution is that it presents the growth dynamics and development stages of two varieties belonging to the Lycium barbarum L. species, making comparisons between the two varieties' characteristics and showing how the second year's measurements compare to those of the first year from planting.

Key words: *biological characteristics, fructification, growth dynamics, Lycium barbarum L. (Goji), varieties.*

INTRODUCTION

Lycium barbarum L. is a deciduous shrub belonging to the Solanaceae family and which is native to Asia and S-E Europe. Its fruit are also known as Goji berries and they have been used for a long time in Traditional Chinese Medicine together with other parts of the plant (Institute of Chinese Materia Medica, 1997).

In recent years, the species' popularity has grown, especially in western countries, as its fruit is being used as a functional food or as a major component for many different categories of healthcare products.

This is mostly due to marketing claims, although scientific research, which is increasingly focusing on goji berries' health promoting properties, has shown that the fruit's nutritional value and sanogene potential are impressing (Amagase et al., 2011).

Thus, these exotic berries are highly valued for their: antiageing properties, antidiabetic effects, antioxidant activity, cardiovascular benefits, for promoting eye health and for strengthening the immune system (Mencinicopschi, 2010).

Though numerous studies on the plants' biological characteristics exist in China, where this species is considered a national treasure, this type of research hasn't been conducted at the same scale in western countries.

Moreover, the majority of studies which have been carried out lately are increasingly focusing on the positive health effects of the berries active components (LBP) and less on the biological characteristic of the plants.

In Romania, *L. barbarum* has only been regarded as a potentially invasive species (Anastasiu, 2005), and the possibility of introducing these plants towards cultivation hasn't been studied yet.

This is why this study aims to present the biological characteristics of growth and development dynamics of the vegetative and reproductive organs of *Lycium barbarum* L. plants, grown in Northern Bucharest region.

MATERIALS AND METHODS

In order to study the growth and development characteristics of plant individuals from the *Lycium barbarum* L. species, the following indicators were used: plant height, number and length of shoots, number of leaves, flowering and fructifying dates, fruit yield, soluble dry substance in fruit (SU%) and fruit weight. Also, the volume and shape of the two years old goji shrubs were determined.

These indicators were determined for two phenotypes (V_1 and V_2), which were planted in a non-random block experiment with 6 repetitions (3 for V_1 and 3 for V_2), on the research field within the Campus of the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

The volume of the plants was determined by using the mathematical formula for the truncated cone shape which bared the most similarity with the plants' architecture.

The plants were regularly measured and the fructification stages were closely observed. The fruit were measured, weighed and tested. Both sensorial and chemical properties were analyzed.

Some of the instruments that were used are: WAA analytical balance/scales, portable refractometer and binocular eyeglass.

The collected data have been statistically processed and interpreted using Microsoft Office Excel™ 2007, according to Pena A. (Pena, 1986) and Cociu V., Oprea S. (Cociu et al., 1989) research methods, in order to illustrate the Goji plants' growing and development dynamics.

The period analyzed in this study was 2010 - 2012, with 2010 being the year in which the shrubs were planted and 2011-2012 being the interval in which the plants' growth dynamics has been studied.

RESULTS AND DISCUSSIONS

Plant height. The average height of the potted plants, at the date of their planting (19.11.2010), varied between 17.86 cm and 44.25 cm. The V1 phenotype had taller plants than V2. For V1, the average height was 41.13 cm, while for V2 the average value was 19.25 cm.

The next year (2011) (Table 1), average plant heights varied between 35.68 cm and 72 cm. The variability coefficient was very high, meaning that the plants had very different growth rates and adaptability potentials. While the tallest plants were those in V_2's 3rd and 1st repetitions, with maximum averages of 107 cm and 99 cm, the average heights of plants as a whole (per year/variety) were rather close: 51.70 cm for V_1 and 52.43 cm for V_2. Besides having the tallest plants, V_2 also had the highest variability coefficient for this indicator.

By looking at the way the plant heights have evolved, we can see that, at first, the growth rate of the V_2 plants was a little slower than that of the V_1 plants, but by the end of November, V_2 caught up and even surpassed V_1. In the end, during 2011, V_2 had a higher growth rate than V_1.

Table 1. Average heights of *Lycium barbarum* plants, the first year from planting

2011		Average plant height (cm)				Variability coefficient of plant height (s%)			
		May	Jul-Aug	Nov	Average	May	Jul-Aug	Nov	Average
V_1	1st repetition	41.50	55.64	52.93	50.02	20.22	27.28	27.02	24.84
	2nd repetition	45.71	66.00	61.14	57.62	33.60	36.89	34.76	35.08
	3rd repetition	38.50	54.75	49.13	47.46	12.46	31.54	48.33	30.78
Average		41.90	58.80	54.40	51.70	22.09	31.90	36.71	30.23
V_2	1st repetition	23.00	94.00	99.00	72.00	104.53	-	-	-
	2nd repetition	12.29	22.50	72.25	35.68	64.56	154.72	105.21	108.16
	3rd repetition	15.83	26.00	107.00	49.61	72.83	137.66	-	105.24
Average		17.04	47.50	92.75	52.43	80.64	146.19	105.21	106.70

In 2012, which is the second year from planting (Table 2), the average plant height varied between 85.14 cm and 180 cm.

The variability coefficient was even higher than in 2011 due to the loss of some of the plants from the second variety. Again, the variability coefficient for V_2 was higher than that for V_1.

This time, the average heights of plants as a whole (per variety) had more distinct values: 107.77 cm for V_1 and 177.50 cm for V_2.

Thus, V_2 plants have grown higher than those of V_1 in the second year as well as in the first year from planting.

Table 2. Average heights of *Lycium barbarum* plants, the second year from planting

2012 (Nov)		Average plant height (cm)	Variability coefficient of plant height (s%)
V_1	1st repetition	85.14	67.64
	2nd repetition	125.43	38.31
	3rd repetition	112.75	46.18
Average		107.77	50.71
V_2	1st repetition	-	-
	2nd repetition	180.00	70.71
	3rd repetition	175.00	-
Average		177.50	70.71

So, V_1 plants went from an average of 41.13 cm to 51.70 cm to 107.77 cm. This shows that the growth rate of these plants was slower in the first year than in the second. V_1's growth rate, over these two years, was also slower than that of V_2's which started with an average height of 19.25 cm, followed by 52.43 cm and reached 177.50 cm by the end of 2012.

These results clearly show that V_2 plants tend to have a slow start when developing, but they compensate by having a more luxuriant growth later on.

As a conclusion, both varieties of *Lycium barbarum* L. had a positive growth trend. The plants of V_1 were shorter and had a slower growth rate than those of V_2.

Also, the first variety showed a lower variability than that of the second, meaning that the average values are more relevant in its case. For V_2, the values reflect the fact that its individuals were more different from one another and had more variable growth rates.

Number of shoots. The dynamics of this characteristic has been studied for every variety, repetition and plant in the research field during the first year from planting. Three major stages were observed in 2011. May represented the growth debut, June-August represented the months with an intensive growth rate and November marked the end of the growth period (Table 3).

Table 3. Average number of shoots of *Lycium barbarum* plants, the first year from planting

2011		Average number of shoots				Variability coefficient of number of shoots (s%)			
		May	Jul-Aug	Nov	Average	May	Jul-Aug	Nov	Average
V_1	1st repetition	7.71	9.14	13.43	10.10	49.48	46.16	44.65	46.76
	2nd repetition	5.86	15.43	25.29	15.52	47.71	120.50	81.01	83.07
	3rd repetition	5.50	18.00	22.25	15.25	70.42	92.63	71.48	78.17
Average		6.36	14.19	20.32	13.62	55.87	86.43	65.71	69.34
V_2	1st repetition	6.00	11.00	18.00	11.67	-	-	-	-
	2nd repetition	1.67	7.50	17.50	8.89	34.64	103.71	125.26	87.87
	3rd repetition	2.67	72.00	81.00	51.89	78.06	-	-	78.06
Average		3.44	30.17	38.83	24.15	56.35	103.71	125.26	82.97

The average number of shoots varied between 9 and 52, with V_2 having both the lowest and the highest values per repetition (i.e. V_2 2nd repetition had the lowest value, whilst its 3rd repetition had the highest number of shoots).

V_1 had a lower variability for this indicator, and its average number of shoots at the end of the year 2011 was of almost 14 (13.62). For V_2, the average number of shoots for the first year from planting was 24 (24.15). For both varieties, the number of shoots has had a positive trend throughout the year.

So, it is clear that whilst V_1 has had less variation in its number of shoots per plant, V_2 plants have had a more dynamic rate of growing new shoots, especially in its 3rd repetition.

In 2012 (Table 4), the average number of shoots belonging to the growth debut stage (May), was higher than that of 2011 for both V_1 and V_2. The average number for V_1 was 21 shoots, which is 3.71 times more than in the same period of the first year. What's more, the average value for the 2nd repetition of V_1 was higher in May 2012 (28 shoots), than in November 2011 (25 shoots), when it was the maximum average value of V_1 that year.

For V_2, the average values in May 2012 (4.79 shoots) surpassed those of the same period in 2011 (3.44 shoots), but they were far less than those of the maximum value of that year (81 shoots, in the 3rd repetition).

Table 4. Average number of shoots of *Lycium barbarum* plants, the second year from planting

2012 (May)		Average number of shoots	Variability coefficient of number of shoots (s%)
V_1	1st repetition	12.57	90.21
	2nd repetition	28.00	78.41
	3rd repetition	23.75	70.32
Average		21.44	79.65
V_2	1st repetition	1.67	173.21
	2nd repetition	7.71	183.59
	3rd repetition	5.00	255.86
Average		4.79	204.22

Similar to the previous year, the variability coefficient for the number of shoots in V_2 plants was higher than that of the V_1 plants. This was mainly because of the loss of several V_2 plants, but it also reflects the different growth and development rates the plants have.

So, as a conclusion, V_2 plants had a higher number of shoots than V_1 in 2011, but lower values for this indicator in the growth debut period (May) of both 2011 and 2012.

This shows its tendency to enter the growth debut period later than V_1. Nevertheless, once the second variety reaches its intensive growth period, it quickly beats V_1's development rate.

It's also worth mentioning the fact that both varieties have developed anticipated shoots in the second year from planting (2012).

Length of shoots. Same as for the previous indicator, the dynamics of this characteristic has been studied for every variety, repetition and plant in the research field during the first year from planting. The same three major stages were observed: the growth debut was in May, June-August represented the months with an intensive growth rate and November marked the end of the growth period.

In 2011, the average shoot length spanned between 11.84 cm and 29.57 cm. Again, the second variety presented both the top and the bottom values per repetition, though not in the same repetitions as those of the previous indicator.

The average shoot length per year was 14.14 cm for V_1 and 19.57 cm for V_2, so the second variety's faster growth rate is also illustrated by this 2011 indicator (Table 5).

The variability coefficient of the shoots' length was, again, higher for the second variety with a peak of 65.40 % for its 3rd repetition. V_1 also had the most variability of this indicator in its 3rd repetition (42.68 %).

In 2012, the average shoot length varied between 4 cm and 19.79 cm. As in the previous year, both of the values belonged to V2's repetitions. The average shoot length in May was 7.40 cm for V_1 and 11.33 cm for V_2 meaning that, once again, the second variety had a more vigorous growth, despite the values being smaller than those of May 2011.

Table 5. Average shoot length of *Lycium barbarum* plants, the first year from planting

2011		Average shoot length (cm)				Variability coefficient of shoot length (s%)			
		May	Jul-Aug	Nov	Average	May	Jul-Aug	Nov	Average
V_1	1st repetition	13.16	15.80	11.39	13.45	40.66	42.51	35.45	39.54
	2nd repetition	17.56	16.64	11.91	15.37	29.20	42.60	23.77	31.86
	3rd repetition	11.40	16.40	13.00	13.60	40.80	69.75	17.50	42.68
Average		14.04	16.28	12.10	14.14	36.89	51.62	25.57	38.03
V_2	1st repetition	22.00	21.70	45.00	29.57	-	-	-	-
	2nd repetition	19.17	12.80	19.95	17.31	76.69	24.31	42.18	47.73
	3rd repetition	9.43	10.70	15.40	11.84	65.40	-	-	65.40
Average		16.87	15.07	26.78	19.57	71.05	24.31	42.18	56.56

So, the 2011 and the 2012 values have shown that the *Lycium* plants' shoots have been growing in both these years. The plants have grown at different rates, especially those in the second variety. Also, it's interesting to point out the fact that the second year, both varieties had a slower growth rate in their growing debut phase (Table 6).

Table 6. Average shoot length of *Lycium barbarum* plants, the second year from planting

2012 (May)		Average shoot length (cm)	Variability coefficient of shoot length (s%)
V_1	1st repetition	5.20	104.07
	2nd repetition	9.04	51.20
	3rd repetition	7.98	47.75
Average		7.40	67.67
V_2	1st repetition	4.00	-
	2nd repetition	10.18	102.92
	3rd repetition	19.79	-
Average		11.33	102.92

Number of leaves. In May 2011, the average number of leaves on the goji shrubs varied between 44 and 260. The minimum value belonged to the 2nd repetition of V_2 and the maximum one was also found in the 2nd repetition, but that of the first variety. The average number of leaves per variety was nearly 227 for V_1 and almost 96 for V_2.

As opposed to the other indicators, the average number of leaves per plant was higher in 2011 for the first variety. The variability coefficient, though, was still higher for the second variety of goji shrubs (Table 7).

Table 7. Average number of leaves on *Lycium barbarum* plants, the first year from planting

2011 (May)		Average no. of leaves	Variability coefficient of no. of leaves (s%)
V_1	1st repetition	217.43	43.95
	2nd repetition	259.86	38.34
	3rd repetition	202.25	48.34
Average		226.51	43.54
V_2	1st repetition	198.00	-
	2nd repetition	44.00	47.62
	3rd repetition	45.50	135.21
Average		95.83	91.41

In the second year from planting, the average number of leaves varied between 147 and 1,589. Both the maximum and the minimum values belonged to the second variety. The variability coefficient was, as in the previous year, higher for V_2 than for V_1.

The average number of leaves per variety was 1,073 for V_1 and 860 for V_2. Although the first variety had the higher value for this indicator in both years, the difference between V_1's and V2's values was smaller in 2012 than in 2011 (Table 8).

Table 8. Average number of leaves on *Lycium barbarum* plants, the second year from planting

2012 (May)		Average no. of leaves (cm)	Variability coefficient of no. of leaves (s%)
V_1	1st repetition	534.43	59.39
	2nd repetition	1,299.57	55.64
	3rd repetition	1,385.50	78.90
Average		1,073.17	64.64
V_2	1st repetition	147.00	-
	2nd repetition	1,589.00	122.46
	3rd repetition	844.00	-
Average		860.00	122.46

By comparing the two years, we can conclude that V_1 plants had more leaves than those from the second variety. Still, the difference between the values of V_1 and V_2 was smaller in 2012 than in 2011, meaning that V_2 plants have increased their development rate in the second year. Also, both varieties had significantly more leaves in 2012 than in 2011, thus reflecting they have undergone a growth stage.

Flowering dates. In 2011, on V_1 individuals, flower buds first appeared at the middle of June. Towards the end of the same month, flowering also occurred on the shrubs. V_2 plants flowered in august, and had far less flowers than those of V_1.

Both phenotypes flowered until late November. The average number of flowers per shoot was between 5 and 40, with the minimum value belonging to V_2 and the maximum value belonging to V_1.

In 2012, the first floral buds appeared at the beginning of May on a V_2 plant. A few days later, they were also seen on V_1 plants. After a few more days, the first flowers also appeared. The average number of flowers and buds, per branch, was 5 to 50, with a maximum of 70. Again, V_1 plants were the ones to bare the most flowers.

Fructifying dates. In 2011, the first fruit appeared at the end of June on V_1 individuals. Production peaked in August and September and fructification continued until the end of November, for both phenotypes. V_2 shrubs had fewer but bigger fruit. For this variety, fructification started later and was less frequent.

In 2012, fructifying started towards the middle of May, which was earlier than the first year. At that time, the first fruit appeared on a V_2 plant, although they had not ripened yet.

Not all plants fructified during the first or the second year, but it is important to point out that the *Lycium* shrubs which bore fruit did so in less than a year's time from their planting. This reveals a precocity trait in the new species' fructifying habits in Romania's pedo-climatic conditions.

Fruit yield. The total fruit yield for 2011 was 1,343.16 g. For 2012 the total fruit yield reached 6,512.13 g. So, the second year's fruit yield was almost 5 times bigger than that of the first year's yield.

The average fruit yield per plant varied between 2.68 g and 128.68 g, the first year from planting. V_1 plants yielded the most fruit. The average fruit yield per variety was 88.33 g for V_1 and 2.68 g for V_2. Also, all the repetitions of this variety had fructifying plants, while in V_2 only the plants from the 2nd repetition bore fruit (Table 9).

The next year, the average fruit yield per plant varied between 23.24 g and 589.28 g. The maximum value was that of V_1's second repetition, while the minimum value belonged to V_2's 3rd repetition. The average fruit per repetition was 317.74 g for V_1 and 50.77 g for V_2 (Table 10).

So, V_1 was - for a second time - the more productive of the two Lycium varieties. Still, in 2012, V_2 had fruit bearing plants in two of its 3 repetitions, which is more than the previous year. Also, the average yield per plant was significantly higher in the second year for both varieties.

In 2012, the average values varied between 0.25 g and 0.34 g for V_1. The average fruit weight for V_1, the second year, was 0.31 g (Table 12). Also, the average fruit weight for V_2 was 0.40 g.

Table 9. Average fruit yield of *Lycium barbarum* plants, the first year from planting

2011		Average fruit yield (g)	Variability coefficient of fruit yield (s%)
V_1	1st repetition	15.41	110.31
	2nd repetition	128.68	79.90
	3rd repetition	120.90	56.95
Average		88.33	82.39
V_2	1st repetition	-	-
	2nd repetition	2.68	-
	3rd repetition	-	-
Average		2.68	-

Table 10. Average fruit yield of *Lycium barbarum* plants, the second year from planting

2012		Average fruit yield (g)	Variability coefficient of fruit yield (s%)
V_1	1st repetition	77.97	140.83
	2nd repetition	589.98	73.84
	3rd repetition	285.28	105.69
Average		317.74	106.79
V_2	1st repetition	-	-
	2nd repetition	78.30	-
	3rd repetition	23.24	-
Average		50.77	-

Fruit weight. The average weight for the V_1 fruit was mostly the same in 2011 and 2012. The first year, average values varied between 0.26 g and 0.39 g. The average fruit weight for 2011 was 0.35 g (Table 11).

Table 11. Average fruit weight of *Lycium barbarum* plants, the first year from planting

2011		Average fruit weight (g)	Variability coefficient of fruit weight (s%)
V_1	1st repetition	0.26	44.74
	2nd repetition	0.41	31.78
	3rd repetition	0.39	19.00
Average		0.35	31.84

Table 12. Average fruit weight of *Lycium barbarum* plants, the second year from planting

2012		Average fruit weight (g)	Variability coefficient of fruit weight (s%)
V_1	1st repetition	0.25	18.76
	2nd repetition	0.33	10.91
	3rd repetition	0.34	16.46
Average		0.31	15.38

Though the average fruit weight values for 2011 were bigger than those of the second year, in 2012 the coefficient of variability of these values was smaller. This means that the *Lycium* shrubs have started to produce more regular sized fruit which are in conformity with the specie's fructification characteristics.

Dry substance in fruit. The average dry substance in 2011's fruit took values between 14.37 % and 17.03 %. For V_1, the average dry substance within fruit was 15.46 %. The average variability coefficient of these values was of only 5.38 %, meaning that the variability was low (Table 13).

Table 13. Average dry substance of *Lycium barbarum* fruit, the first year from planting

2011		Average fruit D.S. (%)	Variability coefficient of fruit D.S. (s%)
V_1	1st repetition	17.03	5.59
	2nd repetition	15.00	3.56
	3rd repetition	14.37	7.01
Average		15.46	5.38

In 2012, the average values for dry substance in fruit were between 14.69 % and 16.85 %. The average dry substance within V_1's fruit was 15.84 %. For V_2's fruit, this indicator was 17.26 % (Table 14).

The variability coefficient of this indicator was higher in 2012 mostly due to the fact that the plants fructified more frequently and in higher quantities than the previous year.

In conclusion, the values for this indicator were slightly higher in 2012 than in 2011. Also, in comparison with V_1's values, V_2's fruit had a superior dry substance concentration.

Table 14. Average dry substance of *Lycium barbarum* fruit, the second year from planting

2012		Average fruit D.S. (%)	Variability coefficient of fruit D.S. (s%)
V_1	1st repetition	15.98	11.64
	2nd repetition	16.85	6.16
	3rd repetition	14.69	19.69
Average		15.84	12.50

Volume and shape. The shape of the *Lycium* shrubs was determined based on the plants' dimensions and architecture. As a consequence, the plants had either truncated cone or inverted (reversed) truncated cone shapes.

The average volume of the plants varied between 77,216.24 cm^3 and 1,636,777.63 cm^3. The minimum value was that of V_1's 1st repetition and the maximum one was that of V_2's 2nd repetition. The average plant volume per variety was 233,905.36 cm^3 for V_1 and 1,361,867.98 cm^3 for V_2 (Table 15).

So, we can see that V_2's more luxuriant growth is, once more, demonstrated by indicators. Also, the variability coefficient is higher for V_2 than for V_1.

Table 15. Average volume of *Lycium barbarum* plants, the second year from planting

2012		Average plant volume (cm^3)	Variability coefficient of plant volume (s%)
V_1	1st repetition	77,216.24	140.96
	2nd repetition	326,277.55	78.01
	3rd repetition	298,222.29	78.76
Average		233,905.36	99.24
V_2	1st repetition	-	-
	2nd repetition	1,636,777.63	139.98
	3rd repetition	1,086,958.33	-
Average		1,361,867.98	139.98

CONCLUSIONS

In a nutshell, we can see that the various indicators representing the dynamics of plant growth have had a positive trend over the two years from planting. V_2 plants have exhibited a more luxuriant growth, though accompanied by a later debut in their development. On the other hand, V_1 plants have had a more constant growth rate and an earlier debut in their development.

With regard to the fruit yield, V_1 incontestably had the superior values. Nevertheless, what V_2 lacked in quantity, it compensated in quality as the fruit of this variety were both bigger in size and had a higher concentration of dry substance. Also, it's interesting to point out the fact that fruit weights were smaller but less variable in 2012 than in 2011. Moreover, both varieties bore flowers and fruit at earlier dates the second year than the first.

The plants belonging to both studied varieties presented a discontinuous variability of their architectural elements. Still, V_2 repetitions had high variability coefficients for all calculated indicators mostly due to the loss of some of the plants.

To sum it all up, while V_1 individuals showed higher survival rates and higher yields, V_2 individuals presented a more luxuriant growth and a higher fruit quality. Also, judging by their growth dynamics, both varieties are exhibiting the normal behaviour of shrubs in their "beginning of fructifying" growth phase of their ontogenetic cycle.

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MORPHOLOGICAL AND BIOLOGICAL CHARACTERISTICS OF SPECIES FROM THE *AMARANTHUS* GENUS

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Abstract

Some morphological characteristics of Amaranth species were studied in 2011-2012. The seeds were collected from different agroecological zones of the country - Plovdiv, Sofia and Dobrich regions, from crops of sunflower and maize. Our research has shown that a large number of seeds in 1 g formed Amaranthus hybridus L. (2038), compared with Amaranthus blitoides L. (824). The mass of 1000 seed was higher in Amaranthus blitoides L. (1.47g). The phenological development of Amaranthus hybridus L. and Amaranthus blitoides L. was carried out. The main phenophase of weeds was observed. The study results show that for the whole growing season Amaranthus hybridus L. requires lower temperature sum (1308.0°C), compared with Amaranthus blitoides L. (1606.5°C).

Key words: *A. retroflexus L., A. blitoides L., morphological characteristics, phenological development.*

INTRODUCTION

The species of the *Amaranthus* genus have some biological and morphological characteristics, which together with their high ecological plasticity and adaptability and short life cycle make them particularly dangerous and competitive to crop plants. They form large seed generation with an extended germination period, and sometimes forms, resistant to some of the commonly used modern herbicides.

In the modern agriculture, the fight against the Amaranth species (*Amaranthus* spp.) is a topical issue and in order to be successful and expedient, it is recommended to study their morphological and bioecological characteristics.

MATERIALS AND METHODS

Material from the seeds of the two Amaranth species - *Amaranthus hybridus* L. and *Amaranthus blitoides* L., collected from different agroecological zones of the country - Plovdiv, Dobrich and Sofia regions from sunflower and maize crops have been used in the present study.

The absolute mass of the seeds from the Amaranth species has been determined (Zhalnov et al., 2001). The effective temperature sums for conducting the main phenophases in the weed development have also been determined using the formula (Gyurova and Peev, 1996):

$$\Sigma t=n(t-B), \text{ where}$$

Σt - the sum of the effective temperatures (°C);
n - number of days of a certain period (phase), number;
t - average temperature for the period (°C);
B - biological temperature minimum (°C).

The observations for the occurrence of the different pehonphases have been made in sunflower and maize crop stands, where permanent plots of 1 m2 have been marked and the growth of *Amaranthus hybridus* L. and *Amaranthus blitoides* L. has been studied.

RESULTS AND DISCUSSIONS

According to Dechkov (1979) in the analyses of soil samples in the country, the plow layer (0-25 cm) contains an average of 44 000 weed seeds are present per 1 m^2. The potential weed infestation with Amaranth species is the highest - 28 000 numbers per m^2, which represents 64% of the total quantity of weed seeds.

The number of seeds in 1 g and the absolute mass of the weed species *Amaranthus hybridus* L. and *Amaranthus blitoides* L. have been determined in laboratory conditions. The data is presented in Table 1.

From the carried out studies it was determined that a greater number of seeds in 1 g was formed in *Amaranthus hybridus* L. – 2038, unlike *Amaranthus blitoides* L. - 824. The mass of 1000 seeds has higher values for *Amaranthus blitoides* L. – 1.47 g.

Table 1. Number of seeds in 1 g and mass of 1000 seeds

Weed species	Number of seeds in 1 g	Mass of 1000 seeds (g)
Amaranthus hybridus L.	2038	0,64
Amaranthus blitoides L.	824	1,47

From the comparative analysis it can be noted that the seeds of *Amaranthus blitoides* L. are large, black, and shiny with a clearly marked edge on the periphery, while the seeds of *Amaranthus hybridus* L. are small, irregularly rounded and with a narrow edge on the periphery. Summarizing the obtained data on the impact of the agroclimatic indices on the phonological development of the two species, the following conclusion can be made:

Amaranthus hybridus L. has shorter vegetation period (120 days) and germinated at lower temperature (9.6°C), while *Amaranthus blitoides* L. has a vegetation period of 153 days and germinates in spring at higher temperature (10.3°C). Similar findings have also been made by Kostov (1999) and Kovachev (1967) (Table 2).

Throughout the vegetation period the hybrid Amaranth requires lower temperature sum (1308.0°C) than the creeping Amaranth (1606.5°C). Regarding the amount of precipitation *Amaranthus hybridus* L. is less demanding than *Amaranthus blitoides* L., respectively 209.4 mm and 245.2 mm (Table 2).

A significant difference between the two species regarding the different agroclimatic indices has been determined during the period first real leaf - weed flowering. This period is 13 days shorter for the hybrid Amaranth (duration of 30 days) and the temperature sum is significantly lower (with 199.2°C).

The duration of the period flowering - seed ripening is shorter for the hybrid Amaranth (with 8 days). During this period for its development it requires higher average temperature (with 4.2°C) and temperature sum (with 13.2°C). The amount of precipitation is 15% lower (76.3 mm) in comparison with the creeping Amaranth (89.2 mm).

Table 2. Agroclimatic indices, affecting the phonological development of Amaranth species

Phenological development (period)	*Amaranthus blitoides L.*				*Amaranthus hybridus L.*			
	Period duration (days)	Average temperature (°C)	Temperature sum (°C)	Precipitation sum (mm)	Period duration (days)	Average temperature (oC)	Temperature sum (oC)	Precipitation sum (mm)
I period - from the sustainable transition of air temperature unitl germination	59	10.3	312.7	57.1	52	9.6	239.2	49.3
II period - germination – first real leaf	13	10.3	68.9	15.2	8	16.9	95.2	6.1
III period - first real leaf - flowering	43	19.4	619.2	83.7	30	19.0	420.0	77.7
IV period - flowering – seed ripening	38	19.1	535.8	89.2	30	23.3	549.0	76.3
V period - from the sustainable transition of the air temperature unitl seed ripiening	153	15.5	1606.5	245.2	120	15.9	1308.0	209.4

CONCLUSIONS

The carried out studies have found that a larger number of seeds in 1 g have been formed in *Amaranthus hybridus* L. – 2038, unlike *Amaranthus blitoides* L. – 824. The mass of 1000 seeds has higher values for *Amaranthus blitoides* L. – 1.47 g.

The phonological development of *Amaranthus hybridus* L. and *Amaranthus blitoides* L. has also been studied. The occurrence of the main phenophases of weed development has been determined. The study results show that for the whole vegetation period *Amaranthus hybridus* L. requires lower temperature sum (1308.0°C) than *Amaranthus blitoides* L. (1606.5°C).

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EFFECT OF STREPTOMYCES METABOLITES ON SOME PHYSIOLOGICAL PARAMETERS OF TRITICALE SEEDS

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Abstract

The influence of metabolites of actinomycetes on some physiological parameters of triticale seeds variety (roots formation, growth of coleoptiles) has been studied. The strains of actinomycetes genus Streptomyces were isolated from various soil samples of R. Moldova with different content of humus. The obtained data showed that the number of roots increased considerably under the influence of metabolites of Streptomyces sp.42 (22.11%, compared with the control – water). The increasing by 36.25, 19.9 and 22.9% of the roots length compared to control was determined after the treatment with metabolites of Streptomyces sp.7, Streptomyces sp. 9 and Streptomyces sp.42 strains. The wet weight of the roots and coleoptiles exceeded 2-3 times and on 11.22-37.76% respectively the control values. Our research showed that the investigated Streptomyces strains are capable to synthesize the substances which stimulate roots forming and development of stems. In summary, the isolated from Moldavian soils strains of streptomycetes can be considered as potential producers of plant growth regulators.

Key words: *triticale, streptomycetes, metabolites, plant growth regulators.*

INTRODUCTION

Triticale is an alternative cereal grain that is a hybrid of wheat and rye. According to many researches, the triticale is a plant species with a high genetic potential for yield and favorable nutritive values so that's why it is considered a promising plant species (Biberdžić et al., 2012). One of the perspective directions of the crop productivity management is increasing of plants' viability and hardness by using natural assistants-soil and rhizosphere microorganisms (Kravchenko et al., 2002; Shirokih, 2007; Tihonovich et al., 2005).

Microorganisms interact with plants because plants offers a wide diversity of habitats including the phyllosphere (aerial plant part), the rhizosphere (zone of influence of the root system), and the endosphere (internal transport system) (Lynch, 1990, Lindow et al., 2002, Montesinos, 2003). Plant-associated microorganisms play essential roles in agricultural and food safety, and contribute to the environmental equilibrium (Montesinos, 2003). Plant-associated microorganisms play an essential role in the plants' development; they participate in supply of plants by nutrients, phytohormones, vitamins and other growth factors. Many plant-associated microorganisms are them- selves capable of synthesizing compounds inhibiting a pathogenic microflora (toxins, antibiotics, siderofors), and also promote the occurrence in partner plants of the so-called induced resistance, helping with protection against phytopathogens (Cattelan et al., 1999; Shirokih, 2007).

Actinomycetes make the forth part of all the soil and rhizosphere bacteria. Possessing a powerful enzymatic system and synthesizing a number of biologically active substances, actinomycetes play an essential role in transformation of organic compounds and in maintenance of potential fertility of the soil (Zenova, 1992). The most common genus among this large group of bacteria is *Streptomyces.* This genus is found worldwide and is considered to play an important role in soil and plant ecology. These organisms have been widely investigated as agents of biological control of several plant diseases (Barreto et al., 2008). Besides the ability to synthesize substances with antimicrobial properties, *Streptomyces* produce growth-promoting metabolites such as auxins, gibberellins, cytokinins, ethylene, siderophores. For example Mansour *et al*. (1994) and Aldesuquy *et al*. (1998) had found seven strains *Streptomyces alboviridis, S. griseoviridis, S. olivaceoviridis, S. rimosus, S. phaeochromogenes, S. rochei* and *Streptomyces* sp. No. 20, which possess comparatively high capacities for production of auxins, gibberellins and cytokinin-like substances together with substantial levels of α-amylase and protease.

Streptomyces lydicus WYEC108 is a root-colonizing actinomycete originally isolated and studied for its properties as an antifungal biocontrol agent. Recently, was demonstrated that strain WYEC108 is also a plant growth-promoting bacterium in the absence of fungal pathogen challenge. This may be due to the ability of strain WYEC108 to produce hydroxamate-type siderophores and/or other plant growth-promoting metabolites in the rhizosphere (Tokala et al., 2002). The researches made by Brazilian scientists had demonstrated that actinomycetes account for a higher percentage of the total population of culturable bacteria in soil than on cacao roots. *In vitro* cellulolytic, xilanolytic and chitinolytic activity, indolacetic acid production and phosphate solubilization activities were observed in most of the isolates tested (Barreto et al., 2008).

Some investigations in this domain were carried out at the Academy of Sciences of Moldova (the Institute of Microbiology and Biotechnology jointly with the Institute of Genetics and Plant Physiology). It was shown the effect of stimulation of seeds' germination and of seedlings' growth (rise of germinating ability of seeds, increasing of roots' number, growth of stems' and gain in roots' length and weight) in the seeds of tomato, cucumber, tobacco, peas, beans, triticale after their treatment with the solutions of metabolites of *Streptomyces* (Boorteseva et al., 2002, 2006, 2008; Maslobrod et al., 2009).

In the Republic of Moldova research aimed for increasing seeds' germination capacity plays an essentially important part in these studies, as an effective germination determines a deeper penetration of emerging roots into the soil providing a stable water and nutrition supply for the plant. So the aim of our work was to investigate the possibility of using the *Streptomycetes* metabolites isolated from the soils of R. Moldova in order to stimulate the process of germination of triticale seeds.

MATERIALS AND METHODS

Triticale seeds. Were offered by the Institute of Genetics and Plant Physiology. Triticale has an excellent productivity potential and a greater flexibility to adapt to difficult agronomic conditions than wheat (Korver *et al*., 2004).

Soil samples. Soil samples were collected at different locations of the central part of the Republic Moldova; mostly it was chernozem (black soil) of different types and with different content of humus.

Soil sample 1: was collected from the plot with monoculture of maize (based in 1947), humus 2.4-2.5% (no fertilizers, herbicides and pesticides);

Soil sample 2: was collected from Poltava road border, humus 2.6%;

Soil sample 3: was collected from ploughed field, water terrace of River Bic, humus 3.5 %;

Soil sample 4: was collected from vineyard, humus 3.3%;

Soil sample 5: was collected from forest reserve, humus 6.8%.

Samples were collected at random and brought to the laboratory under aseptic conditions and stored at 4^0C for further analysis.

Streptomycetes strains and obtaining of cultural liquid. For our experiment the following strains were selected:

From **Soil sample 1**: *Streptomyces* sp. 3, *Streptomyces* sp. 7 and *Streptomyces* sp. 9;

From **Soil sample2**: *Streptomyces* sp. 42, *Streptomyces* sp. 52, *Streptomyces* sp. 73 and *Streptomyces* sp. 120;

From **Soil sample 3**: *Streptomyces* sp.141, *Streptomyces* sp.145;

Soil sample 4:*Streptomyces* sp.155;

Soil sample 5: *Streptomyces* sp. 158, *Streptomyces* sp. 176, *Streptomyces* sp. 178, *Streptomyces* sp. 193.

The streptomycetes strains were *grown* in 1 liter flasks with 200 ml of complex medium M-I (basic source of carbon was corn flour) on an agitator within 5 days at 27^0 C. Biomass has been separated from cultural liquid on a centrifuge (7000 rev/min. during 20 min). Solution of metabolites was obtained by dilution of cultural liquid with distilled water 1:200. According to our previous data this dilution has the most positive effect on plant growth (Maslobrod *et al*., 2010).

Testing of biological activity of streptomycetes. The triticale seeds were soaked in solution of metabolites during 24 h. As a control group we took a number of corn seeds soaked in distilled water. Then the seeds were put to germinate in Petri dishes with distilled water, in thermostat at 25^{o}C during 4 days. We used 100 seeds for each experimental variant. The calculating of the seeds' germination was performed on the third day. We measured the length of coleoptiles and roots (main and secondary roots), the number of roots, their total length, wet and dry weight of their roots and coleoptiles (Voznyakovskaya, 1989).

RESULTS AND DISCUSSIONS

The triticale seeds are characterized by a high level of germination, so in our experiment there were no differences between control and experimental variants by the seeds' germination parameter. The data on the effect of the metabolites of *Streptomyces* on the process of root formation are shown in Table 1. The metabolites had different levels of stimulation of the growth of roots' number compared with the control. For example, the metabolites of *Streptomyces* sp. 73, *Streptomyces* sp. 120*, Streptomyces* sp. 141 had a slight increasing effect on the roots' number (3.21-8.74%), whereas under the influence of metabolites of strains *Streptomyces* sp. 7, *Streptomyces* sp. 9 and *Streptomyces* sp. 42 the number of roots increased up to 10.80-22.11%, compared with the control group.

The roots length was considerably different also (Table 1). Thus in the experimental groups the length of the roots exceeded the control length on 19.89 and 36.25% under influence of metabolites from **soil sample 1** (*Streptomyces sp.* 7 and *Streptomyces* sp. 9) and on 4.87, 17.89 and 22.98% under influence of metabolites from **soil sample 2** (*Streptomyces* sp. 42, *Streptomyces* sp. 73 and *Streptomyces* sp. 120).

A slight increasing effect on the roots' length occurs under influence of metabolites of *Streptomyces* sp. 73, *Streptomyces* sp. 141, *Streptomyces* sp. 145 and *Streptomyces* sp. 178 (4.87, 3.11, 8.03 and 5.03% respectively).

Maximal increasing of main root length were determined under influence of metabolites of *Streptomyces sp.* 145 – 8.96%.

Generally it should be noted that the number of roots parameter is decreasing with increasing of humus content in the soil. It may indicate that in soils rich in humus the biological activity of *Streptomyces* is reduced (Shirokih, 2007; Zenova, 1992). The metabolites of strains of *Streptomyces* also stimulated the growth of coleoptiles (1.7-33.0%). The length of coleoptiles has grown compared with the control unequally, after the influence of the compounds synthesised by the studied strains (Figure 1). Thus the least stimulating effect was found after the treatment of the seeds with the metabolites of strain *Streptomyces* sp. 145 (by 1.7%). The rest of the studied strains led to the increase of coleoptiles' length by 11.3-33.0% in the experimental group compared with the control group. The maximal length of coleoptiles was observed at seeds soaked in the solution of cultural liquid with the strain *Streptomyces sp.* 52 (33% more, comparing to the control).

The weight of roots and coleoptiles has also changed. In the experimental variants the weight of wet roots was 2-3 times higher than in the control (Table 2). The best results were obtained at seeds soaked in the solution of cultural liquid of the strain *Streptomyces* sp. 9 (327.27% to the control), followed by *Streptomyces* sp. 7 (272.73%), *Streptomyces* sp. 42 (236.36%), *Streptomyces* sp. *52 (286.36%)* and *Streptomyces* sp. 120 (227.27%). The metabolites of *Streptomyces* sp. 73 increased the root wet weight on 54.55%. High values of dry root were determined at triticale seed after treatment with cultural liquid of *Streptomyces* sp. *7, Streptomyces* sp. *9, Streptomyces* sp. *42, Streptomyces* sp. 52 (11.22-29.60% comparing to the control group). A metabolites of the same strains promoted the weight increase of wet and dry coleoptiles. Maximal value was noted in the experimental group with *Streptomyces* sp. 9 (weight of wet coleoptiles increased up to 137.76%) and *Streptomyces* sp. 42 (weight of dry coleoptiles increased up to 187.50%) comparing with the control group.

Table 1. Modification of length of triticale seeds' roots after their proceeding with metabolites of streptomycetes isolated from soils of Moldova

Soil sample	Nr. *Streptomyces* strain	Nr. of roots, % to the control	Roots length, % to control	Length of main root, % to control
	Control, H_2O	100	100	100
1	3	94.60	82.42	76.30
	7	112.60	136.25	91.24
	9	110.80	119.89	102.57
2	42	122.11	122.98	105.37
	52	96.66	83.55	104.09
	73	102.83	104.87	89.95
	120	108.74	117.89	100.58
3	141	103.21	103.11	105.05
	145	100.92	108.03	108.96
4	155	90.37	77.14	78.76
5	158	87.84	92.23	101.03
	176	94.04	87.68	90.24
	178	98.85	105.03	104.94
	193	97.02	90.50	95.41

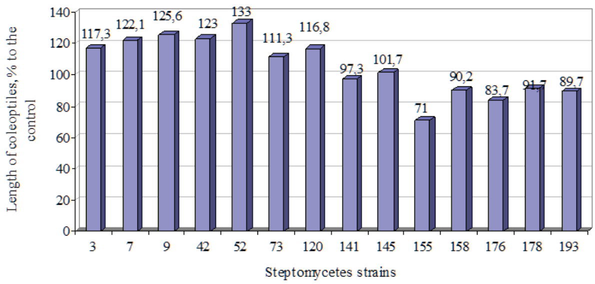

Figure 1. Modification of coleoptiles length after proceeding with metabolites of streptomycetes isolated from soils of Moldova

Table 2. Influence of metabolites of streptomycetes on weight of roots and coleoptiles of triticale seeds

Soil sample .	*Streptomyces* strain	Weight of roots, % to the control		Weight of coleoptiles, % to the control	
		Wet	Dry	Wet	Dry
1	3	54.55	69.15	96.94	62.5
	7	272.73	117.26	111.22	112.50
	9	327.27	134.09	137.76	100.0
2	42	236.36	122.01	129.60	187.50
	52	286.36	123.09	117.35	162.50
	73	154.55	98.17	95.92	70.0
	120	227.27	75.51	100.0	100.0
3	141	79.12	80.0	67.13	111.24
	145	82.72	92.75	104.9	104.9
4	155	76.92	86.43	53.14	81.16
5	158	80.22	83.39	74.83	105.45
	176	74.73	85.57	66.43	68.02
	178	82.72	109.13	85.31	98.26
	193	79.12	80.5	66.43	80.66

Our studies have shown that the investigated strains of soil streptomycetes synthesize substances that stimulate not only root formation, but also development of coleoptiles. Moreover we have revealed some strains possessing the ability to stimulate simultaneously roots formation and growth of coleoptiles. These are strains *Streptomyces* sp.

7, *Streptomyces* sp. 9, and *Streptomyces* sp. 42. Besides that, these strains cause an increase in length and weight of primary rootlets.

Previously we have shown that some other *Streptomyces* strains from the same soil samples have the ability to stimulate growth of maize seeds (Boortseva et al., 2006, Maslobrod et al., 2009, 2010). Therefore, on triticale seeds, with the use of the new *Streptomyces* strains, it was shown once again the specific activity of *Streptomyces* strains from different soil samples on plant objects.

CONCLUSIONS

Thus, it was reviled that the metabolites of *Streptomyces* isolated from soils of Moldova significantly influence the process of seeds' germination, which is reflected in growth stimulation of roots and coleoptiles, as well as in increasing of rootlets' weight. This allows considering the studied strains of *Streptomyces* to be potential producers of growth regulators for plants. Biopreparations created on their basis can be successfully used in crop production.

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STUDY OF SOME GREEN ALGAE "ACCIDENTALLY" INTRODUCED IN ROMANIA

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Abstract

Most algae have great importance for all humanity and the biosphere in general. They are important sources of proteins, soil materials and fertilizers, and also bioindicators of soil condition, depolluting agents (accumulation of radioactive isotopes); algae-based fertilizers can inhibit the growth of phytopathogenic agents (Şchiopu, 2008). Algae provide good results in testing the nutrient supply in soil and the remanence of toxic substances resulted from pesticide use. They could also be used in bioreactors to generate various chemicals from hydrogen to biodiesel or cosmetics.
The presence of algae, known as invasive, has devastating effects as they affect biodiversity of the ecosystems in which they grows, which requires their control (possession, sale, transport).
This study draws attention to the uncontrolled introduction in Romania of some algae known to be invasive.

Key words: *algae, invasive.*

INTRODUCTION

At present, many seaweed species are imported for aquarium decoration. They are used for their decorative appearance (as they do not spread chaotically within the fish basin) and for their capacity to remove nutrients (particularly the nitrates), unfixed to the substrate.
Some algae, such as the marine green alga *Caulerpa taxifolia*, are invasive and can get out of control, causing serious environmental problems and affecting biodiversity.
Caulerpa taxifolia, originating in the Indo-Pacific region, developins dynamic populations that successfully replaces the previously existing algal associations. It was firstly discovered in the Mediterranean Sea in 1984, near the Principality of Monaco, probably resulting from the emptying of the Monaco Oceanographic Institute tanks. Its rapid spreading along the Mediterranean coasts of France and Italy led to the replacement of the local associations of benthic organisms on the extremely varied substrates, which affected the native fauna.
In the recent years, populations of this alga have been reported on the Adriatic coast and the Balearic Archipelago. The occurence of this alga on some points of the North-American costal region - Florida and California - raises new problems, especially since the genetic analysis of the material occurred in California indicated that it was the same strain as the Mediterranean one.
It is assumed that the presence of this alga in Southern California in 2000 was most likely caused by an aquarium owner who had thrown the contents of a fish basin into a sewage system for rainwater. California has passed a law that prohibits the possession, sale or transport of *Caulerpa taxifolia* within the state.
The *Caulerpa taxifolia* invasive strain can tolerate very cold water and can colonize most substrate types. It is a toxic alga due to the presence of poisonous substances produced in a large quantity.

MATERIALS AND METHODS

For identification and description purposes, we used preserved material belonging to six species of green marine algae, brought to Romania as fresh material for aquarium decoration purposes. Macroscopic observations were performed on the algae with the help of algology determinators and treatises, and microscopic observations were made on numerous thalli cross sections of the studied algae. Observations were carried out with a microscope ML-4M IOR belonging to the laboratory of Biology, USAMV Bucharest. The photos were taken with the digital camera Panasonic Lumix DMC - LS60 (6MPX, 3X optical zoom).

RESULTS AND DISCUSSIONS

Macroscopic and microscopic studies have shown the presence in Romania of six species of green marine algae belonging to the Class Chlorophyceae: *Chaetomorpha antennina*, *Cladophora aegropila*, *Chaetomorpha spiralis*, *Caulerpa taxifolia*, *Codium fragile*, *Codium vermilara*, used for aquarium decoration purposes.

Chaetomorpha antennina
This alga belongs to the *Cladophoraceae* family.
It is consists of an unbranched filamentous thallus (Figure 1) and it is thick with large cylindrical cells, numerous nuclei and parietal chromatophores.

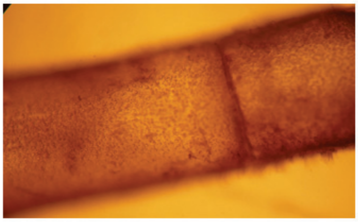

Figure 1. Chaetomorpha antennina – microscopic image

Chaetomorpha spiralis
This alga belongs to the *Cladophoraceae* family.
It has unbranched filamentous thallus and it is thick, with cylindrical cells, large and numerous nuclei (Figure 2).

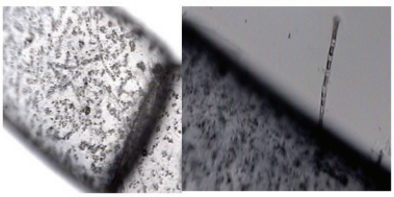

Figure 2. Chaetomorpha antennina – microscopic image

It has propagules that can be detached from the thallus.

Cladophora aegropila - (marimo balls)
This alga belongs to the *Cladophoraceae* family. Its thallus is filamentous (Figure 3), with erect branched filaments, composed of cylindrical, elongated, multinucleate cells; its filaments form spheres.

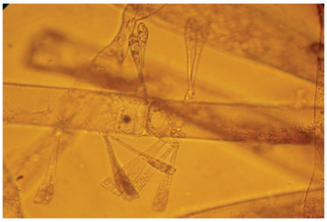

Figure 3. Cladophora aegropila– microscopic image

It presents propagules that can be detached from the thallus.
Caulerpa taxifolia ('killer algae', 'silent killer')
This alga belongs to the *Caulerpaceae* family.
The thallus (Figure 4) is formed of a uniaxial cladomes system, composed of a cylindrical portion (a continuous shaft) which is stoloniferous, repentis, branched, perennial, called kauloid, and develops phyloids - flattened formations similar to green leaves, providing chlorophyll assimilation. It attaches itself to the substrate with its branched rhizoids (Peterfi and Ionescu, 1979).

Figure 4. Caulerpa taxifolia

Its thallus is crossed by numerous cylindrical beams (Figure 5) that are perpendicular to the surface.
Codium fragile (Dead Man's Fingers)
This alga belongs to the Codiaceae family. It has a pseudoparenchymatous (Figure 7), uncalcifying thallus, and spongy consistency. It forms detachable propagules (Figure 6).
It presents tubular, filamentous cells, with dense colourless woven filaments (Figure 8) and peripherally arranged vesicular growths, rhizoids and vertical kauloids.

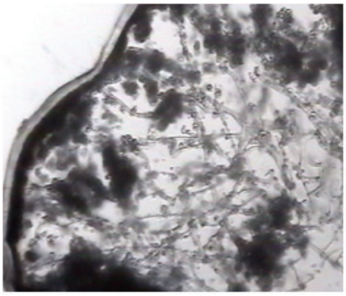

Figure 5. Caulerpa taxifolia - microscopic image

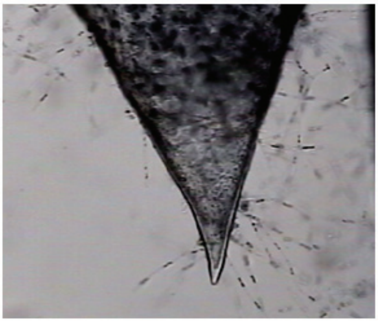

Figure 6. Caulerpa taxifolia – microscopic image

Figure 7. Codium fragile – microscopic image

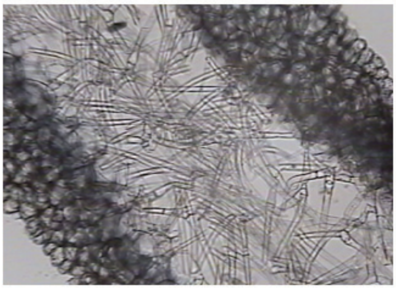

Figure 8. Codium fragile – microscopic image

The terminal branches of the filaments are arranged on the surface of the thallus. The alga presents propagules that can be detached from the thallus.

Codium vermilara

It is a green marine algae (Figure 9).

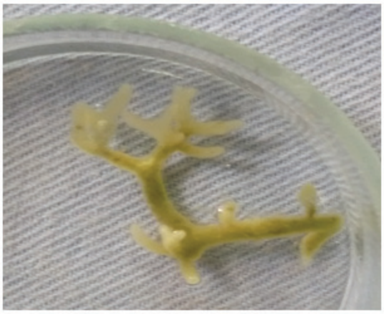

Figure 9. Codium vermilara – microscopic image

Its thallus is pseudoparenchymatous (Figure 10) and uncalcified.

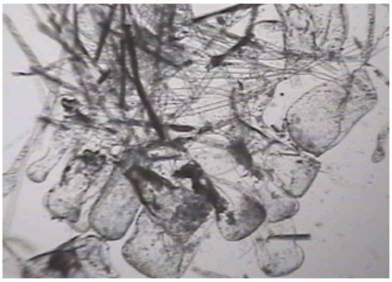

Figure 10. Codium vermilara – microscopic image

CONCLUSIONS

Among algae uncontrolled introduced in Romania are included the invasive algae, such as *Caulerpa taxifolia* wich can colonize different types of substrates and causes serious environmental problems.

The lack of legislation in this regard, leads, sooner or later, to irreversible damage to biodiversity within ecosystems where this algae species develops.

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SOME NEW SPECIMENS FOR ZOOLOGICAL TEACHING COLLECTIONS INTRODUCED FROM MOROCCO IN THE FACULTY OF AGRICULTURE – U.A.S.V.M. BUCHAREST, ROMANIA

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Abstract

Completing the collections for a zoology laboratory, as part of obligatory student's instruction, proves to be a long and ongoing process, in which passion, altruism, patience and some kind of self-sacrifice are often involved. Year after year since its beginning, the Biology specialization's laboratory from University of Agronomic Sciences and Veterinary Medicine of Bucharest reached an important number of vertebrates and macroinvertebrates specimens, most of them belonging especially from field sampling during personal trips or summer practices. For the pedagogical purpose, our collections received recently important help from Dakhla expedition (March-April 2012). Some interesting and well-preserved animal specimens from Morocco/Western Sahara, like whole mollusc shells (Solen, Mytilus, Fissurella, Patella) with barnacles attached, scorpions (Buthus), myriapods, an Raja clavata egg, turtles (Mauremys), and many others, never owned before by U.A.S.V.M. Bucharest, will represent an useful tool in the university practical lessons.

Key words: *teaching collections, zoology, Morocco.*

INTRODUCTION

Around the world, each respectable university with a biological profile holds a zoology department enriched with numerous collections, used for study, research or access of a broader public segment. Teaching collections are of great importance for science instruction at any level (Riccardo et al., 2012). The Biology specialization of the Faculty of Agriculture within University of Agronomic Sciences and Veterinary Medicine of Bucharest, in the short history from its establishment, has managed to achieve various zoological pieces, serving as a teaching collection, useful day by day in the educational process, in the light of fundamental character of the zoology disciplines, for training prospective biology and forestry students. Our specimens can be grouped in three categories: micro slides stored in appropriate slide cases (protozoans, metazoans), invertebrates (the bulk of the resources) and chordates. The majority of specimens are stored in liquid preservatives, alcohol or formaldehyde, sealed in glass jars being old enough to claim at some point their reconditioning. The macroinevertebrates covers the most important systematic groups studied within this academic discipline (sponges, coelenterates, polychaetes, molluscs, chelicerates, crustaceans, insects, echinoderms), representing local but also worldwide in origin fauna. However, acquisition of new species by donations is always welcome. In order to completing the collections, one effort is not enough; in this process, have participated and will continue to do so with enthusiasm: teachers, students, volunteers and friends who understand our approach. Taking care of any kind of collection requires a special kind of passionate people (Verschelde and Adriaens, 2012). The actions involves completion of some phases, often delicate: field trips, sampling, preparation, installation, conservation, identification, labelling and the display of the animals that will serve as teaching support.

Among the exhibits from various places of the world, our laboratory collection recently added some specimens brought from the scientific expedition Dakhla, in Morocoo/Western Sahara, between 15th of March and 21th of

April 2012, organized and funded by "Grigore Antipa" National Museum of Natural History of Bucharest, "Oceanic Club" Society of Oceanographical Exploration and Protection of the Marine Environment and the TV channel Da Vinci Learning.

MATERIALS AND METHODS

Some of the animals sampled on the coast of Eastern Atlantic were whole preserved, on the spot, in alcohol 90%, subsequently transported to the "Grigore Antipa" National Museum of National History of Bucharest laboratories. Much later, one or more specimens of species recorded for the Morocco area, were donated to the Faculty of Agriculture from U.A.S.V.M. Bucharest. The main collecting sites from Africa were represented by the following points: Cap Sim, Sidi Kaouki and Dakhla (Figure 1).

RESULTS AND DISCUSSIONS

The zoological material brought to the laboratory of our faculty comes from both lagoons and intertidal areas but also from desertic zones from Northern Africa.

Figure 1. Collecting sites (map source: Google Earth)

The specimens added to our teaching collections were selected by category and identified. So far, we were able to identify the following invertebrates specimens: Mollusca, Gastropoda (*Conus*, *Fissurella*, *Osilinus*, *Patella*, *Turritella*); Mollusca, Bivalvia (*Mytilus*, *Solen*); Athropoda, Chelicerata: Scorpionides (*Buthus occitanus*); Arthropoda, Chelicerata: Araneae; Arthropoda, Crustacea: Maxillopoda, Cirripedia (*Balanus* sp.); Arthropoda, Malacostraca: Amphipoda, Gammaridea; Malacostraca: Isopoda, Oniscidea; Malacostraca: Decapoda, Brachyura; Arthropoda, Myriapoda: Chilopoda; Arthropoda, Insecta: Coleptera and Hymenoptera. Also, of the chordates, we received one egg of *Raja clavata* (Chondrichthyes, Rajiformes), a *Trachurus mediterraneus* specimen (Osteichthyes, Perciformes) and the reptiles: *Mauremys leprosa* (Testudines, Geoemydidae), *Saurodactylus* sp. (Squamata, Gekkonidae), *Stenodactylus* sp. (Squamata, Gekkonidae) and *Trapelus* sp. (Squamata, Agamidae).

The barnacles (*Balanus* sp.) are attached to molluscs like limpets (*Patella* sp.) and top snails (Trochidae) (Figure 2). Before achieving those complete specimens of *Patella* (with muscular foot) and *Solen* (with both valves still connected, leg and siphons exposed), our collection resources were based solely on dry empty shells of their kind. The reigning notion is that animals collected alive are the most beautiful of all (Bruyne, 2004).

Figure 2. Molluscs from Morocco

As regarding the scorpions, *Buthus occitanus* (Figure 3) represents a new species for our teaching collection, which contained till now one specimen of *Euscorpius carpathicus* and another one of *Pandinus* sp.

Figure 3. *Buthus occitanus*

The thirteen different sizes specimens brought from Morocco, will serve for pedagogical purposes in Invertebrate Zoology practical lessons, where students must indicate chelicerae, claws, pectines and the main regions of a scorpion's body: prosoma, mesosoma and metasoma.

New reptiles for our teaching collections are: the turtle *Mauremys leprosa* (Figure 4), the gekkonids *Saurodactylus*, *Stenodactylus* and also the agamid *Trapelus* (Figure 5, from left to right). The first shark egg of the collection dates from Dakhla expedition and belongs to *Raja clavata* (Figure 6).

Figure 4. *Mauremys leprosa* specimens

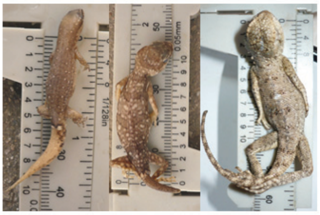

Figure 5. New squamates species for our teaching collections

Figure 6. Raja clavata egg from Cap Sim

CONCLUSIONS

Thanks to contributions from scientific expedition in Dakhla, Morocco in 2012, the Biology students from Faculty of Agriculture - U.A.S.V.M Bucharest, will be the beneficiaries of a valuable didactic material, unique and well preserved. These are essential features when it comes to apply the strict theoretical concepts learned from the zoology lessons.

Absolutely new for our zoology lab are the gekkonid specimens of *Saurodactylus* and *Stenodactylus*, agama *Trapelus*, whole limpets (*Patella* sp.), whole bivalves of *Solen* sp. and also the *Raja clavata* shark egg.

As regarding mollusks collection, the students will be able to make once and again the difference between conchology – the study of dry mollusc shells, and malacology– the study of wet, whole organisms. For this purpose, they will be able to compare, for example, the previously existing empty shells of *Patella*, *Fissurela*, *Mytilus*, *Solen* to name a few, with whole organisms of these species, recorded in Morocco.

All specimens mentioned in this paper are wet preserved in ethanol 70%, labelled and kept in transparent PVC jars with opening-closing system, in order to be easily handled, if necessary, for demonstration purposes.

In the future, we aim: finalization of the database hosted on a variety of zoological taxa in the Faculty of Agriculture; identifying, preservation and proper labelling of the older or newer significant material used for study in zoology lessons in our University; attracting people interested in contributing to our effort to enrich the collections, and also establishing new contacts with various institutions that could help in any way.

ACKNOWLEDGEMENTS

This research work was carried out with the support of “Grigore Antipa” National Museum of National History of Bucharest, Romania and “Oceanic Club” Society of Oceanographical Exploration and Protection of the Marine Environment and the TV channel Da Vinci Learning, which funded the Dakhla scientific expedition in 2012.

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MISCELLANEOUS

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NEW DATA ON THE MORPHOLOGY AND DISTRIBUTION OF TWO SPECIES OF THE *XIPHINEMA AMERICANUM* GROUP (NEMATODA: DORYLAIMIDA) FROM ROMANIA

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Abstract

Several populations of Xiphinema pachtaicum (Tulaganov, 1938) Kirjanova, 1951 and Xiphinema simile Lamberti, Choleva et Agostinelli, 1983, originating from various localities have been studied during 2011-2012. Soil samples were collected at a depth of 20-40 cm in the rhizosphere of grapevine, cherry and apple trees. The identification of the nematodes was based on morphological and morphometrical characters. Descriptions, including morphometric data and illustrations of adults (females and males) and juveniles from different localities and plant associations are provided. Data of X. pachtaicum and X. simile males are provided for the first time for Romania. Both species occurred together in two locations. Malus pumila Mill and Prunus avium L. are new plant association for these nematodes species for Romania.

Key words: *Longidoridae, Xiphinema pachtaicum, X. simile, morphology.*

INTRODUCTION

Nematodes of genus *Xiphinema* (family *Longidoridae)* are ecomically important plant pest, causing direct and indirect damage to a wide number of crops. The number of species in the genus is some 240 (Decraemer, 2007). In Romania, four species of *Xiphinema americanum* group have been recorded: *Xiphinemaparasimile* Barsi et Lamberti, 2004 in association with grapevine and apricot (Groza et al., 2012); *Xiphinema taylori* Lamberti et al., 1992; *Xiphinema pachtaicum* (Tulaganov, 1938) Kirjanova, 1951 and *Xiphinema simile* Lamberti, Choleva et Agostinelli, 1983 in association with grapevine, fruit trees, alfalfa, and peach (Peneva et al., 2006 and Groza et. al., 2012). This work presents a detailed analysis of the morphometrical data of *Xiphinemapachtaicum* and *X. simile* originating from Romania.

MATERIALS AND METHODS

Soil samples were collected from the rhizosphere of grapevine, cherry and apple trees at a depth of 20-40 cm, from different regions of country: Bîrlad, Huși (Vaslui county), Nazarcea, Ostrov (Constanţa county), Urlaţi (Prahova county), Obrejiţa (Vrancea county).

Nematodes were extracted from 200 cm^3 soil by a sieving and decanting technique. Nematodes were heat killed at 60^{o}C for two minutes and fixed in a 4% formaldehyde solution. The specimens were processed and mounted on permanent microscopic glass slides (Seinhorst, 1959).

The morphological and morphometrical observations were made using Leica DMLB microscope fitted with Leica FDC 295 camera.

Table 1. Measurements of *Xiphinema pachtaicum* (Tulaganov, 1938) Kirjanova, 1951 (all in micrometers except for body length)

Locality	Urlati		Nazarcea		Ostrov
Host plant	*Vitis vinifera*		*Vitis vinifera*		*Cerasus avium*
Character	Females	Male	Females	Male	Females
n	10	1	7	1	11
L	2.0±0.88 1.8-2.1	2.1	1.97±0.18 1.77-2.26	1.88	1.89±0.94 1.77-2.11
a	66.4±3.4 62.3-73	70.5	64.0±5.4 56.2-70.9	72.6	63.9±2.5 59.6-68.4
b	6.3±0.6 5.6-7.3	6.4	6.2±0.4 5.7-6.8	6.1	6.1±0.7 4.6-7.1
c	64.0±5.2 56.5-74.1	70.5	62.5±3.6 55.6-67.4	70.1	63.3±4.0 57-71.5
c’	1.8±0.1 1.7-2.1	1.5	1.8±0.1 1.6-1.9	1.4	1.8±0.1 1.7-1.9
V%	57.5±0.7 56.5-58.6	-	57.0±2.8 52.7-59.4	-	57.7±0.6 56.4-58.5
Odontostyle	90.0±1.8 88-92	90	82.6±3.7 79-88	86	87.9±2.5 83-91
Odontophore	50±1.3 48-52	50	49.7±3.0 44-53	47	50.1±1.8 48-54
Oral aperture to guide ring	80.5±3.5 71-83	80	75.0±3.8 70-80	79	78.6±2.9 75-83
Pharynx	318.3±20.7 285-339	326	288.0±15.3 275-320	305	311.5±29.6 269-385
Tail	31.4±2.1 29-35	30	28.4±2.3 25-32	27	29.9±1.4 27-31
Length of hyaline part	8.2±0.6 7-9	8.1	7.8±0.9 6-9	9	9.2±1.1 8-11
Body diameter at: - lip region	9.2±0.3 9-10	10	9.0±0.4 9-10	9	9.0±0.3 8.5-10
- guiding ring	22.5±0.4 22-23	22	21.7±0.9 20-23	21	22.5±1 21-24
- base of pharynx	26.6±1.1 25-28	26.5	26.4±2.6 23-30	25	26.4±1.5 23-30
- mid-body	30.2±1.7 27-34	30	30.8±1.6 29-33	26	29.7±2 28-35
- anus	17.1±0.7	19,6	17.3±0.9 16-19	18	16.7±0.4 16-18
- hyaline part	6.7±0.5 6-7,5	6.5	7.8±0.8 7-9	7	7.9±0.7 7-9
Spicules		40		42	

n=number of specimens; a=body length/greatest body diameter; b=body length/distance from anterior to end of esophageal bulb; c=body length; c´=tail length/anal body diameter; V %distance of vulva from anterior end

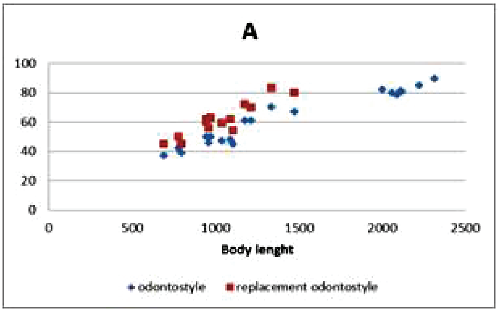
RESULTS AND DISCUSSIONS

Xiphinema pachtaicum (Tulaganov, 1938) Kirjanova, 1951 (Tables 1-3; Figures 1A, 2, 3,5)

Female. Habitus in the shape of a single spiral or C when relaxed. Labial region 3-4 µm high, offset from the rest of the body, expanded, frontally flattened, laterally rounded. Genital system with two almost equally developed branches, uteri short. Rectum 23µm long for Ostrov population, 17-21 µm for Urlați, 21-24,5 µm for Bîrlad population.

Male. Body posture as in female, tail end coiled stronger ventrally. Head region as in female, lip region 4 µm high. Ventromedian supplements 1+5 (Urlați specimen) and 1+6 Nazarcea specimen). Spicules slightly curved ventrally.

Tail dorsally convex, with elongated mucro. (Figure 5).



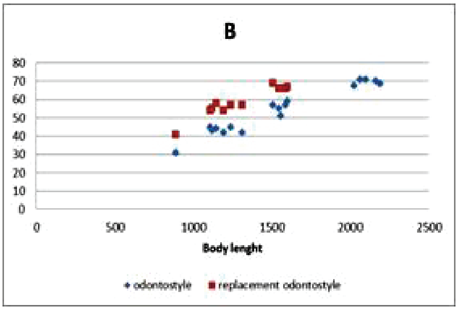


Figure 1. Scatter plot of odontostyle and replacement odontostyle agaist body length of *Xiphinema pachtaicum* (A) and *Xiphinema simile* (B) from Bîrlad populations

Table 2. Measurements of *Xiphinema pachtaicum* (all in micrometers except for body length)

Locality	Birlad-pachtaicum				
Host plant	*Vitisvinifera*				
Character	Females	J1	J2	J3	J4
n	7	3	6	2	2
L	2.13±0.10 2.0-2.3	0.75±0.056 0.69-0.79	1.00±0.07 0.94-1.10	1.17, 1.21	1.33, 1.47
a	69.3±3.3 64.4-74.9	39.8±5.9 33.2-44.7	51.1±5.2 44.2-59.8	51.8, 57.9	61.9, 64.2
b	7.3±1.1 6-9.4	4.6±0.3 4.3-4.9	4.7±0.5 4.3-5.5	4.7	5.2, 5.7
c	49-74.7	24.4±1.5 22.7-25.6	31.7±3.3 26.9-35.1	34.6, 35.3	38.7, 41.4
c’	1.6-2.5	2.6±0.3 2.3-2.9	2.2±1.1 2.2-3	2.3-2.4	2.1, 2.4
V%	56.0±1.2 52.6-57.6	-	-	-	-
Odontostyle	82.4±3.7 79-90	39.8±2.7 37-42	48.2±2.2 45-50	61.61	67.70
Odontophore	51.8±2.6 48-55	31.9±0.1 32-32	35.8±2.4 32-39	37.38	44
Replacement odontostyle	-	47.8±4.5 45-53	59.5±3.7 54-63	70.72	80.83
Oral aperture to guide ring	72.5±2.2 71-76	34.2±1.1 33-35	41.3±3.4 36-45	54-54	41. 55
Pharynx	296.3±31.1 247-345	165.7±6.4 162-173	212.3±10.9 198-223	250-256	235-283
Tail	34.0±3.7 28-41	30.9±0.4 30-31	32.2±2.2 29-35	33.35	32.38
Length of hyaline part	9.5±1.5 8-12	5.0±0.3 5-5	5.1±0.5 4-5	5.6	6.5-8
Body diameter at: - lip region	9.6±0.4 9-10	7.4±0.4 7-8	7.5±0.3 7-8	7.7	8-9
- guiding ring	21.2±0.8 20-22.5	13.7±1.4 13-15	15.4±1.2 15-18	16-17	17-19
- base of pharynx	26.7±1.2 25-28	18.1±3.0 16-21,5	18.4±1.9 16-21	19-21	20-22
- mid-body	30.8±1.9 28-35	19.3±4.1 17-24	19.8±2.4 18-25	21-23	21-23
- anus	18±0.9 17-19	11.9±1.6 11-14	12.8±1.5 12-15	14-14	15-16
- hyaline part	8.6±1 8-10	3.8±0,3 3.5-4	4,9±0,6 4-5	5-6	5.5-7

n=number of specimens; a=body length/greatest body diameter; b=body length/distance from anterior to end of esophageal bulb; c=body length; c´=tail length/anal body diameter; V%=distance of vulva from anterior end

Table 3. Measurements of *Xiphinema pachtaicum* (all in micrometers except for body length)

Locality	Obrejita (Vrancea county)				
Host plant	*Vitis vinifera*				
Character	Females	J1	J2	J3	J4
n	9	4	5	5	4
L	2.03±0.15 1.83-2.23	0.73±0.028	0.93±0.053 0.85-0.98	1.27±0.05 1.22-1.35	1.65±0.07 1.58-1.73
a	69.9±6.1 62.2-78.9	43.7±1.8 41.4-45.6	48±2.1 45.9-50.5	57.3±2.1 53.7-58.8	61.8±3.6 57-65
b	7±0.9 5.4-8.5	4.4±0.4 3.9-4.9	4.9±0.1 4.8-5.1	5.5±0.4 5.0-6.2	6.8±0.3 6.5-7.2
c	70.1±5.6 59.5±76.3	24.8±0.6 24.2-25.3	28.5±1.4 27.5-29.4	40.9±2.8 37.8-43.2	50.3±2.3 47.4
c’	1.7±0.1 1.6-1.9	2.7±0.1 2.6-2.8	2.7±0.3 2.5-2.9	2.1±0.1 2.1-2.3	2.0±0.0 1.9-2.0
V%	54.1±1.2 52-55.6	-	-	-	-
Odontostyle	78.6±1.5 76-80	39.7±0.5 39-40	44.7±2.9 40-47	58.0±1.0 57-59	32.9±1.8 31-35
Odontophore	48.2±2.9 42-53	28.4±2.0 26-30	32.3±2.2 30-35	37.2±1.3 35-38	42±0.8 41-43
Replacement odontostyle	-	45.9±0.7 45-47	40.4±2.5 37-43	68.4±1.5 67-70	78.3±3.6 73-81
Oral aperture to guide ring	70.5±1.7 67-73	34.8±1.0 34-35	40.4±2.5 37-43	51.2±1.1 50-53	59±0.8 58-60
Pharynx	294±26.6 260-342	166.3±11.2 155-177	189.4±7.6 179-198	232.8±13.7 219-253	244.3±10 235-258
Tail	29.1±1.3 28-31	29.3±0.5 29-30	33±0.5 33-33	31.4±1.0 31-33	32.9±1.8 31-35
Length of hyaline part	8.3±0.6 7-9	4.5±0.4 4-5	4.6±0.4 4-5	5.5±0.4 5-6	6.9±0.5 6-7
Body diameter at: - lip region	9.1±0.3 9-10	7.2±0.1 7	7.5±0.3 7-8	8.1±0.4 8-9	8.4±0.3 8-9
- guiding ring	21.5±0.8 20-23	13.3±0.8 12-14	14±0.7 13-15	17.0±0.4 17-17.5	19.1±0.7 18-20
- base of pharynx	25.6±1.5 23-28	16.2±1.0 15-17	17.8±1.2 16-19	20.6±0.5 20-21	23.5±0.1 22-24
- mid-body	29.2±1.6 27-32	16.8±1.0 15-18	19.5±1.4 18-21	22.2±0.8 21-23	26.8±1.5 25-28
- anus	16.7±1.2 15-18	10.8±0.1 11-11	12.4±1.6 11-13,5	14.7±0.5 14-15	16.6±1.1 16-18
- hyaline part	7.3±0.7 6-8	3.6±0.3 3-4	4.4±0.3 4-5	5.2±0.6 5-6	6.4±0.5 6-7

n=number of specimens; a=body length/greatest body diameter; b=body length/distance from anterior to end of esophageal bulb; c=body length; c´=tail length/anal body diameter; V%=distance of vulva from anterior end

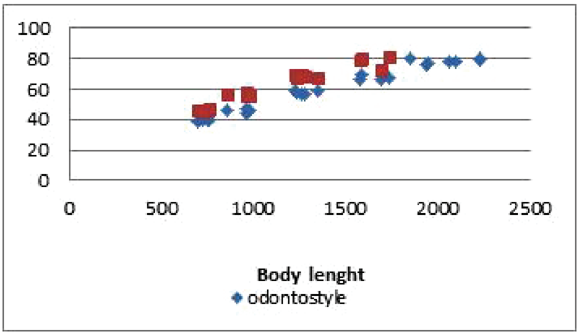


Figure 2. Scatter plot of odontostyle and replacement odontostyle agaist body length of *Xiphinema pachtaicum* from Obrejița population

Table 4. Measurements of *Xiphinema simile* (all in micrometers except for body length)

Locality	Nazarcea		Husi	Bîrlad			
Host plant	*Vitisvinifera*		*Maluspumila*	*Vitisvinifera*			
Character	Females	Male	Femeles	Females	J1	J2	J3
n	3	1	6	5	1	6	5
L	2.16±0.14 2.02-2.30	1.97	2.0±0.1 1.83-2.0	2.05±0.13 1.81-2.18	0.7	1.18±0.077 1.10-1.30	1.55±0.036 1.5-1.59
a	74.2±3.4 70.9-78.3	73.1	72±3 69-78	79±3 76-83	41.6	58.2±5.5 48.0-63.9	73.7±3.9 70.6-80.3
b	7.0±1.0 6.4-7.7	7.2	6.9±0.1 6.8-6.9	7.2±0.7 6.5-8.2	4.3	5.7±0.2 5.4-5.9	6.1±0.4 5.8-6.7
c	70.2±5.4 62.9-76	70.5	66.2±8.8 56.2-79.5	79.9±13 62.9-86.7	22.7	39.6±3.8 35.1-44.5	50.4±3.8 44.1-53.8
c’	1.8±0.1 1.7-1.9	1.3	1.7±0.2 1.4-2	1.7±0.2 1.5-1.9	2.9	2.3±0.2 2.1-2.7	2.1±0.2 1.9-2.5
V%	53.8±0.9 52.6-54.8	-	55.2±0.6 54.4v56	5.,5±1.1 54.6-57.4	-	-	-
Odontostyle	69.5±6.4 66-72	66	68.3±2.3 65-70	69.7±1.3 68-71	37	43.5±1.4 42-45	55.8±3.0 51-59
Odontophore	45.5±5.1 42-50	46	46±1.7 43-48	43.1±2.5 40-46	-	33.0±1.7 31-35	36.8±1.5 35-39
Replacement odontostyle	-	-	-	-	45	55.8±1.7 54-58	66.7±1.4 66-69
Oral aperture to guide ring	61±6.4 56-65	63	60.7±1.0 59-62	59.2±0.8 58-60	33	37.0±1.3 36-39	48.5±1.9 46-51
Pharynx	305.5±17.7 293-318	267	292.3±15 265-304	285.7±21.7 253-306	162	207.9±8.9 200-223	254.7±17.5 231-273
Tail	30.9±1.4 29-32	27,6	30.6±2.8 26-34	27.5±3.7 24-32	30,4	30.1±2.9 26-34	31.1±2.6 28-35
Length of hyaline part	7.1±1.6 5-9	7.1	61±0.7 5-7	6.2±0.6 6-7	5	4.2±0.4 4-5	4.7±0.7 4-6
Body diameter at: - lip region	9.6±0.4 9.1-10	9.8	10±0.4 10-11	9.3±0.4 8.8-10	7.3	7.8±0.3 7-8	8.5±0.1 8-9
- guiding ring	19.4±1.6 19-22	20	19.4±0.6 19-20	18.8±1.1 17-20	12.6	14.0±0.5 14-15	16.8±0.9 15-18
- base of pharynx	25±3.9 22-28	24.7	24.2±0.9 23-26	22.9±2.0 21-26	16	18.2±2.2 16-22	19.9±0.7 19-21
- mid-body	29.2±2.7 26-32	26.6	27.8±1.6 26-30	25.6±1 24-27	16.6	20.6±3.0 18-26	21.2±1.2 19-22
- anus	17.6±1.1 17-19	19.8	18.1±0.9 17-19	16.2±0.4 16-17	10.6	13.2±1.1 12-15	14.6±0.7 14-16
- hyaline part	7.0±0.8 6-7	6.3	7.8±0.6 7-9	7.4±0.8 6-8	4	4.3±0.4 3.8-5	5.5±0.6 5-6
Spicules		38	-	-	-	-	-

n=number of specimens; a=body length/greatest body diameter; b=body length/distance from anterior to end of esophageal bulb; c=body length; c´=tail length/anal body diameter; V%=distance of vulva from anterior end

Juveniles. The scatter plot diagram based on functional and replacement odontostyle and body length reveal the presence of four juveniles stages (Figure 1A, 3)

Xiphinema pachtaicum was found in rhizosphere of *Vitis vinifera* L. (Bîrlad, Urlaţi, Nazarcea, Obrejiţa), and *Prunus avium* L. (Ostrov) (Table 1, 2, 3).

All populations of *X. pachtaicum* studied are similar in most morphological and morphometrical characters. However, Obrejita specimens compared to other have shorter odontostyle (ave.78.6 vs ave. 90-82.4 µm).

This species is wide-spread in Europe and has been shown to occur in several countries such as: Bulgaria (Choleva, 1975, Lamberti et al., 1983, Peneva & Choleva 1992), Croatia (Samota et al. 1994), Czech Republic (Kumari, 2004, Kumari et al. 2005), Macedonia, Montenegro, Serbia (Barsi & Lamberti, 2002). Slovakia (Liskova, 1992, Lamberti et al., 1999), Hungary (Repasi et al., 2008), Spain, Italy (Gutiérrez-Gutiérrez et al., 2011).

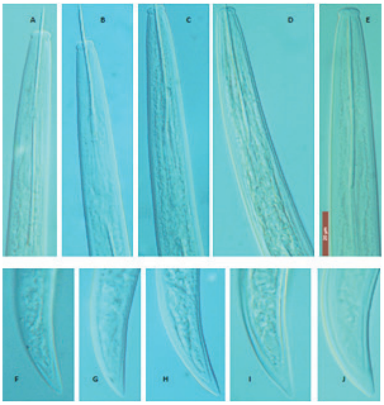


Figure 3. *Xiphinema pachtaicum* A-D, anterior region of first, second, third and fourth stage juveniles; E, female anterior end; F-I, tail of first, second, third and fourth stage juveniles; J, female tail. Scale bar: A-J, 20µm

Xiphinema simile Lamberti, Choleva et Agostinelli, 1983 (Table 4, Figures 1B,4, 5).
Female. Habitus in the form of a single spiral or C when relaxed. Labial region 4 µm high, separated from the rest of the body by a deep constriction. Gonads paired, opposed and reflected. Rectum 20-23 µm long for Huşi population, 16-20 µm for Nazarcea specimens. Tail conoid, dorsally convex, terminus rounded, in some specimens pointed.
Male. Similar to female in habitus, the posterior region more strongly coiled ventral. Anterior testis 75 µm and posterior 77 µm long, filled with sperms. Spicules slightly curved, one adanal pair and 4 ventromedian supplements present (Figure 5).
Juveniles. Three juveniles stages were distinguished on the basis of body, functional and replacement odontostyle lengths (Figure 1B, 4).
The morphometric characters of *X. simile* (Table 4) found in rhisosphere of *Vitis vinifera* L. (Nazarcea, Bîrlad) and in *Maluspumila* Mill. (Husi) are almost identical.
Romanian specimens closely agree in measurement with populations from Bulgaria (Peneva & Choleva, 1992, Lazarova et al., 2008), Slovakia (Liskova & Brawn, 1996: Lamberti et al., 1999), former Yugoslavia (Barsi, 1994; Barsi & Lamberti , 2002, 2004), Czech Republic (Kumari, 2006) and Kenya (Coomans & Heyns, 1997). Body length is shorter than in Hungarian specimens (Repasi et al., 2008).

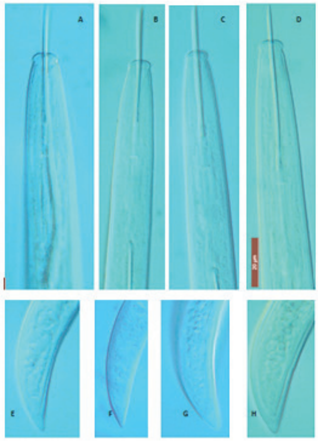


Figure 4. *Xiphinema simile* A-C, anterior region of first, second, and third juvenile stages; D, female anterior end; E-G, tail of first, second and third juvenile stages; H, female tail. Scale bar: A-J, 20µm

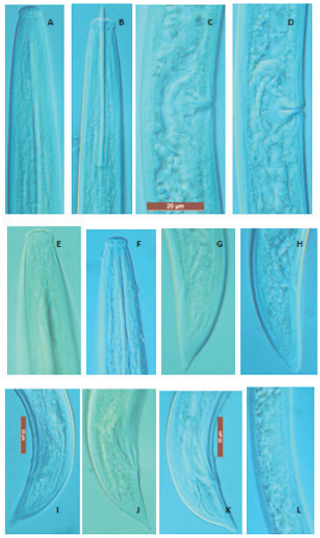


Figure 5. *Xiphinema pachtaicum*, A, anterior region of female; C, vaginal region; E, anterior region of male; G, female tail; I, J,male tail and copulatory apparatus; Xiphinema simile, B, anterior region of female ; D, vaginal region, F, anterior region of male; H, female tail; K, male tail and copulatory apparatus, L, anterior testis. Scale bar: A-J, 20µm

CONCLUSIONS

Morphological data and measurements of juvenile stages and male specimens are presented for the first time for Romanian populations.

Malus pumila and *P. avium* are new host plant associations for these species in our country.

Xiphinema pachtaicum and *X. simile* were found to occur together in Bîrlad and Nazarcea populations in the rhizosphere of grapevines.

All localities are new records for both species.

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STUDY ON THE HIDROCLIMATIC PARAMETERS IN THE UPPERBASIN OF THE TÂRGULUI RIVER AND THEIR ENVIRONMENTAL IMPACT

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Abstract

The evaluation of the hydrological parameters allows the elaboration of the hydrological forecasts and the identification of the risks arising from flash flood, construction size and improvement of the hydrotechnical buildings. In the upper basin of the Târgului River, annual precipitation ranges from 429.6 mm to 1209.3 mm, the lowest amounts being recorded in February (36.9 mm) and highest in June (115.8 mm). The mean annual runoff was recorded at the Voina hydrometric station, i.e. 2.05 m^3/s, and the highest reached was 75. 0 m^3/s. Between 1970 and 2009, 181 flash floods occurred, of which 7 were major (4%), with flow rates above 38 m^3/s, exceeding the attention share. Probabilistic calculations show that every 100 years the maximum flow rate can reach 99.10 m^3/s, and every 50 years it can exceed 76.84 m^3/s. The hydrotechnical objectives built on the Târgului River in the 1980s changed the natural flow of water, affecting the morphology of the area and its ecological balance.

Key words: *accumulation, attention share, runoffs, precipitations, flash floods.*

INTRODUCTION

Knowledge of the characteristics and particularities of a hydrographical basin presents a special importance for the sustainable and efficient management of water resources, in accordance with the current legislation. 'The defense and improvement of the environment is an issue of major importance which affects the well-being of populations and economic development throughout the world. It corresponds to the desire of the peoples of the world and is a duty for all governments" (Stockholm Declaration, June 1972).

Water resources present a sharp sensitivity to climate change. Relatively small variations in climate can cause large problems for water resources. Besides the climatic factors, the anthropic factor has an important role owing to the changes in the water flow regime and the morphology of the area (Musy and Laglaine, 1992).

The Hydrographical Basin of the Târgului River is the most important water system of the Upper Argeş, with an area of 1096 km^2, a length of about 70 km and a mean width of about 25 km. Springing from the Iezer Mountains, the Târgului River drains via the tributaries Bătrâna and Râuşor, ice beneath of the peak of the Iezer Mountains. After crossing the Câmpulung Depression, in the Piedmont Hills area, it receives two main tributaries, Bratia and Bughea on the right, and the Argeşel River on the left.

There is a series of hydrotechnical objectives built on the Târgului River in different stages, which have an interconditioned operation, in order of upstream-downstream: accumulation of the Râuşor, CHE Lereşti, Lereşti polder, CHE Voineşti , Voineşti polder, Schitu Goleşti and Voineşti accumulation and Schitu Goleşti CHEMP. These arrangements have increased its economic importance but have also changed its ecological balance.

MATERIALS AND METHODS

For this study we used the data from the Câmpulung weather station (A.N.M.) and for the assessment of water resources we used the data from the Câmpulung hydrological station (ANAR-DAAV) for the period 1970-2009. The following were calculated and interpreted:

- monthly and annual precipitation;

- the mean, minimum and maximum monthly and annual flow;
- extreme phenomena – flood production.

RESULTS AND DISCUSSIONS

The orographic configuration of the Târgului River basin, with the altitudinal layout of the main forms of relief, and a general orientation to the South and the mountains in the North, have marked the distribution of air masses and the weather course directly, causing a local climate characteristic of the Carpathian Depressions.

In the Câmpulung Muscel Depression, precipitations amount varies greatly from one year to another due to the continuous fluctuations of the general circulation of the atmosphere, as determined by the frequency and duration of displacement and the development of the atmospheric systems, baric fronts, and air mass nature. Pluviometric fluctuations result from the years with significant cyclonic activity, alternating with years of blockage and persistent anticyclonic circulation.

At Câmpulung, the mean multiannual of the annual precipitations amount was 798.5 mm. Equation of the regression line recorded a negative coefficient (-0.8823), which showed a slight declining trend in the annual precipitations, caused by the increasing anticyclonic activity (Figure 1).

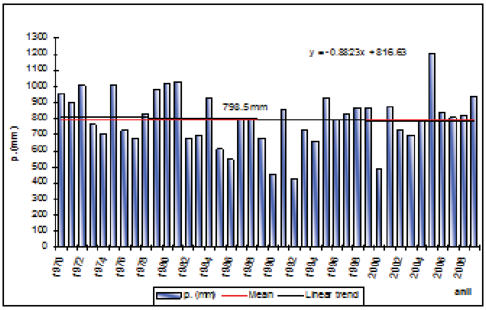

Figure 1. Annual variation of precipitations (mm) at Câmpulung (1971-2009)

Between 1970 and 2009, the lowest precipitations were: 1992 (429.6 mm), 1990 (452.9 mm), 2000 (485.8 mm), 1986 (546.3 mm) and 1985 (610.4 mm). The highest precipitations were recorded in 2005 (1209.3 mm), 1981 (1026.7 mm), 1980 (1016.7 mm), 1975 (1012.2 mm), 1972 (1006.2 mm) and 1979 (975.3 mm).

Annual precipitations differ from one month to another, due to the influence of the front type acting in the area, resulting in the interference of the tropical air masses with the polar ones. The lowest precipitations occurred between January and March, as a result of the predominant anticyclonic regime which prevented the development of the thermal convection.

The driest month was February, in the period 1970-2009, when the mean precipitations amount was 36.9 mm. Since March, precipitations increased progressively until June, when they recorded the maximum (115.8 mm), after which they started to decline towards the end of the year, the multiannual mean of December being 46.6 mm. The monthly extreme precipitations amounts varied between very broad limits of 0.1 mm (December 1972) to 147.4 mm (December 1981). In the warm season, they varied between 21. 2 mm in June 2003 and 277.2 mm in June 1974 (Figure 2).

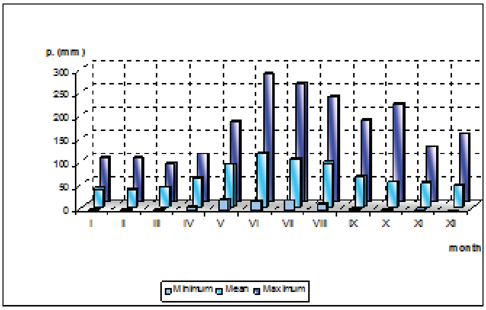

Figure 2. Monthly variations of mean, minimum and maximum precipitations at Câmpulung meteorological station (1971-2009)

The analysis of the precipitations fallen within 24, 48 and 72 hours was also important. Large precipitations in a short span of time were favoured by certain synoptic situations, and less local physical and geographical conditions.

In the Câmpulung Muscel Depression between 1971 and 2010, the highest precipitation amount fallen in 24 hours was 104.4 mm (June 1975). The highest amounts fallen in 48 and 72 hours were 133.7 mm and 138.2 mm (July 1981 and 1975, respectively) (Figure 3).

Precipitations with a rate of over 100 mm in 3 days were recorded in June 1975, 1979 and 1984, July, 1975 and 1981, August 1997 and 2005, September 2005 and October 1972.

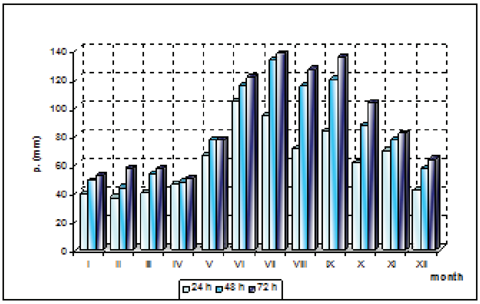

Figure 3. Maximum precipitations fallen at Câmpulung in 24, 48 and 72 hours (1971-2010)

The probabilistic calculation, after the Gamma double exponential distribution method, highlighted that every 100 years the maximum precipitations fallen in 72 hours might reach 152.8 mm, every 50 years could surpass 141.1 mm, and every 20 years could exceed 124.5 mm. For the highest precipitations recorded, the amount was 2.44% (138.2 mm), 4.88% (135.7 mm), 7.32% (133.7 mm) and 9.76% (126.9 mm) (Figure 4).

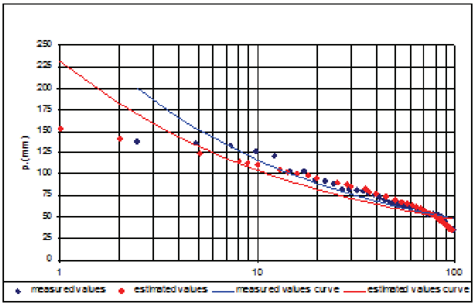

Figure 4. Highest precipitations measured and estimated in Câmpulung Muscel Depression in 72 hours (1971-2010)

The monthly and annual fluctuations of precipitations in turn generate large variations of the riverflows. In this context, the annual mean of the runoff recorded on the Târgului River at the Voina hydrometric station ranged between 1.09 m^3/s, in 1990 and 3.20 m^3/s in 2005; the multiannual flow mean was 2.05 m^3/s (Figure 5).

The flow rates under the multiannual mean were concentrated in the period 1982-2003, which represented 55%, except for 1991 and 1998, when the flow exceeded the multiannual mean. The lowest mean annual flows were recorded in the years: 1986 (1.39m^3/s), 1990 (1.09m^3/s), 1992 (1.11m^3/s), 1993 (1.37 m^3/s) and 2000 (1.32 m^3/s). The flow rates over multiannual mean were present in 45% of the cases, being concentrated in the range 1970-1981. The highest mean annual flows were recorded in the years: 1970 (3.05 m^3/s), 1972 (2.86 m^3/s), 1975 (2.84 m^3/s), 1991 (2.73 m^3/s) and 2005 (3.20 m^3/s). Throughout the analyzed period, the multiannual mean flow rates recorded an increasing trend, the regression line equation having a negative coefficient.

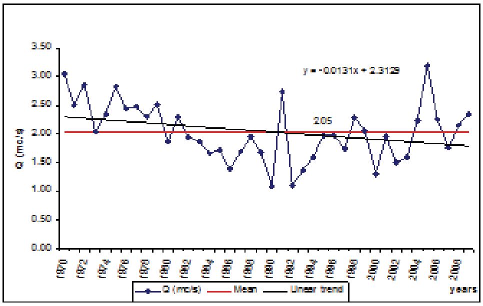

Figure 5. Annual mean flows, recorded on the Târgului River, at the Voina hydrometric station (1970-2009)

Studying the seasonal repartition of the mean flow at the Voina hydrometric station during 1970-2009, we found that the lowest amount of drained off water was recorded in winter (13.5%), and highest in summer (33.8%) (Figure 6).

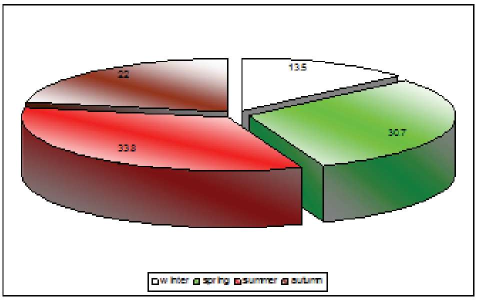

Figure 6. Seasonal repartition of the mean runoff on the Târgului River, at Voina (1970-2009)

The monthly mean of the flow highlighted a large variability of the flows during the year. The lowest values of the flows were recorded in January, February, March and December, i.e. between 0.94 and 1.33 m^3/s, and the highest in May and June, i.e. 4.16 m^3/s and 3.51 m^3/s, respectively. The minimum flow rates were between 0.34 m^3/s in February 1984 and December 1976, and 0.95 m^3/s, in June 1992 (Figure 7).

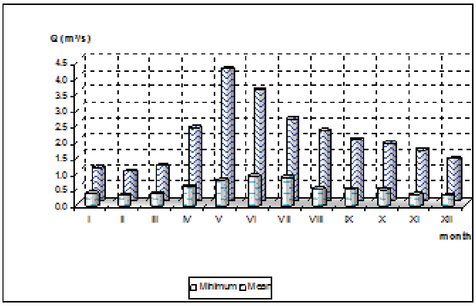

Figure 7. Monthly minimum and mean flows recorded on the Târgului River, at Voina (1970-2009)

The maximum runoff values ranged between 5.74 m^3/s in March 1976 and 75.00 m^3/s in August 1999 (Figure 8).

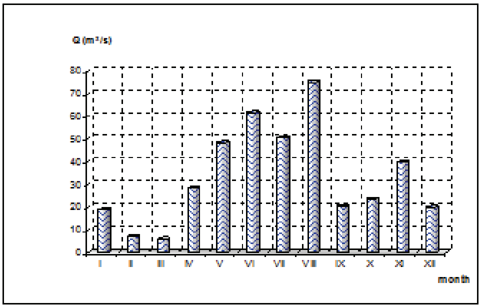

Figure 8. Monthly maximum flows recorded on the Târgului River, at the Voina (1970-2009)

The minimum and maximum flow are important characteristics of the hydrological regime, with major practical implications that need to be taken into account in the design, implementation and operation of hydroconstructions, the judicious management of the water, the pooled flood vulnerability and defense (Pişotă et al., 2005).

The maximum flow is the most important phase, being generated by torrential rains, sudden snow melt or superimposition of the two events. At the Voina hydrometric station, at a rate of 38 m^3/s, water level reaches a warning shade of 120 cm, which means share danger of major floods in the riverbed (Drobot et Şerban, 1999).

At the Voina hydrometric station between 1970 and 2009, the share of attention was superseded in 7 years, representing 17.5 % of the situations. The years when the shade of attention was superseded were: 1973 (48.5 m^3/s), 1975 (50.5 m^3/s), 1983 (50.7 m^3/s), 1998 (61.7 m^3/s), 1999 (75.00 m^3/s) 2004 (39.61 m^3/s) and 2005 (38.5 m^3/s), maximum flow rates due to an uptrend (Figure 9).

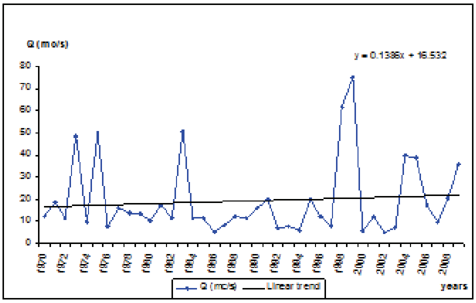

Figure 9. Annual maximum flows recorded on the Târgului River, at the Voina (1970-2009)

The Pareto curve highlighted the possible registration of the maximum flow rates higher than the measured ones (Helsel et Hirsch, 1992). Probabilistic calculations showed that every 100 years (0.01 %) the maximum flow rate could reach 99.10 m^3/s, every 50 years (0.02) they might exceed 76.84 m^3/s, and every 20 years (0.05 %) they could exceed 52.98 m^3/s (Figure 10).

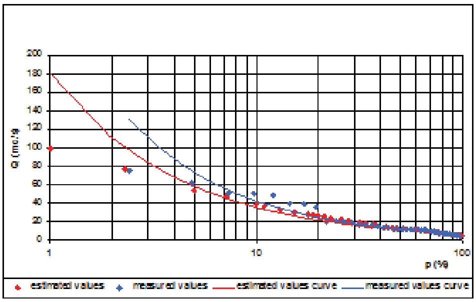

Figure 10. Assurance of maximum flows measured and estimated at the Voina hydrometric station (1970-2009)

The highest flow recorded had an assurance of 2.44 % (75.00 m^3/s), 4.88 % (61.70 m^3/s), 7.32 % (50.70 m^3/s) and 9.76 % (50.50 m^3/s).
On the Târgului River, at the Voina hydrometric station, between 1970 and 2009, there were 181 flash floods, with flow rates ranging between 5.00 and 75.00 m^3/s, of which 91% were minor flash floods, with flow rates of 5 m^3/s to 15 m^3/s, 5% of mean flood with flow rates between 15-38 m^3/s, and 4% major flash floods with flow rates above 38 m^3/s (Figure 11).

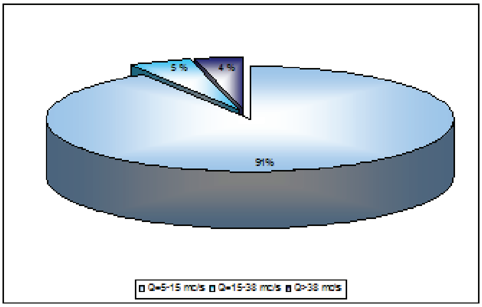

Figure 11. Classification of flash floods from flow on the Târgului River, at Voina (1970-2009)

Most flash floods were recorded on August 13, 1999, as a result of abundant rainfall, which totalled 170 l/m^2 in the range August 11-13.
The maximum flow rate reached 75 m^3/s, considered a historic flow, the highest recorded on the Târgului River, at Voina (Figure 12).

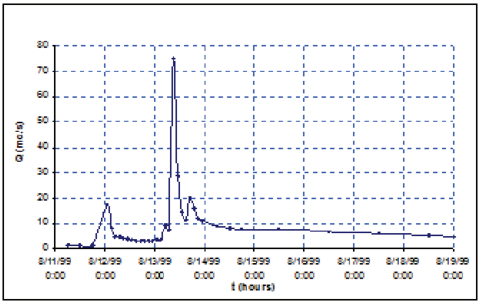

Figure 12. Flood hydrograph recorded on the Târgului River, at Voina (August 11-19, 1999)

Several objectives were built on the Târgului River in the 1980s, which altered the water regime of the natural water flow, affecting the morphology of the area and its ecological balance. The most important goal is the Râuşor accumulation, with an area of 160 hectares and a volume of 52.80 mil. m^3. In addition to the constructive functions of the Râuşor dam electricity production, the supply of drinking water and industrial area of Câmpulung, and mitigation of flood waves recorded an available volume of 15.6 million m^3 (Figure 13).

Figure 13. The Râuşor dam and accumulation (original photo)

By creating the lake, the flow of ground water was altered, with a considerable influence on slope stability. Large and rapid fluctuations of the water levels in the lake rose due to inertia and large-scale gradients, which enabled an underground leak, causing a series of landslides in 1988 and 1991 (Figure 14).

Figure 14. Slipping on the left slope (original photo)

The stability of the slope reserve was low, under conditions in which the water level in the lake was close to the normal retention (906.50 mdM); the reserve was lower and the water level was higher. For this reason, recommendations included limiting the lowering speed of the water level in the lake at the maximum value of 0.1 m/day, when the water level in the lake exceeded 890 mdM.
Stopping or reducing the important solid material transport into the lake led to the downstream flow defluation of relatively clean water, with increased erosion, which was no

longer in balance with the existing riverbed upstream (Figure 15).

Figure 15. Riverbed of the Târgului River, upstream of the dam (original photo)

Thus, the riverbed downstream from the lake would be gradually eroded until it restored the balance between the riverbed slope and the new transport. The riverbed downstream was subject to erosion due the pulsatory flow for producing electricity from the top (Figure 16).

Figure 16. Riverbed of the Târgului River downstream of the dam (original photo)

Flora had a special role in maintaining ecological balance, through air and water oxygenation, providing shelter and living conditions for animals, birds and fish and, last but not least, by the beauty of the landscape. By creating the lake, water conditions changed radically, the poor flora was replaced with lush vegetation on the banks, owing to the highly humid local micro climate (Gâştescu et al., 2003). At the same time, the hydrotechnical facilities on the Târgului River were a landmark, the beauty of the new views created by the dam, which can attracts tourists interested in a grand sight or water sports, swimming or fishing in the waters of the lake.

CONCLUSIONS

In the upper basin of the Târgului River, annual precipitations range between 429.6 mm and 1209.3 mm, with a multiannual mean of 798.5 mm. The lowest precipitations were recorded in 1985, 1986, 1990, 1992 and 2000, while the highest 1972, 1975, 1980, 1981 and 2005.

The annual precipitation values differed from one month to another, the lowest precipitations being recorded in January-March (36.9-40.7 mm) and the maximum in June (115.8 mm).

The annual mean runoff, recorded on the Târgului River at the Voina hydrometric stations, ranged between 1.09 m^3/s, in 1990 and 3.20 m^3/s, in 2005, the multiannual mean flow of 2.05 m^3/s, the lowest water volume being drained in winter (13.5%), and highest in summer (33.8%).

At the Voina hydrometric station, at a rate of 38 m^3/s, the water level reached the share of attention of 120 cm, which means danger of flooding in the riverbed. The share of attention was superseded in 1973 (48.5 m^3/s), 1975 (50.5 m^3/s), 1983 (50.7 m^3/s), 1998 (61.7 m^3/s), 1999 (75,0 m^3/s), 2004 (39.61 m^3/s) and 2005 (38.5 m^3/s).

The hidrotechnical objectives, built in the 1980s on the Târgului River, altered the natural flow of water, which may have a morphological impact and affect the ecological balance of the area.

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ASPECTS OF FLORISTIC DIVERSITY IN THE TOPOLOG COMMUNE (TULCEA COUNTY): I – SEGETAL FLORA

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Abstract

Botanical reports made during the months of July and October in wheat, barley, maize, sunflower and soybean crops allowed to make an inventory of segetal species and to characterize this kind of flora in terms of floristic composition, general distribution, biological and ecological types.

Key words: *segetal flora, Topolog commune, Tulcea county.*

INTRODUCTION

References to wild species found „in cultivated lands, crops" in Dobrogea, are present in the first paper on the flora of this area (Branza, 1885) and in subsequent work (Anghel et al., 1970; Anghel et al., 1972; Chirilă, 2001; Chirilă et al., 2002, Ciocârlan et al., 2004; Zaharidi and Drimuş, 1954).

The Dihoru and Doniță study (1970) on flora from the Babadag Plateau include a chapter about segetal species discussing the results of the mapping in crops such as maize, grape vines, sunflowers, wheat, flax, alfalfa, beans, orchards as well as shelterbelts, balks, edges of cultivated fields or roads (performed in 7 characteristic points).

Our research, conducted in the Topolog commune (Tulcea county), aims to update and supplement existing data on weeds from the central part of Dobrogea.

MATERIALS AND METHODS

Topolog commune is placed in the northwestern part of the Tulcea county, on the 22A national road, Hârşova-Tulcea.

Geographically, the commune is situated in the central-northern part of Casimcea Plateau (Central Dobrogea Plateau), bordering to the north with Babadag Plateau; it is an area whose geological substrate consists of green schist which sometimes appear on the surface (Ghinea, 1996); its landscape is the hills above 300 m high (Figure 1). In terms of flora, the area is included in the Pontic-South-Siberian Region, Danube-Black Sea Province, Northern Dobrogea Forested District (Ciocârlan, 2009).

Figure 1. Hills and folded green schist on surface near the village Fagarasul Nou (Tulcea county)

The commune consists of Topolog, the central village, and other six villages. The main occupation of the inhabitants is agriculture, growing cereals, industrial crops and livestock (http://www.primariatopolog).
paginadestart.com). The plant species inventory was conducted on land located at the entrance to the Fagarasul Nou village and the adjacent area of the Luminita village. The reports was conducted from October 2010 to October 2011 to observe summer and autumnal aspects of segetal flora of winter grain crops (wheat, barley), maize, sunflower and soybean. Areas were investigated by crossing diagonally and

recording the encountered plant species in phytosociological tables. To characterize vegetation in terms of floral composition and biological and ecological types, for each species were noted the systematic family, the geographic element, the class and the lifetime, the life forms, the flowering period, the ecological indicators, and the distribution in our country.

RESULTS AND DISCUSSIONS

Segetal flora according to the crop plant

In the winter wheat crop the following species were found: *Consolida regalis*, *Salsola kali* subsp. *ruthenica*, *Falopia convolvolus*, *Melilotus albus*, *Euphorbia agraria*, *Daucus carota*, *Diplotaxis tenuifolia*, *Reseda lutea*, *Anagalis arvensis*, *Cynancum acutum*, *Ajuga chamaepytis*, *Stachys annuua*, *Carduus acanthoides*, *Centaurea spinulosa*, *Chondrilla juncea*, *Xanthium saccharaum*, *Elymus repens.*

In winter barley crop noted segetal species were: *Consolida regalis*, *Glaucium corniculatum*, *Canabis sativa* subsp. *spontanea, Chenopodium album*, *Salsola kali* subsp. *ruthenica*, *Diplotaxis tenuifolia*, *Anagalis arvensis*, *Heliotropium europaeum*, *Datura stramonium*, *Artemisia scoparia, Onopordon tauricum*, *Xanthium spinosum, Cynodon dactylon, Setaria viridis, Setaria pumila*.

28 segetal species were listed in winter cereals. Comparing the data collected with that in Dihoru and Doniţă's work (1970) it was found that 16 species also occur in wheat crop reports from Babadag Plateau, 6 species are found in other cultures of that area and 6 species are not found in the list of segetal species of the Babadag Plateau (*Melilotus albus, Daucus carota subsp. carota, Cynancum acutum, Ajuga chamaepytis, Xanthium saccharatum Artemisia scoparia*).

Segetal species encountered in the summer reports associated to the maize crop were: *Amaranthus blitoides, Salsola kali subsp. ruthenica, Melilotus officinalis, Hibiscus trionum, Convolvulus arvensis, Heliotropium europaeum, Stachys annua, Centaurea cyanus, Setaria pumila, Sorghum halepense.* By comparing the results of our reports with those of Dihoru and Doniţă it has been observed that of the 10 segetal species recorded, 8 species are common with those found in maize crops from Babadag Plateau and 2 species are found in other crops from that area.

Segetal flora of sunflower include: *Amaranthus blitoides, Falopia convolvulus, hibiscus trionum, Reseda lutea, Convolvulus arvensis, Lappula squarossa, Solanum nigrum, Centaurea solstitialis, Xanthium saccharatum, Setaria pumila, Sorghum halepense.* Of the 11 species of weeds noted in in this crop, 5 species were found also in the records of Babadag Plateau (Doniţă and Dihoru, 1970), 5 species appear in other crops and 1 species were not found in the above-mentioned work.

In soybean crop the following species were marked in the summer reports: *Consolida regalis*, *Papaver dubium*, *Chenopodium album*, *Hibiscus trionum*, *Cynanchum acutum*, *Convolvulus arvensis*, *Heliotropium europaeum*, *Lappula squarossa*, *Carduus thoermeri*, *Conyza canadensis*, *Phragmites australis*, *Setaria pumila*, *Sorghum halepense*. Overall, in this type of crop were recorded 13 species of weeds. Our results indicate the presence of two species that are not found in segetal species lists from Babadag Plateau (Dihoru and Doniţă, 1970), *Cynanchum acutum* and *Phragmites australis* respectively.

Vegetation peculiarities in terms of floristic composition and general distribution (geographic element)

Regarding the floristic composition our collected data indicates that the 40 species found in the field belong to 20 families. The distribution of the species into families is the following: Ranunculaceae-1 species, Papaveraceae-2 species; Cannabaceae-1 species, Amaranthaceae-1 species, Chenopodiaceae-2 species, Polygonaceae-1 species, Fabaceae-2 species; Euphorbiaceae-1 species; Apiaceae-1 species, Malvaceae-1 species, Brassicaceae-1 species; Resedaceae-1 species, Primulaceae-1 species; Asclepiadaceae-1 species, Convolvulaceae-1 species, Boraginaceae-2 species, Lamiaceae-2 species, Solanaceae-2 species, Asteraceae- 10 species, Poaceae-6 species (Table 1).

Table 1. Floristic composition and general distribution of segetal species of the commune Topolog

Species	Sistematic family	Geographic element
1. *Consolida regalis*	Ranunculaceae	Eur
2. *Papaver dubium*	Papaveraceae	Eur
3. *Glaucium corniculatum*	Papaveraceae	Medit
4. *Cannabis sativa* subsp. *spontanea*	Cannabaceae	Cont.euras
5. *Amaranthus blitoides*	Amaranthaceae	North – Am.
6. *Chenopodium album*	Chenopodiaceae	Cosm
7. *Salsola kali* subsp. *ruthenica*	Chenopodiaceae	Euras
8. *Fallopia convolvulus*	Polygonaceae	Circ
9. *Melilotus albus*	Fabaceae	Euras
10. *Melilotus officinalis*	Fabaceae	Euras
11. *Euphorbia agraria*	Euphorbiaceae	Pont.-balc
12. *Daucus carota* subsp. *carota*	Apiaceae	Euras
13. *Hibiscus trionum*	Malvaceae	Euras
14. *Diplotaxis tenuifolia*	Brassicaceae	Centr.eur.-medit
15. *Reseda lutea*	Resedaceae	Euras
16. *Anagalis arvensis*	Primulaceae	Circ
17. *Cynanchum acutum*	Asclepiadaceae	Pont.-medit
18. *Convolvulus arvensis*	Convolvulaceae	Cosm
19. *Heliotropium europaeum*	Boraginaceae	Submedit
20. *Lappula squarossa*	Boraginaceae	Euras
21. *Ajuga chamaepytis*	Lamiaceae	Pont.-medit
22. *Stachys annuua*	Lamiaceae	Submedit
23. *Datura stramonium*	Solanaceae	Cosm
24. *Solanum nigrum*	Solanaceae	Cosm
25. *Artemisia scoparia*	Asteraceae	Cont.euras
26. *Carduus thoermeri*	Asteraceae	Pont.-balc
27. *Centaurea cyanus*	Asteraceae	Cosm
28. *Centaurea solstitialis*	Asteraceae	Medit
29. *Centaurea apiculata* subsp. *spinulosa*	Asteraceae	Centr. și SE Eur
30. *Chondrilla juncea*	Asteraceae	Cont.euras
31. *Conyza canadensis*	Asteraceae	North – Am.
32. *Onopordum tauricum*	Asteraceae	Balc
33. *Xanthium saccharatum*	Asteraceae	North – Am.
34. *Xanthium spinosum*	Asteraceae	Cosm
35. *Cynodon dactylon*	Poaceae	Cosm
36. *Elymus repens*	Poaceae	Circ
37. *Phragmites australis*	Poaceae	Cosm
38. *Setaria pumila*	Poaceae	Cosm
39. *Setaria viridis*	Poaceae	Cosm
40. *Sorghum halepense*	Poaceae	Medit

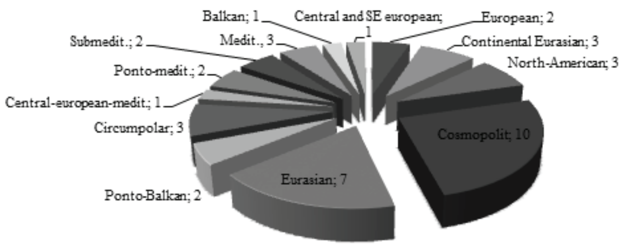

Figure 2. Spectrum of the segetal species of the commune Topolog in terms of geographic element

The analysis of the general distribution (the categories of the geographic elements) (Figure 2) indicates cosmopolitan species (10) as the majority, followed by Eurasian category of species (7) considered the most represented in cormoflora Romania (Cristea et al., 2004); 3 species are of North-American origines, 3 are circumpolar and 2 are European species. The remaining 14 species originating in warm climates, some with water deficit registered in summer mounths, from Europe or continental Asia: Eurasian Continental (3), Ponto-Balkan (2), Central European-Mediterranean (1), Ponto-Mediterranean (2), Submediteranean (2), Mediterranean (3), Balkan (1), Central and SE Europe (1) (Table 1).

Vegetation peculiarities in terms of biological types

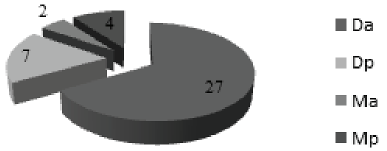

Figure 3. Spectrum of the village Topolog segetal species according to class and lifetime (Da – dicotyledonous annual; Dp – dicotyledonous perennial; Ma – monocotyledonous annual; Mp – monocotyledonous perennial)

According to the ratio between species depending on class and lifetime, annual dicotyledonous species constitute the majority in the communities studied-67.5% (27 species), perennial dicotyledonous represent 17.50% of all species (7 species), monocotyledonous annual 5% (2 species) and the perennial monocotyledonous 10% (4 species) (Table 2, Figure 3).

As regards the form of life, most species, 17, belong to the category Therophyta-plants undergoing lifecycle, from seed, in one growing season; annual hibernating and bisanuale species included in Hemiterophyta are 12 in number; 5 species belong to the category Hemicryptophyta; one species is from Chamaephyta; 5 species belong to the category Geophyta (Table 2).

The analysis of the distribution of species depending on the time of flowering indicates that most species are blooming in the summer months (June to September) (Table 2).

Vegetation peculiarities in terms of ecological types and distribution in the country

Vegetation analysis based on ecological factors (Table 3) reveals that the dominant species are those whose requirements are low relative to the humidity factor, medium and high relative to the temperature factor, and are indifferent or neutro-alkalinophilic in terms of soil pH.

In terms of wather requirements, 16 species are xero-mesophilic, 11 xerophilic, 8 mesophilic, 2 euryhydric and one hygrophilic (Figure 4).

Concerning the air temperature 19 species are moderately thermophilic, 6 thermophilic, 11 eurythermal and 4 micro-mesothermophilic (Figure 5).

On the requirements for soil pH we observed that 19 species are euryacidophilic, followed by those neutro-alkalinophilic – 15 species, those weakly acido-neutrophilic – 5 species; one species is acido-neutrophilic (Figure 6).

Ecological factors with an important role in plant distribution in this area are soil moisture and temperature, similar to that in the Babadag Plateau (Bindiu et al., 1971).

Related to the distribution in the country, most species are common from the steppe zone to sessile oak floors, areas where the average annual temperature is between 8 and 10.50 C. 3 of the species-Cynancum acutum, Carduus thormeri and Onopordon tauricum are found only in the SE of the country, in Dobrogea's counties (Table 3).

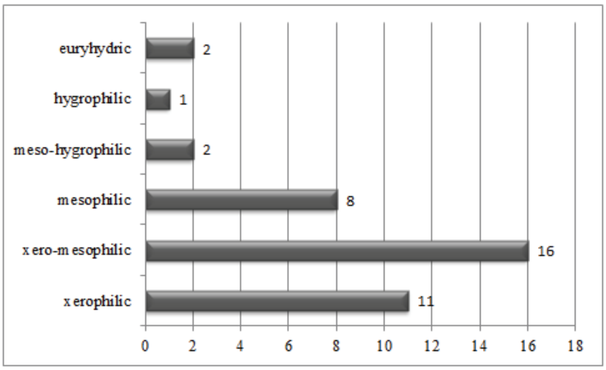

Figure 4. Segetal species spectrum according to soil moisture

Table 2. Segetal species of crops in the commune Topolog according to sistematic class and lifetime, form of life, and the flowering period

Specia	Systematic class and lifetime	Form of life	Floweing period
1. Consolida regalis	Da	Th, Ht	VI-VII
2. Papaver dubium	Da	Th	V-VI
3. Glaucium corniculatum	Da	Th	VI-VIII
4. Cannabis sativa subsp. *spontanea*	Da	Th	VII-VIII
5. Amaranthus blitoides	Da	Th	VII-X
6. Chenopodium album	Da	Th	VII-X
7. Salsola kali subsp. *ruthenica*	Da	Th	VI-IX
8. Fallopia convolvulus	Da	Th	VI-IX
9. Melilotus albus	D2a	Ht	VI-IX
10. Melilotus officinalis	D2a	Ht	VI-IX
11. Euphorbia agraria	Dp	H	VII-VIII
12. Daucus carota subsp. *carota*	Da (winter)	Ht	VI-IX
Specia	Systematic class and lifetime	Form of life	Floweing period
1. Hibiscus trionum	Da	Th	VI-VIII
2. Diplotaxis tenuifolia	Dp	H (Ch)	V-IX
3. Reseda lutea	Da-Dp	Ht-H	V-IX
4. Anagalis arvensis	Da-Da (winter)	Th-Ht	VI-IX
5. Cynanchum acutum	Dp	H	VI-VII
6. Convolvulus arvensis	Dp	(G) H	V-IX
7. Heliotropium europaeum	Da	Th	V-VII
8. Lappula squarossa	Da-D2a	Th,Ht	VI-VII
9. Ajuga chamaepytis	Da	Th	V-VIII
10. Stachys annuua	Da	Th	V-VIII
11. Datura stramonium	Da	Th	VI-IX
12. Solanum nigrum	Da	Th	VI-X
13. Artemisia scoparia	D2a	Ht	VII-IX
14. Carduus thoermeri	D2a	Ht	VI-VII
15. Centaurea cyanus	Da (winter)	Th,Ht	VI-VIII
16. Centaurea solstitialis	D2a	Ht	VI-X
17. Centaurea apiculata subsp. *spinulosa*	Dp	H	VI-IX
18. Chondrilla juncea	D2a-Dp	Ht-H	VII-IX
19. Conyza canadensis	Da	Th	VI-IX
20. Onopordum tauricum	D2a	Ht	VI-VII
21. Xanthium saccharatum	Da	Th	VII-IX
22. Xanthium spinosum	Da	Th	VII-X
23. Cynodon dactylon	Mp	G	VI-VIII
24. Elymus repens	Mp	G	VI-VII
25. Phragmites australis	Mp	G	VII-IX
26. Setaria pumila	Ma	Th	VI-X
27. Setaria viridis	Ma	Th	VII-X
28. Sorghum halepense	Mp	G	VI-VIII

Systematic class, lifetime: Da – dicotyledonous annual species; D2a – dicotyledonous bisannual species; Dp – dicotyledonous perennial species; Ma – monocotyledonous annual species; Mp – monocotyledonous perennial species
Life form: Th – *Therophyta*; Ht – *Hemiterophyta*; H – *Hemicryptophyta*; Ch – *Chamaephyta*; G-*Geophyta*
Flowering period: V-X – the months when plants are in flower

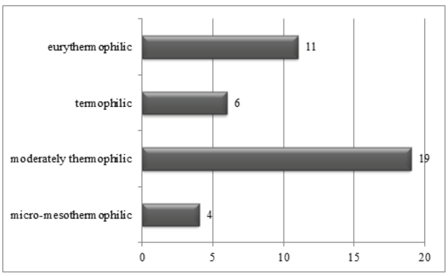

Figure 5. Segetal species spectrum according to air temperature

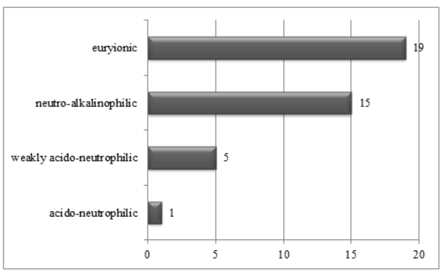

Figure 6. Segetal species spectrum according to soil pH

Table 3. Segetal species of the Topolog commune according to the requirements of environmental factors and country distribution

Specia	Soil moisture	Air temperature	Soil pH	Country distribution
1. Consolida regalis	2-2,5	0	5	steppe zone-ses.oak floor
2. Papaver dubium	2-2,5	4,5	5	steppe zone-ses.oak floor
3. Glaucium corniculatum	2-2,5	4,5	5	steppe zone-ses.oak floor
4. Cannabis sativa subsp. *spontanea*	2-2,5	4,5	0	steppe zone-ses.oak floor
5. Amaranthus blitoides	1-1,5	5	0	steppe-forest-steppe zone
6. Chenopodium album	3 – 3,5	0	0	steppe zone-beech floor
Specia	Soil moisture	Air temperature	Soil pH	Country distribution
1. Salsola kali subsp. *ruthenica*	1,5-2	5-5,5	5	steppe zone-ses.oak floor
2. Fallopia convolvulus	0	0	0	steppe zone-beech floor
3. Melilotus albus	2,5	3	0	steppe zone-beech floor
4. Melilotus officinalis	2,5	3,5	0	steppe zone-ses.oak floor
5. Euphorbia agraria	1,5-2	4,5-5	5	steppe zone-ses.oak floor
6. Daucus carota subsp. *carota*	0	0	0	steppe zone-ses.oak floor
7. Hibiscus trionum	2,5-3	4,5-5	4	steppe-nemoral zone
8. Diplotaxis tenuifolia	1,5-2	4,5-5	5	steppe-nemoral zone
9. Reseda lutea	2,5-3	4,5-5	5	steppe zone-ses.oak floor
10. Anagalis arvensis	3	0	0	steppe zone-beech floor
11. Cynanchum acutum	1,5-2	5	5	steppe-forest-steppe zone, in SE
12. Convolvulus arvensis	3	4,5-5	0	steppe zone-beech floor
13. Heliotropium europaeum	2,5-3	4,5-5	5	steppe zone-ses.oak floor
14. Lappula squarossa	1,5	3,5	4	steppe zone-beech floor
15. Ajuga chamaepytis	1,5-2	5	5	steppe zone-ses.oak floor
16. Stachys annuua	2,5-3	4,5-5	5	steppe zone-ses.oak floor
17. Datura stramonium	3	4,5-5	5	steppe zone-ses.oak floor
18. Solanum nigrum	3	0	5	steppe zone-beech floor
19. Artemisia scoparia	3	3	0	steppe zone-ses.oak floor
20. Carduus thoermeri	1,5	5	3	steppe-forest-steppe zone, in Dobr.
21. Centaurea cyanus	3	0	0	steppe zone-beech floor
22. Centaurea solstitialis	2	4	0	steppe zone-ses.oak floor
23. Centaurea apiculata subsp. *spinulosa*	1,5-2	4,5-5	4	steppe-forest zone-beech floor
24. Chondrilla juncea	1,5-2	4,5-5	5	steppe zone-ses.oak floor)
25. Conyza canadensis	2,5-3	0	0	steppe zone-beech floor
26. Onopordum tauricum	1,5	4,5-5	5	steppe – forest-steppe zone
27. Xanthium saccharatum	4	5-4,5	0	steppe – nemoral zone
28. Xanthium spinosum	2,5-3	4,5-5	0	steppe zone-beech floor
29. Cynodon dactylon	2,5	4,5-5	4	steppe zone-ses.oak floor
30. Elymus repens	3	0	0	steppe zone-beech floor
31. Phragmites australis	5,5-6	0	4	steppe zone-beech floor, in crops, on groundwater-wet mold
32. Setaria pumila	4-4,5	0	0	steppe zone-beech floor
33. Setaria viridis	2,5-3	4,5-5	0	steppe zone-ses.oak floor
34. Sorghum halepense	2,5-3	4,5-5	0	steppe – nemoral zone

Soil moisture: 0 – euryhydryc species; 1-1.5 –xerophilic species; 2-2.5 – xero-mesophilic species; 3-3.5 – mesophilic species; 4-4.5 – specie meso-hygrophilic species; 5-5.5 –hygrophilic species; 6 –hydrophilic specie

Air temperature: 0 –eurythermal species; 3-3.5 –micro-mesothermophilic species; 4-4.5 –moderately thermophilic species; 4.5-5 – thermophilic species

Soil pH: 0 –euryacidophilic species; 4 –weakly acido-neutrophilic species; 5 –neutro-alkalinophilic species

CONCLUSIONS

The segetal flora of the commune Topolog is composed of plants adapted to low soil moisture and high air temperatures, mostly found from the steppe zone to sessile oak floor. Three species-*Cynanchum acutum*, *Carduus thormeri* and *Onopordon tauricum* have a limited area, living in the SE of Romania

(Dobrogea or Giurgiu, Tulcea and Constanta county).

Flora summer aspect is given by annual plant species, di-or monocotyledonous, with flowering period in the summer months, and which belong to categories of Therophyta and Hemitherophyta.

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ANALYSIS OF THE MELLIFEROUS AREAS FOR PASTORAL BEEKEEPING – CASE STUDY FOR GIURGIU COUNTY, ROMANIA

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Abstract

In the case of Romania, pastoral beekeeping becomes more and more a system of industrial maintenance of bee families, with economic importance given by beekeeping products that could be obtained, but also with ecological importance given by realisation of the pollination process. The Romanian main areas with importance for pastoral beekeeping are represented by the agricultural crops consisting mainly of sunflower and rapeseed, forests consisting mainly of acacia and lime, and melliferous vegetation from Danube Delta.
The present paper presents an analysis of the main types of honey harvest (rapeseed and sunflower, acacia and lime) from Giurgiu County, in terms of opportunities to practice pastoral beekeeping. We had drawn up the county melliferous balance for the main types of honey harvest on the basis of data regarding honey potential/ha (kg), total surfaces (ha), and total number of bee families from Giurgiu County. Also, we have calculated the percentage of use of the existing honey potential per type of honey harvest by the bee families in the county, and the total number of bee families that could be brought from other counties, through practising pastoral beekeeping.
Out study revealed that Giurgiu County could assure the economic operation of 31,923 bee families, which means about 2.4 times more than the existing number of bee families in the county. By practicing a rational pastoral beekeeping to rapeseed and sunflowers crops, and to acacia and lime forests, on the territory of Giurgiu County could be brought a number of 18,516 bee families, which means the county has an important potential for practicing the pastoral beekeeping.

Key words: *pastoral beekeeping, honey potential, melliferous maps, melliferous crops, melliferous forests.*

INTRODUCTION

Development of beekeeping and increasing the apiculture production (honey, pollen, and other beehive products) are closely related to the richness and diversity of melliferous plants (Ion et al., 2010).
Due to its geographical position, Romania has three large areas of vegetation, namely plain vegetation (36%), hill vegetation (33%) and mountain vegetation (31%), very well balanced in proportion, providing good conditions for development of beekeeping in all areas of the country. The plentiful and varied melliferous flora represented by agricultural crops, forests, and grasslands provide an annual average production of about 20,000 tonnes of honey, out of which polyfloral honey represents about 50%, acacia honey about 35%, and lime honey about 15%.
In order to be sustainable and competitive, the beekeeping has to be “pastoral”, this activity being carried out only by an appropriate planning (Vlad et al., 2012). In the Romanian conditions, the pastoral beekeeping becomes more and more a system of industrial maintenance of bee families, which is aiming not only its economic importance, by beekeeping products which are obtained, but also the ecological importance through the process of pollination.
For supporting and monitoring the activity of the pastoral beekeeping in Romania, within the Ministry of Agriculture and Rural Development there is a National Commission for Pastoral

Beekeeping. Its role is to transfer to beekeepers the possibility to use the excess of the melliferous resources from their county and from other counties, according with Romanian Beekeeping Law no 131/2010. In this way, there is preventing the large agglomerations of hives in some areas, which have as a result healthy risks on bee families, a reduced efficiency for producing honey, and even conflicts between beekeepers. But, an optimal functioning of National Commission for Pastoral Beekeeping requires a good knowledge of the geographical distribution of melliferous areas, surfaces and the potential honey production of these areas, number of bee families present in each county, and number of bee families that could efficiently use the melliferous resources existing in each county.

In the context of those said above, a pilot research project (www.stupas.ro) has been carried out during the period 2008-2011. The main aim of the project was to identify and to evaluate the acacia, lime, sunflower and rapeseed areas, from eight counties, as well as to evaluate the number of bee families, which could be maintained in these areas, from each county. In addition, as one of the final results, the STUPAS project has demonstrated the power and usefulness of the database as a means of storing the apicultural data, this database following to be implemented in a GIS format, which ensures the flow of accessible and useful information to the National Commission for Pastoral Beekeeping, as well as to all beekeepers interested in the spatial distribution of the melliferous forests and agricultural crops.

In this paper, we have presented the results based on data from Giurgiu County, and the perspective of the development of beekeeping on the territory of this county, in direct correlation with melliferous potential of the areas occupied by acacia and lime forests, and by sunflower and rapeseed crops.

MATERIALS AND METHODS

1. Implementation of the data base. For the achievement of this goal, there have been requested three sets of information, namely:

- *Evaluation data of apiaries*. These data include the owner name of the apiary, his address, and the number of bee families in the apiary. The data have been provided by town halls of Giurgiu County.

- *Evaluation data of forest areas*. These data include information about each forest area in the county, respectively total surface of forests, acacia surface, lime surface, and surface occupied by other species. The data have been provided by the Research and Management Forestry Institute.

- *Evaluation data of agricultural crops*. These data include information about the agricultural areas in each locality, at the level of 2009, respectively the name of the locality, total agricultural surface (ha), out of which sunflower and rapeseed surfaces (ha), other agricultural entomophilies species (ha), as well as the names of the farms. The data have been provided by Agricultural Office of Giurgiu County.

Before including the data said above into the database, each data category received a three-letter code. These codes are used, on the one hand, to the identification of apiaries, forestry areas and agricultural crops, and on the other hand they will allow their use within the GIS system of the melliferous resources.

2. Delimitation of melliferous units with high melliferous opportunities. For achieving this goal, three types of maps have been created, namely:

- Digital maps (in GIS format) with the spatial distribution of acacia and lime forests.
- Digital maps with the spatial distribution of rapeseed and sunflower crops.
- Digital maps of the spatial distribution of the bee families and beekeepers.

Delimitation of these units have been made on the basis of the following criteria: there is at least one forest which can assure at least one main honey harvest; there is a main transportation way and a water source to supply the bee families; there are natural (rivers, lakes, etc.) or artificial (roads, cultivated fields, etc.) limits between the beekeeping units; there are other melliferous sources which can assure the continuity of honey harvest.

3. Establishment of melliferous potential for the main type of honey harvest. The types of honey harvest are specific for each county, from point of view of melliferous potential. For achieving this goal, studies have been performed concerning the relationship between the amount of sugar/flower and the honey potential for each type of area. Based on the data set, it was established the main types of honey harvest. Scientific establishment of types of honey harvest and their melliferous potential is needed to be established, because it provides various advantages and opportunities for local beekeepers.

4. *Calculation of the percentage use of the existing melliferous resources by the county bee families, and the calculation of the percentage supportability for other bee families that could be brought from other counties, through practising pastoral beekeeping.* We had drawn up the county melliferous balance based on the obtained data at the four melliferous species (respectively the capacity to secret nectar, in mg/flower, and their total surfaces, in ha) and total number of bee families from Giurgiu County. Taking into consideration three elements (respectively the quantity of honey needed for maintaining the life of the bee family per type of honey harvest; the production of honey planned per bee family and per type of honey harvest; global potential of honey production per type of melliferous area) we have calculated, on the one hand, the percentage use of the existing honey potential per type of honey harvest, by the county bee families, and on the other hand the total number of bee families that could be brought from other counties, through practising pastoral beekeeping.

RESULTS AND DISCUSSIONS

Giurgiu County is located in South Romania, on the left side of Danube River.

Cultivated areas are represented especially by sunflower and rapeseed. In 2009, these crops occupied 49,126 ha, of which 26,725 ha sunflower and 22,401 ha rapeseed.

Forests areas cover an area of over 30,000 ha (Figure 1), among which there are important areas of acacia and lime (Figure 2). Acacia trees cover an area of 4,500 ha, and lime trees cover an area of 3,300 ha.

Due to Danube River, in the South part of the county there is meadow vegetation with high melliferous potential, due to the floristic composition and the amount of nectar/flower, but also due to the favourable flowering period.

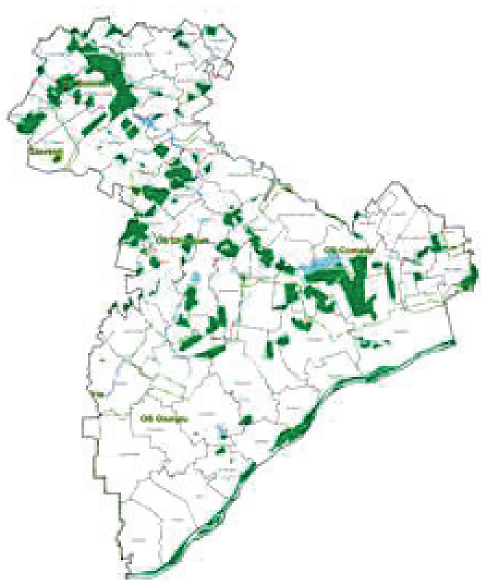

Figure 1. Distribution of forests within Giurgiu County, in 2009

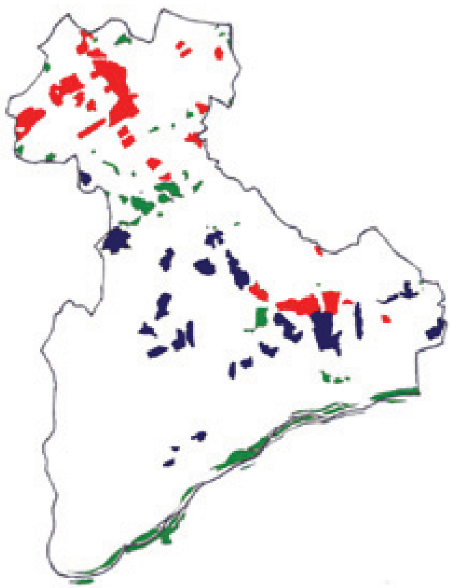

Figure 2. Distribution of forests which have acacia and lime species in their floristic composition within Giurgiu County, 2009

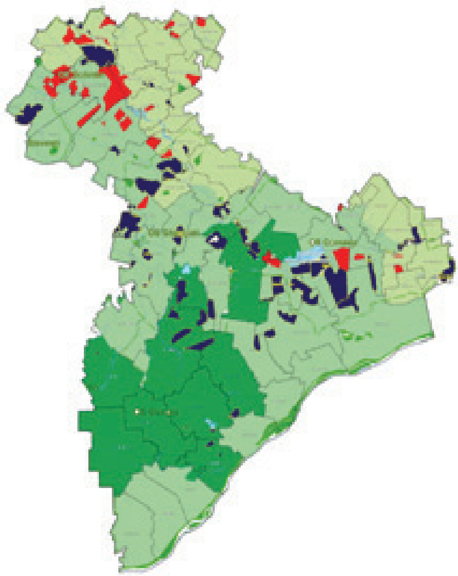

Figure 3. Distribution of areas cultivated with sunflower and rapeseed crops within Giurgiu County, 2009

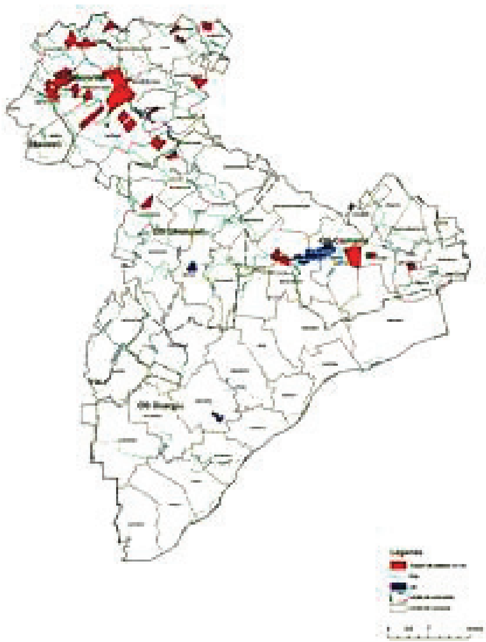

Figure 5. Distribution of lime forests within Giurgiu County, 2009

Figure 4. Distribution of beekeepers and apiaries within Giurgiu County, 2009

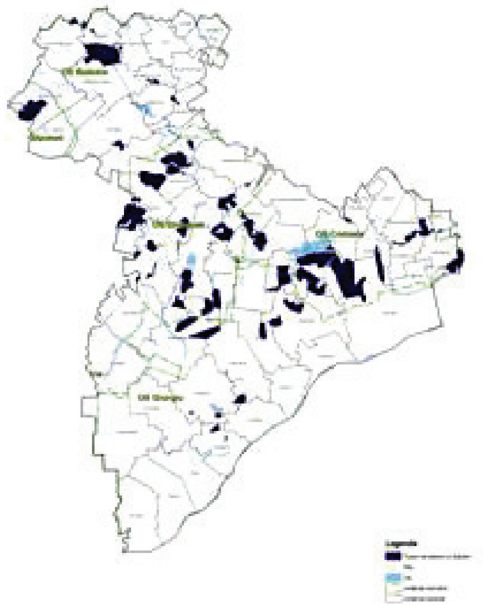

Figure 6. Distribution of acacia forests within Giurgiu County, 2009

Territorial concentration of melliferous areas. In the year 2009, there was a maximum concentration of rapeseed and sunflower crops in South-West part of the county (Figure 3), while the forests which have acacia and lime species in their floristic composition are concentrated in North-East part of the county (Figures 2). In the year 2009, in South-West part of the county, there was cultivated a large area with rapeseed and sunflower crops, respectively 23,452 ha rapeseed and 15,054 ha sunflower, which have represented more than 50% of the total surfaces cultivated within the county.

Number of the local bee families. In the year 2009, there were 13,407 bee families which were managed by 359 beekeepers, out of which 30% had more than 50 bee families and operated over 60% of county population of bee families. Within Giurgiu County, there are no beekeepers practicing industrial beekeeping.

Territorial distribution of beekeepers and apiaries. The beekeepers and apiaries are heterogeneous spread out on the county territory, except two areas, respectively South-East and North-West parts of the county (Figure 4). The majority of areas with high concentration of professional beekeepers are around forest habitats, which proves that beekeeping is an important and sustainable alternative source of income in rural areas, for the benefit of the communities that live in and around forests. From this point of view, beekeeping can be a practical tool for increasing the degree of awareness of these rural communities with respect to the correct and well management and conservation of forests, as well as with respect to increase the forests biodiversity.

Territorial distribution of forest pieces with acacia and lime species in their composition. Lime forests are concentrated in North-East part of the county (Figure 5), while acacia forests are concentrated in the Central part of the county (Figures 6).

Based on the distribution maps of sunflower and rapeseed crops, acacia and lime forests, and bee families, there have been identified two areas of melliferous vegetation:

1. The steppe and silvosteppe area*,* which includes also the meadow agricultural land. All agricultural land is topped with some lawns and forests across meadow. From an apiculture point of view, this area is characterised by various honey harvests, respectively:

- two main harvests in the spring, provided by rapeseed crops and acacia forests, which are very intense, but for a short duration, followed by a gap in the melliferous harvest;
- one main harvest in summer, provided by the sunflower crops, with less intensity, but for a longer duration;
- one maintenance harvest in autumn, provided by the vegetation along Danube River, while in the rest of area there is a lack of honey harvest.

2. The hilly area, with vast areas of lawn and forests of beechwood. From an apiculture point of view, this area is characterised by various honey harvests, respectively:

- one maintenance harvest in spring, provided by the rapeseed crops, which are not as important as surface;
- two main harvest in the second half of May and beginning of June, provided by acacia and lime forests;
- one maintenance harvest in summer, provided by sunflower crops and natural lawns.

Due to the vast melliferous areas said above and favourable climatic conditions, Giurgiu County is a very active area, both for the local beekeepers and beekeepers from other counties, in terms of practicing pastoral beekeeping.

On the county territory, there have been delimited four melliferous units with high melliferous opportunities, respectively Bolintin, Ghimpaţi, Comana, and Giurgiu (Figure 7).

Data processing has shown that, in the year 2009, the four melliferous species analyzed had a potential of 12,450 tons of honey, of which honey bees could collect 4,150 tons of honey, if climatic conditions would have been without any calamities.

Data processing showed us that a number of 31,923 bee families could be economically exploited through the pastoral beekeeping at the crops of rapeseed and sunflower and at the forest of acacia and lime, while there are only 13,407 bee families in the county (Table 1). The difference between the potential number and the existing number of bee families show us that there is an important quantity of honey unexploited.

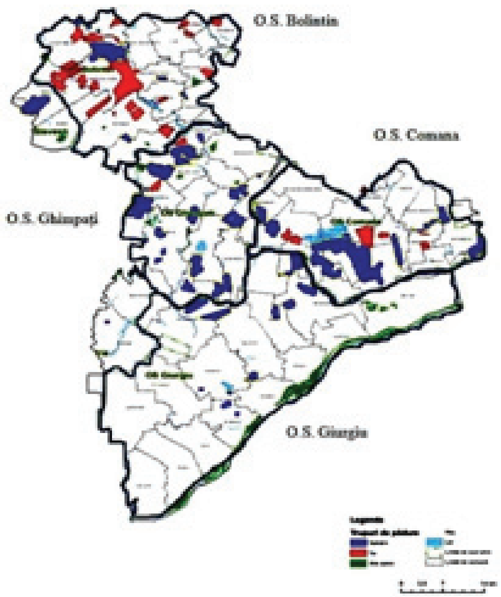

Figure 7. The melliferous units delimited on the territory of Giurgiu County, in 2009

The unexploited honey was recorded at all type of honey harvest analysed, respectively the crops of rapeseed and sunflower and the forests of acacia and lime. However, it should be noted that the surplus of melliferous resources is found out especially at the rapeseed crops and lime forests, which produces almost 58.5%, respectively 21.5% of the total quantity of overall potential production of honey in Giurgiu County. This means that even doubling the current county population of bee families, it would not be possible to valorise completely these sources of nectar (Table 1). As a result, for a more efficient use of the melliferous resources in Giurgiu County, it is recommended that on the one hand, to be increased the number of local bee families and, on the other hand, to be achieved an intensification of pastoral beekeeping from the neighbour counties. In Giurgiu County, the excess of melliferous resources results not only from interpretation of the data, but also from the situation existing in this county. For many years, year after year, many beekeepers from the neighbour counties move their hives to the melliferous forests or crops from Giurgiu County.

Knowing the types of honey harvest and their features (the areas, the honey potential, the percentage use by county bee families of the existing honey potential per type of honey harvest, the total number of bee families that could be brought from other counties, through practising pastoral beekeeping) from each melliferous units allow the beekeepers to properly establish the method of growth and maintenance of bee families, in accordance with the specific biology of bee families. Also, it creates the premises of a planned work for the preparation of bee families with the aim to obtain a large production of honey and other specific hive products. Moreover, it creates the premises for the improvement of the local melliferous resources, as well as for giving the possibility to organise the pastoral beekeeping on scientific basis.

Table 1. Melliferous balance in Giurgiu County, in 2009

Botanical species	Surface (ha)	Melliferous potential of each resource (kg honey per ha)	Overall potential production of honey (tonnes)	Harvested potential production of honey (tonnes)	Harvested real production at hive* (kg honey per bee family)	Number of bee families which could have economic harvests
Acacia	3,439	335	1,152	384	18	10,666
Lime	4,570	587	2,682	894	11.5	38,878
Rapeseed	22,401	325	7,280	2,427	17	71,375
Sunflower	26,725	50	1,336	445	11	20,246
TOTAL	**57,135**	**-**	**12,450**	**4,150**	**-**	**31,923**

*Data obtained in 2009, in Giurgiu county, South Romania

In terms of ensuring pollination of rapeseed and sunflower crops, the number of local bee families existing in Giurgiu County is unsatisfactory. Data analysis has shown us that there is a deficit of 31,395 bee families for rapeseed crops and 40,043 bee families for sunflower crops. It has to be underline that this deficit is accentuated by the irregular repartition of the bee families at the rapeseed and sunflower crops on the territory of the Giurgiu County. From the analysis of the data regarding the allocation of bee families on the territory of the county, there is a considerable deficit regarding the needs for saturated pollination of the rapeseed and sunflower crops on the territory of some communes.This deficit can be only partially compensated, by the rational distribution of hives on the territories of the communes from Giurgiu County during flowering of agricultural entomophily crops.

CONCLUSIONS

In Giurgiu County there are two main types of honey harvest (rapeseed and sunflower, acacia and lime), with a global potential of 4,140 honey tonnes.

The four main types of honey harvest could assure the economic operation of 31,923 bee families, which means about 2.4 times more than the existing number of the local bee families.

A number up to 18,516 of bee families could be brought within the county by practicing a rational pastoral beekeeping to the main types of honey harvests.

The surplus of honey potential is provided especially by rapeseed crops and lime forests.

There are no beekeepers practicing industrial beekeeping within Giurgiu County; 30% of the total number of beekeepers have more than 50 bee families and operate over 60% of county bee families.

In Giurgiu Country, there is a considerable deficit regarding the pollination of the rapeseed and sunflower crops with the existing number of bee families.

Method developed in the STUPAS project will allow us to study whether melliferous plants existing in an area (cultivated area, forest area, spontaneous area) at level of village, county, or even in the whole country, provides cost-effective maintenance of the bee families.

For having a correct image regarding the possibilities to increase the number of families of bees and regarding the possibilities for practicing the pastoral beekeeping, it would be absolutely necessary to be carried out studies on the subject on all the counties in the country.

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A COMPARATIVE STUDY OF GENDER PARTICIPATION IN DECISION MAKING REGARDING CROP MANAGEMENT

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Abstract

The present study was conducted during 2011 to compare the gender participation in decision making regarding crop management in district Swabi of Khyber Pakhtunkhwa province, Pakistan. For this purpose, six union councils i.e Ganduf, Kabgani, Ganichatra, Gabasni, Nara Amazi and Menai were selected. Data were collected from 240 male and 240 female respondents randomly selected for the purpose and analyzed using a paired t-test for comparison of gender participation in decision making regarding crop management. The results indicate that overall level of women participation in decision making was lower as compare to men in the study area.This situation reflects a male dominated society. However, the highest difference of gender participation was recorded in decision making regarding land preparation which ranked 1st with mean difference 0.71 followed by purchase of inputs and marketing of produce which ranked 2nd and 3rd with mean difference 0.60 and 0.56, respectively. Likewise, there existed a highly significant difference in the aspects of insect/ pests' identification followed by controlling insect/ pests with local recipes and manually which ranked 1st, 2nd and 3rd with mean difference 0.55, 0.50 and 0.49, respectively. Similarly, there was a highly significant difference between gender decision making in all weed control measures. However, the highest difference was found in the chemical weed control closely followed by manual and cultural weed control measures which were ranked 1st, 2nd and 3rd with mean difference 0.51, 0.50 and 0.47, respectively.However, women enjoyed sufficient authority in decision making regarding some of the farm activities like harvesting of crops, bringing produce to one place, its threshing and storing grain in domestic godowns. The study concludes that overall women participation in decision making regarding crop management was lower than men which may be enhanced by launching development projects to increase agricultural productivity through exploiting available resources by both genders of the society.

Key words: *Gender participation, Decision making, Crop management, gender empowerment.*

INTRODUCTION

The economy of Pakistan is based on agriculture. It had a population of 13.24 million (Census, 1998; Govt. of Pakistan, 2007), whereas, the present estimated figure has reached to 17.71 million persons. Among this huge populace, women shares over 50% of the total count and perform vital roles in the domestic and economic life of the society. Rural and national development can hardly be achieved if this important segment of the society is neglected (Kishor et al. 1999). In acknowledgment of the important role of women in the national development, the Government of Pakistan has made a separate federal ministry at Islamabad for dealing women affairs and thus focus is laid on bringing about planned and desirable change in the rural societies through agricultural development. The success of these planned programmes principally depends on the rational decision making by women (Vandana, 2004). However, the role of women in decision-making regarding agriculture has not generally been investigated (Amali, 1989). Even today male dominance in decision making regarding family and economy is continued even in the regions where women are the principal providers of labour because the influence of women is not recognized. The women are downgraded and bound to play a secondary role both at home and the economy levels. Okafor et al 2002 also confirmed that women of developing countries are disadvantaged as compared to men. Women are denied equal access to land structure and availing extension services under male dominated socio-political system. The lack of women consultation and ignoring their specific capabilities and responsibilities prevent new agricultural projects and technologies from adoption at farm (Awake, 1998). Rahman et al. 2003 stated that numerous reasons are responsible for the deprived position of women in the developing countries. They are low skilled, less literate and lack organizational structures, through which resources can be mobilize for their benefit. Similarly their access to formal education is limited by having separate gender school system, because boys' schools are given priority (Penh, 2006). At the same time poor health conditions and high fertility rate restrict their development and lack of mobility further worsens the situation (Parveen, 2001; Rani, 1992). Rural women in Pakistan, are working in the crop and livestock production, cottage industry and household maintenance but their work is not recognized. (Naqvi et al., 2003). Therefore it is necessary to analyze the gender participation in agriculture decision making and rural development Tackling all the gender issues in agriculture and rural development, it is widely accepted that full participation of all citizens, both men and women is the best way to build and sustain society that will reduce conflict and achieve human development (Damisa et al. 2007). Keeping the importance of rural women in agricultural production in view, this study was conducted in the six union councils of district Swabi of Khyber Pakhtunkhwa province to investigate the level of women participation in decision-making in various areas of crop management with the following specific objectives:

Objectives of the study

1. To compare gender participation in decision making regarding crop management in district Swabi of Khyber Pakhtunkhwa province, Pakistan.
2. To present appropriate recommendations based on the findings of the study.

MATERIALS AND METHODS

The population for the study consisted of the men and women farmers in the 6 union councils of districts Swabi of Khyber Pakhtunkhwa province i.e Ganduf, Kabgani, Ganichatra, Gabasni, Nara Amazi and Menai. District Swabi has two sub-divisions also called tehsils. These are tehsil Lahor and tehsil Swabi. District Swabi has a total cultivated area of 87,046 hectare (Crop statistics, 2010-11) and had a total population of 1,026,804 persons (Census, 1998; Govt. of Pakistan, 2007). Whereas, the present estimated population of this district is 1.41 millions. It has 56 union councils i.e 15 urban and 41 rural. There are 157 villages in the district. Researchers used multistage random sampling technique for the purpose of study. Thus, one tehsil was selected by using simple random sampling technique. Thereafter, six villages were selected at random including one from each union council. Furthermore, 40 men and 40 women respondents were selected by means of systematic random sampling technique. Thereby making a total of 480 respondents i.e 240 men and 240 women. An interview schedule was constructed, checked for its validity and reliability and was pre-tested. The respondents were interviewed through the pre-tested interview schedule by "survey". The data collected were analyzed by applying Statistical Package for Social Sciences (SPSS). Means and standard deviation were computed for different variables. However, researchers also applied t-test to determine the difference between men and women participation in decision making process regarding crop management and results drawn are given as follow.

RESULTS AND DISCUSSIONS

Table 1 indicates that the difference between responses of men and women respondents was highly significant in almost all areas of decision making regarding crop management. This situation reflects a male dominated society because level of women participation in decision making was lower as compare to men. However, the highest difference in decision making process by men and women was recorded in the area of land preparation which ranked 1st with mean difference 0.71 followed by purchase of inputs and marketing of produce which were ranked 2nd and 3rd with difference in mean values as 0.60 and 0.56, respectively.

The results of the present study are strongly supported by those of (Damisa et al, 2007) who concluded that woman farmer is heavily involved in agriculture in Nigeria but the level of her participation in farm management decision making is quite low, especially in case of land preparation it was found to be nil with regard to considering final decision.

The highest difference in decision making between the two categories in all aspects may be due to the fact that men are still dominating segment of the society. This may also be due to the unawareness about Islamic education which lay emphasis on seeking mutual discussion and thereafter proceeding in all matters of life. The mean values indicate that participation level in decision making of both the respondents ranged from medium to high but those of men tended towards high and those of women respondents tended towards medium categories.

Table 1. Mean ±SD with t-values for comparison of gender participation in decision making regarding various crop production activities

Areas of decision making regarding crop production	Men participation in decision making	Women participation in decision making	Mean difference	t-value	P-value
	Mean ± SD	Mean ± SD			
Preparation of land	3.98 ± 0.64	3.27 ± 0.61	0.71	-6.92	<0.001**
Purchase of inputs	3.90 ± 0.62	3.30 ± 0.54	0.60	-7.91	<0.001**
Marketing of produce	3.96 ± 0.74	3.40 ± 0.61	0.56	-5.60	<0.001**
Which fertilizer to apply	3.86 ± 0.79	3.32 ± 0.55	0.54	-5.61	<0.001**
How much seed rate to use	3.73 ± 0.63	3.22 ± 0.57	0.51	-6.96	<0.001**
Which sowing method to follow	3.92 ± 0.63	3.42 ± 0.65	0.50	-6.26	<0.001**
Applying FYM to fields	3.89 ± 0.70	3.42 ± 0.66	0.47	-4.82	<0.001**
Irrigation methods	3.65 ± 0.67	3.31 ± 0.58	0.34	-5.03	<0.001**
Controlling pre & post harvest losses	3.56 ± 0.75	3.23 ± 0.53	0.33	-4.25	<0.001**
How to control weeds	3.71 ± 0.79	3.39 ± 0.65	0.32	-3.65	<0.001**
Grain store management	3.51 ± 0.67	3.28 ± 0.70	0.23	-2.33	<0.05*

Source: Survey data; * = Significant (P< 0.05); ** = Highly significant (P< 0.01)

Table 2 shows that there was a highly significant difference between the extent of men and women participation in the decision making process regarding crop management. However, the highest difference was found in the aspects of insect/ pests' identification followed by insect/ pest control with local recipes as well as manually and ranked 1st, 2nd and 3rd with mean difference 0.55, 0.50 and 0.49, respectively.

The highest difference between gender participation in decision making regarding pest control measures was due to the low education rate of women, and so lack of knowledge regarding latest agricultural technologies.

The mean values indicate that participation level in decision making of both the respondents ranged from medium to high but those of men tended towards high whereas those of women respondents tended towards medium classes.

Table 2. Mean ±SD with t-values for comparison of gender participation in decision making regarding various pest control activities

Areas of decision making regarding pest control	Men participation in decision making	Women participation in decision making	Mean difference	t-value	P-value
	Mean ± SD	Mean ± SD			
Insect/ pests' identification	3.92 ± 0.66	3.37 ± 0.62	0.55	-10.21	<0.001**
Insect/ pests control by local recipes	3.93 ± 0.68	3.43 ± 0.60	0.50	-9.40	<0.001**
Manual pest control	3.90 ± 0.70	3.41 ± 0.64	0.49	-9.94	<0.001**
Seed treatment	3.86 ± 0.64	3.38 ± 0.50	0.48	-10.54	<0.001**
Mass killing of insects pests	3.88 ± 0.68	3.41 ±0.64	0.47	-9.39	<0.001**
Biological control of Insect/ pests	3.85 ± 0.62	3.39 ± 0.57	0.46	-10.46	<0.001**

Source: Survey data; * = Significant (P< 0.05); ** = Highly significant (P< 0.01)

Table 3 shows that there was a highly significant difference between the level of men and women participation in the decision making process regarding all weed control measures. However, the highest difference was found in the aspect of chemical weed control closely followed by manual and cultural weed control measures which were ranked 1st, 2nd and 3rd with mean difference 0.51, 0.50 and 0.47, respectively.

The highest difference in the decision making in regarding chemical weed control measure may be due to the reason that women farmers not involved at all in the spray of chemicals i.e pesticides rather this task is exclusively considered as the responsibility of male farmers in the study area.

The mean values indicate that responses of male and farmer respondents regarding cultural weed control measure in the pre FFS scenario ranged from medium to high but tended towards medium. However, it ranged between high and very high categories in the post-FFS scenario, but tended towards high category.

Table 3. Mean ±SD with t-values for comparison of gender participation in decision making regarding various weed control measures

Areas of decision making regarding weed control measures	Men participation in decision making	Women participation in decision making	Mean difference	t-value	P-value
	Mean ± SD	Mean ± SD			
Chemical	3.83 ± 0.61	3.32 ± 0.56	0.51	-10.77	<0.001**
Manual	3.84 ± 0.1	3.34 ± 0.55	0.50	-11.13	<0.001**
Cultural	3.86 ± 0.69	3.39 ± 0.64	0.47	-10.41	<0.001**
Mechanical	3.74 ± 0.64	3.30 ± 0.54	0.40	-11.40	<0.001**
Legal	3.73 ± 0.62	3.34 ± 0.51	0.39	-10.48	<0.001**

Source: Survey data; * = Significant (P< 0.05); ** = Highly significant (P< 0.01)

Table 4 reflects that the difference between gender participation in the decision making process regarding all farm activities was a non-significant. This means that women were empowered as they enjoyed sufficient authority in decision making process regarding harvesting of crop, bringing produce to one point, threshing and these areas of farming. storing grain at home godowns.

The results of the present study are strongly supported by those of the mean values indicate that responses of farmers regarding collecting insect/ pests specimens was good while rest of the aspects regarding zoo maintenance ranged from satisfactory to good but tended towards good.

Table 4. Mean ±SD with t-values for comparison of gender participation in decision making regarding various farm activities

Areas of decision making regarding farm activities	Men participation in decision making		Women participation in decision making		Mean difference	t-value	P-value
	Mean	SD	Mean	SD			
Harvesting of crops	3.83	0.73	4.00	0.74	-0.17	-1.58	0.1154 NS
Bringing produce to one point	3.81	0.69	3.90	0.77	-0.09	-0.85	0.3935 NS
Threshing	3.79	0.68	3.82	0.75	-0.03	-0.25	0.8038 NS
Storing grain	3.77	0.70	3.92	0.70	-0.15	-1.44	0.1513 NS

Source: Survey data; * = Significant (P< 0.05); ** = Highly significant (P< 0.01)

CONCLUSIONS

It can be concluded from the study that the difference in the level of men and women participation in decision making was highly significant in almost all areas of crop management. This differential situation reflects that level of women participation in decision making was quite lower as compare to men in the study area. Although men and woman has lot of participation in farming but the level of women participation in decision making regarding crop management is low. This can be attributed to the widely existence of male dominance across third world countries which may be reduced by acknowledging as well as appreciating the work of women. This situation reflects a male dominated society. However, women enjoyed sufficient authority in decision making process regarding harvesting of crop, bringing produce to one point, its threshing and storing grain at home godowns. Hence it is recommended that overall women participation in decision making regarding crop management may be enhanced by launching development projects possessing women in development (WID) section to increase agricultural productivity through exploiting available resources by utilizing services of both genders of the country.

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HYDRAULIC PERFORMANCE ANALYSIS OF IN-LINE DRIPPERS

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Abstract

The ultimate purpose of the study is to reveal the reacts of in-line drippers' hydraulic performance emerging from the differences in the production process and the different technical features to flow changes; however, the drippers were produced in different companies at different rates of flow and technical features.
In order to reveal the relationship of drippers' pressure-flow, 3 different types of inline drippers have been used 51 pieces of drippers have been selected for each type of drippers and totally 153 tests have been carried out. Tests have been performed 0.5, 1, 1.5 and 2.0 atm pressure values. At the end of the research, it has been proved that the relationship of in-line drippers and pressure-flow is in directed proportionate. The results obtained from the following coefficiency tests; Manufacturing Variation (CVm), the Emission Uniformity (EU), Christiansen Uniformity (Cu) and Statistical Uniformity (Us), have showed that these coefficiencies have been observed higher (perfect rank) in pressure unregulated in-line drippers than the other types of drippers.

Key words: *In-line Drippers, Hydraulic Performance Analysis, Flow Rate-Pressure Relationship.*

INTRODUCTION

The drippers are the most important elements of the drip irrigation system which are used to give the roots of the plants required amount of water within a specific time period and with a defined pressure. Pressured water in the lateral pipes passes to the dripper where energy of the water decreases considerably due to the friction while it is advancing through the flow line. Water gets out of the dripper with a very small flow rate and infiltrates to the soil that is why drippers should be chosen very carefully.
The efficiency in the drip irrigation systems are dependent on the equivalence of the flow rate of the drippers. Therefore all the drippers in a system should ideally distribute water evenly (Ozekici and Bozkurt, 1996). The variation between the flow rates of the drippers must remain within particular limits in order for a high efficiency irrigation system. Otherwise the expected high performance of the system would not be reached (Korukcu and Yildirim, 1984). The structural differences, of the drippers are significant factors limiting efficiency of the irrigation systems which create flow rate inconsistency among the drippers that should essentially have identical flow rates. (Ozekici and Bozkurt, 1996). Drippers are the most important factors affecting the drip irrigation system both economically and in terms of functional performance. Therefore while conducting performance analyses of the system, priority should been given to determine the appropriate dripper models.
The change of the flow rates of the drippers are resulted from many factors like hydraulic changes and performance changes of drippers (Tüzel, 1993). The flow rate of the drippers may change significantly according to the pressure. In a drip irrigation system that is composed of pressure regulated drippers, all the single drippers having higher pressure values will make it possible to quench in a stable flow rate regardless of the system pressure (Demir, 1992). Drippers are the most sensitive units of the drip irrigation system which may partly or completely be obstructed as they have very small water canals. These obstructions may block the consistent flow of water in the system (Tüzel and Anaç, 1991).
The aim of this study is to analyze the flow rate - pressure connections and hydraulic performance of the different in-line drippers

under different system pressures and to provide information to the users regarding the in-line drippers that can be found in the market.

MATERIALS AND METHODS

This research is conducted in the Biosystem Engineering laboratories of the Faculty of Agriculture at Kahramanmaraş Sütçü Imam University (KSU) in order to evaluate the flow rate - pressure connections and the hydraulic performances of different dripper types displayed in different pressures. City water supply was used in the research to prevent the obstructions of the drippers during the experiments. Water was filled to a 40 liter tank with the help of a hose and the water circulation in the system was ensured from this tank. Water used in the experiment was provided through a water pump of 0.5 kW that was located between the tank and the main pipeline. Support structure is approximately 100 cm higher from the ground and consists of 3 sections. Water tank is located at the bottom while the pump and control unit was in the middle and the laterals are on the top. Laterals were located approximately 25 cm above the support structure as graduated bowls were positioned under the laterals in order to collect water. The length of the laterals is 80 cm in average and they were fixed, using clips till the end of the support structure to keep the elevation of the laterals steady. 3 lateral pipelines were echeloned at 25 cm intervals and there is 1 dripper on each lateral. The main pipe was made of 32 cm PPRC (polypropylene random copolymer). There were valves on the pipeline that were used to control the flow of the lateral lines and manometers that were used to monitor the system. Teflon band and clips were used to prevent water outlet leaks from the connection points of the experimental system that may happen as a result of high pressure. To evaluate system pressure 4 units of manometers with a capacity of 6 kg cm^{-2} were used. 3 of these manometers were used at the beginning of laterals to assess the pressure of the laterals and 1 of them was located on the pump to assess the system pressure. Moreover a filter (150 meshes) was installed to the system after the pump. 3 different types of in-line drippers that are widely used in our country were used in the experiment and the features of these drippers are given in Table 1.

Table 1. Features of the drippers used in the experiment

Dripper Type	Kind of Dripper		Flow-Rate (L/h) (1.0 Atm)
A	In-line	Pressure unregulated	2.0
B	In-line	Pressure unregulated	4.0
C	In-line	Pressure regulated	2

All the lateral pipes used in the experiment were circular PE with a 16 mm diameter. 51 units from each 3 kinds of the drippers were tested. The flow rate of the drippers were chosen among 2 L h^{-1} and 4 L h^{-1} that are used widely in the market. In-line drippers were chosen among those having minimum 40 cm as dripper distance in order to keep 1 dripper on the lateral in the experiment.

Experiments were conducted at 0.5, 1.0, 1.5 and 2.0 atm by getting results from the manometers that were located on each lateral. The flow rate measurements were made with the graduated bowls. During the experiments, the temperature of water in the tank was kept stable at 24-26^{o}C.

Using the flow rate values measured from each dripper, the coefficient dependent to flow regime (x), the flow coefficient (k), the correlation coefficient (r), the significance values showing the importance of the difference between adj R^2 showing the flow rate - pressure cohesion and flow rates and manufacturing variation (CVm), the Statistical Uniformity (Us), the Emission Uniformity (EU) and Christiansen Uniformity (Cu) coefficients were calculates in the experiment. The classifications of the drippers were done according to ASAE standards shown in Table 2.

Table 2. Proposed Limits of CVm, Us and EU coefficients (ASAE, 2002)

Accepted Class	CVm (%)	Us (%)	EU (%)
Excellent	5	100-95	100-94
Good	5-7	90-85	87-81
Average (in the limit)	7-11	80-75	75-68
Poor (very bad)	11-15	70-65	62-56
Unacceptable	>15	<60	<50

RESULTS AND DISCUSSIONS

x, k, r, $\mathbf{R^2}$ and sig. values concerning the drippers tested in the proposed operating pressure (1 ATM) for the determination of the features of the drippers were found as shown in Table 3.

Table 3. Dripper x, k, r, R2 and significance values.

Type of Dripper	x	k	r	R^2	Sig.
A	0.3897	0.6297	0.994	0.982	0.006**
B	0.3561	1.0807	0.997	0.991	0.003**
C	0.1567	0.7109	0.980	0.941	0.020*

According to the results of table 3, r values in the experiment came out between 0.980 and 0.997, which shows that the linear correlations between the pressure of all the drippers and the flow rate is very strong.

After inspecting the levels of importance, it is seen that the results of A and B types of drippers are very important ($P<0.01$) and the results of type C drippers are important ($P<0.05$).

When we look up the x coefficients in the table, all the drippers are classified as 'partial pressure stabilizer'.

Average flow rate amounts and standard deviation rates of the evaluated drippers in different pressures were given in Table 4. When the flow rate values under ideal operating pressures received from the producers and the values measured in the experiment are compared, type A differed 42% while type B and type C differed 6.75% and 21% respectively. As a result of these comparisons, the deviation in the type B drippers was observed low while the deviation in the type A and C were high.

Table 4. Average flow rate and standard deviation values of the drippers in different pressures that were used in the experiment (mL h-1)

Type of Dripper	Pressure (atm)			
	0.5	1.0	1.5	2.0
	$X \pm S_x$	$X \pm S_x$	$X \pm S_x$	$X \pm S_x$
A	225 ± 146.6	2841± 112.5	3447 ± 105.5	3995± 133.7
B	3466 ± 194.9	4274 ± 197.8	5100 ± 198.2	5917 ± 200.6
C	2162 ± 142.3	2426 ± 158.8	2618 ± 163.3	2737 ± 155.1

The connection between the flow rate and pressure for the dripper type A, B and C are modeled with linear regression and it was found out that the total variation of the data set of the model created were able to explain 99%, 100% and 95% respectively (Table 3). In other words, a positive correlation between the pressure and the flow rate was observed (Figure 1).

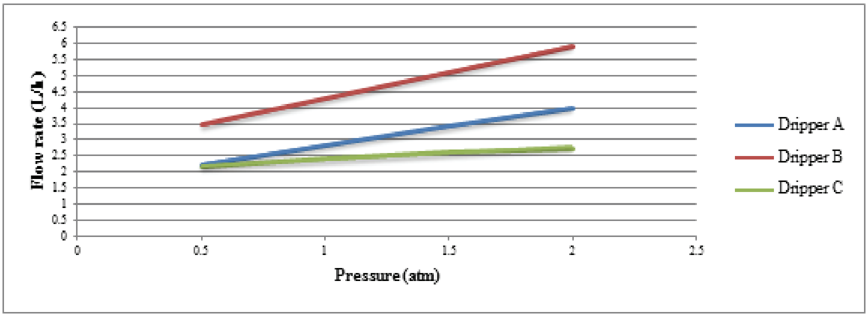

Figure 1. Flow rate - pressure correlations of the drippers used in the experiment

As Karmeli (1977), Von Bermuth and Solomon (1986) stated, the dripper type A, B and C increase in a complete logarithmic relation depending on the operating pressure (Kapar, 1991).

It can be observed in Figure 1 that the flow rates of the dripper type A and B increased together with the pressure, just as they were anticipated by the company as pressure unregulated. The dripper type C which is marketed as a pressure regulated unit did not totally conform marketed properties as pressure increase affected flow rate of this dripper too.

Table 5. CVm, Us and EU values of the drippers used in the experiment and their classification

Pressure (ATM)	Company								
	A			B			C		
	CVm Class	Us Class	EU Class	CVm Class	Us Class	EU Class	CVm Class	Us Class	EU Class
0.5	6.59 G	93.40 E	91.20 G-E	5.62 G	94.70 G-E	92.92 G-E	6.58 G	93.41 G-E	91.49 G-E
1	3.96 E	96.03 E	95.72 E	4.62 E	95.37 E	94.17 E	6.54 G	93.45 G-E	91.19 G-E
1.5	3.06 E	96.93 E	95.84 E	3.88 E	96.11 E	95.25 E	6.24 G	93.75 G-E	91.90 G-E
2	3.34 E	96.65 E	96.11 E	3.39 E	96.90 E	95.65 E	5.66 G	94.33 G-E	92.61 G-E

Bozkurt (1996) in his research ascertained that CVm values were changing jointly with the pressure, however the change rates of the pressure regulated drippers are more than the pressure unregulated ones. Similar results were attained in the experiments based upon this research (Table 5). While the ranges of CVm values in the pressure unregulated dripper type A and B were around 1%, the measurements of the pressure regulated type C dripper did not exceed 1% except those in 2 atm.

As it can be observed in the Table 5, CV values of the dripper type A and B classified as "excellent" is the indication of the fact that the drippers water application quantities are similar. As CVm values of the dripper type C remained under 5%, which is the ASAE standard, it was seen that the homogeneity of the dripper type C in terms of the manufacturing were not as high as dripper A and B and their homogeneity of water application were poor (Figure 2).

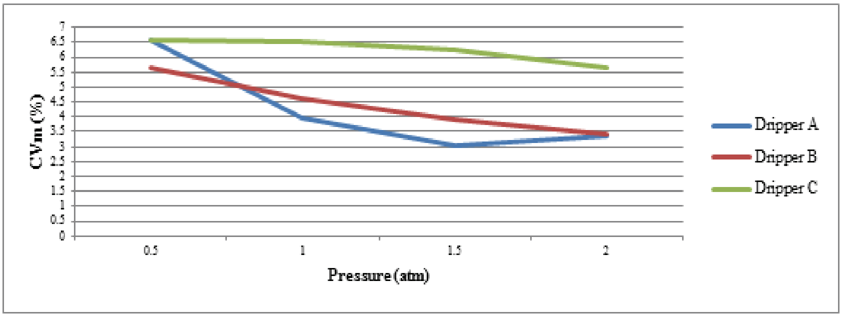

Figure 2. CVm-Pressure Relations of the drippers used in the experiment

The dripper type that had the highest Us value in accordance with the measurements conducted was the type A dripper, which also had the lowest CVm coefficient (1.5 ATM). Çamoğlu (2004) in his research tested 17 drippers under 1.0 ATM pressure and found out that the Us values of 65% of the in-line drippers remained over 95% while 67% of the in-line drippers in our experiments were over 95% (Figure 3).

While the EU values in the dripper A stabilized after 1 atm, an increase was observed in the dripper B together with the pressure. The EU value of the dripper C started to increase after 1 atm pressure. The highest EU value was observed in the type A dripper (Figure 4).

In accordance with the 95% Cu principle under 1.0 atm pressure as Wu and Gitlin (1974) states, the dripper type C was below this level while the dripper type A and B were over it. The results obtained from the experiment shows us that – as we take the loss of pressure and friction in the experiment were negligible – the difference of structural coefficients caused these values. In order to ensure Cu≥95% condition of the dripper B, it was deemed suitable to operate equal and over 1 atm pressures (Figure 5).

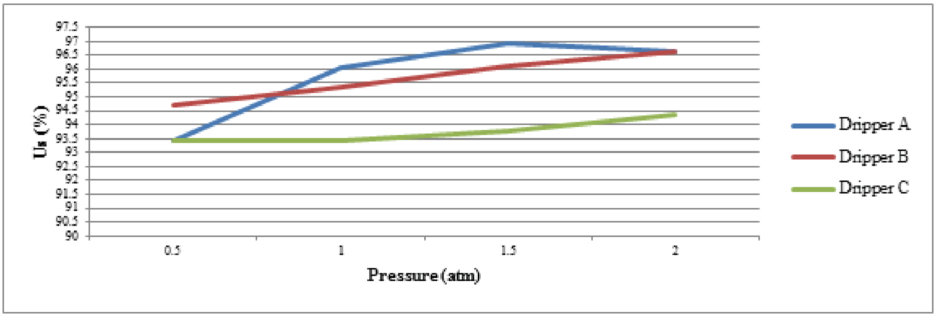

Figure 3. Us-Pressure Relations of the drippers used in the experiment

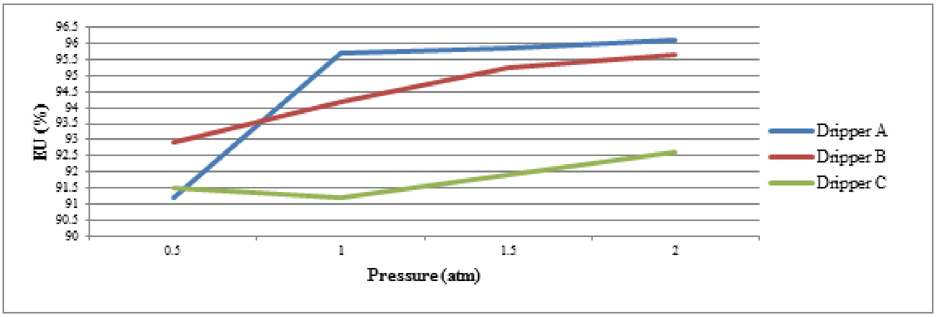

Figure 4. EU-Pressure Relations of the drippers used in the experiment

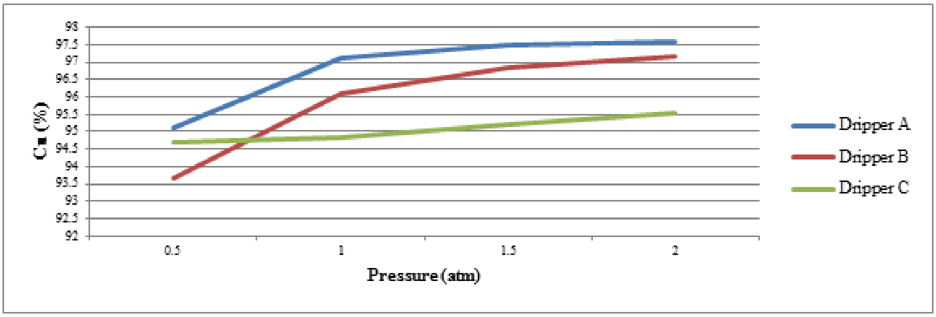

Figure 5. Cu-Pressure Relations of the drippers used in the experiment

CONCLUSIONS

When the flow rate values given by the companies and the values obtained at the end of the experiment are compared, the change in the in-line pressure regulated drippers is around 10%. When we analyzed the features of the dripper, obtaining the correlation coefficient values, shown as 'r', in all drippers between 0.980 and 0.997, indicates that the correlation between the pressure and the flow rate is very strong in every type of drippers. Different flow rates at the same pressure shows that drippers have an important effect on equal water distribution. Experiment results showed that the CVm coefficients of the in-line pressure regulated drippers are classified as 'good' while the in-line pressure unregulated drippers are classified as 'excellent' as they remained below 5% in terms of the proposed limits. Demir (1991) states that water leakage is caused between the dripper and the lateral pipe when the holes for drippers are not drilled carefully and thus the intended consistency level in the in-line drippers are not reached. The EU coefficients of the in-line drippers in our research were classified as 'excellent'. When the irrigation consistencies of the drippers are analyzed, the highest Us and EU coefficients were obtained in the in-line pressure unregulated drippers and therefore classified as 'excellent'. When the Cu coefficients were analyzed, the 95% limit that was mentioned by Wu and Gitlin (1974) were passed by the dripper A and B

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