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WATER STRESS AND K NUTRITION EFFECTS ON GROWTH INDICES AND SEED YIELD OF SUNFLOWER

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Abstract

In order to study the effect of water stress and potassium levels, growth indices and yield of sunflower a split plot experiment based on randomized complete block design(RCBD) was conducted with four replications during 2011 growing season in Bojnourd International Airport's field. Water stress was applied by irrigation regimes as main factor at three levels, 60, 90, 120 mm evaporation, from Class A evaporation Pan, and four K^+ levels (0, 70, 140, 210 kg/ha K^+ as potassium sulphate) as sub plots.
The important growth indices i.e. Leaf area index (LAI), total dry matter (DM), Crop growth rate (CGR), plus seed yield was determined. The highest seed yield was obtained from the interaction between $K_{210} \times I_{60mm}$ about 4.79 t/ha, and the lowest one in $K_0 \times I_{120mm}$ with 1.70 t/ha. The more potassium nutrition, the more compensation of moisture stress adverse effects and reduction of yield loss. There was a positive relationship between growth indices and seed yield, so increasing of K^+ nutrition resulted to higher DM, LAI and CGR, then seed yield. The highest quantities for these three indices were 4.5, 800 gr/m^2, and 15.5gr/ m^2.days, respectively.

Key words: *Helianthus annuus, growth analysis, potassium, drought stress.*

INTRODUCTION

Iran has located between 25-38′ North latitude with arid and semi arid climatic conditions. So irrigation economy is very important for our farmers. Amongst oilseeds, more than 190000 ha of Iran's arable lands is under cultivation of sunflower, and most of them are subjected to deficit or supplementary irrigation. This plant has a good capability for drought tolerance but needs a very good and efficient agronomic management (Shekari, 2013). Yield formation of sunflower under water stress conditions is related to rapid phenological development, higher assimilate translocation and partitioning, and also achieving more biomass before ripening (Elizondo, 1991).
Growth analysis is a valuable method for studying the growth capabilities of plants in different climatic and management conditions (Hunt, 1991). LAI reduction especially in flowering time, is one of the obvious effects of water stress (Chimenti et al., 2002). Total dry matter (TDM), has a sigmoidal trend across the sunflower growth period, but any stress can decrease the TDM curve to a lower level. Crop growth rate (CGR), is very susceptible to water stress too. Deficit irrigation in mid flowering and after that, has significant effect on CGR and seed filling period of sunflower (Shekari, 2013). Erdem, et al. (2006), demonstrated the effect of water stress on 58% yield reduction of sunflower. It seems that the budding and flowering stages are more susceptible to water stress in relation to seed yield (Pankovic el al., 1999).
Maintenance of high K^+ levels for plants in water stress conditions has a important role for crop production. Potassium can compensate the adverse effects of moisture stress on yield. So application of K^+-based fertilizers is a key management factor for crop production in water limited areas (Azizi, 1998).

MATERIALS AND METHODS

In order to study the traits related to yield and growth indices of sunflower a split plot experiment based on randomized complete block design (RCBD) was conducted with four replications during 2011 growing season in Bojnourd International Airport's field.

Irrigation regimes arranged as main factor with three levels, ie. Irrigation after 60, 90 and 120 mm evaporation from Class A Pan, and four K levels comprised (0, 70, 140, 210 $kg.ha^{-1}$ K^+, as potassium sulphate) as sub plots.

Traits under consideration were: Leaf area index (LAI), Total dry matter (TDM), Crop growth rate (CGR) plus seed yield of sunflower cv. Hysun25. For growth analysis 2-weekly plant sampling from 0.5 m^2 soil area was done. Leaves surface area and total dry biomass per unit area was determined. Then the best fitted curves for these three indices were estimated via regression methods. At the end of growing season economic seed yield was determined in each plots. Mean comparison was done based on least significant difference method (LSD).

RESULTS AND DISCUSSIONS

LAI trend was different for irrigation and potassium treatments (Figures 1 and 2).

The highest LAI (4.5) was achieved in I_{60}, but severe water stress forced it to significant reduction about 2.8.

This phenomenon is the result of reduction of leaves number, decline of leaf area, leaf abscission and changing the morphology of plant because of water stress (Shekari, 2013). Also the slope of decreasing the curve of LAI in water stress treatments after its peak was sharper than $I_{60,}$ the non stress treatment.

The more potassium application resulted to more LAI. So the K_{210}, had superiority in its leaf area trend compared to the least one ie. K_0.

Potassium deficiency, either due to soil shortage or due to its low availability because of water stress, is resulted to cessation of leaf expansion and reduced carbon exchange rate (Azizi, 1998). As leaf K^+ deficiency is increased the total photosynthetic area decreased (Ozbun et al., 1965).

TDM trend was different for irrigation and potassium treatments (Figures 3 and 4).

Increasing of water stress reduced the whole trend of TDM. But with more plant K consumption in each irrigation regime, dry matter was increased even in severe water stress. In I_{120} the maximum dry matter was decreased up to 30% compared to control. The highest TDM, about 800 g/m^2, was obtained in K_{210} and in non stress treatment. It seems that the compensatory effects of potassium in water stress conditions can balance the accumulation of dry mater for better seed yield (Azizi, 1998).

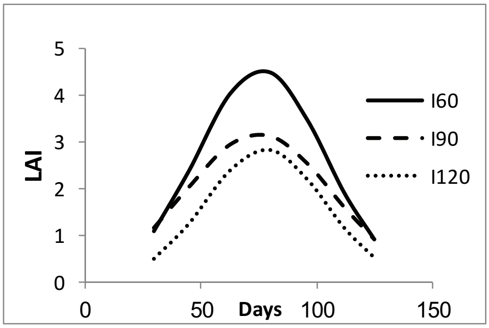

Figure 1. Comparison of LAI trend in different irrigation regimes (I_{60}….I_{120} means non to severe water stress)

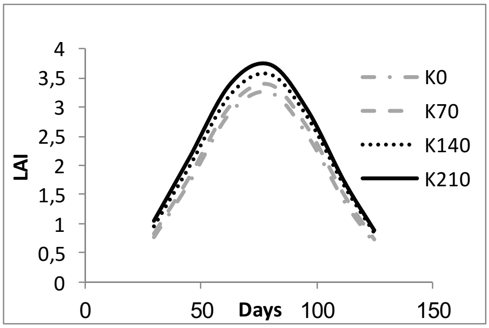

Figure 2. Comparison of LAI trend in different potassium Levels (K_0…K_{210} means non to high K application)

CGR trend was different for irrigation and potassium treatments (Figures 5 and 6).

Maximum CGR was obtained in I_{60}, 15.8 $g.m^{-2}$ $days^{-1}$, and for potassium the maximum ones was about the same rate in higher K applied. It is concluded that potassium had more obvious effect on LAI and TDM than CGR. Turner and Sobrado (1987) were reported the reduction of crop growth efficiency and rate of sunflower with water stress.

With reduction of water consumption from I_{60} to I_{120}, interacted with all levels of potassium, kernel weight was decreased significantly. Economic yield of sunflower in I_{90} and I_{120} were reduced 24.3 and 58.4% compared to I_{60}. Potassium application in all levels of irrigation treatments increased the kernel yield. The highest kernel yield was achieved from the combination of $I_{60}\times k_{210}$ equal to 4.79 $t.ha^{-1}$, and the least one in $I_{120}\times k_0$ equal to 1.34 $t.ha^{-1}$.

Results showed, sunflower have a very good response to potassium nutrition especially in water stress conditions or in dryland farming.

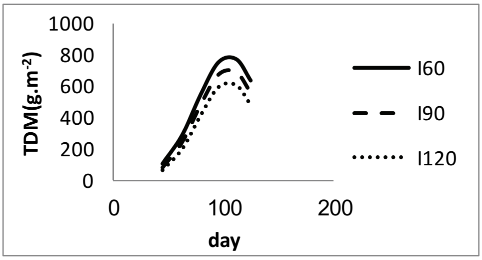

Figure 3. Comparison of TDM trend in different irrigation regimes (I_{60}…I_{120} means non to severe water stress)

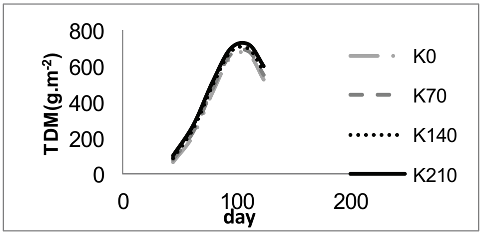

Figure 4. Comparison of TDM trend in different potassium Levels(K0…K210 means non to high K application)

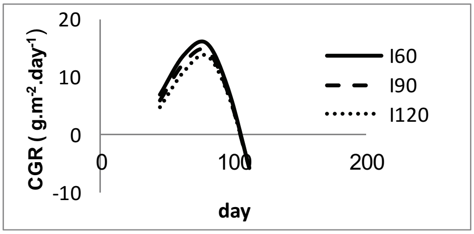

Figure 5. Comparison of CGR trend in different irrigation regimes (I60…I120 means non to severe water stress)

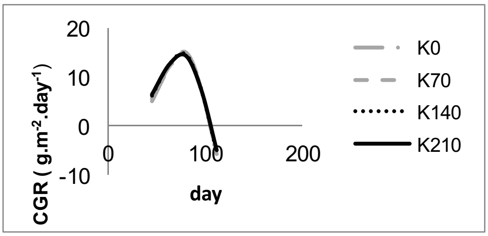

Figure 6. Comparison of CGR trend in different potassium Levels (K_0…K_{210} means non to high K application)

CONCLUSIONS

Adverse effects of water stress on kernel yield of sunflower are recoverable by using proper rates of potassium fertilizers like potassium sulphate. Potassium can modify photosynthetic apparatus in water stress conditions so that the reduction of growth indices responsible for yield formation is compensated for better drought tolerance.

Potassium increased total dry matter, leaf area index, crop growth rate, and kernel weight in all levels of irrigation treatments especially in severe water stress.

It seems that, application of potassium in dryland areas under cultivation of sunflower, is a key management strategy that prevent significant yield loss.

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EFFECT OF POTASSIUM, ZINC AND MANGANESE ON AGRONOMIC TRAITS OF SOYBEAN

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Abstract

In order to evaluation of the potassium, zinc and manganese effects on agronomic traits of soybean, a factorial experiment was conducted on 2008 growing season with three replications at Kohne-kan research field in Bojnourd, Iran. This experiment was done based on RCBD design. Treatments were, potassium in three level(0, 80 and 160 kg/ha K_2O in form of potassium sulphate fertilizer) and application of micronutrients including of, control, Zinc Librel, Manganese Librel, Zinc + Manganese Librel (1.5/1000 v/v) and also Solopotash, trade mark for soluble potassium sulphate, spraying (2/1000 v/v). Results showed potassium had no significant effects on yield, but Zn^{2+}+Mn^{2+}, and Solopotash increased yield via effect on yield components. The highest seed yield was obtained from application of Solopotash alone, about 4767 kg/ha. This is a result of increasing in seed number per pod, branch number and seed weight at that treatment. The greatest seed per pod was obtained from 160 kg/ha K_2O + Solopotash. Application of only Mn^{2+}, increased the harvest index.

***Key words**: Glycine max, potassium, zinc, manganese, potassium sulphate, harvest index.*

INTRODUCTION

Potassium and yield formation in soybean

Potassium concentration in soybean varies depends on K^+ availability in soil. Plant absorbs wide range of K^+ concentration from the soil. Potassium plays an important role in activation of enzymes, particularly the enzymes that are active for CO_2 reduction. Plant water content preservation is facilitated by K^+. Potassium helps N fixation in pulses too (Laegreid et al., 2000). Mahler et al. (1985) explored K^+ fertilizer rate effect on soybean, during its floral stage and concluded that applying 90 kg/ha of potassium leads to significant increase of yield and 100-seed weight. Gill and Kamprath (1990) in an acidosis soil with K^+ deficient conditions added various rates of K^+, mixed with lime to soil. They concluded that K^+ increases soybean yield. High available K^+ in soil leads to higher accumulation of this ion in growing parts of plant such that when the plant arrives at R_5 stages, developing seed benefits from redistribution of K^+ inside the plant. However, when K^+ reduces, developing seeds are less protected and stem stock of K^+ does not meet the requirements.

Zinc and yield formation in soybean

Zinc plays very metabolic role in the plant. Zn^{2+} is required for Tryptophan and Gibberellin synthesis. Auxin production requires Tryptophan substrates too. Zn^{2+} contributes in N metabolism, when it decreases.Also RNA and Ribosomes are reduced, leading to lower protein production and higher glucose as well as non-protein nitrogen based substances. In zinc deficient plants, protein synthesis is observed while amino acids, amides and nitrates accumulation in the plant also increase. Zn^{2+} contributes in following parameters in soybean, i.e. length of floral stage, pod set and seed filling period, higher oil and protein rate, as an enzyme activator in carbohydrate metabolism, protein formation and finally seed yield (Savithri et al., 1985). Khampariva (1996) stated that Zn^{2+} contributes in plant height, number of pods per plant, biological yield, harvest index and finally seed yield in soybean. Rose et al. (2002) explored spray treatment before floral stage on four soybean cultivars and found higher seed yield and protein content percent in seeds. Martens and Westerman

(1991) studied plant sensation levels and found that soybean represents medium sensation towards Zn^{2+} element. They held that Zn^{2+} application in soybean leads to its higher seed yield.

Manganese and yield formation in soybean

Soybean shows great sensitivity to Manganese loss, happening in high pH or neutral soils and leading to yellow leaves and dwarf stems. Singh (1997) reported that seed and biological yield of soybean were increased by Manganese (10 mg). Parker et al. (1981) concluded that treatment of Manganese sulphate (11.2-22.4 kg/ha) leads to 27% increase of seed yield comparing to control, due to higher weight of seeds. Mitra et al. (1985) stated that application of manganese (5-10 mg /pot) increases seed yield and 100-seed weight of soybean.

MATERIALS AND METHODS

This study performed in Kohne-kan research field near to Bojnourd city (Lat. 37^o 28' N & Longt. 57^o 19' E) in North-East of Iran. The soil was Silty Clay Loam with pH=8.35. This highland region has a colder climate with 258.9 mm annual precipitation and 13.2^{o}C mean temperature. This experiment was done based on RCBD design. Treatment were, potassium in three levels of (0, 80 and 160 kg/ha K_2O from potassium sulphate fertilizer) and application of micronutrients including, Control, Zinc Librel, Manganese Librel, Zinc+ Manganese Librel (1.5/1000 v/v) and also Solopotash spraying (2/1000 v/v). The measured traits were as follows: Seed yield, number of productive nodes in main stem, number of pods per main stem, number of seeds per pod, 100 seed weight, seed weight in branches and harvest index.

RESULTS AND DISCUSSIONS

The results of analysis of variance (Table 1) showed, potassium had significant effect on number of pods per plant, number of branches, number of seeds per pod and 100 seed weight. Zn^{2+} nutrient represents significant effect on number of pods per plant, number of seeds per pod, 100-seed weight, seed weight in branches and total seed yield. Potassium× micronutrients correlation showed statistically significant effect in terms of number of pods per plant, number of branches , number of seeds per pod, 100 seed weight, branches seed weight, total seed yield and harvest index.

Table 2, shows the average rates. Fertilizers had no significant effect on productive nodes per main stem. Manganese alone produced the highest pods per node of main stem (2.19, on average). The researchers reported positive effect of manganese on this feature (Mitra et al., 1985). 80 kg/ha K_2O as well as Solopotash treatment represented highest number of pods per plant. Hemantarajan and Trioedi (1997) studied sulphur effect on pod production in soybean and reported that, it increases this feature as well as pod length. Solopotash alone could produce highest number of branch per plant. Combination of micronutrients and potassium showed less important increase of branches. It seems that sulphur and potassium elements in solopotash play an important role in branch production. Application of combined solopotash + potassium (160 kg/ha) produced highest seeds per pod (3.35, on average).

Solopotash alone showed such a effect. Application of 80 kg/ha K_2O + Zn^{2+}+ Mn^{2+} as combined, produced the highest 100 seed weight (12.44 gr). Previously, researchers insisted on positive effect of Zn^{2+} and Mn^{2+} application on 100-seed weight (Azizi, 1999). Potassium oxide (80 kg/ha) created the highest seed weight per branches. Solopotash alone could produce the same result. It seems that the potassium in fertilizer contributes in the weight gain of seed in branches, leading to yield increase. Table 2, shows that solopotash alone has produced highest seed yield (4767 kg/ha). It seems that sulphur and potassium play more important role than other elements available in the fertilizer. This fertilizer is used as spray, so it is easily fixed in soil. Tanpon (1993) reported that a lot of sulphur is absorbed by soybean and it contributes in soybean yield. Sulphur absorption in soybean can facilitate interactively the absorption of other nutrients including phosphorus. Potassium (160 kg/ha) and Zn^{2+} and Mn^{2+} nutrients were used in interactive treatment and the yield ranked as the second highest (4632 kg/ha). Amara and Nasr (1995) showed that Mn^{2+} and Zn^{2+} improve soybean yield. Therefore, the experiments illustrate that solopotash alone can cover positive effect of Mn^{2+}, Zn^{2+} and other similar potassium- based fertilizers and they are able to produce better yield than other treatments. The highest harvest index was produced by Mn^{2+} (33.94%).Simultaneous use of Mn^{2+} and Zn^{2+} decreased harvest index (15.23%). It seems that availability of enough Mn^{2+} for plant can follow photosynthetic enzymes efficiency gain and it may prevent the thylakoid membrane reconstruction. Increasing photosynthesis efficiency leads to dry matter production increase and ultimately to improve substances translocation to seed (Khoshgoftarmanesh, 2008).

Table 1. Analysis of variance and F values for soybean yield and its components in experimental conditions
*, ** *represent statistically significant difference (p≤0.05),and very significant difference(p≤0.01) respectively*

SOV	df	Number of productive nodes per main stem	Number of pods per main stem	Number of pods per plant	Branch numbers	Number of seeds per pod	100-seed weight (gr)	Seed weight per branch	Seed yield (Kg/ha)	Harvest Index
Replication	2	4.41*	3.42*	1.79	3.15	0.36	0.54	3.3	0.22	0.0004
K^+	2	1.85	2.65	3.87*	6.55**	5.43*	6.77**	1.97	1.89	2.27
Micronutrient	4	1.41	2.61	3.24*	2.43	8.1**	2.89*	3.1*	8.1**	2.51
K^+×Micronutrient	8	1.84	1.36	3.22**	4.51**	4.39**	2.86*	4.47**	2.68*	4.71**
Error	28	-	-	-	-	-	-	-	-	-
CV%		6.32	9.59	14.59	31.47	2.24	4.66	53.62	7.65	17.88

Table 2. Comparison of interaction effects of yield and yield components means in experimental conditions

Treatments	Number of productive nodes per main stem	Number of pods per main stem	Number of pods per plant	Number of branches	Number of seeds per pod	100 seed weight (g)	Seed weight per branch	Seed yield (Kg/ha)	Harvest Index
K0+S0	18.73a	2.16a	58.13abc	1.27bcd	3.05e	11.83abcd	2.29bc	3751de	18.71bc
K0+Zn	18ab	2.14a	56.47abc	0.87cd	3.25abc	11.61abcd	1.53bc	3720de	18.14bc
K0+Mn	18.87ab	2.19a	66.67ab	2ab	3.24abc	11.09cd	4.48abc	4235abcd	33.94a
K0+Zn+Mn	17.2ab	2.08ab	59.2abc	1.4bcd	3.1de	12.33ab	3.21bc	4256abcd	22.63bc
K0+Solopotash	17.4ab	2.1ab	67ab	2.4a	3.34a	11.33bcd	5.13ab	4767a	20.33bc
K80+S0	17.93ab	2.04ab	70.73a	1.93ab	3.13cde	12.13abc	6.86a	3623e	23.55b
K80+Zn	17.47ab	1.91ab	50.67bc	0.93cd	3.18bcde	11.68abcd	1.81bc	4014cde	22.43bc
K80+Mn	16.33b	2.16a	60abc	1.2bcd	3.27ab	11.58abcd	3.82abc	4261abcd	17.21bc
K80+Zn+Mn	16.67ab	2.04ab	50.08bc	0.53d	3.16bcde	12.44a	0.95c	4393abc	20.1bc
K80+Solopotash	16.2b	1.74b	47.07c	1.33bcd	3.23abcd	12abc	2.22bc	3625e	20.26bc
K160+S0	17.73ab	2.15ab	56.07abc	1.2bcd	3.29ab	11.06cd	2.24bc	3656de	21.04bc
K160+Zn	16.73ab	1.81ab	55.73abc	1.67abc	3.23abcd	11.63abcd	2.89bc	4115bcde	22.21bc
K160+Mn	17.53ab	1.91ab	52.27bc	1.6abc	3.16bcde	11.54abcd	2.71bc	4398abc	22.15bc
K160+Zn+Mn	18.2ab	2.03ab	52.13bc	0.93cd	3.34a	11.61abcd	1.73bc	4632ab	15.23c
K160+Solopotash	17.07ab	1.88ab	50.53bc	1.2bcd	3.35a	10.87d	2.26bc	4185abcd	18.88bc

CONCLUSIONS

Seed yield and its components were increased with application of potassium, Zn^{2+}, and/or these two combinations. Pods per node of main stem took the highest effect from nutrient treatments especially for Zn^{2+}. Potassium increased number of branches. The highest seed yield was achieved in Solopotash application alone, and afterwards with combination of K_2O + Mn^{2+} + Zn^{2+} without any statistically differences. It seems that sulphur and potassium (in form of Solopotash) play more important role than other elements available in the fertilizer for soybean, and it can be compensate the effect of other micronutrients for adjusting higher soybean seed yield.

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INFLUENCE OF ORGANIC AND MINERAL FERTILIZATION ON SOME AGROCHEMICAL MODIFICATION OF CHROMIC LUVISOL FROM ROMANIAN PLAIN

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Abstract

*The present papers has as purpose to quantify some soil chemical modifications as a result of organic and mineral system of manuring after 21 years of experimentation in crop-rotation with: sugar-beet, winter wheat and winter barley. Chemical analyses were made on the soil sampled from 0-30 cm depth, after the winter wheat, at 8 Jully 2012 and conditioned after the usual rules. The experiment has two factors: **A-organic manuring:** a_1 - without organic manure; **a_2** -remanence with stable manure; **a_3** - fertilized with leaves and crown of sugar-beet 40 t/ha and **B-fertilized with ammonium nitrate**: b_1 - N_0; b_2 - N_{60}; b_3 - N_{100}; b_4-N_{150} and b_5 - N_{200}. The analyses made up: pH-H_2O; hydrolytic acidity and degree of base saturation. In conclusion, applying of mineral fertilizer, negatively influenced the soil pH, but applying stable manure, in posterior effect, this was improved. Ammonium nitrogen increased hydrolytic acidity, being required soil amendment with lime. Degree of base saturation achieved significant more values in the variants with organic fertilization*

Key words: *soil, pH, hydrolitic acidity, basic degree saturation.*

INTRODUCTION

In many countries, research on soil led to the establishment of crop rotations and fertilization systems that contribute to maintaining and enhancing soil fertility (Campbell et al., 2005; Liu et al., 2006; Sandoiu et al., 1996; Stefanic et al., 2006; Grennfelt et al., 1986). Frequently, practicing intensive agriculture results in the degradation of some physical, chemical and biological properties of soils.
This paper aims to quantify soil chemical changes as a result of organic and mineral fertilization system. These changes reflect direct influences on soil biological parameters (Dinca et al., 2013; Sandoiu et al., 2012; Meng et al., 2005).

MATERIALS AND METHODS

Soil samples were collected on July 8, 2012 from a long experience of the Moara Domnească - ILFOV organized on a short rotation: sugar beet, winter wheat, winter barley. Soil samples were collected from 0-30 cm depth after winter wheat in each experimental variant were subjected to conditioning by screening and removal of visible plant debris.
Experimental variants derived from the combination of two factors: factor A-organic fertilization (a_1–organic unfertilized, a_2-remanence of 30 t/ha stable manure and a_3-application of 40 t/ha of sugar beet crop residues). Factor B-mineral fertilization (b_1–N_0, b_2–N_{60}, b_3-N_{100}, b_4-N_{150}, b_5–N_{200}). Samples were subjected to chemical analysis of soil biology in the laboratory belonging to the Faculty of Agriculture in Bucharest. Were determined as follows, the values of pH, hydrolytic acid and the base saturation degree that were performed according to the method of variance analysis (Snedecor, 1965; Carter, 1993; Schollenberg, 1945).

RESULTS AND DISCUSSIONS

The influence of organic fertilization on mineral fertilization average on pH, there is a difference statistically assured. Remanence of stable manure influence was placed in trust group **a**, which can be seen in Table 1, with a value of 5.45, followed by application of crop residues in group **b.** This can be explained, among other things, by the fact that from stable manure is released ammonium relieves acidity chromic luvisol. This was observed by Sandoiu et al. (2012) and Dinca et al. (2013). Nitrogen application rates on average organic fertilization decreased the pH from 5.62 to 4.90 to 5.62 from N_0 to N_{200}, which would be calculate to 0.003 pH units/kg N.

The influence of organic fertilization on mineral fertilization media on hydrolytic acidity, there is a difference, statistically ensured (Table 2), stable manure was placed in group c of confidence, having a value of 4.454 me/100 g ground, followed by variant fertilized, which was placed in group B reliable, hydrolytic acidity value of 5.067 m.e/100 g soil.

Application rates of nitrogen fertilization on organic average negatively influenced hydrolytic acidity.

It has registered, to the mineral unfertilized, a value of 3695 me/100 g soil, at N_{60}, the value 4.167 me/100 g soil, at N_{100}, 5.108 me/100 g soil and 6.563 me/100 soil to dose N_{200} alone in group **a**. The highest hydrolytic acidity of 7098 me/100 g soil organic fertilization was achieved with 40 t/ha of beet leaves and sugar beet to N_{200}.

The influence of organic fertilization on mineral fertilization average concerning the degree of base saturation (Table 3) there is a difference statistically ensured. Remanence of stable manure was placed in a trust group with a value of 78.14%, followed by unfertilized variant, which was placed in group b of confidence, with a value of 74.27%. On average of organic fertilization, nitrogen application rates negatively influenced the degree of base saturation. It has registered a value of 81.504% to mineral fertilized and the amount of 67.931%, dose N_{200} application.

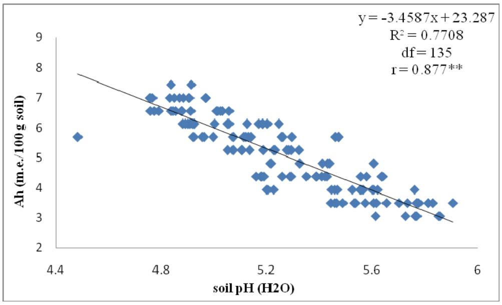

Figure 1. Correlation between hydrolytic acidity (m.e./100 g soil) and soil pH (H_2O)

CONCLUSIONS

1. Applying of mineral fertilizers, negatively affected the soil pH, and remanence of stable manure improved the soil quality.
2. Mineral nitrogen application increased the hydrolytic acidity, for which it is recommended the application of amendments to the variants fertilized with mineral nitrogen.
3. The degree of base saturation values recorded significantly better increase of pH (H_2O) in organic fertilized variants.

Table 1. Influence of organic and mineral fertilization on chemical reaction of chromic luvisol from Moara Domnească - ILFOV

B / **A**		**b_1– N_0**	**b_2–N_{60}**	**b_3-N_{100}**	**b_4–N_{150}**	**b_5–N_{200}**	**Average A**
a_1– unfertilized		c 5.48 a	c 5.22 b	b 5.13 b	c 4.88 c	b 4.84 c	c 5.11
a_2–remanence of 30 t/ha stable manure		a 5.79 a	a 5.66 b	a 5.45 c	a 5.31 d	a 5.02 e	a 5.45
a_3–application of 40 t/ha leaves and crown of sugar beet		b 5.58 a	b 5.56 a	b 5.21 b	b 4.99 c	b 4.84d	b 5.24
Average B		5.62 a	5.48 b	5.27 c	5.06 d	4.90 e	
Factors		*A*	*B*	*B*A*	*A*B*		
LSD	*5%*	0.011	0.029	0.046	0.050		
	1%	0.018	0.039	0.062	0.068		
	0.1%	0.033*	0.052*	0.085*	0.091*		

Table 2. Influence of organic and mineral fertilization on hydrolitic acidity (m.e/100 g soil) of chromic luvisol from Moara Domnească – ILFOV

A \ B		b_1– N_0	b_2–N_{60}	b_3-N_{100}	b_4–N_{150}	b_5–N_{200}	Average A
a_1– unfertilizat		b 3.647 e	b 4.234 d	b 5.106 c	b 5.886 b	b 6.465 a	b 5.067
a_2– remanence of 30 t/ha stable manure		c 3.305 e	c 3.500 d	c 4.234 c	c 5.104 b	c 6.127 a	c 4.454
a_3–application of 40 t/ha lives and crown sugar beet		a 4.134 e	a 4.767 d	a 5.984 c	a 6.610 b	a 7.098 a	a 5.719
Average B		3.695 e	4.167 d	5.108 c	5.867 b	6.563 a	
Factors		*A*	*B*	*B*A*	*A*B*		
LSD	*5%*	0.0998	0.0998	0.1724	0.1711		
	1%	0.1656*	0.1338*	0.2462*	0.2318*		
	0.1%	0.3096	0.1792	0.3661	0.3104		

Table 3. Influence of organic and mineral fertilization on basic degree saturation (%) of chromic luvisol from Moara Domnească – ILFOV

A \ B		b_1– N_0	b_2–N_{60}	b_3-N_{100}	b_4–N_{150}	b_5–N_{200}	Average A
a_1– unfertilizat		b 80.801 a	b 78.01 b	b 74.75 c	b 70.93 d	c 66.878 e	b 74.27
a_2– remanence of 30 t/ha stable manure		a 83.911 a	a 81.22 b	a 79.85 c	a 75.83 d	a 69.911 e	a 78.14
a_3–application of 40 t/ha lives and crown sugar beet		c 79.800 a	b 77.48 b	c 71.47 c	c 67.55 d	b 67.00 d	c 72.66
Average B		81.504 a	78.908 b	75.363 c	71.441 d	67.931 e	
Factors		*A*	*B*	*B*A*	*A*B*		
LSD	*5%*	1.0099	0.7181	1.3657	1.2437		
	1%	1.6747*	0.9731*	2.0080*	1.6854*		
	0.1%-	3.1318	1.3031	3.1459	2.2570		

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ELEMENTS OF EVOLUTION FOR TYPICAL CHERNOZEM HUMUS MODERATED UNDER VARIOUS TILLAGE CONDITIONS

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Abstract

Modern agriculture is distinguished from that practiced in seventies-eighties of last century through diversification of tillage methods, fertilization and soil maintenance. Alternative tillage systems lead to the formation of pedogenetic ambiance intrinsic that differs essentially from the ambiance created in the traditional system. No-Till tillage system favors the process of humus formation with his accumulation in the 0-20 cm layer. Also it is taking place preponderant accumulation of $N\text{-}NO_3$, $N\text{-}NH_4$, mobile forms of phosphorus and exchangeable potassium. Mini-Till and deep loosening without returning furrow lead to creating an ambiance in which the processes of humus formation only ensures sufficient compensation for losses of humus during crop growing.

Key words*: tillage methods, fertilization, soil maintenance, traditional system.*

INTRODUCTION

Modern agriculture is distinguished from that practiced in seventies-eighties of last century through diversification of tillage methods, fertilization and soil maintenance. Nowadays into the space between Prut and Dniester broader use have the traditional tillage systems. At the same time, extensively are used several versions among the alternatives – Deep loosening without returning furrow, Mini-Till, No-Till and Strip-Till.

At the moment in Moldova these works are practiced on more than 70 thousand hectares and area constantly increasing. The experience acquired in several agricultural units which practiced these methods about 10 years has highlighted many advantages of alternatives works.

Among them should be mentioned primarily significantly reduction of connected expenses (by 40-50%) for carrying out the works, already reduced after first two years, with 25-30% (wheat, barley, maize) expenses per unit of production (sunflower reduction constitutes more than 40%) as well is reduced after 4-5 year the amount of fertilizer consumed. An important element is to ensure the crops stability during dry years (this is obvious in the No-Till case) contributing to significant reduction of soil erosion. Despite these advantages, the specialized literature and information available on the impact of alternative work processes and the evolution of chernozems, most commonly, include only some episodic data.

The present researches are dedicated to the study of physical and agrochemical parameters dynamics of typical chernozem humus moderated.

MATERIALS AND METHODS

Researches were conducted within the north area of Moldova under production conditions. The pilot land has been arranged in 2009. Total surface is 160 hectares. That was subdivided into four plots as 40 hectares each, Structure of crops include wheat, barley, sugar beet and maize.

The research included applied studies on field and laboratory analyses. Applied field studies were conducted in the reference profiles. For analyzes methods were used STAS methods:

- Determination of bulk density - Kacinski method;
- Determination of moisture - Gravimetric method;
- Determination of humus content - $N\text{-}NO_3$, $N\text{-}NH_4$ – TINAO method;
- Determination of P_2O_5 and K_2O – Macighin method.

RESULTS AND DISCUSSIONS

The survey shows that the bulk density at the beginning of vegetation its values in all four variants throughout the profile (0-150 cm) remain in the range of optimal values (1.0-1.3 g/cm^3). Exception makes it the upper segment of the arable layer where the bulk density values were insufficient presented < 1 g/cm^3, which is determined by the high degree of structure dusting. At the same time and even at this stage, variants No-Till and deep loosening through the bulk density values and their distribution on profile are detached from other variants, in the plowing segment bulk density values vary in the range 10-100 cm from 1.03-1.20 g/cm^3 and the variant Mini-Till they vary from 1.05-1.23 g/cm^3.

In the case of No-Till variant bulk density varies in a low range of values (1.24-1.28 g/cm^3), which indicated the settlement and spatial undistributed distribution of solid constituents. Soil profile under deep loosening variant is distinguished by excessive aeration of surface segment (bulk density 0.84 g/cm^3). At depth bulk density values and their vertical distribution is typical for chernozems under natural regime (Figure 1).

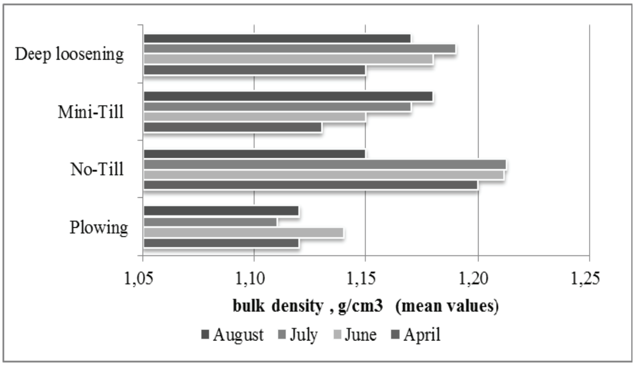

Figure 1. Bulk density dynamics in typical cernozem humus moderated in different tillage conditions

In all four cases the values of bulk density in the upper segment (0-30 cm) is not correlated with soil moisture, that fact is caused by different degree of structure modification but well as different organic matter content.

In June the soil profile under No-Till variant further detaches from the other variants. In his framework clearly distinguishes arable horizon (bulk density 1.16 g/cm^3) and subarable (bulk density from 1.35-1.32 g/cm^3). The analogue features bearing soil profile under plowing and deep loosening variants, and in it clearly distinguishes arable horizon (0-30 cm) with a distribution of bulk density values typical for them. Subarable horizons are characterized with values from 1.18-1.32 g/cm^3 (plowing) and 1.20-1.31 g/cm^3 (deep loosening). From our point of view at this stage determined role in the dynamics of bulk density returns to physic-mechanic processes, especially those blowing-contraction.

At the next phase (July, August) enhances the role of root system in the formation of agro-physic soil profile. Therefore the difference between agro-physical profiles in the various tillage variant is diminishes.

Dynamics of total reserves and productive of water are determined by tillage system used.

At the beginning of vegetation period with a maximum total reserves of water (877 m^3/ha) in the 0-30 cm layer characterized the No-Till variant. Of these more than 45% are productive reserves. Plowing, Mini-Till and Deep loosening is characterized by total reserves almost identical (Figure 2). However deep loosening variant detach from others tillage variants through increasing of water storage capacity (402 m^3/ha).

Later studied variants significantly detach through the consumption processes of water reserves in the 0-30 layer.

More intensive the water reserves are consumed in plowing variant. From Figure 3 we find that in June despite abundant precipitated from May and June, moisture content in 0-30 cm layer is reduced to interruption of capillary continuity. In July it is reduced to the level of hydroscopicity of the first 10 cm and wilting coefficient in 20 cm.

Mini-Till and deep loosening variants are characterized by relatively analog trend of water reserves consumption, but with different quantitative expression. However, under the variant Mini-Till the consumption of water reserves is attenuated.

No-Till is characterized by attenuated consumption of water. From Figure 2 we see that at the end of vegetation in the 0-30 cm layer is preserved about 50 % of total reserves at the beginning of vegetation and about 1/5 of useful reserves.

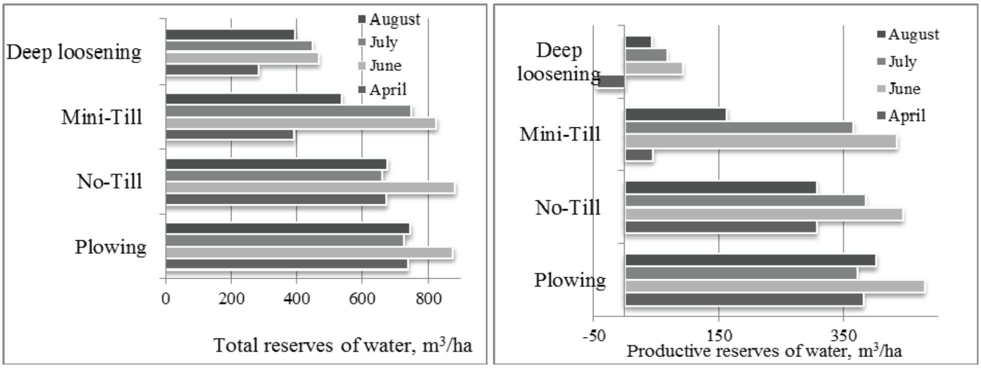

Figure 2. Dynamics of total reserves and productive reserves of water under typical chernozem humus moderated under various tillage conditions (0-30 cm layer)

Dynamics of water reserves in the 0-150 cm layer is correlated with their dynamics in the layer 0-30 cm, which allows us to conclude that in all tested variants is ensured the migration through capillary ascension from the deeper layers to surface layers. Comparative analysis of the dynamics of useful water reserves in the 0-150 cm layer shows that they are consumed more efficient in the deep loosening variant (Figure 3). Importantly, for all three variants of alternative tillage the useful water reserves in the layer 0-30 cm are sufficient to practice intermediate crops.

Based on the above mentioned we can conclude that the dynamics of soil physic characteristics create different functional framework for pedogenesis processes.

This clear trend of development is highlighted for agricultural indices. In this respect the data from Table 1 shows that under pedogenetic framework created through practice of No-Till, already, within the first 4-5 years, is likely to favor the more rapid accumulation of organic matter in the soil. At the same, time however, this process is limited to 0-20 cm layer.

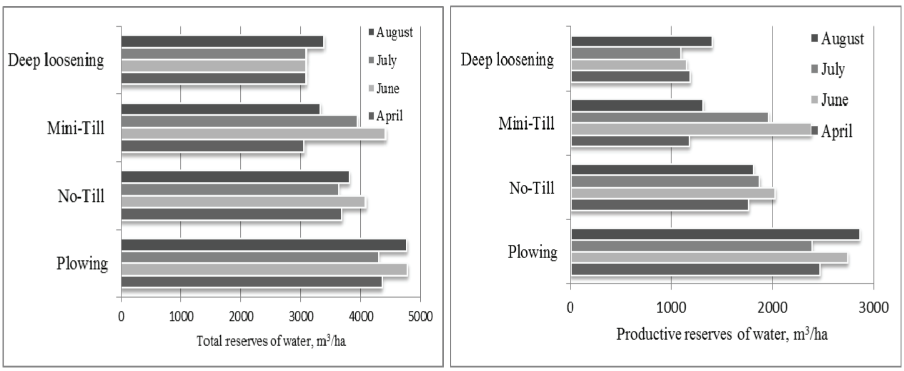

Figure 3. Dynamics of total reserves and productive reserves of water under typical chernozem humus moderated under various tillage conditions (0-150 cm layer thickness)

Table 1. Dynamics of humus content and its reserves

Tillage	Depth, cm	Humus content,%		Humus reserves, t/ha			
		Year		Year		Layer 0-50 cm	
		2013	2014	2013	2014	2014	2014
Plowing	0-4	4.18	4.20	38.8	39.1		
	16-20	4.08	4.05	42.0	41.7		
	26-30	3.86	3.80	43.2	42.6		
	48-52	3.39	3.40	40.4	40.5	164.4	163.9
No-Till	0-4	4.51	4.60	43.8	44.6		
	16-20	4.13	4.20	52.5	53.3		
	26-30	3.80	3.80	47.1	47.1		
	48-52	3.20	3.20	40.0	40.0	183.3	185.0
Mini-Till	0-4	4.26	4.30	41.0	41.7		
	16-20	3.97	4.00	41.7	42.0		
	26-30	3.80	3.80	42.9	42.9		
	48-52	3.20	3.20	37.1	37.1	162.7	163.7
Deep loosening without furrow returning	0-4	4.00	4.05	33.6	34.0		
	16-20	3.90	3.90	39.8	39.8		
	26-30	3.55	3.55	42.2	42.2		
	48-52	2.55	2.55	31.4	31.4	147.0	147.4

Specified phenomenon also reflected on other agrochemical indices. From Figures 4, 5, 6 and 7 we see that in the No-Till variant principal reserves of mineral nitrogen, mobile phosphorus and exchangeable potassium remain accumulated in the surface layer. This implies the conclusion, the layer is characterized by better capacity to provide useful water for plants, and their rood system will focus on the first, maximum 0-20 cm from the surface, implying several risks, including vulnerability to drought.

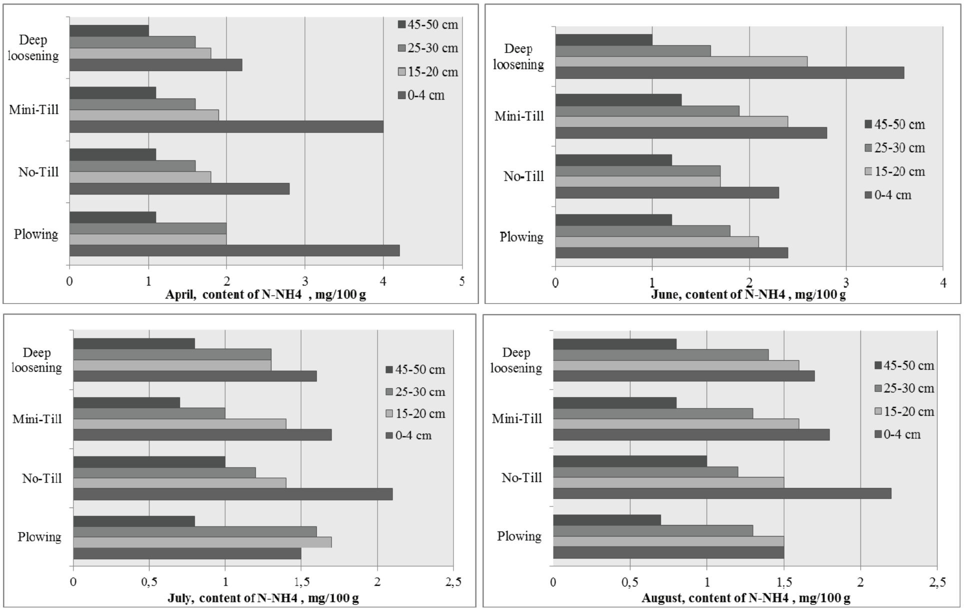

Figure 4. Dynamics of $N\text{-}NH_4$ in soil profile under various tillage system (April-August, 2013)

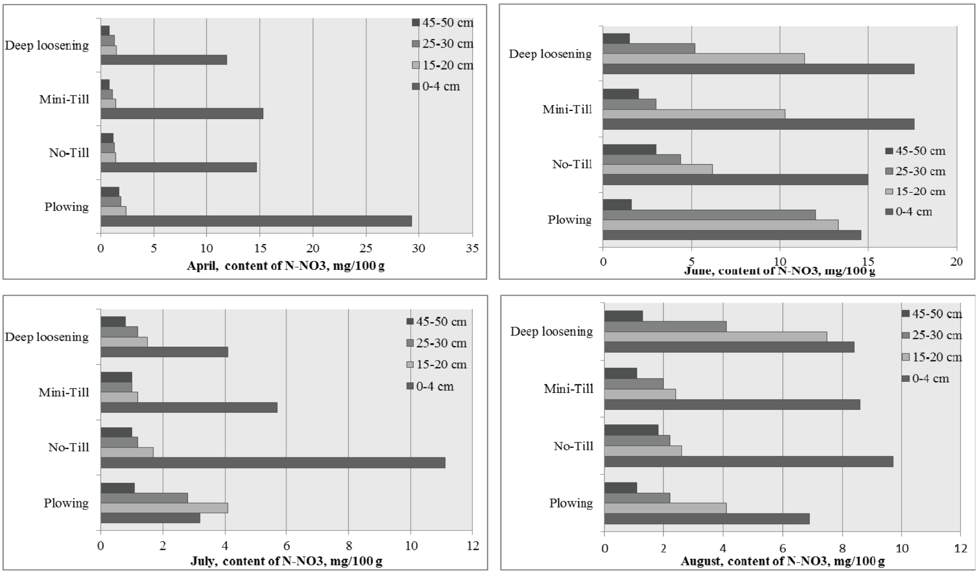

Figure 5. Dynamics of $N\text{-}NO_3$ in soil profile under various tillage system (April-August, 2013)

In the case of Mini-Till and deep loosening variants, processes of humus formation are performed in a sufficient proportion to ensure the stability of humus content in arable layer. Compared to Mini-Till variant in the alternative variants No-Till and deep loosening is resulting intense mineralization processes of organic waste, which leads to the formation and accumulation of large quantities of $N\text{-}NO_3$ in the 0-30 cm layer. Through the values of this parameter these variants carries several common features with plowing variant and substantial is detached from No-Till variant. For directing the processes of decomposition of vegetal debris with the meaning of formation and humus accumulation, it requires the involvement in the pedogenesis the vegetal debris reserves richest in nitrogen. This implies cultivation of nitrogen accumulator plant as intermediate crops.

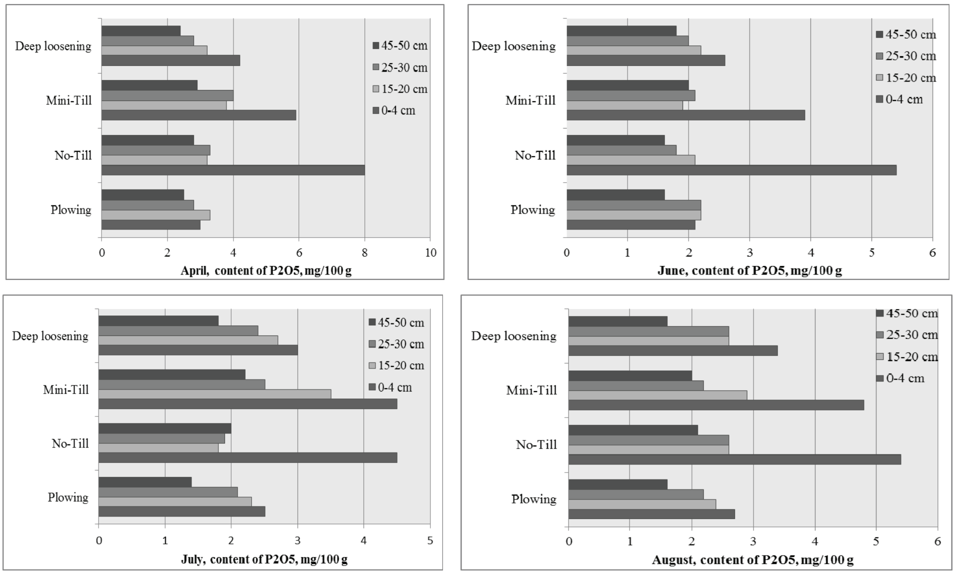

Figure 6. Dynamics of P_2O_5 in soil profile under various tillage system (April-August, 2013)

No-Till variant is distinguished from other variants through the intensive accumulation of phosphorus. In other alternatives tillage the phosphorus accumulation is less pronounced. In fact the proportions of phosphorus accumulation correlates well with organic matter content, this implies that the phosphorus in the alternative systems condition is accumulated in organic compounds (Figure 6).

Exchangeable potassium content in the investigated variants varies within range of values. As in the case of phosphorus with high-intensity of accumulation is characterized potassium in No-Till variant. At the same time is accumulating with significant accumulation intensity are characterized Mini-Till and deep loosening variants. In No-Till variants accumulation occurs in 0-10 cm layer.

Contrast to this, in the case of variants Mini-Till and deep loosening was found accumulation of potassium on the entire thickness of 0-30 layer. In this regard variants Mini-Till and deep loosening tillage variant are identical. This conclusion implies that in these variants arable horizons is more functional than the No-Till variant.

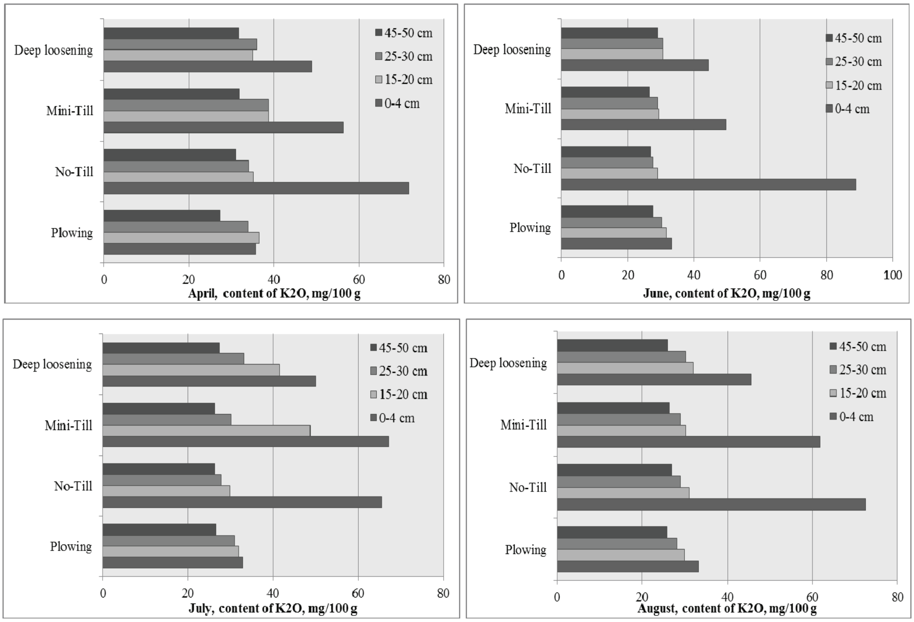

Figure 7 Dynamics of K_2O in soil profile under various tillage system (April-August, 2013)

CONCLUSIONS

Alternative tillage systems lead to the formation of pedogenetic ambiance intrinsic that differs essentially from the ambiance created in the traditional system.

No-Till tillage system favors the process of humus formation with his accumulation in the 0-20 cm layer. Also it is taking place preponderant accumulation of $N\text{-}NO_3$, $N\text{-}NH_4$, mobile forms of phosphorus and exchangeable potassium.

Mini-Till and deep loosening without returning furrow lead to creating an ambiance in which the processes of humus formation only ensures sufficient compensation for losses of humus during crop growing.

Within these accumulation processes of macro elements are reflected throughout the arable layer thickness (0-30 cm).

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THE AGROGEN EVOLUTION OF CHERNOZEMS UNDER PRUT AND DNIESTER SPACE (REPUBLIC OF MOLDOVA)

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Abstract

Agriculture implies the disturbance of ecological balance and modification of soil, materialized at all levels of the soil structural-functional organization. In this regard, soil science, instituted a special research direction concerned with the study of mechanisms and proportions of these changes. Chernozems are involved in the new phase of evolution determined by modification of external and internal factors. The sustainable management of this new phase requires knowledge of evolutionary mechanisms for soils and its management in agricultural landscape conditions.

***Key words**: chernozems, agrogen evolution, soils, agricultural landscape.*

INTRODUCTION

Agriculture, in any form used, implies the disturbance of ecological balance and modification of soil materialized at all levels of structural-functional organization of the soil. In this respect, soil science, instituted a special research direction concerned with the study of mechanisms and proportions of these changes. Today it is known that all this lead to modification of soil ecosystem functionality. In the same time, how they are interpreted raises a number of problems. The present research is a first attempt to assess these changes in the positions of pedogenesis theory.

MATERIALS AND METHODS

In the literature, frequently, changes in the agricultural soils are considered incoming from degradation phenomena. In our opinion this is a simplistic approach from the positions of their impact on soil productivity. Such approach is coming subsequently with recommendations oriented on mitigation of the impact of certain and other factors/processes on productivity. Frequently these are oriented on creating more favorable conditions for plants and soil; this is considered an object that can be modeled. In reality however, the measures applied in these positions just go to slightly productivity increasing with its most severe decrease in further. This is, in our opinion the main cause why against all efforts to stop or reduce the effects caused by agriculture not obtained results. This approach implies all the changes on the soil under the influence of agriculture as elements of a new phase in the development of soil that suffer cover due to changes in pedogenesis environment.

RESULTS AND DISCUSSIONS

The natural landscape formation within Prut and Dniester rivers is synchronized with the development of soil-plant relationships during Holocene. Most research demonstrated univocally that engagement of chernozems in the agricultural circuit put a new phase in the evolution of chernozems (Jigau, 2013). In this respect our research and other researchers indicated several features of chernozems and these results presented a number of agrogen transformation processes. Through the prism of ideas on the relative stability of mineral substrate (parent rock) the evolutionary contemporary factors of chernozems between the Prut and Dniester can be divided into three groups (Figure 1).

In this point of view the natural factors reduced significantly the role of the biological factor and enhance the role of geomorphological factor. This involves modification of the substances balance in the contemporary pedogenesis in order to reduce the volume and dynamics of biogeochemical substances circuit. For anthropological factors, should be mentioned diminishing of soil-plant relationships and intensification the role of drought, desertification and erosion in the evolution of the landscape.

Systematization of contemporary evolutionary factors of chernozems between Prut and Dniester allows identification of the main elementary processes of evolution of landscapes (Table 1).

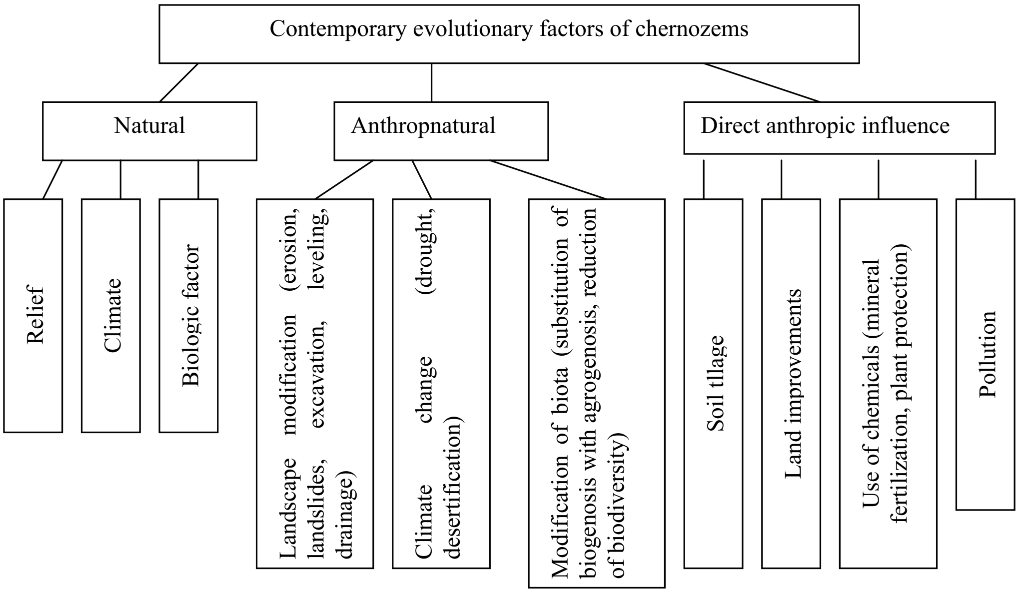

Figure 1. Contemporary evolutionary factors of chernozems under Prut and Driester

Grubbing chernozems and prolonged agricultural use leads to a range of morphological change pronounced, these modification presented in upper segment of the profile supports agrogenesis implications. The latter reached to the degradation and spraying of soil mass in the arable layer, practically the disappearance of total structure of grain, and formation of a new type of aggregate with high density packaging of the soil mass.

When not soaking softens in the dry state and is waterproof for the roots of the plants. Inferior layer in this segment represent a consolidated table (foot plow) with a negative impact on the exchange of substances in the soil profile being also materialized an area with a new aggregate formation materialized in anthropogenic chernozems with rigid packing that reinforced soil mass.

Systematization of several researches during 2003-2013 has highlighted the following morphogenetic modifications of chernozems under agriculture regime:

1. Modification of humus profile materialized in reduction of thickness, color and humus content.
2. Neo-horizons formation as agrogen nature especially arable horizon and sub-arable.
3. Modification of the profile structural organization, materialized in changing the thickness of horizons, aggregate composition and indices of settlement.

The main factors and processes that determine morphogenetic modifications are shown in Table 2.

Table 1. Typification of landscapes between the Prut and Dniester depending on the agrogen evolution and conditions of chernozems

Nr.	Landscape type	Baseline features			Agrogen processes	Agrogenesis forms
		Inclination	**Lithogenic composition**	**Groundwater level, m**		
1	Interfluvial plains	< 1-3 °	Clay, loamy clays, silty clays	> 6	Compaction, destructuring, dehumification, exhaustion, deflation	Reduction reserves of humus nutrients and humus. Modification of pedogenesis regimes (airhydric, hydrotermal, oxidation-reduction), etc.
2	Plains	-	Clay, loamy clays, silty clays	> 6	Compaction, destructuring, dehumification, exhaustion	Reserves reduction of humus and nutrients. Instability regimes of pedogenesis (airhydric, hydrothermal). Modification of hydrophysical profile.
3	Interfluvial plateau	< 1-3 °	Clay, loamy clays, clays	< 6	High humidity conditions, destructuring, crimping, fatigue	Structure type modification Airhydric poor regime. Biotic degradation.
4	Slopes	3-6 °	Clay, loamy clays, clays	> 6	Compaction, destructuring, erosion, exhaustion	The thikness profile reduction, reduction of humus layer thikness, humus content and nutritional elements
5	Inclined slopes	> 6	Clay, loamy clays, clays	< 6	Erosion, high humidity, exhaustion	Lower thikness for soil profile with a beginning of humus formation. Gleyic features.

Tabel 2. Factors that determine the morphogenetic modifications of chernozems under agricultural regime

Factors	Processes / morphogenetic effects
Land grabbing	Destructuring. Reduction of role for plant system roots in loosening and structure of soil mass
Soil tillage	Mixing the soil mass. Dusting structure. Agrogen layer formation
Compaction and destructuring	Agrogen layer stratification in arable horizons and sub arable horizons. Establishment of neohorizons
Pseudostructuring	Formation of agrogen aggregates as chernozems types during soil formation
Water and wind erosion	Soil profile truncation. The thikness of humus layer reduction. Basic features modification of humus profile. Carbonate profile modification (depth of effervence), the occurence of visible carbonates, depth of iluvial carbonate horizon.

Specified morphogenetic changes reflect taxonomic affiliation ofchernozems at different levels (subtype, genre, species and subspecies).

In this respect, we mention attenuation and differences between subtypes of chernozems, especially of typical chernozem moderated humus and those leachates, typical chernozem weak humus and carbonated chernozem. Through the development concept of the structure for soil cover agrogen morphogenetic modifications represents an element of soil cover convergence at higher taxonomic levels. In the same time, however, the homogenization provokes compaction of the soil cover structure at lower taxonomic levels. The evolutionary trend of morphogenetic features of chernozems subtypes between the Prut and Dniester involves attenuation level and gender differences and diversification of the species, subspecies, variants, etc.

Assessment of functional-genetic features studied on chernozems is determined by the evolution of types and genetic processes, accumulation and humus formation, structure and migration of carbonates.

The impacts of soil tillage on the process of humification support a multilateral character. On the one hand works, especially plowing helps to form a homogenous uniform distribution of soil and organic material in arable layer, which is positively reflected on the humification processes. At the same time, increases the degree of aeration, increases the rate of decomposition of organic debris and humus.

On the other hand grubbing and soil tillage suppose a considerable reduction in the amount of organic debris that accumulated annually in the soil. However, plowing work leading to the destruction of the dendrite humus, which is the main provider of organic substances involved in the process of humification.

Regarding chernozem there is no a unique point of view on the placement of mineral fertilization in the evolution process of humification. Several researchers argue that increasing of mineral fertilization is useful for crops.

In this respect in the soil increases the amount of organic debris, which leads to increased humus content and reserves. Despite these claims, in the agricultural chernozems was established a stable trend of humus content and reserves reduction. With reference to this subject, our research showed that over time mineral fertilizers leads to soil dispersion and disintegration of soil mass Specific processes adversely affect soil structure. In its composition is significantly reduced aggregate content particularly those agronomic valuable with a diameter of 5-1 mm. As a result, significant modifications suffer pedogenesis regimes (air hydric, hydrothermal, aeration, oxidation-reduction). It is demonstrated that even though mineral fertilizers negatively affect soil life, and fermentation activity.

In our opinion in the first years after framing the land in agricultural use the humus losses are the most significant due to the reduction of humus source as a result of increased mineralization processes. At this stage no significant impacts cause mineral fertilizers on soil biota functionality. Following a relatively short time period, they facilitated enhance and partial restoration of humus content and reserves (1965-1980). As result of negative effects caused by the intensity of the mineral fertilizers, humification is significantly reduced because of a reduction of the amount of crop residues as a result of the significant decline in yields and reduction due to biological activity. Amounts of humus produced annually are decreased, while they are enough to offset losses and elluvial mineralization/erosion.

As consequences the trend of humification is stable and we can conclude that currently practiced technologies received an irreversible trend. Humification process not only reduced the arable horizon. This affects the underlying horizons. In the same time, given the humus genesis condition increases humus mobility and partial displacement occurs in the layer of humus content in underlying sub arable horizons which frequently result in humus content increases while arable horizon is reduced. Processes mentioned are materialized in the formation of humus profiles specific for arable chernozems.

Therefore we consider that in the conditions when anthropogenic and technological energy consumption embodied in mineral and organic fertilizers are ineffective for preserving and extended reproduction of pedogenesis process, priority is given to less expensive processes, which models (stimulates) pedogenetical conditions of natural biocenosis .

In these activities the balance and dynamics of the humus profile differs from the one to other subtypes of chernozems.

In case of typical chernozem with weak humus and carbonated and reductions in humus affects the whole profile. Therefore in the agrogen evolution of these soils easily pass from one species to another.

In typical chernozem humus moderated losses are more intensive in surface and inferior horizon. Therefore apparently profiles of typical chernozem humus moderated get some profile features elluvial-humus-illuvial.

Modification of the chernozem structure, occurs after directed modifications of the processes that determine the structure of the accumulation of humus, leaching - carbonates eluvia, mineralogical composition modification, driven in a materialized dynamic on periodically repeated cycles (inflation-contraction as a result of wetting-drying and freeze-thaws, bioporosity modification due to changes in agrophytocenoses crop rotation, soil tillage). The modification of structure is the result of all evolution processes occurred in the soil.

In this respect the structure evolution requires neoaggregates of chernozem type during soil formation. Their dimensions can be and are being the most different. As a result of their occurrence this lead to increase of aggregate content > 5 mm and those of <1 mm. To support this assertion when is compared to the uncultivated arable chernozems aggregates > 5 mm practically lacking aggregate stability.

Based on the research we consider that this is caused modification of porosity aggregates > 5 mm as a result of their compaction (Jigau, 2009). As well is increasing compaction and the stability of aggregates <1 mm. Thus we come to the following conclusions about the direction and intensity of the processes of structure evolution based on the change in the structure factor calculated by the relation Ks = A / B where:

Ks - Coefficient of structure;

A - Content of aggregate 5-1 mm;

B - Content of aggregated > 5 mm + <1 mm.

To assess the degree of change in their structures on the basis of coefficient of structure the Ks is being proposed to use the following gradations:

- 1.5 to 2 poorly changed structure. A soil does not require any special measures to improve the structure;
- 1.5 to 0.7 moderately modified structure. Soils require measures for agrogen layer biologization;
- <0.7 advanced modification structure. Phytoameliorative and agrochemical measures are necessary special to recovery/restore structural state of aggregates.

CONCLUSIONS

Chernozems between the Prut and Dniester space are involved in a new phase of evolution determined by the modification of external environment of pedogenetic (pedogenesis factors), internal ambience (pedogenesis regimes) and relationships soil ← factors.

The sustainable management of this new phase requires knowledge of evolutionary mechanisms for soils and its management in agricultural landscape conditions.

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SOIL NITROGEN CONTENT AND EFFECTIVENESS OF NITROGEN FERTILIZERS FOR WINTER WHEAT IN MOLDOVA

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Abstract

The paper presents the experimental data on the state of nitrogen fund in soil of Moldova, modification of nitrification capacity and mineral nitrogen reserves in agricultural land in use and efficiency nitrogen fertilizers in the cultivation of winter wheat. It was established that soil mineral nitrogen reserves are insufficient for plant nutrition and obtaining high yields of winter wheat. Nitrogen fertilizer application on the optimal fund of mobile phosphorus in soil provides a significant increase in harvest. Each kilogram of nitrogen applied on the cultivation of winter wheat recovers with 10-15 kg of grain.

Key words: *effectiveness, fertilizers, harvest, soil nitrogen, winter wheat.*

INTRODUCTION

Nitrogen has the leading role in plant life. It is part of the protoplasmic structural proteins, cell nuclei, nucleic acids, pigments, vitamins and enzymes. For winter wheat crop formation of 4.0 to 5.0 t/ha the plants extract from the soil 120-150 kg/ha of nitrogen. Soils of Moldova annually produce about 75 kg/ha of nitrogen available to plants from organic matter mineralization account. Insufficient nitrogen nutrition of winter wheat leads to yellowing plants, forming small low-quality crops. The experimental data on soil nitrification capacity reserves of mineral nitrogen accumulated in the soil at the current stage of development of agriculture and weather efficiency nitrogen fertilizers in the cultivation of winter wheat has been presented.

MATERIALS AND METHODS

The research was conducted in the period 1985-2013 in field long-time experiences and in production conditions. In field experiments was determined the composition of fund nitrogen and nitrification capacity depending on the soil type and subtype, and the level of fertilizer. For this purpose soil samples were taken from 0-20 and 20-40 cm layers.

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In the production conditions were determined stocks of mineral nitrogen in the soil. Investigations were carried out in all pedoclimatical zones of the country. Soil samples were collected in early spring. In each zone the land parcels was divided in dependence of soil type and subtype, degree of soil erosion, precursory culture, development phase of plants. On the each field was drilled three wells. Soil samples were collected every 20 cm on the layer to 1.6 m, the were determined to moisture and nitrate nitrogen stocks. The research was conducted every agricultural year on the 17-80 soles with an area of 1200-4500 ha.

RESULTS AND DISCUSSIONS

Diagnosis of winter wheat nitrogen nutrition was performed on the basis of the stock of N - NO_3 in the 0-100 cm layer of soil (Andries et al., 1993). The experimental data were processed by different statistical methods.

The soils of Moldova are relatively rich in nitrogen. Total nitrogen content in gray soils is 0.12-0.14% and 0.21-0.24% in chernozems

(Andries, 2011). Researches (Andries, 2007) have shown that the background of nitrogen consists from organic compounds (95-96%), unchangeable ammonium fixed in the space formed by clay minerals (3-4%), and mineral forms available to plants (less than 1% of total). The main amount of the organic nitrogen (80% of total) is shown by the non-hydrolysable organic compounds in the acid concentrates, such as humines, melanines, bitumens, closely connected with the humus.

This form plays an important role in the formation and maintenance of nitrogen fund structure in the soil. It is a distant reserve to ensure plants to this nutrient.

Hydrolysable heavy fraction (10% of total) also presents a reserve supply the plants with nitrogen. Easily hydrolysable nitrogen makes up 8-10% of the total. It is made of organic forms and mineral compounds that participate in providing plants with nitrogen. About 20-30% of the nitrogen fraction is composed of the amino acids (Donos, 2008).

Nitrification capacity of the soil (NCS) characterized the mineralization speed of organic nitrogen and is a function of humus content and quantity and quality of crop residues. Established a close link between nitrification capacity (y, mg NO_3/100 g of soil) and soil organic matter content (x, %), which is described by the following equation:

$$y = 6.71 + 7.99x - 0.67x^2, \quad r = 0.90$$

Experimentally was determined that increasing the organic matter content by 1% ensures the formation and accumulation in soil of 24 kg/ha of mineral nitrogen (Donos, 2008). Currently the soils of Moldova contain on average 3.1% of humus and annually produce 74 kg/ha of mineral nitrogen. This quantity of nitrogen available to plants is sufficient to form 2.4 t/ha of winter wheat.

In the years 1989-2013 was evaluated the reserves of moisture and mineral nitrogen in the soil, the state of wheat plants after winter period, phenological phase of plant development. Based on the results was developed winter wheat crop forecast and determine the effectiveness of nitrogen fertilizers. It was found that the reserves of N - NO_3 of 1 m layer in early spring ranged from few hundred kilograms up to 10-20 kg/ha. The largest amount of mineral nitrogen is contained in typical, leached and ordinary chernozems, with a relatively high content of humus from 3.6 to 4.3%, after the precursory cultures, as alfalfa, peas, and also in the fertilized plots, and the small (12-20 kg/ha) - in the gray and eroded soils, after later precursors (corn grain, sunflower).

For the evaluation of the degree of plant mineral nitrogen and the forecast efficiency of nitrogen fertilizers N-NO_3 reserves were grouped according gradation effect. The amount of N-NO_3 below 60 kg/ha is considered very low and low, 61-100 kg - moderate, 100-140 kg - optimal, more than 141 kg/ha - high (Andries and et al., 1993).

There highlighted two periods of accumulation of mineral nitrogen in soil depending on how land use. First period - 1981-1990.

During this period in the crop field rotation was applied by 3.0 to 5.6 t/ha of organic fertilizer and by 90-170 kg/ha of NPK, including 52-101 kg/ha of nitrogen fertilizers. Share of biological nitrogen fixing leguminous crops was about 300 thousand ha, including perennial grasses 180-210 thousand hectares.

Humus balance became slightly deficient, the nitrogen and phosphorus balance - positive. Systematic application of fertilizers in crop rotation field led to increase the soil fertility. Mobile phosphorus content increased 2 times, potassium content by 2-3 mg/100 g of soil.

The use of chemical substances in agriculture allowed weeds, diseases and pests plant protection (Вронских, 2005, 2011). Number of the tractors in the agriculture increased to 53.3 thousand, the drives combine up to 4.5 thousand units.

During this period, the intensive technologies (industry) implemented everywhere. Against this background of the agriculture development the reserves of mineral nitrogen at the winter wheat were under graduation in use, moderate and optimal.

For example, in 1989 the average reserves of N-NO_3 in soil were 115 kg/ha and correspond to optimal gradation of ensure plants to mineral nitrogen. But, on the land cultivated with winter wheat was a pronounced difference in providing plants with mineral nitrogen. Only 23% of the total surface of wheat was supplied optimal with nitrogen, allowed weed plant protection (Table 1).

Table 1. Nitrate nitrogen reserves in the 1 m of soil layer, in the spring at the cultivation of winter wheat, % of total

Content of $N\text{-}NO_3$	Average for 2007-2013
Low	64
Moderate	26
Optimum	10
High	0
Average, kg/ha	**55**

About 10% of the land occupied by winter wheat is characterized by a low content of nitrate nitrogen. On these fields the effectiveness of nitrogen fertilizers was high. Note that the fertilizers application without the recommendations developed by agricultural science has led to the accumulation of mineral nitrogen in the soil in amounts greater than the optimal, over 141 kg/ha.

On such soles the mineral fertilizer efficiency was low, and in some fields occur fall plants. Systematic application of fertilizers in optimal doses, compliance of winter wheat growing technologies led to yielded 3.6 t/ha of grain.

A second formative period reserves of mineral nitrogen in the soil are the years 1994-2013. During this period the volume of applied fertilizer suddenly decreased in agriculture. Each hectare upon her only by 0.01 to 1.1 t/ha of manure and 4-17 kg/ha of nitrogen fertilizers. Surface of vegetable crops in field crop rotation decreased 5-6 times, constituting 30-40 thousand ha of perennial grasses and 15-20 thousand ha of peas.

Balance of humus, nitrogen, phosphorus and potassium in soils of Moldovan agriculture became negative (Table 2).

Productivity of winter wheat in the 2006-2010 period decreased on average by 2.2 t/ha of grain. In the 2008-2011 years the weighted average reserves of $N\text{-}NO_3$ in soil cultivation of winter wheat were low, constituting 55 kg/ha. Quota of soils with low content of mineral nitrogen was 64% of the total.

The fields with high soil $N\text{-}NO_3$ have disappeared. Share of fields with optimal mineral nitrogen content in soil was low and did not exceed the 10% level.

Under these conditions essentially increased efficiency of nitrogen fertilizers applied to optimal background of phosphorus in the soil. Each kg of nitrogen recover 10-15 kg of winter wheat grain.

Table 2. Balance of nitrogen, phosphorus and potassium in the Moldovan soils, kg/ha

Years	N	P_20_5	K_20	Sum of NPK
1913	-22	-13	-52	-92
1940	-26	-15	-62	-99
1945	-15	-15	-52	-82
1950	-27	-13	-68	-108
1951-1955	-27	-12	-62	-102
1956-1960	-40	-14	-82	-136
1961-1965	-59	-14	-80	-132
1966-1970	-36	-9	-84	-130
1971-1975	-22	-1	-79	-103
1976-1980	-15	+11	-66	-69
1981-1985	+9	+22	-33	-4
1986-1990	-15	+25	-49	-8
1991-1995	-18	-11	-80	-113
1996-2000	-30	-21	-83	-134
2001-2005	-24	-23	-81	-128
2005-2010	-26	-22	-84	-132

Agriculture requirement of mineral fertilizers in the Republic of Moldova

In the conditions of Moldova the natural factors which limit the production of high harvests are the insufficiency of nutrients in the soils as well the moisture deficit.

In order to achieve the growth rate in harvest of 40-50% it is necessary to compensate the deficit of nutrients by the use of fertilizers and rational utilization of the soil moisture.

The optimal level of fertilization provides the increase of the fertility of soils, obtaining high crops and a maximum profit from a unit of agricultural land, the protection of the environment from the pollution by nutrients.

The optimal application of fertilizers is required for a level of the modern agriculture soil no-till with respecting zonal crop rotations, the soil no-till, the integrated protection of plants, extension of irrigation, the development of the livestock sector, the implementation of intensive technologies of plant cultivation.

This system is based on the combined application of organic and mineral fertilizers in couple with fuller use of the biologic nitrogen (Table 3).

The optimal demand for nitrogenous fertilizers for the crop rotation will be 82.3 thousand tons of the active substance or N_{55} on average per 1 ha.

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Table 3. The optimum doses of mineral fertilizers for the fertilization of the main crop plants, kg/ha of the active substance

Crop plants	*Recommended dose*			*Remark*
	N	P_2O_5	K_2O	
Winter wheat	80	60	40	annual
Winter barley	34	60	0	*
Spring barley	34	60	0	*
Maize grains	60	50	0	*
Peas for grains	30	20	0	*
Sugar beet	105	80	40	*
Sunflower	45	40	40	*
Tobacco	35	40	40	*
Potatoes	60	60	60	*
Vegetables	90	60	60	*
Maize for silage	40	40	0	*
Fruitful vineyards	60	60	60	once in 3 years
Fruitful orchards	60	60	60	once in 3 years
New vineyards (founding)	-	400	400	to foun-ding
New orchards (founding)	-	400	400	to foun-ding

For potatoes and vegetable crops will be needed 6.8 thousand tons of nitrogen with the average dose for 1 ha - N_{60}. For the fruitful orchard fertilization will be needed 2.0 thousand tons of nitrogen, for the fruitful vineyards 1.5 thousand tons. The phosphoric fertilizer requirements will constitute 69.9 thousand tons for the field crops, 9.0 thousand tons for vegetables and potatoes, 1.5 thousand tons – for fruitful vineyards, 1.2 thousand tons for the fruitful orchards. The annual requirement of potassium fertilizers will be 28.3 thousand tons for field crops, 6.8 thousand tons for vegetables and potatoes and 3.1 thousand tons supplementary for the irrigated lands.

The total annual demand of fertilizers for the agriculture of the Republic of Moldova after 2020 will constitute 236.7 thousand tons of the active substance, including 99.9 tons of nitrogen, 91.0 thousand t of phosphorus and 45.8 thousand tons of potassium. This level of fertilization was reached in the 1976-1985 years by applying annually 243.6-362.0 thousand tons.

The use of the optimal fertilization system coupled with other technological links of cultivation of the crop plants will allow to get 4.0-4.2 tons of the winter wheat, 3.6 tons of grain maize and will form an equilibrated nutrient balance in Moldova's agriculture.

CONCLUSIONS

In the result of the investigations it was established that during the years 1981-1990, when in soil was applied 3-6 t/ha of manure, 50-70 kg/ha of nitrogen fertilizers, and quota of biological nitrogen fixing leguminous crops was about 300 thousand ha, the reserves of $N-NO_3$ in the root layer formation were optimal for yields of 3.4-3.8 t/ha with high bakery quality. In recent years (1996-2013) the amount of applied fertilizers in agriculture fell sharply, constituting 0.01 to 1.1 t/ha of manure and 5-20 kg/ha of NPK. Balance of humus and nutrients in the soils is negative. Accumulated reserves of mineral nitrogen in the soils are low, and provide only to 2.2-2.5 t/ha of winter wheat. Application of nitrogen fertilizers on optimal background of phosphorus and potassium nutrition ensures a significant increase in harvest. Each kg of nitrogen applied to winter wheat cultivation recovers 10-15 kg of grain.

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NATURAL CONDITIONS CONTRIBUTING TO APPEARANCE AND DEVELOPMENT OF SOIL DEGRADATION IN MOLDOVA

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Abstract

The paper aimed to present the natural conditions contributing to soil degradation in Republic of Moldova: geological structure of territory, parental rocks, relief, climatic conditions and vegetative cover. Description of these factors was performed based on the fundamental and applied researches, field and laboratory analyses. Each factor in a greater or lesser measure influences soil degradation and land desertification. Knowing the degree of influence allows developing measures on prevention of factor degradation and measures of restoring fertility of degraded soils. These measures were discussed in state programs for exploitation of degraded soils and low productivity.

Key words*: climate condition, geological structure, parental rocks, soil erosion, vegetative cover.*

INTRODUCTION

Natural conditions of Moldova combined with anthropogenic determine, on the one hand, the intensity and direction of soil formation, and on the other hand, the nature and extent of soil degradation. Depending on the combination of natural and anthropogenic factors change the shape and extent of land degradation.

MATERIALS AND METHODS

Study on natural conditions that contribute to soil degradation and land desertification was conducted in aims to develop the measures to mitigate the consequences, to implementation the elaborations on soil protection and monitoring. Were studied scientific historical literary sources, statistics date, monitoring bulletins and data bank.

RESULTS AND DISCUSSIONS

1. Geological structure, parent rocks and their influence on the process of soil degradation. In the geological history the territory of the Republic of Moldova are two main periods: the geosynclinal and platform. The platform stage led to an effusion of bases, the emergence of many geological faults and the formation of four platform depressions: Hincesti, Predobrogian, Pontiac and Prut.

In the Neocene, in connection with the evolution of the Carpathian geosynclinal and the Pontiac depression, the immersion process, involved almost the entire territory of Moldova (submerged under the sea). This led to the accumulation of large sectors of marine Neocene sediments, which currently places come to the surface or overlain by Quaternary deposits. Tertiary sediments are saline Sarmatian clays with lenses of sand and loam.

The Quaternary deposits are developed almost everywhere and are loess-like loams, ancient and modern alluvial sediments of different grain size - from clay to sandy loam.

Parental rocks of Moldovan soils are present mainly by Quaternary and partial Neocene origin of surface sediments:

Neocene clay. Come to the surface in the upper and middle slopes of the Central Moldovan Plateau and High Ciuluk Hills, occupying 24 thousand hectares, contain up to 80% of physical clay and more than 35% of silt, on these rocks are formed automorphic solonetzes and vertisoils.

Neocene clay loam. Take 55 thousand hectares on the same plateaus, comprise up to 55% of the physical clay and about 30% of silt, have satisfactory agronomic characteristics.

Quaternary loam clays and their derivatives. Distributed mainly on the North Moldavian Plateau and on the stabilized spaces of the

Central Moldovan Plateau. Occupy 257 thousand ha, contain no more than 64% of the physical clay and 38% of silt, have satisfactory agronomic characteristics, contribute to precipitation water stagnation in the soils and formation of swampy soils on the slopes, as well as the development of linear erosion.

Quaternary loess loamy clays and their derivatives. Occupy 1433 thousand hectares and contain 54-56% of physical clay and 30% of silt. In Moldova this rocks adopted as the standard-parent rocks. Have favorable physical and chemical properties.

Quaternary loess clays and their derivatives. Distributed over an area of 473 thousand hectares, mainly in the south of Moldova, contain 35-37% of physical clay and 20% of silt. Characterized by very favorable physical and chemical properties. However, the soils, formed by those rocks are weak and moderate resistance to water and wind erosion.

Sandy loams and loamy sands of diverse origin. Cover about 50 thousand hectares, contain 19-26% of physical clay and 12% of silt. Very unstable to deflation. Characterized by moderate favorable properties for growing field crops, as are poor in nutrients and have a less favorable water regime. Soils formed on these deposits, especially suitable for the cultivation of high-quality tobacco varieties, planting stone fruit trees, vineyards for special purposes etc. (Leah, 2012).

In conclusion, it should be noted that the parent rocks contribute to the development of the following soil degradation processes:

- *clayey size composition of soils* - conduct to the emergence of excess moisture with stagnant character, formation of the solonetzes on the slopes, the appearance of vertic processes (vertisoils), development of linear erosion;
- *clayey size composition of underlying rocks* - to the accumulation of ground water, forming sliding faces and the appearance of landslides, forming the salinization and alkalization soils in meadows as a result of chemical denudation;
- *saline parent rocks* - to forming solonetzes on the slopes, increased salinity degree of groundwater, salinization and alkalization of soils, as result of chemical denudation;
- *moderate and easy size composition of soils and rocks* - to development of erosion and deflation, aridity and desertification.

2. Relief and soil degradation. The contemporaneous relief of Moldova formed by the interaction of tectonic movements of the earth's crust and denudation processes in continental conditions, extended from the end of the Neocene period. The average altitude of Moldova surface is 147 m, the maximum reached 429.5 m (Balaneshti hill). Elevation of the terrain falls to the north-west to south-east.

At the same time in the Central part of the country, there is a combination of high plains and heights less strongly fragmented.

Within the Moldova limits is identified the following major orographical units: North Moldovan Plateau, North Moldovan low undulating Plain, Central Moldovan Plateau, Dniester Hills, Lower Dniester Plain, South Moldavian hilly plain, Tigheci hills.

North Moldovan Plateau is characterized by smooth topography, which contributes to the weak expression of soil erosion processes. Absolute altitude - 250-300 m. Horizontal fragmentation of valleys - 1.5-2.0 km/km^2, vertical average fragmentation - 50-100 m, in the west, in the fossil reefs chains up to 150 m.

North Moldovan Undulated Plain by the local topography and the expression of the soil erosion like the North Moldovan Plateau, but differs from it in smaller altitudes - 200-250 m.

Central Moldovan Plateau (Codri) is a combination of narrow comb watersheds with deep valleys and wide long slopes which are dissected by erosion and landslides semi-enclosed depressions, called "*hârtopuri*". Horizontal fragmentation of surface is 2.5-4.0 km/km^2 and vertical - 200-300 m. This contributes to the extensive development of landslides, mechanical and chemical denudation, erosion of soil cover. As a result of chemical denudation and salt removal from the Neocene clays, the ground water of floodplains are mineralized and cause salinization and alkalization of hydromorphic soils.

Dniester Hills has a height of 250-300 m, the maximum is 347 m, the vertical dissection - 150-200 m. Western slopes are slow, and eastern - descends sharply to the river Dniester. Soil erosion processes occurs widely.

Plain (terraces) of Lower Dniester is characterized by low horizontal fragmentation of the surface (less than 1 km/km^2) and low absolute altitudes - below 100 m.

South Moldovan undulating plain is characterized mainly by an absolute height in the range of 100-200 m (max. 247 m), the horizontal dissection - 2.0-2.5 km/km^2, vertical - 100-150 m, the soil erosion are widespread, but much weaker that at higher elevations.

Within South Moldavian hilly plains stands ***Tigheci Hills***, elongated in the sub meridional direction. The absolute altitude of the northern part of the upland reaches 300 m, and the southern - 220 m. Erosion appear moderated.

Seven orographical units characterized by specific morphological structure, present in a relatively small area of the country, determines increasing the intensity of contemporary exogenous processes, leading to the destruction of soil cover. Among these exogenous processes should be mentioned the following: erosion and landslide, proluvial-delluvial, crash, colluvial, suffusion and carst. Most strongly manifests erosion and landslide processes, the primary cause of the destruction of soil cover and land degradation.

Relief indicators, which determine the intensity of soil erosion manifestation are: total degree of territory fragmentation, local base of erosion depth, average slope length, slope steepness and forms. In Moldova these parameters are combined in a system so complex that it is impossible to give relief a single integrated assessment. It is necessary that each water catchment area and even slope can be treated separately, taking into account their morphometric characteristics.

According to experimental data, the quantity of eroded soil by erosion increases in proportion to the slope length from 0.5 to 2, on average 1.6. Increasing the slope length with 100 m leads to the increasing the amount of eroded soil by 1.5 times, doubling the slope length from 200 to 400 m increases the volume of eroded soil by 4 times.

Republic of Moldova is characterized by a wide diversity of surface slopes, including inclinations of agricultural land. Experimental data have shown that the amount of soil removed by erosion increases proportionally with the inclination of the slope. Doubling the slope inclination increases the amount of eroded soil by 2.3 times. Increasing the slope angle with 1° (beginning from 2°) increases the eroded index on the surface with maize, the average - 6.6 t/ha, sunflower - 5.7 t/ha, autumn plowing - 4 t/ha, winter wheat - 3.1 t/ha.

Areas with slopes from 0^0 to 2^0 are considered relatively horizontal, the erosion does not occur (up to 1°), or as manifested in a smaller (1-2°) and can be stopped using relatively simple protection processes. Slopes with inclination of 2-6° are already erosion dangerous leading to the formation of weak, medium and even heavily eroded soils. Land with slopes 6-10° shows the high risk and require a complex implementation of special protection measures. The areas of land with slope of more than 10^0 should be taken out of the phyto-intensive works and aforestation alienated or turned into pastures with grazing strictly regulated.

A large influence on the erosion intensity of erosion has slope exposure. Sunny slopes are more susceptible to erosion than shady.

In connection with the general inclination of Moldovan territory from northwest to south and southeast in total the slope which north-facing are the least (21%), the east, south and west exposition are almost equal (26-27%). But the areas are essential differences. For example, in the central part of Moldova slopes with southern exposition predominate (29%).

The depth of the local base level of erosion, both average and maximum is higher in the central area (130-328 m), which indicates an increased risk of manifestation of erosion within that territory. In the northern and southern zones these values are lower, but still significant and should also be taken into consideration the protective measures.

Slope form is essential significance for the erosion manifestation and erosion control measures selection. Danger manifestation of erosion is low for straight slopes that are more prevalent in the North (40%) and about two times less in the South (18%) and Central (23%). Therefore, conditions for minimization of erosion in the last two zones are very complicated. On the other hand, the large number of slopes with concave central area (49%) can contribute to reducing fluid flow and deposition within the slope the material washed away by erosion.

The lowest risk of erosion is characteristic for Plain (terraces) of Lower Dniester, where more than 80% of the territory has a horizontal surface, and 15% - in the slopes 2-6^o. Slopes greater than 10 ° there is no. On the second place is North Moldovan Plateau, where horizontal areas occupy 56% and 31% of the area has slope 2-6°. Close to these parameters ranges the weak undulated Plain of North Moldova - respectively 51 and 39%, and land with slope greater than 10° are only 3%.

Within South Moldovan hilly plains and Tigheci Hills are spread respectively 38 and 43% on the quasi horizontal surfaces.

The greatest erosion danger present territory of Central Moldovan Plateau (Codri), where only 22% of land is occupied by quasi horizontal surfaces and 18% were over 10°. Similar results have the area of Dniester Hills (30 and 14%). In other natural areas quasi horizontal space occupied 25-35%, and with the slope more than 6° - 7-15%. The steep slopes and heights plateaus are mostly covered by forest, which almost completely protects the soil from erosion processes (Monitoring, 2010).

Finally it should be noted that the topography exerts its influence mainly on the forms and intensity of erosion and landslides manifestation - the main factors of land degradation. Therefore, in developing concrete schemes of land use and erosion control measures necessary to consider, first, the quantitative parameters of relief (slope) of specific territories.

3. Climatic conditions and their impact on land degradation and desertification. The Republic of Moldova is characterized by a warm continental climate with short and mild winters (average temperature in January is -3^0, -5^{0}C), with warm and long summers (average temperature in July is +20^{o}C, +22^{o}C) with relatively little rainfall.

Depending on the latitude, altitude and orographic features on the Moldova identified three climatic zones, which are both agropedological climatic zones: North, Central, South. These areas, in turn, depending on local climatic conditions, due to the absolute height and the local topography, climatic divided into subzones. The Northern zone is characterized by moderately warm and moderately humid climate, Central - warm humid and Southern - hot dry. Thermal resources in the Moldova provide a wide range of growing crops, which greatly expanded the movement from north to south. Monthly average soil temperature at the depth of the plow layer is positive or close to 0^0 on the entire territory of Moldova, but in the absence of snow cover or a small thickness, the soil may freeze to a depth of 1 m.

Amount of annual precipitation varies from 500-600 mm in the north and 450-500 mm in the south. Value coefficient of moisture (K - the ratio between the annual rainfall and evaporation from the water surface in the same period), is respectively 0.7-1.0 and 0.5-0.6. In winter falls 18% of the annual amount of precipitation, and in the warm period - 70%. Although the maximum precipitation occurs during the warm season, summer in Moldova is dry. Dry season begins in July and lasts 2-3 months. There are frequent dry winds.

Agriculture of the Moldova must be adapted to arid conditions, which are the negative aspect of climate. The frequency of manifestations of drought in 10 years is: once in the northern, 2-3 times in central and 3-4 times in the southern zone. Drought leads to intensification of desertification processes and reduce their productive capacity.

According to the UN Convention to Combat Desertification standards the territories with a value of $K<0.65$ are prone to desertification. Central and Southern areas of Moldova is characterized by values of this ratio less than 0.65 which indicates the possibility of desertification processes evolution to those territories. Agriculture must also take account of this information.

To estimate the soil erosion hazard assessment are important the data on rainfall character. During the summer, fall long rains of low intensity, which are well moistened the soil and do not cause significant erosion, however, is dominated heavy rains of high intensity (erosion rains). The latter are usually accompanied by hailstorm. Torrential rains condition unnecessary water spills on the slopes, causing soil erosion and surface depth. Large droplets of heavy rains, with considerable speed, shred with their power dynamics the soil structural aggregates, weakening resistance to erosion.

Annual average values of natural flow are not large, from 0.5 l/m^2 in the South-East to 1.5 l/m^2 in the North and Codri zones. Presents a greater interest average leakage rain indicator. On most territory it has a value of about 4.5 mm/10min and reaches 6 mm/10 min and more in the southwest. In general, it can be considered as characteristic typical values within the range 5-6 mm/10 min.

Republic of Moldova, as well as the Carpathians, parts of the Mediterranean Europe and the Balkans refers to the region with extremely heavy temporary rainfall. Within 24 hours, may fall more than 100 mm. These precipitations are particularly dangerous with erosion standpoint. To minimize the effect of erosion is necessary, first, strict adherence to the whole complex of soil conservation measures, and secondly, the construction in high-risk areas (short tributaries of the Prut River), capital waterworks.

To assess the risk of land erosion needed rainfall data that fell within one rain and their intensity. The maximum average value of rain intensity, duration less than one hour is placed within 0.5-2.4 mm/in. Rains with precipitation in 8, 19, 23, 28, 37, 45 mm, respectively, fell for 9, 10, 15, 14, 18 and 58 min cause severe soil erosion. On slopes of up to 5^o the soil loss in row crop cultivation varies from 12-65 t/ha, and on slopes above 5^o can reach 212 t/ha. Under similar conditions, the increase of precipitation amount of 30 to 60 mm (for 15 and 30 min, respectively) leads to an increase in wastewater from 4 to 15 mm or 3.6 times, while further doubling precipitation - only 3.1 times. In the case where the amount of precipitation increases 4 times (from 30 mm to 120 mm) effluents increases from 4 to 45 mm or 11 times.

Also important are the data on the risk of loss periods of heavy rainfall. In Moldova the most dangerous period is the May month, quite dangerous is June, July, August, less dangerous is April and September. In February and early March the torrential rains occurs rarely. In years with a thick snow cover in the case of rapid snowmelt in the spring, locally, once in every 5 years, can manifest process of erosion.

Finally it should be mentioned that the general nature of the arid climate, the frequent repetition of droughts, event planning territory predisposition to desertification processes requires a total adoption of agriculture to drought conditions. The fragmental relief and character of torrential rainfall are causing manifestation of intensive soil erosion.

4. Vegetation cover and soil erosion. The role of vegetation in erosion control multifaceted: more or less important in different cases, it is still always positive. Vegetation cover reduces erosion manifestation or prevents it entirely through the surface (soil cover) and the root part. Superficial part protects the soil from direct destruction of raindrops and an obstacle to formed water rain flow. Root mass connects soil particles, increases aggregates resistance to breakage - washing - slip. Vegetation not only reduces rainfall flow and soil denudation, but also contributes to retaining solid spill originating on either slope located above.

Cultivation of annual and perennial grasses on the slopes is an effective measure to protect the soil from erosion. Along with other measures grasses, forming a dense surface cover and an extensive root system, reduce soil runoff from the slopes to the permissible norms of 5 t/ha. For example, the root mass of alfalfa and sainfoin at age of three reaches in the soil layer 0-40 cm about 100 q/ha, in the upper soil layer (0-10 cm) concentrated about 40-50% of the root mass. The role of perennial grasses in soil protection is determined mainly by the degree of ground cover. In case of intensive rainfall on land sown by herbs there is a slight runoff precipitation with very low water turbidity.

Crops on their soil protection abilities are divided into four groups (Complex Program I, 2004):

1. *Culture with very high soil-protective ability* - perennial cereals and legumes after the first year of use, provide protection for 90-95% of the soil area.
2. *Cultures with high soil-protective ability* - cereals, perennial legumes and cereals after the first year of use, the annual fodder plants with high stand density per unit area, protects 70-90% of the soil area.
3. *Culture with moderate soil-protective ability* - annual legumes, provide protection for 50-70% of the soil area.
4. *Cultures with low soil-protective ability* - row crops of low planting density (corn, sunflower, sugar beet, vegetables) provide protection for 20-50% of the soil area.

Cropping erosion are determined based on the slope characteristics, soil erosion resistance, which depends on their characteristics, reduction degree of leakages of soil by crops.

Erosion resistance depends on the absorption parameters and soil water retention. It was established that the culture with a dense cover reduces the intensity of erosion, the weeding crops contribute to its manifestation.

Under field crops compared with the bare fallow the soil erosion resistance increases as follows: in the weeding crops - 1.5 times, spring grasses - 3.2, autumn grasses - 5 times.

For removal 1 t/ha of cropland soil with winter crops it is need 58.4 m^3/ha of water leakage, spring vegetables - 37.5, weeding crops - 17.8 and clean fallow - 11.6 m^3/ha. Depending on the intensity field crop species absorbing and retaining water runoff and soil denudation is changed considerably. Depending on the field crop species the intensity of the absorption and water retention, runoff and soil denudation is changed considerably.

The field research and the calculations show that the coverage degree of agricultural land by plants increases as their growth and development and achieve the highest index in July and then in August, in September is reduced by 2.2-2.6 times. This indicates that the soil erosion protection should be intensive in the first phase of plant development and less intensive in the later stages.

Proportions of soil denudation during the crop vegetation changes depending on the species, density and development phase of plant.

Soil denudation character while under the compact crops is almost the same - the highest intensity of denudation occurs in May. In June there is an obvious decline - soil denudation is 2-13 times lower compared to its initial value and increases again in July, but not as sharply.

Thus, special attention to the protection of soil from erosion on dense cultures must be exerted in the autumn after sowing, before germination and early spring - before the resumption of vegetation. Under the spring bean crops the protective measures must be made immediately after planting and as the weeding, from May until July. The intensity of soil denudation in weeding crops can be 3-4 times higher than in cultures with compact vegetative cover. With increasing the share of weeding crops in crop rotation decreases sharply the degree of coverage and soil protection. Whether the share weeding crops in crop rotation increases from 20 to 60%, the protection level of soil erosion is reduced by 12-15%, and the need to increase erosion measures increase by 23-25%.

Therefore, in conditions of agriculture on the slopes one should apply special anti-erosion crop rotation, and the structure is dominated by dense and perennial grasses (Complex Program II, 2004).

A special role in protecting the soil against erosion plays landscapes with natural vegetation. In order to maintain the ecological balance between natural and agricultural ecosystems and reducing the erosion risk of territories are required considerable reconstruction and major expansion of landscapes with natural vegetation by increasing the territory of forests, pastures, hayfields, wetlands, etc.

CONCLUSIONS

Natural conditions causing the hazard manifestation and evolution of the processes of soil degradation and land desertification are: geological conformations, solification rocks, topography, climatic conditions, vegetative cover. These conditions with anthropogenic determine the intensity and direction of soil formation, the nature and extent of soil degradation. Based on this research were developed soil protection measures that are implemented on degraded and eroded areas.

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EVALUATION OF NUTRIENTS AVAILABILITY BY APPLYING FERTILIZER AT DIFFERENT DOSES IN SOIL COLUMN

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Abstract

The issue of exchange processes, retention and leaching of ions in soil is far from being completely elucidated, most of the researches being conducted on pure materials and the organic-mineral complexes from soil differs significantly from those. In addition, details of soil nutrients availability rate are unknown, requiring fundamental research studies for each type of soil. In order to study the retention and migration processes it was developed an experiment on epicalcaric chernozem soil from Scânteia, Ialomiţa County for a number of cations and anions involved in plant nutrition. The retention and migration in soil of ammonium, nitrate, phosphate and potassium nutrient ions have been experimentally investigated by providing an experimental device that consisted in a series of glass columns filled with 100 g of soil air dried. A solution containing investigated ions, in different doses, was applied in soil by percolation. The soil columns experimental method allows us to determine the equations that describe the availability of nitrogen forms (ammonium and nitrate), phosphorus and potassium based on applied dose of fertilizer. The relation between the content in soil of mineral nitrogen (N-NH_4^+ and N-NO_3^-), potentially available phosphorus and potassium and applied dose of N, P and K indicate a highly significant correlation. Nutrient retention and leaching simulation processes by applying different doses of chemical fertilizers in soil allowed us to establish the available and accessible quantities, and to obtain the optimal levels of fertilizer required by crops.

Key words: *fertilizer doses, nutrients availability, retention, soil column.*

INTRODUCTION

Researches concerning retention and migration processes of nutritive species in different experimental conditions are scarce in literature (Heckrath et al., 1995; Madjar et al., 2004), so this concern is far of being solved and may be subject of many fundamental research studies developed for each type of soil. Column sorption experiments confirmed the pH influence in the amounts of metals mobilised (Anderson et al., 2000). Understanding of these processes may have an important influence on soil fertility management and provide useful information regarding agricultural practices that could improve this feature. Leaching can play an important role in agricultural nutrients losses when fertilizers are applied to the soil. Estimation of nitrogen, phosphorus and potassium leaching from soil is necessary in sustainable agriculture (Jalali et al., 2008). A series of leaching column experiments were set-up to investigate the effects of increasing and decreasing the sulphate of an acidified podzolic soil (Hodson et al., 1999).

Moreover, it is outstanding to identify the specific equations which describe the retention and migration of interest nutritive ions in order to obtain proper rates of fertilizers that are required by crops. This is useful for economical use of fertilizers but also to prevent environmental pollution caused by their use.

In the case of pollutant species, knowledge of migration and retention processes are fundamental for comprehension of movement in contaminated soils for a preventive environment control. Therefore, these processes regarding heavy metals (Selim et al., 1992; Zhang et al., 2006; Zhao et al., 2009; Ramachandran et al., 2013; Selim et al., 2013) and organic pollutants (Acher et al., 1989; Jackson et al., 1990; Conte et al., 2001) are intensively studied through experiments that are carried out in soil columns. The potential risk of heavy metal in soil depends on their mobility and of the release of metal cations to the water phase (Xu et al., 2005)

Considering the scientific evidence that fertility is a soil feature that must be maintained through proper agricultural practices including judicious use of fertilizers, we developed an experiment with the aim to investigate the retention and migration processes on epicalcaric chernozem soil from Scânteia, Ialomiţa County for some nutritive species (NH_4^+, NO_3^-, PO_4^{3-} and K^+) involved in plant nutrition. In order to evaluate the species mobility, the soils should be representative of agricultural area (OPPTS 835.1240, 2008). The main objective of the research is to determine the specific equations which describe the retention and migration of studied ions in soil column experiment by applying graduated concentrations of the nutrients.

MATERIALS AND METHODS

Studied area

The investigated soil in retention and migration process research was epicalcaric chernozem from Scanteia, Ialomita County.

Scanteia village is situated in the north-east part of Ialomita County at the edge with Braila County. The position of Scanteia on Romania map is presented in Figure 1. The main activity of inhabitants is agriculture.

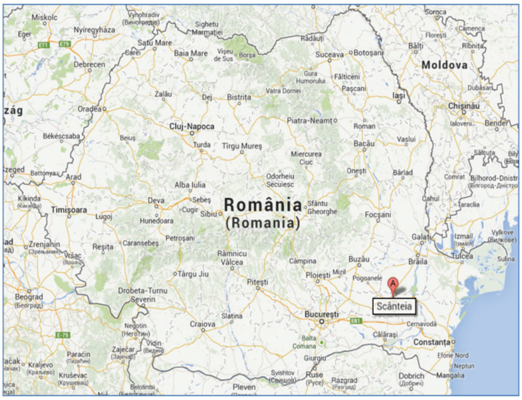

Figure 1. The position of Scanteia on Romania map

Agrochemical characteristics of the soil indicate at the start of the experiments a pH value of 7.48, a very slightly alkaline soil reaction. The total soluble salts content of 0.11488% indicates a low saline soil (situated in interval of 0.100 to 0.250%).

Mineral nitrogen content of the soil is the sum given by the ammoniacal and nitric nitrogen accessible forms. The result (12.75 ppm N) indicates normal mineral nitrogen supply (9.1 - 14 ppm N) for analyzed soil sample.

Mobile phosphorus soil content extractable in ammonium acetate lactate (P_{AL}) is 73.2 ppm and this value indicates a very high level (P_{AL} > 72 ppm), meanwhile soluble phosphorus content of 2.3 ppm P-PO_4^{3-} is low ($P_{soluble}$ <7 ppm), its availability being conditioned by soil pH.

Soil potentially available potassium content of 240 ppm K_{AL} is high (201-265 ppmK_{AL}), and the soluble potassium content of 20 ppm $K_{soluble}$ is low ($K_{soluble}$ <40 ppm).

Humus content of 3.09% indicates a medium supply soil level (2.1 to 4.0% humus).

Experimental device

The experiments are performed to determine the leaching potential of the test nutritive species in soils under controlled laboratory conditions (OECD, 2004).

Soil processes of retention, migration, and retrogradation were experimental investigated for the ions with nutritive role: N-NH_4^+, N-NO_3^-, P- PO_4^{3-} and K^+.

The experiments were conducted in an experimental device that consisted in a series of glass columns with a diameter of 3.5 cm. In each column was introduced 100 g of soil air dried, the soil column height being of 20 cm. In each column, the soil was brought to saturation humidity with 50 ml of distilled water so that the moisture of the soil to be uniform. A solution containing investigated ions, in different doses, was applied in soil by percolation, in three repetitions for each graduated concentrations. The ratio between the soil and the leaching solution was of 1/5 (w/v), and the percolation solution volume was of 500 ml. The solution flow rate was adjusted to have a constant liquid column height at 10 cm.

The solutions used in the experiment were prepared starting from the following chemical fertilizers: ammonium nitrate (35% N), superphosphate (18% P_2O_5), and potassium chloride (63.08% K_2O). The concentrations of the percolating solutions correspond to the doses of nitrogen, phosphorus and potassium applied to the soil in kg N, P_2O_5, K_2O/ha (Table 1).

Chemical analyses and analytical methods

After percolation, the soil from columns was air-dried, milled and sieved with 2 mm mesh size. The following soil analyses were performed:

- *soil pH* in aqueous suspension (1/2.5) by potentiometric method;
- *the total soluble salts content* in aqueous extract (1/5) by conductivity method;
- *soluble forms of* $N\text{-}NH_4^+$, $N\text{-}NO_3^-$, PO_4^{3-}, K^+ in aqueous extract (1/5);
- *potentially available or mobile forms of* P_{AL} *and* K_{AL} in ammonium acetate lactate (1/20).

The levels of phosphate nitrate and ammonium species were assessed by spectrophotometric means. Phosphate was quantified as molybdenum blue, meanwhile for nitrate was used phenoldisulphonic acid in basic medium and for ammonium determination was used Nessler reagent. The potassium content was quantified by flame photometry.

Experimental scheme

The following experimental schemes were performed based on the nutrients ions, applied fertilizers and doses:

Table 1. The amounts of N, P and K applied by leaching in chernozem epicalcaric soil from Scânteia, Ialomiţa County

Nitrogen experimental scheme			**Phosphorus experimental scheme**			**Potassium experimental scheme**		
Column no.	**Experimental variant**	**kg N/ha**	**Column no.**	**Experimental variant**	**kg P_2O_5/ha**	**Column no.**	**Experimental variant**	**kg K_2O/ha**
$1_{(R11R12R13)}$	V1 (N_0)	0	$1_{(R11R12R13)}$	V1 (P_0)	0	$1_{(R11R12R13)}$	V1 (K_0)	0
$2_{(R21R22R23)}$	V2 (N_{50})	50	$2_{(R21R22R23)}$	V2 (P_{50})	50	$2_{(R21R22R23)}$	V2 (K_{50})	50
$3_{(R31R32R33)}$	V3 (N_{100})	100	$3_{(R31R32R33)}$	V3 (P_{100})	100	$3_{(R31R32R33)}$	V3 (K_{100})	100
$4_{(R41R42R43)}$	V4 (N_{150})	150	$4_{(R41R42R43)}$	V4 (P_{150})	150	$4_{(R41R42R43)}$	V4 (K_{150})	150
$5_{(R515R52R53)}$	V5 (N_{200})	200	$5_{(R515R52R53)}$	V5 (P_{200})	200	$5_{(R515R52R53)}$	V5 (K_{200})	200
$6_{(R61R62R63)}$	V6 (N_{300})	300						

RESULTS AND DISCUSSIONS

Availability and leaching of nitrogen in the chernozem epicalcaric soil from Scanteia

The application of nitrogen in increasing doses determined a different content of mineral nitrogen in soil. In the control variant V1 (N0), without applied fertilizer, the mineral nitrogen content, which represent the sum of $N\text{-}NH_4^+$ and $N\text{-}NO_3$, indicates a value of 8.5 ppm, a moderate nitrogen supply (6-9 ppm N) (Madjar, 2008).

The results obtained in variants V2 (N50), V3 (N100) and V4 (N150) reveal a normal mineral nitrogen supply in soil (9.1 - 14 ppm N). Applying a dose of 200 kgN/ha lead to 15.75 ppm nitrogen available in soil, indicating a high nitrogen supply class (14.1-18 ppm N), and for 300 kgN/ha applied was obtained 22.25 ppm, a very high nitrogen supply (> 18 ppm N) (Figure 2).

The experiment allows determining the equations of ammoniacal, nitric and mineral nitrogen availability depending on the fertilizer applied doses.

The equation that describes the amount of soil available ammonium nitrogen in ppm (mg N/kg soil) depending on the applied quantities, called dose (**D**), in kg N / ha, is:

$$N\text{-}NH_4^+,\ ppm = 0.0001D^2 + 0.0029D + 6.4462$$

The relation between the content of ammoniacal nitrogen in the soil and the applied dose as ammonium nitrate shows a highly significant correlation (R = 0.9261 ***).

Similar, was calculated the regression equation between nitric nitrogen, in ppm (mg N/kg soil), and applied fertilizer dose (**D**), in kg N / ha:

$$N\text{-}NO_3^-,ppm = -1E\text{-}05D^2 + 0.023D + 2.080$$

The correlation coefficient is very significant ($R= 0.9375^{***}$).

The sum of ammoniacal and nitric nitrogen gives the amount of soil available mineral nitrogen and the equation that describes the nitrogen content in ppm (mg N/kg soil) depending on the applied quantities as dose (**D**) in kg N / ha is:

$$N_{mineral}, ppm = 0.0001D^2 + 0.0263D + 8.5266$$

The relation between soil mineral nitrogen content and the applied dose indicates a highly significant correlation ($R = 0.9731^{***}$) (Figure 3).

The experiment allows determining the equations of ammoniacal, nitric and mineral nitrogen availability depending on the fertilizer applied doses.

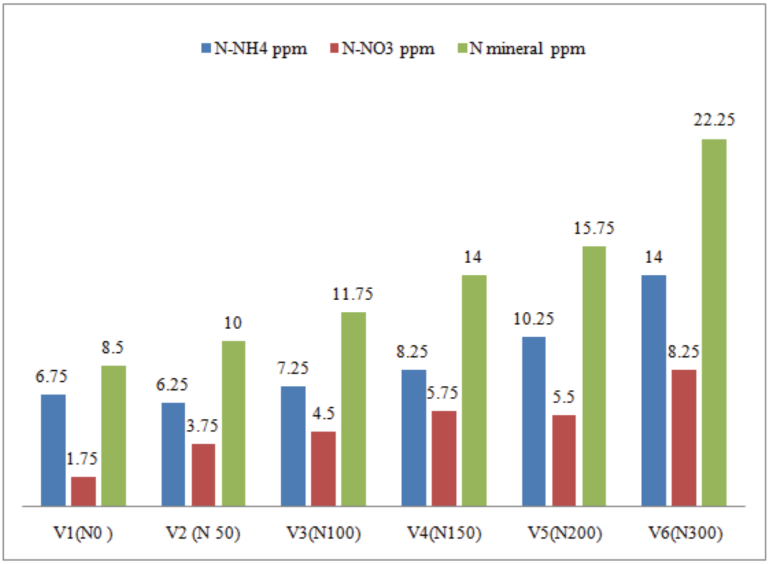

Figure 2. The content of ammoniacal, nitric and mineral nitrogen in soil

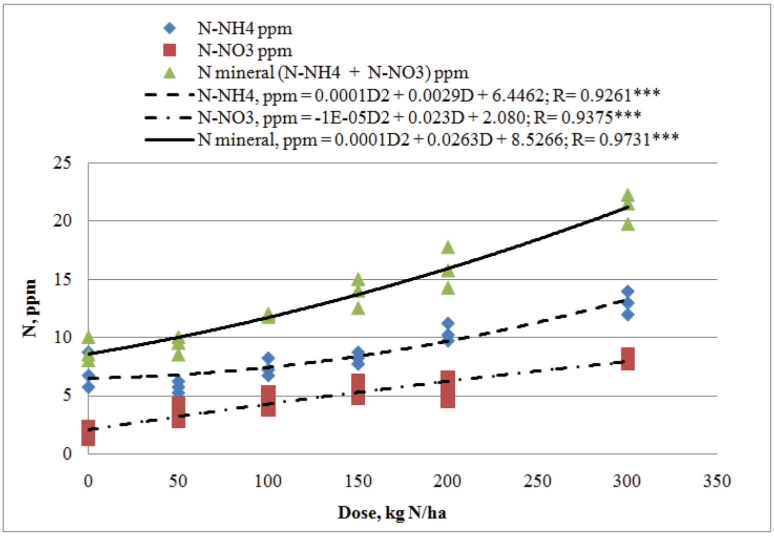

Figure 3. Dose influence on soil nitrogen availability

The equation that describes the amount of soil available ammonium nitrogen in ppm (mg N/kg soil) depending on the applied quantities, called dose (**D**), in kg N / ha, is:

$$N\text{-}NH_4^+, \text{ppm} = 0.0001D^2 + 0.0029D + 6.4462$$

The relation between the content of ammoniacal nitrogen in the soil and the applied dose as ammonium nitrate shows a highly significant correlation (R = 0.9261 ***).

Availability, leaching and retrogradation of phosphorus in the chernozem epicalcaric soil from Scânteia

The soil reactions that lead to the phosphorus retrogradation process are influenced by pH values > 7.3 when results calcium compounds with low solubility but also by pH values < 5.5 that favour obtaining of iron and aluminium poorly soluble compounds. Maintaining soil pH between 6 and 7 determine the highest availability of phosphorus in the soil. Study regarding the intensity of phosphorus retrogradation and leaching processes on the basis of the soil column method also need a further investigation on more soils with a wide range of physical and chemical properties (Li et al., 2013).

At the control variant V1, without applied phosphorus fertilizer the obtained value of 65.2 ppm P indicates a high level of mobile P supply. Experimental variants of V_2 (P50), V3 (P100), V4 (P150) and V5 (P200) indicates a very high level of potentially available phosphorus with values >71 ppm (Madjar, 2008) (Figure 4).

The equation that describes the influence of fertilizer doses on potentially available phosphorus content in soil is:

$$P_{AL}, \text{ppm} = -0.0007D^2 + 1.0206D + 68.2057$$

The relation between the content of phosphorus in soil and applied dose as superphosphate with 18% P_2O_5 indicate a very significant correlation *** R = 0.9957 (Figure 5).

Retention and leaching of potassium in the chernozem epicalcaric soil from Scanteia

Part of the potassium quantities from percolated solution was retained by various processes, mainly through cation exchange, or fixed between clay minerals, some remained in the soil solution, and the rest passed in percolate.

By applying increasing doses of potassium was obtained different potassium content in the soil. The obtained results indicate in all fertilized variants a very high supplied of potentially available potassium (K_{AL} > 266 ppm), and in the case of soluble potassium the soil analysis reveals low soluble potassium ($K_{soluble}$< 40 ppm) (Madjar, 2008) (Figure 6).

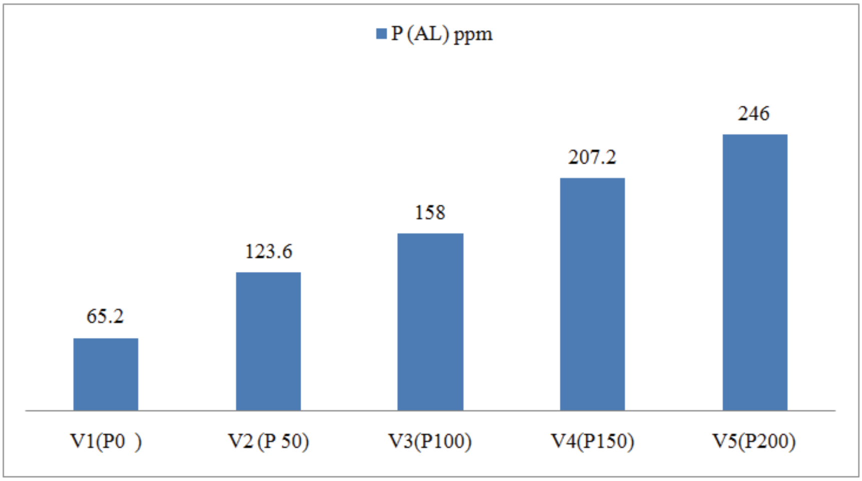

Figure 4. The content of potentially available phosphorus in soil

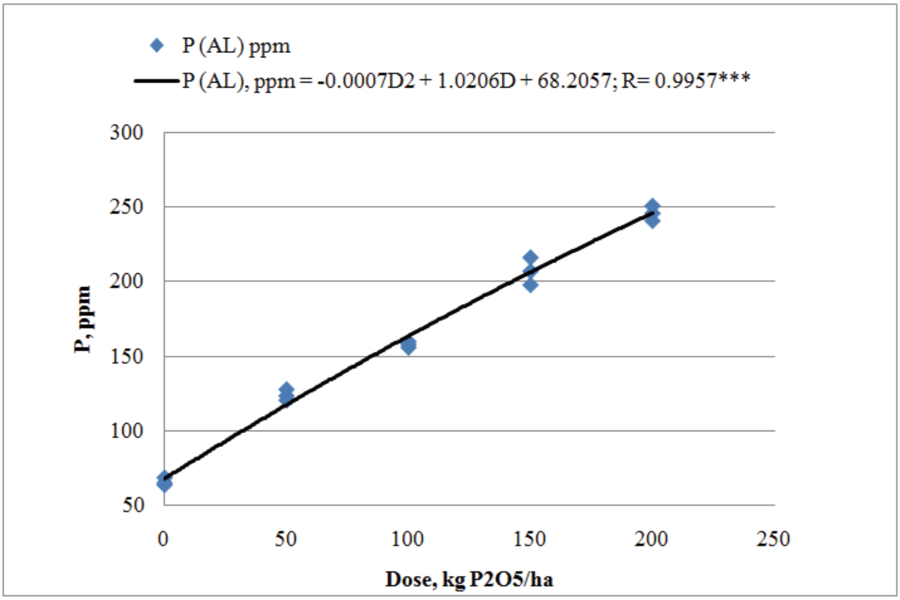

Figure 5. Dose influence on soil potentialy available phosphorus

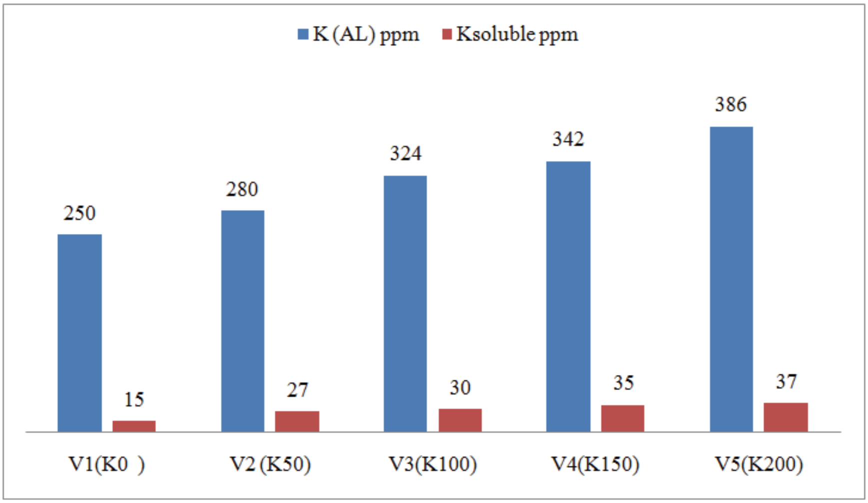

Figure 6. The content of potentially available potassium in soil

The regression equations that determine the potassium availability in soil as mobile and soluble forms depending on applied fertilizer doses are the results of the potassium cation exchange in retention simulation process achieved by soil columns experiment.

The mathematical relations between available potassium quantities and applied fertilizer dose (**D**) are:

$$K_{AL}\text{, ppm} = 0.0001D^2 + 0.6566D + 249.8857$$
$$K_{soluble}\text{, ppm} = -0.0005D^2 + 0.2069D + 15.8286$$

A highly significant correlation R = 0.9860 ***, respectively R=0.9477*** was calculated between mobile and soluble potassium content in soil and applied dose as KCl indicates (Figure 7).

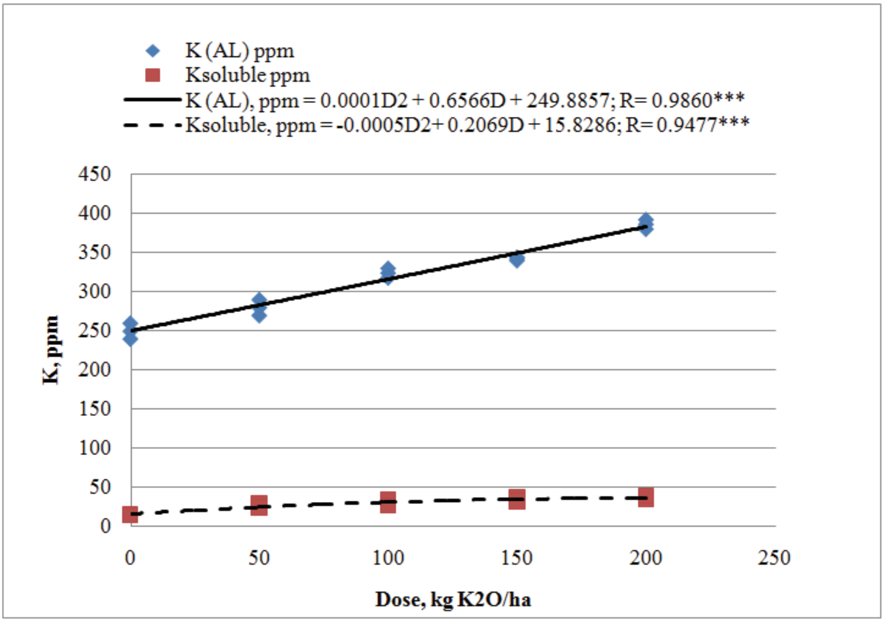

Figure 7. Dose influence on soil potentialy available potassium

CONCLUSIONS

Simulation processes of nutrient retention and leaching by applying fertilizer at different doses on soil chernozem epicalcaric from Scânteia, Ialomiţa County allowed us to determine the plant available quantities, to obtain optimal fertilizing levels to achieve a soil nutrients supply required by the crops.

For unilateral application of nitrogen as ammonium nitrate, phosphorus as superphosphate and potassium as potassium chloride revealed the following:

1. Soil fertilization with doses of nitrogen between 50 kg N/ha and 150 kg N/ha determined a mineral N ($N\text{-}NH_4^+ + N\text{-}NO_3^-$) content that ensures normal soil nitrogen supply. A high supply of mineral N is supported by a dose of 200 kg N/ha (V5).
2. Research regarding the nitrogen availability and leaching processes at the increasing doses of nitrogen as ammonium nitrate allows us to calculate the regression equations that describe the influence of applied fertilizer dose on soil nitrogen content.
3. Soil column experiment with superphosphate applied achieves a very high potentially available phosphorus supply of 123.6 ppm P_{AL} at minimum dose of variant V2 (P50). Higher doses than 50 kg P_2O_5/ha are not justified, soil being assured in mobile phosphorus reserves by applying the referred dose. Due to the slightly basic pH the soluble phosphorus form not pass in soil solution, even if the soil is very high supplied in potentially available phosphorus.
4. Potassium fertilizer doses between 50 and 200 kg K_2O/ha lead to low supply in soluble potassium ($K_{soluble}$ <40 ppm) and very high content in potentially available potassium (K_{AL} > 266 ppm).

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EVALUATION OF CHERNOZEMS FROM BALTA ALBA AREA, BUZAU COUNTY

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Abstract

The research were carried to detemined influence of cultivation technologies upon physico-chemical properties of chernozems from Balta Albă, Buzău. Soil samples were collected from six plots were determined humus content, nitrogen, phosphorus and potassium supply, bulk density, total porosity and soil penetration resistance. Were recorded significant decreases of soil reaction and the phosphorus content of soil and increase the soil compactness of the area studied.

***Key words**: chernozem, evaluation, physico-chemical properties.*

INTRODUCTION

Chernozems occupies in Romania an area around 4.2 million hectares and are considered the most productive soils, however a series of restrictive factors that may give lower yields such as: moisture deficit, soluble salts, Na high content, moisture excess derived from the ground water, low nutrients content etc.

Wide distribution area have led to the formation of several subtypes of chernozems according to Romanian System of Soil Taxonomy 2012, such as: calcic, forest, leptic, haplic, greyic, luvic, vertic, fluvic, gleyic, hyposalic, hyposodic, skeletic (Florea et al., 2012). In the last years as a result of agricultural technologies some properties of soil have been affected in a negative way - humus content, soil reaction, compaction, the degradation of structure.

Researches showed a degradation of the main physical properties under the influence of applied technology (Dumitru et al., 1999). Also, inadequate use of chemical fertilizers led to decreased reaction in the horizon from soil surface (Gata et al., 2004, 2005; Mihalache et al., 2012).

MATERIALS AND METHODS

The research were carried in 2013 to determine the influence of cultivation technologies on physico-chemical properties of chernozem from Buzau area. For this aim were collected soil samples from six plots at 0-20 cm depth, in the disturbed and undisturbed state (with metal cylinders, 100 cm^3 volume). Were made the following determinations: texture by wet sieving method, bulk density, total porosity and compaction degree.

To characterize the soil from studied area, also were collected soil samples for chemical analysis: organic carbon content, total nitrogen, C/N, phosphorus and potassium mobile content, soil reaction, electrical conductivity and nitrogen index.

Organic carbon was determined using Walkley-Black-Gogoasa method, mobile phosphorus content was evaluated by spectrophotometric molybdenum blue method, using ammonium acetate-lactate (AL) as extractive solution, at pH 3.7 (Egner-Riehm-Domingo method). The mobile form of potassium was quantified in the same extract (AL) by flame photometry technique.

Total form of nitrogen was determined using Kjeldahl method, meanwhile total phosphorus was assessed spectrophotometrically (as molybdenum blue) and potassium using flame photometry method. Nitrogen index was determined by calculation.

The reaction of soil and sewage sludge (pH) was carried out through potentiometric method, in an aqueous suspension, 1:2.5 (w/v).

RESULTS AND DISCUSSIONS

The research were carried in the Balta Albă area, located in the eastern part of the Buzau county.
The main type of soil in this area is chernozem, with a surface over 80% of the arable land (Figure 1).

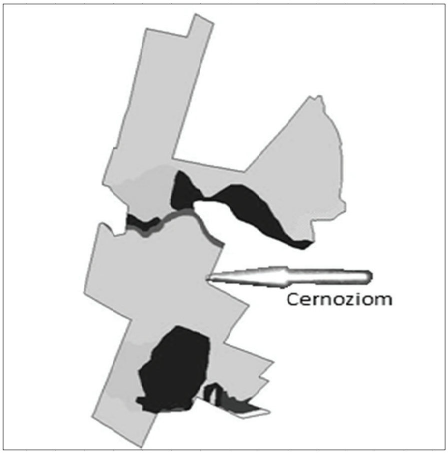

Figure 1. Chernozems distribution on the studied area

Generally, the investigated chernozems have very favorable characteristics for plant growth. The texture is loamy, with a clay contain bellow than 20% in the upper part of soil, has a good air and water permeability (Figure 2).

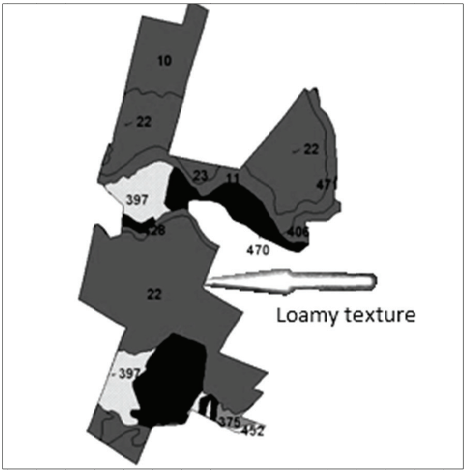

Figure 2. Texture of the investigated chernozem

The main physical properties of chernozems are presented in the Table 1.

Table 1. The main physical soil properties

Plots	Bulk density (g/cm^3)	Total porosity (%)	Compaction degree (%)	Penetration resistance (Mpa)
1	1.35	51.12	-4.51	1.29
2	1.32	50.79	-3.68	1.24
3	1.30	49.85	-1.92	1.12
4	1.42	44.12	9.72	1.65
5	1.45	46.23	5.47	1.50
6	1.37	52.11	-6.54	1.23

Soil bulk density values, to 0-20 cm depth, ranges from 1.30 g/cm^3 on plot no. 3 (low) to 1.45 g/cm^3 on plot no. 5 (medium). The soil compaction degree shows that the soil is very low on plots 1, 2, 3, 6 and low compacted on plots 4 and 5 (Hakansson, 1992).
Soil penetration resistance is ranges from low to medium, higher values are recorded in plot no. 4 (1.65 MPa) and 5 (1.50 MPa). At points where the soil is low compacted required deeper work to increase soil air porosity.
The chernozem has a surface horizon rich in humus, but the organic matter content depending on the agricultural technologies applied, it varies very widely. Humus content of the analyzed samples is average, with values between 3.12 to 3.78% and the soil humus content of plot no. 6 is medium with values of 2.94% (Figure 3).

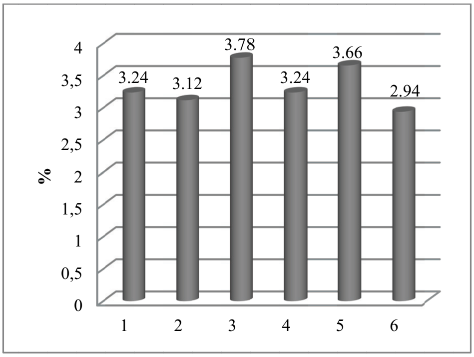

Figure 3. The humus content

Total nitrogen supply status is average, with values between 0.15-0.17%, and the plot no. 6 soil nitrogen supply is poor with the nitrogen content of 0.143% (Figure 4).
A large variation was recorded for soil phosphorus content, from 10 mg/kg to 81 mg/kg. Plots 4, 5 and 6 are very poorly supplied with phosphorus reflecting lately that have not applied phosphorus fertilizer.

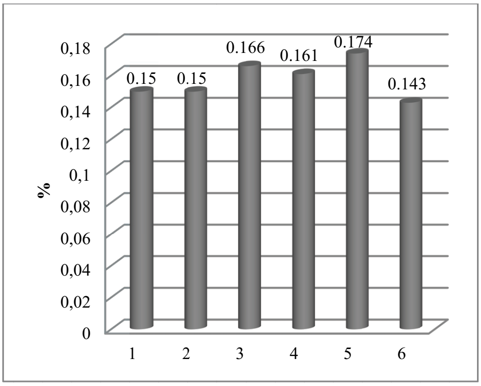

Figure 4. The total nitrogen soil content

The content of phosphorus is very good (81 mg/kg) for plot no. 1 (Figure 5).

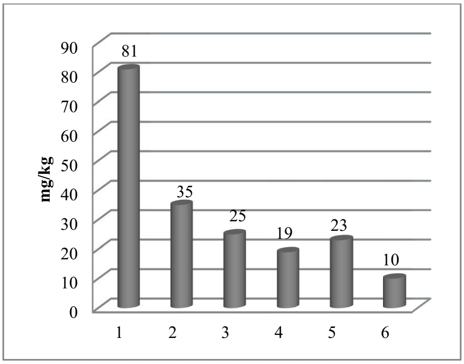

Figure 5. The phosphorus soil content

The soil potassium content is very good to plots 1 and 5 (262-264 mg/kg), and good to the other analyzed samples (177-206 mg/kg) (Figure 6).

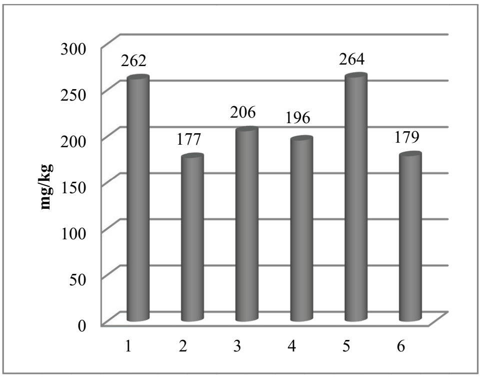

Figure 6. The potassium soil content

Although in the last period have not applied potassium fertilizer on the chernozems from the studied area, are well supplied with the potassium.

Significant changes of soil reaction as a consequence of used nitrogen fertilizers with physiologically acid reaction were recorded on plots 2, 3, 5 and 6 (Figure 7).

On these plots should apply lime amendments and avoid further fertilization with ammonium nitrate.

In case of plots 1 and 4, the soil reaction is slightly alkaline (pH = 7.32-7.64).

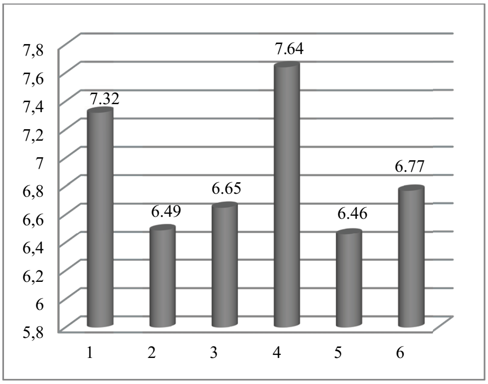

Figure 7. The soil reaction

Analysis of soluble salts show that there are not high concentration, the all soil samples has a low electrical conductivity, with values ranging from 89.8 to 136.5 µS/cm (Figure 8).

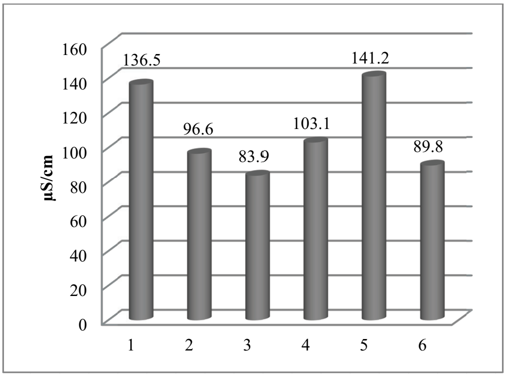

Figure 8. The soil electrical conductivity

CONCLUSIONS

The chernozems from investigated area is well supplied with humus, low supplied with phosphorus and nitrogen and the potassium content is average.

Agricultural technologies applied on the chernozems from Balta Albă area determined a decrease of soil reaction in most studied plots.

In case of plots with slightly acid reaction is necessary to apply lime amendments.

A significant increase of soil compaction degree, low total porosity of soil influence the air and water permeability.

The chernozems from studied area are classified on second class of quality, with 79 points of evaluation.

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THE EFFECT OF CROPS AND FARMING SYSTEMS ON SOIL QUALITY

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Abstract

Soil biological quality can affect key soil functions that support food production and environmental quality. The objective of this study was to determine the effects of crops and climatic conditions on soil biological quality in two contrasting agricultural cropping systems from South estern part of Romania. The experiment was bifactorial of type 2 x 4 in 3 repetitions, with A factor (farming system: a_1 – organic farming; a_2 – conventional farming system) and B (crops: b_1 - soybean, b_2 - winter wheat, b_3 - maize, b_4 - sunflower). Soil biological properties (respiration and biodegradation of celulose) were assessed at depths of 0-20 cm in 2012 during vegetation period of studied crops. Also, the chemical reaction of soil was tested. Compared to conventional system, organic farming system had greater chemical reaction of soil, high respiration and catalase activity of soil under 2012 year conditions.

Key words: *organic and conventional agriculture system, soil reaction, cellulase activity of soil, soil respiration.*

INTRODUCTION

Management practices to sustain crop yields are necessary to conserve or enhance soil quality. Thus, a difference in management practices often results differences in biological, chemical and physical soils properties which in turn results changes in functional quality of the soil (Islam and Weil, 2000).

Soil quality is the capacity of soil to maintain some key ecological functions, such as decomposition and formation of soil organic matter. Microbial processes are important for the management of farming system and improvement of soil quality. Microbial respiration of soil has received considerable attention because it can be used as a soil quality indicator and it is one important variable to quantify soil microbial activity, organic matter content and its decomposition (Araujo et al., 2008). Generally, higher values of soil respiration indicate a better quality of soil (Stefanic, 1994; Stefanic, 2006).

Cellulose is the main component of plant tissues (30-60%) and will be the most important compound with carbon in soil and water. In nature, microbial decomposition of the cellulose is greatly influenced by environmental factors such as oxidation-reduction potential, pH and assimilable nitrogen content of the soil are the most important.

In our country studies on soil microbial activity especially in organic farming system are relatively few. For those intended objective was to highlight the effect of crop and climatic conditions on soil quality in organic and conventional farming system.

MATERIALS AND METHODS

Samples from the plow horizon (0-10 cm) of a chernozem soil from National Agricultural Research and Development Institute from Fundulea Romania were used in this experiment. The experience was bifactorial of type 2 x 4 in 3 repetitions, with A factor (farming system: a_1 – organic farming; a_2 – conventional farming system) and B (crops: b_1 - soybean, b_2 - winter wheat, b_3 - maize, b_4 - sunflower). This experience was founded in 2004, under dryland condition, on cambic chernozem, well drained, formed on loess, with 33.8% clay content and 2.8% organic matter in arable layer. The soil samples were taken in summer of 2012 and 2013 (July).

Experimental factors were: *A factor (farming system: a_1 – organic farming; a_2 – conventional* *farming system) and B factor (crops: b_1 - soybean, b_2 - winter wheat, b_3 - maize, b_4 - sunflower).*

In the organic farming system has been practiced an 8-year rotation (wheat/soybean, corn, sunflower - alfalfa (4 years, cover crop) and work done were stubble, disking (18 cm), worked with combiner, sowing and for weeding crops two mechanical and two hand hoeing. In the conventional farming system we performed a 4-year rotation (wheat-soybean-corn-sunflower) and were conducted in addition works fertilizers and chemical treatments so: the wheat was fertilized during autumn with 80 kg to N / ha and Icedin to herbicides, soybean, corn and sunflower was fertilized with 100 kg / ha NPK complex fertilizers (15:15:15) have been treated the weed vegetation, one manual and two mechanical hoeing.

The fresh soil samples were sieved by a sieve of 2 mm, all visible plant remains were removed and then were tested for respiration, cellulose biodegradation potential (Stefanic methods 1994, 2006) and soil chemical reaction (Elena Stoica method, 1986). Cellulolytic activity is expressed in % cellulose degraded and respiration in mg CO_2 from 100 g dw soil

The results were statistically interpreted by multiple test (Snedecor) and by correlations. For an easer interpretation of the experimental data, the bifactorial tables were utilized. The data were grouped and significantly separated by letters; letter "a" for the higher values and for those inferior, the letter "b", 'c", etc.

RESULTS AND DISCUSSIONS

1. Climatic conditions

In 2012 average of monthly temperatures in the growing season of crops were above the annual average, on average 1.9°C. There was a deficit of rainfall in the early part of the growing season, followed in May of precipitation that exceeded the normal of the zone and again a deficit of rainfall in June, insufficient to meet water needs of crops (Table 1).

Table 1. Average temperature (°C) and monthly distribution of rain fall (mm) during the crop vegetation period Fundulea, 2012

Month	**March**	**April**	**May**	**June**	**Average**
Temperature 2012	5.5	14.2	18	23.3	15.3
Multi-annual average	*4.7*	*11.1*	*16.9*	*20.7*	13.4
Differences	0.8	3.1	1.1	2.6	1.9
Rainfall	4.8	35.1	159.5	20.7	55.0
Multi-annual average	37.6	44.1	60.5	71.8	53.5
Differences	-32.8	-9.0	99.0	-51.1	1.5

2. Soil chemical reaction

The results obtained showed a very significant influence of the farming system, crop and its interaction on the soil reaction. The chemical reaction of the soil had lower values in conventional farming system (5.86) than the organic farming system as a whole is observed a higher pH (6.02) (Table 2).

Table 2. The influence of the agricultural farming system and crops on soil chemical reaction (pH-H_2O)

Farming system (Factor A)	**Crop (Factor B)**				**Average(A)**
	b_1 soybean	**b_2 winter wheat**	**b_3 maize**	**b_4 sunflower**	
a_1- organic farming	a 6.06 a	a 6.15 a	a 6.01 b	a 5.87 c	a 6.02
a_2- conventional farming	b 5.87 a	b 5.93 a	b 5.81 b	a 5.84 a	b 5.86
Average (B)	5.97 b	6.04 a	5.91 b	5.85 c	
Factors	**A**	**B**	**B*A**	**A*B**	
LF 5%	0.012	0.034	0.042	0.048	
LF 1%	0.028	0.047	0.061	0.067	
LF 0.1%	0.088*	0.067*	0.093*	0.094*	

At the average of crops (factor B), one observes the influence of factor B on chemical reaction of soil. Variant winter wheat crop is framed in the group „a" with the highest values of pH (6.15) under organic farming and then diminishes in conventional farming system (5.93). The increase of pH, could be explained by the a large amount of plant debris which improve soil pH by the decomposition of the protein to ammonium (Table 2).

3. Cellulolytic activity

Cellulolytic activity in chernozem soil was positive influenced by the farming system.

In organic farming system the soil cellulolytic activity was more intense (4.13) compared to conventional farming system (2.39). One possible explanation could be the use of fertilizers in the conventional farming system. Fertilizers reduce soil cellulolytic activity (Feliang Fan et al., 2012).

Very significant differences are due to the crops, too. Thus, we note a synergistic effect, in organic farming the degradation processes of organic cellulose were more active in the corn crop as compared to crop wheat while in the conventional farming the highest values were in wheat crop and the lower in corn crop (Table 3).

Table 3. The influence of the agricultural farming system and crops on soil cellulolytic activity

Farming system (Factor A)	**Crop (Factor B)**				**Average(A)**
	b_1 soybean	**b_2 winter wheat**	**b_3 maize**	**b_4 sunflower**	
a_1- organic farming	a 4.72 b	a 2.64 d	a 5.70 a	a 3.44 c	a 4.13
a_2- conventional farming	b 2.64 b	a 3.76 a	b 1.40 c	b 1.76 c	b 2.39
Average (B)	*3.68*	*3.20*	*3.55*	*2.60*	
Factors	**A**	**B**	**B*A**	**A*B**	
LF 5%	1.842	0.597	1.579	0.844	
LF 1%	4.249	0.837	3.304	1.183	
LF 0.1%	13.530	1.183	9.590	1.672	

Stefanic et al., (1994, 2011) show that cellulolytic potential is a sensitive test to assess the improvement of living conditions in soil and highlights the effect of soil tillage, chemical and organic fertilization and the climate conditions on this indicator.

The relationship between chemical soil reaction and cellulolytic activity was significant positive for conventional farming system (r = 0.75**) and non significant for organic farming system (r = - 0.11), (Figure 1), which can be explained by the low values of pH and the use of mineral fertilization in conventional farming system.

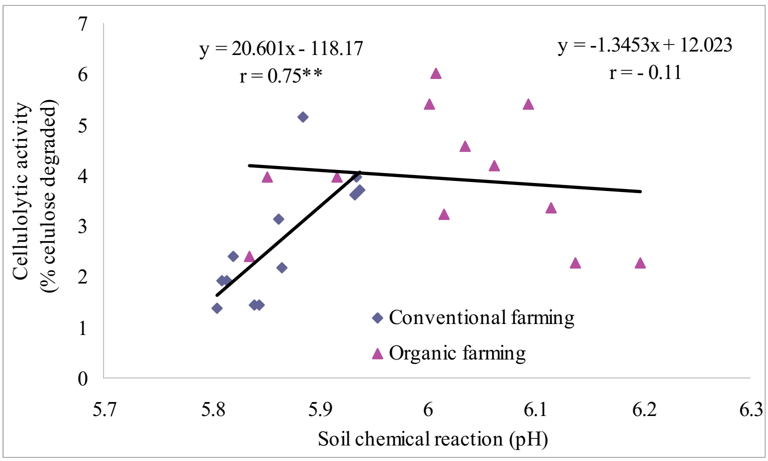

Figure 1. The relationship between soil chemical reaction and cellulolytic activity in organic and conventional farming systems

Cellulase activity in agricultural soils is affected by a number of factors.
These include temperature, pH, and oxygen from the soil, the chemical structure of the organic mattter and its location in the soil profile, the quality of organic matter from plant debris, nutrients from the soil and trace elements from fungicides (Arinze and Yubedee, 2000).

4. The soil respiration

The soil respiration, under 2012 year condition, was very significant influenced by the farming system and by the interaction between farming system and crop (Table 4).
In organic farming system soil respiration values were higher (48.64) as conventional farming system (42.87), suggesting a more rapid decomposition of organic debris (Table 5).

Table 4. Analyses of variance for soil respiration

Source of variance	Sum of squaers	LF	Mean square	F values and signification
Farming system (Factor A)	197.626	1	197.626	122.10***
ErorrA	3.237	2	1.618	
Crop (Factor B)	48.371	3	16.123	2.59 NS
Interaction A*B	85.457	3	28.485	4.577**
Erorr B	74.67	12	6.223	

***significant at < 0.001 level of probability; **significant at < 0.01 level of probability

Table 5. The influence of farming system and culture on soil respiration (mg CO_2/100 g dm soil)

Farming system (Factor A)	Crop (Factor B)				Average(A)
	b_1 soybean	b_2 winter wheat	b_3 maize	b_4 sunflower	
a_1- organic farming	a 51.17 a	a 44.20 b	a 51.96 a	a 47.22 b	*a 48.64*
a_2- conventional farming	b 41.16 a	a 43.99 a	b 43.71 a	a 42.62 a	*b 42.87*
Average (B)	*46.17*	*44.09*	*47.83*	*44.92*	
Factors	**A**	**B**	**B*A**	**A*B**	
LF 5%	2.227	3.137	4.227	4.437	
LF 1%	5.136	4.398	6.483	6.220	
LF 0.1%	16.353	6.217	11.672	8.792	

Decreased of the soil respiration indicates that there is a small amount of organic matter or aerobic microbial activity in soil. Other comparisons of conventional and organic system have also reported increased soil microbial respiration under organic management (Glover at al., 2000). A higher soil respiration, in the organic farming system, is an indicative of high biological activity, suggesting rapid decomposition of organic residues that make nutrient available for plant growth (Swezy at al., 1998). Also there is the assumption that under global warming due to the increase of CO_2, increases root biomass which in turn leads to increased of the soil microbial activity (Lipson et al., 2005).

Soil respiration was not affected by soil reaction, the correlations between them were insignificant in both farming systems (Figure 2). The most important factors affecting soil respiration are soil temperature, soil moisture, quality, quantity of organic carbon and soil texture (Tripathi et al., 2011).
Between cellulolytic potential and soil respiration there are significantly distinct correlation (r = 0.79**) in organic farming system and low in conventional farming systems (r = 0.32) (Figure 3). Cellulolytic potential was highest in the organic system, and this likely is the mechanistic link to the greatest cumulative respiration observed in this farming system.

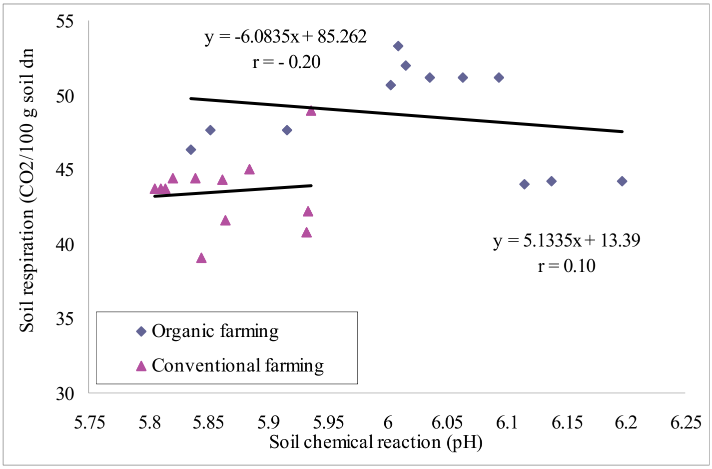

Figure 2. Relationship between soil chemical reaction and soil respiration in organic and conventional systems

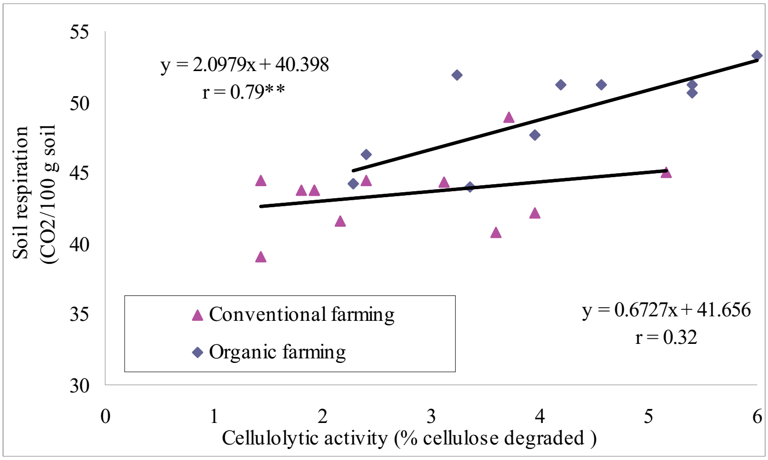

Figure 3. Relationship between cellulolytic potential and soil respiration in organic and conventional systems

CONCLUSIONS

The culture and management system have produced some rapid changes in soil properties as soil chemical reaction and soil microbial activity measured by soil respiration and cellolityc activity. Our results showed that the conventional farming practices resulted in lower soil reaction and this was correlated with cellulolytic potential of the soil. Wheat had the most obvious effect on soil chemical reaction.

The cellulolytic activity was highest in the organic system and lowest in the conventional system.

Soil respiration was stimulated by farming system practiced and by ineraction between culture and farming system. Cellulolytic potential was highest in the organic system, and this correlated with soil respiration.

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PROCESSING OF ANIMAL MANURE, OBTAINED FROM CATTLE, PIGS AND CHICKEN WITH RED CALIFORNIA WORMS

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Abstract

At the present moment approximately 9 million tones of animal manure are accumulated in the Republic of Moldova every year. Due to lack of financial sources livestock waste can't be transported in the field, they are accumulated on small areas for storage, polluting the soil, groundwater and the air. The animal droppings at the same time contain various pathogenic agents, which serve as a source of infection for people, animals and plants diseases.
The livestock waste processing with the California's red earthworms permits to diminish their quantity with 2 times, to increase the NPK concentration and diminish the doses of incorporation of the obtained vermicompost. The obtained experimental dates demonstrate that the processing of various types of animal manure with the aid of California's earthworms in the situation of the Republic of Moldova is related to significant losses of nitrogen and carbon. By the chemical composition of the vermicompost, obtained from different species of animals it is a little different from the properly fermented animal manure. Therefore, the doses of incorporation of the vermicompost for various crops will be very close compared with traditional manure.
The existent recommendations for application of the vermicompost in the countries with advanced agriculture can't be used in the situation of the Republic of Moldova. The content of NPK in the vermicompost from our country is 8 – 10 times lower. In order to obtain a concentrated product (humus, biohumus, vermicompost) it is necessary to use in the process of waste processing with earthworms other additions too such as phosphorites flour (or apatites), bone meal, ash, blood meal, other slaughterhouse waste or food waste.

Key words: *California's red earthworms, vermicompost, biohumus.*

INTRODUCTION

Plant growing aims to provide the people needs with vegetable food. The livestock sector of agriculture consumes a part of the plant production, turning it into food of animal origin. Along with meat, eggs, dairy and other products obtained from livestock, in the Republic of Moldova annually approx. 9 million tonnes livestock waste (manure, grape manure, poultry manure, compost, etc.) are accumulated. But the lack of financial resources and corresponding machines, animal waste can't be transported and incorporeted into the soil. It is accumulated on special platforms in which various substances are washed, polluting the soil, groundwater and air. It should be also mentioned that animal droppings, contain various pathogens and servas a source of infection for people, animals and plants.

In order to minimize the negative impact of the livestock waste on the environment, they are composted, or anaerobically fermented (to obtain biogas). They can also be processed using the California's red earthworms or house fly larvae. Different species of food mushroom grown on some animal waste. But the main way of the use livestock wastes is its incorporation in the soil as organic fertilizer.

The processing of organic wastes with earthworm has the following ***advantages*** compared with other technologies: it is a quite simple technology; waste odour disappears quickly; its decomposition by earthworms is 3-5 times faster; waste volume is reduced by 40-60%; nutrient concentration becomes higher and application rates of this organic fertilizer is approx. 10 times smaller (4-6 t/ha as compared to 40-60 t/ha to traditional manure; earthworms in waste processing destroy many pathogens that cause animals disease, such as septoria, tuberculosis, salmonellosis, anthrax etc.

For example, content of NPK in biohumus, obtained by (Miorzlaia, 2004) in Russia is: N - 0.6-1.4%, P - 0.4-2.7%, K - 0.5-1.9%. Vermicompost produced in Germany contains much more nutrients: N - 4%, P - 5%, K - 2.5% (Melzer, 1988). Biohumus obtained by Cremeneac (2003) in Moldova contained much loss nutrients: N - 0.8%, P - 1.4%, K - 1.2%. The purpose of this investigation was to study the chemical composition of manure, obtained from cattle, pigs and poultry and the content of NPK of viermicomposts, obtained from the processing of waste using Red California's earthworms, in the situation of the Republic of Moldova. Proceeding from the actual content of NPK in viermicompost, we can determine the application dose of manure in soil of this valuable organic fertilizer.

MATERIALS AND METHODS

The experiments were carried out in 2007-2011 in Mihailovca village, district of Cimislia, Republic of Moldova. In experiments was used litter manure obtained from cattle, pigs and chickens. Before using livestock waste as feed for the California's Red worms, first they were fermented by the mixed method - 5-6 months for cattle and swine feces and about 12 months, for the droppings of chiken. In spring, when the temperature reached 15-20°C worms with pupae (about 20 000 per m^2) were applied to platforms prepared and filled with different livestock waste. Before placing the worms in the substrate it was tried the biological sample: three-liter jars were filled with fermented waste up to 2/3 of the volume. In each jar were placed by 50 earthworms. After 2-3 minutes the earthworms have penetrated the substrate, that confirmed that the substrate was good for earthworms. California red frame, is a specially selected subspecies from manure worms (Eisenia foetida). Unlike the wild specimens California worms are leon multiplied qucker (over 1500 copies per year). It has length of 6-8 cm, weight approx. 1 g and not leave the place of residence, even if the environmental factors are unfavorable. In 24 hours a mature worm processesthrough her body about 0.7-1 g of waste. Worms grow and multiply rapadly if the substrate optimum temperature reaches 15 ... 20° C, pH = 6-7 units, the substrate humidity is of 70-80%. The substrate must also be loose for O_2 sufficiency frames. During the warm period care is to maintain the limited substrate moisture, shading the platforms, turning the waste and feeding them once a week. In samples of organic fertilizers and in the obtained viermicompost was determined: the moisture content by the drying method in an oven at a temperature of 100-105°C to constant weight. Mineralization of organic substance was performed by the Iodlibauer 's method. Total nitrogen content was measured by the volumetric method (Kieldahle's distillation system), total phosphorus by colorimetric method (after Denije), total potassium in the flame of the photometer. The experiment was conducted in 3 replicates.

RESULTS AND DISCUSSIONS

The famous Russian agrochemister D. Preanisnicov mentioned that as many mineral fertilizers would be used, manure will never lose its value. Approximately 30 million tons of wastes are accumulated every year in Republic of Moldova (Bulimaga, 2009). Livestock wastes accounts approximately 9 million tons annually and are concentrated mainly in the private sector. They are the most complex natural fertilizers and at the same time the cheapest fertilizers. Just such fertilizers must be applied in conditions of crisis. If the livestock wastes would be applied fully in the dose of 40 t/ha we would have fertilized every year about 250,000 hectares in Moldova.

The content of nutrients in different types of livestock wastes various greatly. One ton of the bedded manure contains about 5 kg N, 2.5 kg P and 6 kg K, 75% water (Lixandru and Filipov, 2012). Manure without litter has a higher water content - 89-90% in cattle wastes and 95-97% in pigs manure, 0.23-0.30% N, 0.13-0.17% P, 0.08-0.17% K. Chicken manure (with litter) is more concentrated: N 2.0-2.2%, P 1.5-1.8%, K 1.1-1.4%, humidity - 56% (Andrieş, 2011). From feed to manure go approx. 40% organic matter, 50% N, 80% P and 95% K (Lixandru and Filipov, 2012). The chemical composition of different organic waste and vermicompost (biohumus, humus), obtained from them depends on animal species, age, quantity and quality of feed, litter quantity and its composition, method of fermentation, way of storage and other factors. Storage, transportation and incorporation in soil of a large quantities of organic fertilizers demands a high costs and to reduce those costs is necessary to increase the concentration of nutrients in the compost and to reduce the dose of applied fertilizer. One of the way to resolve this problem is processing of the livestock waste using California red worms. Analysis of chemical composition of manure derived from cattle (Table 1), pigs and chickens show that moisture and NPK content varies significantly (Andries, 2011). Thus, nitrogen, phosphorus and potassium contained in a tone of manure with bedding or solid fraction of bovine waste is approximately the same. Cattle manure without litter contains 2 times less nutrients, than the one litter. Liquid fraction of cattle is the poorest in NPK (content is only 0.02 to 0.09%).

Table 1. Chemical composition of manure, obtained from different animal species

Type of manure	Moisture, %	Dry matter, %	pH	Content, % in mass		
				N	P	K
Cattle manure						
With bedding	58	42	8.2	0.53	0.31	0.81
Without bedding	89	11	8.7	0.30	0.17	0.37
Solid fraction	73	27	8.3	0.57	0.42	0.79
Liquid fraction	98	2	8.2	0.07	0.02	0.09
Swine manure						
With bedding	60	40	7.5	0.89	0.53	0.52
Without bedding	`95	5	8.5	0.23	0.13	0.08
Solid fraction	82	18	8.7	0.56	0.66	0.25
Liquid fraction	98	2	8.0	0.06	0.03	0.05
Chicken manure						
With bedding	48	52	7.7	1.5	1.44	1.00
Solid fraction	52	48	7.1	1.8	1.29	0.92
Liquid fraction	99	1	7.0	0.1	0.03	0.09

Swine manure with bedding is more rich in nutrients, than that of cattle: 0.89% nitrogen, 0.53% phosphorus and 0.52% potassium. Solid droppings without litter have a lower content of NP and the amount of potassium is 2 times lower (0.25% comparatively with 0.52%). Liquid fraction of swine manure differ little from the liquid fraction of cattle or chicken manure.

Poultry manure with bedding or solid excrement of chicken are most concentrated in nutrients. One tone of chicken wastes contains: nitrogen 15-18 kg, phosphorus 12.9-14.4 kg and potassium 9.2-10 kg.

So, for livestock waste processing with red worms of California it is reasonable to use only the bedded manure or solid fermented fractions of different animal species. Liquid fractions contain very little nutrients and can't be processing directly by earthworms.

The manure processing with different content of nutrients by earthworms, changes little the chemical composition of the obtained vermicompost (Table 2). Phosphorus and potassium content in biohumus is slightly high compared to manure (for phosphorus 0.51-1.77% compared to 0.31-1.44%, for potassium 0.76-1.37% compared to 0.52-1.0%). This probably explains that the loss of approx. 50% of the initial mass of manure in the processing with earthworms and almost the same amount of PK, reported to a smaller amount of waste, increased the content of nutrients. It should be noted, that phosphorus and potassium are poorly absorbed by the worms weaker and during the processing these elements are being little washed.

Nitrogen content reverse - is lower in all types of vermicompostes, compared with manure, because that worms use some nitrogen substances, especially proteins. Another part of nitrogen from the waste is eliminated in the air during the processing in the form of NH3, NO, NO2. For example, bovine and porcine biohumus accordingly contain 0.34 and 0.59% nitrogen, compared with 0.53 and 0.89% in cattle and swine manure.

Table 2. Chemical composition of viermicompost, obtained from manure of different animal species in 2007-2010

Moisture, %	Dry matter, %	Natural mass content, % in mass		
		N	P	K
Vermicompost from Cattle manure				
45.1	54.9	0.34	0.51	1.11
Vermicompost from Swine manure				
41.7	58.3	0.59	0.72	0.76
Vermicompost from Chicken manure				
43.8	56.2	1.29	1.77	1.37

So, livestock waste processing using California red worms, leads to considerable loss of nitrogen. At the same time increase the phosphorus and potassium content. Vermicompost obtained in the Republic of Moldova differ a little from traditional manure and can't be applied in very small doses (4-6 t / ha). To increase the content of nutrients in vermicompost it is necessary to use during processing of livestock waste other additives.

CONCLUSIONS

The obtained experimental dates permit to draw the following conclusions:
The highest content of the NPK is observed in the bedded manure or solid fraction of manure, indifferently of animal species. The most concentrated in nutrients is the chicken bedded manure, followed by those obtained from pigs and cattle. Liquid wastes are very diluted and contain only 0.02 to 0.09% NPK. They can't be processed directly with earthworms.
Processing of different types of manure with California red worms is followed by significant losses of nitrogen. Vermicompost, obtained in the Republic of Moldova, is little more concentrated in PK, but poorer in N compared to fermented manure. The content of these elements in vermicompost and different type of manure are quite close. Therefore, the incorporated doses for vermicompost and traditional manure for different cultures will be almost the same.
Existing recommendations for application of vermicompost in countries with advanced agriculture can't be used in the Republic of Moldova. To obtain a more concentrated (vermicompost or biohumus, humus,) it is necessary to use in waste processing technology with earthworms other additives too such as phosphorites meal (or apathy meal), bone meal, ash, blood meal, wastes from slaughterhouses and other food wastes.

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NITRATE MONITORING IN PRIVATE WELLS FROM PRAHOVA DISTRICT

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Abstract

As water quality has become an increasing, environmental and social constraint for modern society, we found it suitable to evaluate the nitrate levels in drinking water collected from private wells from Fantanele, Prahova County. The present study conducted during November 2012 and April 2013 describes the nitrate levels of drinking water from four private wells (F1-F4). Nitrate species were assessed using spectrophotometric method and the analytic results allowed us to draw up the following variation of nitrate concentrations: F4<F3<F2<F1. In the case of well F1 nitrate levels were greater than 50 mg/L at all three collection moments and these results are associated with nitrogen fertilisation techniques adopted by well owner, a local vegetable producer. Nitrate concentrations for F3 and F4 were below maximum admitted level (50 mg/L), meanwhile in the case of F2 water collected at M3 (25.04.2013) reached the value 50.14 mg/L.

Key words: *nitrate, well-water, pollution, methemoglobinemy.*

INTRODUCTION

Nowadays, protecting the quality of groundwater is a major challenge considering that it represents an important water source used intensively for domestic purposes and for drinking, as well. Undesirable pollutants in groundwater may be unacceptable due to their health effects and decrease of water quality (bad taste, unpleasant odour, aesthetic reasons). Among the contaminants of water, nitrate occupies an important place and is a common problem in many parts of the world and it is generated by agriculture (fertilizers and manure), domestic activities, municipal wastewater and sludge, septic systems. Nevertheless, the intensive use of nitrogenous fertilizers in agriculture is the main contributor to nitrate in water worldwide.
According to current legislation of the European Union such as Nitrate Directive (96/676/EEC), Drinking Water Directive (98/83/EC) and Romanian legislation (Law 458/2002), nitrate concentrations in water used for drinking purposes must not exceed the threshold of 50 mg/L. The WHO report of 2004 maintains that extensive epidemiological data support limiting the value of nitrate-nitrogen to 10 mg/L or as nitrate to 50 mg/L for human consumption (WHO, 2004).
Despite the European Community Directives there still exist regions in EU countries (Karavoltsos et al., 2008; Pele et al., 2010) and in other different parts of the world (Suthar et al., 2009) where nitrate concentrations exceed the value of 50 mg/L threshold.
Nitrates by themselves are not very toxic, but in human body are converted to nitrites due to the action of specific enzymes and, finally lead to carcinogenic products like nitrosamines and nitrosamides. The hazardous effect of nitrite is its ability to react with haemoglobin (oxyHb) to form methaemoglobin (metHb), according to reaction: $NO_2^- + \text{oxyHb}\ (Fe^{2+}) \rightarrow \text{metHb}\ (Fe^{3+}) + NO_3^-$ (Santamaria, 2006). Ferrous haemoglobin iron (II) is oxidized to ferric iron (III) which is not able to participate in oxygen transport (Bradberry, 2011). This manifestation is known as methemoglobinemy (blue baby syndrome) and is characterized by cyanosis which is the earliest clinical feature that occurs when approximately 15% of total haemoglobin is replaced by methaemoglobin (Bradberry, 2011). Methemoglobin levels between 35-40% cause headache, fatigue, dizziness and dyspnea,

meanwhile levels greater than 70% may be lethal (El-Husseini, 2010).

The link between nitrate-contaminated water and blue baby syndrome was firstly described by Hunter Comly who identified two infants that were fed with formulas prepared with nitrate rich well water (90 mg/L and 150 mg/L, respectively) (Knobeloch et al., 2000). There are studies that support the idea that the maximum contaminant level of 45 mg/L nitrate or 10 mg/L nitrate-nitrogen protects the babies from nitrate induced toxicity (Fan et al., 1987).

A national study developed in Romania during 2009 (Tudor et al., 2009) revealed that 58% from reported cases of infant methemoglobinemy appeared when consumed well water was 101-500 mg /L nitrate-contaminated. When nitrate levels were between 0-50 mg/L, it were reported 20% cases, meanwhile levels between 51-100 mg/L led to 10% cases.

In Romania, Bacau County during 2000-2005 period it were reported a number of 161 cases of methemoglobinemy (Popescu et al., 2008).

In Romania, during 1997-2004 were reported 2160 cases of methemoglobinemy at infants, the highest number of cases (453) being encountered in 2000. During 2005-2009, infantile methemoglobinemy cases decreased to 807, the highest number (243) being reported in 2006 and the smaller (89) in 2009 (Tudor et al., 2009).

Beside methemoglobinemy, there are reported many other negative effects produced by large quantities of nitrates: gastric cancer (Prakasa et al., 2000), central nervous system defects and some other cancers (Dourson et al., 1990; Gondim et al., 2005). Also, it has been demonstrated that nitrate can interfere with iodine retention by thyroid, resulting in hypertrophy of the thyroid (Vermeer et al., 1998).

Given that the presence of nitrates in groundwater is mainly perceived as a pollution problem and are harmful for human health, we have developed a monitoring study for six months (during 2012-2013) of nitrate contents from wells located in Fantanele, Prahova County. Other reason that sustained our research was that literature survey reveals lack of information regarding this subject related to Fantanele area.

MATERIALS AND METHODS

Studied area

Fantanele (Prahova) is geographically located at latitude (45.0075 degrees) 45°0'27.18" North of the Equator and longitude (26.3793 degrees) 26°22'45.74" East of the Prime Meridian on the Map of the world. It is located in the east of the county Prahova, in the contact area between of Mizil plain and Dealu Mare, wine-region. The position of Fantanele on Prahova district map is presented in Figure 1 and sampling points are detailed in Figure 2.

Figure 1. Position of Fantanele on Prahova map

Figure 2. Sampling points (F1, F2, F3, F4) located on Fantanele map

Sample collection

Water samples collected from four wells (labelled F1, F2, F3, F4) located in Fantanele, Prahova were analyzed. The samples were collected from a depth of 10-15 m at three moments: M1 (07.11.2012), M2 (18.02.2013) and M3 (25.04.2013). Selected wells represent sources of drinking water and are used also for domestic usage as cooking, washing, etc. From each well at every sampling moment were taken four samples. It were analyzed in totally 48 water samples in duplicates and the results are average of the determinations. All samples were collected in polyethylene bottles rinsed with sample water before collection and were carried to the laboratory where were stored at 4^oC to avoid possible degradation of chemical species that are present in water. Chemical analyses were conducted within 48 hours of collection. The samples were allowed to stay until they reached room temperature before analysis.

Reagents

Analytical grade chemicals were used throughout the study without any further purification. Standard stock solution containing 1000 mg/L NO_3^- was prepared by dissolving 0.1631 g of KNO_3 in 100 mL distilled water, after drying in oven at 105^oC for 6 hours. Working standards were prepared by diluting the stock solution.

Analytical method

Nitrate content in water samples was determined by spectrophotometric method. This was based on reaction between phenol-2,4-disulphonic acid and nitrate ions in basic medium. It was obtained yellow nitroderivatives that have absorption maxima at 420 nm. The calibration curve for nitrate was linear for studied concentration ranges (R^2=0.9987).

RESULTS AND DISCUSSIONS

Water collected at three different sampling moments from four wells distributed in the area of Fantanele village from Prahova County have been subject of analysis in order to determine nitrate levels. It has been analyzed 48 water samples in duplicates and the results presented in table 1 are average of the determinations.

Table 1. Nitrate concentrations for all analysed water samples

Well	Parameters	Sampling moment		
		M1 07.11.2012	**M2** 18.02.2013	**M3** 25.04.2013
F1	NO_3^-, mg/L	87.97	76.44	58.45
		85.44	77.42	62.23
		88.73	77.84	61.33
		86.22	74.54	59.79
	Av.± SD	87.09±1.52	76.56±1.46	60.45±1.67
	CV, %	1.74	1.91	2.76
F2	NO_3^-, mg/L	49.19	43.28	48.42
		47.23	44.28	51.29
		47.93	44.94	51.78
		50.06	45.30	49.08
	Av.± SD	48.60±1.26	44.45±0.88	50.14±1.64
	CV, %	2.60	1.99	3.27
F3	NO_3^-, mg/L	38.30	35.46	37.80
		38.88	36.48	38.38
		40.42	34.96	36.58
		39.97	35.20	37.39
	Av.± SD	39.39±0.97	35.52±0.66	37.53±0.75
	CV, %	2.47	1.88	2.01
F4	NO_3^-, mg/L	19.86	23.96	25.43
		21.56	25.09	25.20
		20.34	24.26	24.87
		19.56	25.29	25.93
	Av.± SD	20.33±0.88	24.65±0.64	25.35±0.44
	CV, %	4.33	2.60	1.75

Av.= average; SD= standard deviation; CV= coefficient of variation, %

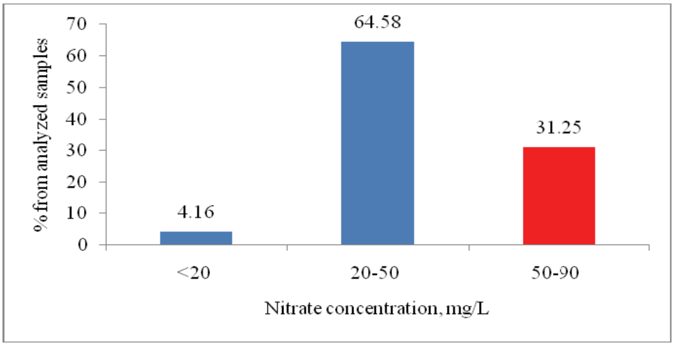

Figure 3. Quantification of nitrate levels

Analyses indicated that 31.25% from all water samples contain nitrate over admitted level imposed by EU and Romanian legislation (Figure 3) and it is recommended to find another water sources for drinking and further monitoring and surveillance of water from these points need to be enhanced. A small number of water samples (4.16%) contain nitrates close to 20 mg/L and there are no concerns regarding environmental or health issues.

The influence of well locations and sampling moments on the nitrate found levels were investigated (Table 2) and the conclusions are withdrawn below.

The average of the nitrate concentrations in different wells located in Fantanele village indicate significant differences, with concentrations that are over limit set by European (96/676/EEC; 98/83/EC) and Romanian (Law 458/2002) legislation, in the case of F1 (74.40 mg/L) and close to the threshold in the case of F2 (47.73 mg/L). The influence of the sampling moment on the recorded nitrate levels present significant differences with values that are exceeding the value 40 mg/L, but below the maximum admitted level.

The highest concentration (48.85 mg/L) was found in the water sample collected at moment M1 (07.11.2012).

The variance analysis indicates at the same sampling moment very significant differences determined by the location of the wells from which the samples were collected. The highest nitrate concentration (87.09 mg/L) was found in F1 sampling point at M1 sampling moment. Well F1 is situated in an area where are grown vegetables in intensive system. In the case of the same well (sampling point), the variance analysis shows for F1 and F3 significant differences between sampling moments, that suggesting variations of nitrate levels during evaluation period.

Even if for F1 are recorded decreasing values of nitrates (87.09 > 76.56 > 60.45 mg NO_3^-/L), all of them are over maximum admitted level at all sampling moments, this well representing the highest polluted point and the most dangerous drinking water source. This situation appeared as consequence of intensive agriculture practices and is associated with nitrogen fertilisation techniques adopted by well owner, a local vegetable producer. It is widely known that high nitrate levels are often associated with poorly constructed or improperly located wells (near septic fosses, greenhouses, etc). In addition, literature studies related to nitrate levels in water and methemoglobinemy (Fan et al., 1987; Tudor et al., 2009) must be considered a serious warning, it is recommended to suspend the consumption of water from this point. Also, nitrate levels must be monitored strictly and environmental risk produced by these species is mandatory to be estimated.

In the case of F2 and F4 wells there are not observed significant differences at moments M1 and M3, M2 and M3, respectively.

Nitrate concentrations for sampling point F2 are very close to the limit value (50 mg/L) and at M3 moment exceed very slightly this value (50.14 mg/L).

The lowest values for nitrate are encountered in F4 location, at M1 sampling moment the value was 20.33 mg NO_3^-/L.

Table 2. The influence of location (A factor) and sampling moment (B factor) on nitrate concentrations (mg/L) from water samples collected from Fantanele, Prahova County

B / A	M1 07.11.2012	M2 18.02.2013	M3 25.04.2013	Average A
F1	a87.09a	a76.56b	a60.45c	a74.70
F2	b48.60a	b44.45b	b50.14a	b47.73
F3	c39.39a	c35.53c	c37.54b	c37.49
F4	d20.33b	d24.65a	d25.35a	d23.44
Average B	48.85a	45.30b	43.37c	

Average A: DL 5%= 0.98* mg/L; DL 1%=1.41 mg/L; DL 0.1%=2.08 mg/L.
Average B: DL 5%= 0.84* mg/L ; DL 1%=1.13 mg/L; DL 0.1%=1.52 mg/L.
B ct. A var.: DL 5%= 1.55* mg/L; DL 1%=2.14 mg/L; DL 0.1%=2.97 mg/L.
A ct. B var.: DL 5%= 1.68* mg/L; DL 1%=2.27 mg/L; DL 0.1%=3.05 mg/L.

*Interpretation of the results were made according to DL 5%

CONCLUSIONS

Nowadays, in many regions nitrate concentrations in drinking water are close to levels which are unacceptable under current legislation of the European Union and this is due mainly to the intensive use of nitrogenous fertilizers in agriculture. The increasing interest has been observed essentially on account of environmental and human health concerns.

The aim of present survey was to evaluate nitrate levels in wells located in Fantanele village, Prahova County after six months monitoring. The results allowed us to withdrawn the conclusions that are discussed below.

Violations of the parametric value (50 mg/L) imposed by European and Romanian legislation were detected for a large number of water samples (31.25% from total).

A percent of 4.16% water samples contain nitrates close to 20 mg/L and there are no concerns regarding environmental or health issues.

Even if for F1 are recorded decreasing values of nitrates (87.09 > 76.56 > 60.45 mg NO_3^-/L), all of them are over maximum admitted level at all sampling moments and greater than any water sample analyzed in this study.

Well F1 represent the highest polluted sampling point and the most risky drinking water source, this situation occurring because of the nitrogen fertilisation techniques adopted by well owner, a local vegetable producer.

In the case of F2 sampling point, nitrate levels were close to maximum admitted level at M1 and M2 moments, meanwhile in the case of M3 the found value was slightly above limit value (50.14 mg/L).

Water samples collected from wells F3 and F4 contain nitrate species below 50 mg/L, the latter containing lower concentrations.

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EVALUATION OF ORGANIC AMENDMENTS EFFECTS ON SOIL MICROORGANISMS AND ENZYMATIC ACTIVITIES OF DEGRADED CHERNOZEM

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Abstract

Microbiological and enzymatic properties of the long term stored municipal sewage sludge from 11 cities of the Republic of Moldova were investigated in connection with the problem of its utilization. The microbial biomass content in the sewage sludge fluctuated from 0.32 to 6.72 mg C g^{-1} waste, ratio between microbial and organic carbon content – from 0.70% to 5.09%, coli-titer index from >0.1 to 0.0001 respectively. As a result of keeping wastes and mineralization processes intensification, organic carbon, microbial biomass and enzymatic activity reduced. Microbiological and biochemical parameters depended on storage duration of wastes and organic matter content. The correlation coefficient between organic carbon content and microbial biomass constituted 0.74, catalase activity – 0.68. Using of the municipal sewage sludge as a fertilizer for reducing of the soil degradation is possible only after the preliminary composting in the combination with sugar industry waste materials (sugar lime) and manure. As a result of composting wastes sanitary indicators were improved. Organic amendments ramped up microbiological and enzymatic properties of degraded chernozem. Wastes amended soil showed a significant increase in the microbial biomass, enzyme activities and the humus content in 12 years after the application of composts.

Key words: *coli-titer, compost, degraded chernozem, enzymatic activities, microbial biomass, sewage sludge.*

INTRODUCTION

Recycling of the municipal sewage sludge is the actual problem in the Republic of Moldova. The amount of the sewage sludge produced annually in the country is about 35.5 thousand tons of the dry weight or 71.0 thousand tons with 50% of humidity (Rusu et al., 2012). The organic matter content in the waste with the natural moisture constitutes in average of 43.5% and the content of heavy metals does not exceed the maximum permissible concentration after the purification (Rusu et al., 2012).

The motivation for using sewage sludge on agricultural land lies in its value as a nutrient-rich fertilizer and source of organic material. For several decades, controlled application of sewage sludge to agricultural land has been a major route for disposing of sludge (Tsurkan et al., 1989; Banaru et al., 2003; Arhip, 2011; Rusu et al., 2012).

The sewage sludge is the valuable fertilizer, but may represent an environmental hazard from the standpoint of the fecal pollution and the possible threat for worsening epidemiological situation. It is known that sewage sludge and municipal solid waste samples can contain hazardous substances and pathogenic organisms and are liable to undergo biological action (Gerba, 1987). Untreated sewage sludge contains a wide variety of pathogens, including bacteria, viruses, fungi, cysts and eggs of parasites. These pathogens can potentially pose a risk to the environment, public health and food safety when sludge is applied to agricultural land (Santamaría and Toranzos, 2003). The permanent microbiological monitoring of the long stored precipitations and soils after their application in the republic is not carried out, although during the long period the wastes management had been searching the ways in order to obtain economic benefits and reduce the negative effect on the environment.

Standards for the treatment of sewage sludge are proposed in numerous regulations and guidance on best practice for its beneficial use. They are also been described in many codes of practice covering the use of sludge in agriculture of different countries (Board on Environmental Studies and Toxicology, 2002;

Standing Committee of Analysts, 2003; Sanitary regulations and standards, 2010). A variety of treatment methods, such as composting, aerobic and anaerobic digestion, alkaline stabilization, conditioning, dewatering and heat drying, is used in wastewater-treatment plants to reduce pollutants and to destroy pathogens (European Commission, 2001).

Using of the municipal sewage sludge as a fertilizer for reducing the soil degradation is possible only after the preliminary composting. Composting of sewage sludge has been practiced long ago and is a satisfactory method for handling these wastes (Tsurkan et al., 1989). The problems with composting wastewater sludge are the high moisture content, the density of the sludge particles, pathogenic microorganisms and a potential high oxygen demand. Usually sewage sludge is combined with other wastes. In this procedure the sludge is first mixed with bulking products such as straw. The promising way of the sludge' utilization is their mixing with the sugar industry waste material, an alkaline reaction, for the purpose of the decontamination from pathogens.

The purpose of the research was to evaluate the microbiological status of sewage deposits in cities of the country and to determine the effect of composts with the sewage sludge on microbiological and enzymatic properties of the leached chernozem, degraded as the result of the long-term agricultural utilization.

MATERIALS AND METHODS

Sewage sludge samples from 11 cities of the Republic of Moldova were investigated in connection with the problem of its utilization. The storage duration of wastes ranged from 1 to 20 years. Composts with the sewage sludge and straw of 2% were examined in the dynamics in 1 and 3 months and in 1 and 1.5 years.

Experimental site. The site was located in the center of the country, in the Ivancha village, Orhei region. The long-term arable soil without fertilizers (control), sewage sludge and composts with sewage sludge treatments were tested in 12 years after the application of fertilizers. Investigations were carried out on plots with the sunflower, soybean and the winter wheat. In 1986 sewage sludge was introduced in the dose of 40 t ha^{-1}. The other plot was amended with the compost from the 40 t ha^{-1} of sewage sludge, 40 t ha^{-1} of defecate and 40 t ha^{-1} of manure. Organic fertilizers were introduced under the first crop rotation links culture (Serjentu et al., 1991). The soil at the site is the leached chernozem with humus content of 4.22%, total nitrogen – 0.22%, phosphorus – 0.105%, potassium – 1.90%; hydrolytic acidity was 2.5 me 100 g^{-1} and pH = 6.6-7.2 in the topsoil (Serjentu et al., 1991).

Soil samples were collected from the 0-30 cm layer of the experimental plots in the spring.

Microbiological properties. The microbial biomass carbon was measured spectrophotometrically by the rehydratation method based on the difference between carbon extracted with 0.5 M K_2SO_4 from fresh samples and from samples dried at 65-70^oC for 24h, with K_c coefficient of 0.25 (Blagodatsky et al., 1987). Counts of microorganisms were obtained on agar plates (Zvyagintsev, 1991). The number of lactose-positive E. coli (coli-titer) was determined by the fermentation method with the subsequent seeding at the *Endo* medium. The CO_2-producing capacity of composts was measured by the titration method (Zvyagintsev, 1991).

Enzymatic activity. The potential enzymatic activity was determined in samples of the air-dry soil and waste. The catalase activity was determined by the volumetric method by the rate of hydrogen peroxide's decomposition during its interaction with the soil and by the volume of released oxygen (Haziev, 2005). The urease activity was measured by estimating the ammonium released on incubation of soil with buffered urea solution by colorimetrical procedures (Haziev, 2005). The dehydrogenase activity was determined colorimetrically by the presence of triphenylformazan (TPF) from 2, 3, 5-triphenyltetrazolium chloride added to air-dry soil (Haziev, 2005). The polyphenoloxidase and peroxidase activities were determined colorimetrically using hydroquinone as a substrate (Karyagina and Mikhailovskaya, 1986).

Soil chemical properties. Organic carbon was analyzed by the dichromate oxidation method.

Microbiological, enzymatic and chemical

indices were evaluated by the analysis of variance and correlation analysis.

RESULTS AND DISCUSSIONS

Microbiological characteristics of municipal sewage sludge. Sewage sludge is the material with a slightly alkaline reaction (pH = 7.5) and a considerable humidity (47.8%); it has a high content of organic matter, in average of 43.5% in terms of the natural moisture content (Rusu et. al., 2012). As a result, the raw waste has a high number of bacteria, CO_2-producing capacity and dehydrogenase activity (Table 1). It has been determined that sewage sludge is a biologically active material, in which bacteria are predominant among the microbial community. The number of fungi is insignificant. Sewage sludge contains methane bacteria in the amount of 350 •10^3 CFU g^{-1}. The traditional indicator, such as the contents of *E.coli* demonstrated a high degree of the fecal contamination of the waste, coli-titer was 0.0000001. This value significantly exceeds the sanitary standard for the sewage sludge which has been developed in different countries (Standing Committee of Analysts, 2003; Sanitary regulations and standards, 2010).

The long term stored municipal sewage sludge demonstrates the substrate which is enriched with microorganisms (Table 2).

Table 1. Microbiological and biochemical characteristics of the fresh sewage sludge (Kishinev city)

Heterotrophic bacteria	***Nocardia***	**Actinomycetes**	**Methane bacteria**	**Fungi**	**CO_2**	**Dehydrogenase activity**
CFU* g^{-1}•10^6			CFU* g^{-1}•10^3		mg 100g^{-1} 24h^{-1}	mg TPF 10g^{-1} 24h^{-1}
1286.8	249.3	22.8	350	5.4	1.91	11.8

Table 2. Microbiological and enzymatic indices, the carbon content in the municipal sewage sludge in the Republic of Moldova

City	**Storage period, years**	**C_{org}, %**	**Microbial biomass C, mg C g^{-1} waste**	**C_{MB}/C_{org}, %**	**Catalase, cm^3 O_2 g^{-1} waste min^{-1}**
Balti	2-3	11.42	5.81	5.09	11.3
	10	2.63	0.36	1.36	0.9
Floreshti	1	13.26	4.40	3.32	5.4
	10	5.93	1.40	2.36	2.9
Edinets	3-4	21.06	6.52	3.10	5.4
	4-6	4.40	0.32	0.72	0
Faleshti	2-3	19.10	5.77	3.02	10.2
	10	9.18	0.83	0.91	3.7
Ungheni	7-8	17.98	3.49	1.94	2.4
	8-10	18.10	3.84	2.12	0.8
Kishinev	1	11.36	2.54	2.24	6.8
	2-3	15.65	1.53	0.98	3.0
	5-6	13.26	2.38	1.79	6.1
Tighina	1	28.46	6.72	2.36	39.1
	2	11.73	3.15	2.68	10.3
	5	7.52	0.87	1.16	0.4
Orhei	3	12.42	2.03	1.64	2.8
	4-5	4.59	0.64	1.39	0.8
Hyncheshty	1	17.29	3.09	1.79	10.1
	5	6.06	1.81	2.99	3.4
	7-8	10.25	1.10	1.07	2.0
Chimishliya	8-10	13.17	2.01	1.53	1.2
	15-20	13.23	2.31	1.75	3.7
Kahul	1	23.34	1.62	0.70	19.0
	4-5	13.94	1.27	0.91	0.7
	7-8	11.76	2.25	1.91	0.4

The quantity of the microbial biomass in the waste with the 1-4 years of storage is 1.53-6.72 mg C g^{-1} dry waste that in 4-18 times greater than this value in soils.

One ton of the waste contains 3.0-13.4 kg of dry microbial biomass.

The share of the microbial carbon in the total content of the organic carbon in the sewage sludge constitutes of 0.70-5.09%.

The catalase activity can reach values 39.1 cm^3 O_2 g^{-1} waste min^{-1}.

E. coli content in investigated samples is from 0.0001 to 0.1 and above 46% of the samples are characterized by a titer of 0.001; this indicator is 0.01 in 27% of the samples and 0.1->0.1 in 18% of sewage sludge samples. Coli titer is at the level 0.0001 only in 9% of the samples.

All sewage sludge samples were divided into 3 groups according to the duration of the retention period (Table 3).

As a result of the keeping wastes and mineralization processes intensification, the organic carbon content, the total biomass of microorganisms, the ratio between the microbial and total carbon and the catalase activity in the sludge had been reduced, sometimes to the level of the average values of this index in the zonal soils.

Sewage sludge keeping at landfills leads to the marked reduction in the number of *E. coli*. The changes in the index of coli-titer mean that contamination of wastes reduces and their sanitary state improves through the storage.

Microbiological and biochemical parameters depended on storage duration of wastes and organic matter content.

The correlation coefficient between organic carbon content and microbial biomass constituted 0.74, catalase activity 0.68 accordingly.

The dynamics of microbial processes during composting of municipal sewage sludge. The maximum number of heterotrophic microorganisms and actinomycetes was determined in the initial period of composting of the sewage sludge with a straw (Table 4).

Their abundance was reduced in 3.1-11.0 and 1.9-24.5 times respectively as a result of mineralization processes in the compost.

The greatest number of nitrifying bacteria and CO_2 emissions was detected after 3 months of composting. The polyphenoloxidase and the peroxidase activities ranged from 4.0 to 8.0 and from 8.0 to 25.0 mg 1.4-p-benzoquinone $10g^{-1}$compost 30 min^{-1} accordingly. The highest activity of these enzymes was registered after 3 months of composting. Probably the synthesis of humic substances in the compost, in which these enzymes participate, is the most intensive in this period. Composting of the sewage sludge leads to the significant reduction in the number of *E. coli*. Composted waste had a standard titer *E. coli* only after 1.5 years.

Table 3. Influence of the storage duration on the carbon content and microbiological indicators in the sewage sludge (mean values)

Storage period, years	C_{org}, %	Microbial biomass C, mg C g^{-1} waste	C_{MB}/C_{org}, %	Catalase, cm^3O_2 g^{-1} waste min^{-1}	Coli-titer
1-5 (n=11 -12)	16.93 ± 3.43	3.92±1.21	2.42 ± 0.74	11.2±6.9	0.0001 -0.001
5-10 (n=11)	10.56 ± 2.95	1.68±0.63	1.56 ± 0.42	1.9±1.3	0.0001 -0.01
>10 (n=3-4)	5.91	0.86	1.54	2.1	0.001- >0.1

Table 4. Dynamics of microbiological and enzymatic indicators in the compost from the sewage sludge and straw (n=3 for each indicator)

Index	1 month	3 month	1 year	1.5 year
Heterotrophic bacteria, CFU g^{-1} compost • 10^6	352.8	114.8	32.0	50.3
Nitrifying bacteria, CFU g^{-1} compost • 10^3	8.0	151.8	17.9	3.5
Actinomycetes, CFU g^{-1} compost • 10^6	412.0	216.3	143.2	16.8
CO_2 emission, mg 100 g^{-1} compost 24 h^{-1}	223.1	339.8	104.3	120.1
Coli-titer	0.0000001	0.000001	0.0001	0.01
Polyphenoloxidase, mg 1,4-p-benzoquinone 10 g^{-1} compost 30 min^{-1}	4.0	8.0	4.8	5.8
Peroxidase, mg 1,4-p-benzoquinone 10 g^{-1} compost 30 min^{-1}	8.0	25.0	15.0	14.0

Effects of organic amendments on soil microorganisms and enzymes.

The use of sewage sludge with the sugar industry waste material and manure aiming to the reduction of degradation processes in the leached chernozem has prolonged after-effects. The use of the compost consisting of sludge (40t ha^{-1}) and sugar lime (40t ha^{-1}) as well as sludge in the dose of 40t ha^{-1} with sugar lime (40t ha^{-1}) and manure (40t ha^{-1}) contributed to the increase of the microbial biomass content from 307.6-380.2 to 363.2-441.6 μg C g^{-1} soil in 12 year after the application into the leached chernozem (Table 5).

Table 5. Microbiological indices and the carbon content in the leached chernozem
(12 years after the application of wastes)

Variant	Humus, %	C_{org}, %	Microbial biomass (MB), µg C g^{-1} soil	C_{MB}/C_{org}, %
Sunflower				
Control	3.72	2.16	308.3	1.43
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1}	4.04	2.34	428.2	1.83
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1} + manure, 40 t ha^{-1}	3.98	2.31	441.6	1.91
Soybean				
Control	3.57	2.07	307.6	1.49
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1}	3.57	2.07	375.9	1.82
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1} + manure, 40 t ha^{-1}	3.91	2.27	363.2	1.60
Winter wheat				
Control	3.79	2.20	380.2	1.73
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1}	3.98	2.31	415.8	1.80
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1} + manure, 40 t ha^{-1}	3.92	2.27	428.5	1.89

Growth of the share of microbial carbon in the organic carbon content was observed. Significant changes were determined on the plot with sunflower where the increase of the proportion of microbial and organic carbon was on the 28.0-33.6%. The humus content at the fertilized plots was also higher than the control plot, on average by 0.17-0.25%. *E. coli* has been not detected.

Soil enzymes under organic system with wastes were active even in 12 years after the administration of composts use. Urease activity in the chernozem increased on average of 1.3-2.2 times under the influence of composts and dehydrogenase activity of 1.5-1.9 times respectively (Figures 1 and 2).

A long-term soil management practice with wastes application led to increases in the polyphenoloxidase activity by 2.0-4.3 times and the peroxidase activity by 34.6-62.4% compared to the unfertilized control plot (Table 6). The correlation coefficient between humus content and microbial biomass constituted 0.77, dehydrogenase activity 0.72. Thus, the stabilization of indicators of the microbial community and the humus content at the higher level, compared with the initial, indicates the prolonged action of composts with sewage sludge. As a result of the interaction of wastes with soil microorganisms, soil obtains the other quality.

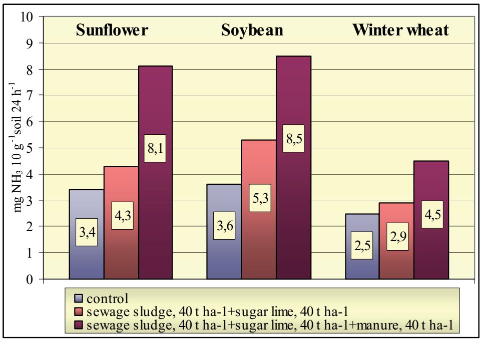

Figure 1. Urease activity of the leached chernozem in conditions of the application of composts with the sewage sludge ($LSD_{0.5}$=1.9)

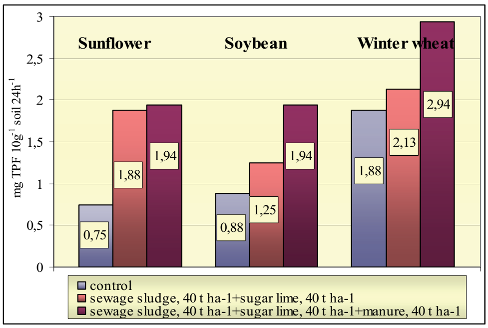

Figure 2. Dehydrogenase activity of the leached chernozem in conditions of the application of composts with the sewage sludge ($LSD_{0.5}$=0.56)

Table 6. Polyphenoloxidase and peroxidase indices of the leached chernozem (12 years after the wastes application)

Variant	Polyphenoloxidase	Peroxidase
	mg 1,4-p-benzoquinone 10 g^{-1} soil 30 min^{-1}	
Sunflower		
Control	2.5	19.5
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1}	3.5	23.5
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1} + manure, 40 t ha^{-1}	4.0	32.8
LSD 5%	0.8	6.5
Soybean		
Control	2.0	19.5
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1}	7.5	33.5
Sewage sludge, 40 t ha^{-1}+ sugar lime, 40 t ha^{-1} + manure, 40 t ha^{-1}	16.3	31.0
LSD 5%	6.8	7.2
Winter wheat		
Control	2.8	22.5
Sewage sludge, 40 t ha^{-1} + sugar lime, 40 t ha^{-1}	3.3	25.8
Sewage sludge, 40 t ha^{-1} + sugar lime, 40 t ha^{-1} + manure, 40 t ha^{-1}	10.8	36.0
LSD 5%	4.3	6.9

CONCLUSIONS

Sewage sludge is a biologically active material but dangerous for the environment with regard to its fecal contamination. As a result of keeping wastes at landfills and mineralization processes intensification, organic carbon, microbial biomass, the number of *E. coli* and enzymatic activity reduced. Microbiological and biochemical parameters depend on storage duration of wastes and organic matter content. Composting of sewage sludge with straw leads to the significant reduction of *E. coli* number. The microbiological testing of sewage sludge should be carried out in each concrete case. The soil management practice with the sewage sludge application and sugar industry waste material and manure contributes to increase the level of microbiological and enzymatic indices in chernozems, which were degraded as a result of the long-term utilization. Composts with sewage sludge have the prolonged action on the microbial community and humus content. The regular microbiological monitoring of the sewage sludge and fertilized lands is mandatory for the environmental safety of soils and crop products.

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RESEARCH REGARDING THE POSSIBILITY OF USE THE WINE YEAST AS FERTILIZER

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Abstract

It was studied the possibility of use as fertilizer the wine yeast, a wine industry waste which results from the settlement of wine after fermentation. Its amount ranges from 12 to 15% of the wine. It has a very heterogeneous composition contains a number of precipitated substances such as tartrates, proteins, polyphenols, polysaccharides, pectin, fats, minerals. The complex and valuable composition of wine yeast show that its utilization is useful both economically and socially, as an indispensable mean to reduce pollutant load of wine cellars and distilleries.

***Key words**: vine, Sauvignon grapes, white wine, wine yeast, organic fertilizer.*

INTRODUCTION

The wine making technology is a complex technological process during which approximately 70% of raw material is used to make the wine. The amount of 30% accumulates as waste (wine yeast) that may represent about 40-80 thousand tons per year (Statistical Yearbook, 2012).
Winemaking also causes environmental problems because of the fact that neutralization process and use of fermentation wastes that are mixed with cyanide compounds containing heavy metals (iron, copper, etc.) that are forming during production of the raw wine represent an evident danger to the environment and human health (Duca, 2011; Ruggieai et al., 2009).
At the same time, wine yeast contains the basic elements necessary for plant nutrition and soil fertility that strongly need to be recovered. One hundred cubic meter of wine yeast contains approximately 190 kg of total nitrogen, 190 kg of phosphorus and 550 kg of total potassium. Based on the above mentioned facts, it was founded a field experiment aiming to highlight fertilizer potential of wine yeast as bio-organic fertilizer with beneficial effects on plants, soil, end products and environment, and with a high economic return. Its rational use in agriculture will solve two major problems: the first – environmental, through reducing environmental pollution and the second – sustainable use of land resources, through soil fertility increase.

MATERIALS AND METHODS

Research and observations were made in 2011-2012 at the Experimental Station "Codru" of Practical Scientific Institute of Horticulture and Food Technology. The experimental field was located on a north-eastern slope with inclination 2-3° (Figure 1).
At the plantation of grape-vine in 1998 soil was deep tilled at a depth of 60 cm with the incorporation of 100 t/ha manure. In the experiment was planted Sauvignon variety. Rootstock cuttings were raised on the type Riparia x Ruperstris 101-14. Scheme of seedlings location is 1.5-2.3 m. The studied soil was a clayey-silty on clay loam leached (cambic) chernozem with a very deep humus profile. The physical-chemical properties of the soil are shown in Table 1.
Experience was founded in three repetitions. The surface of a plot is 55 m^2 (4.6 m x 12 m). Wine yeasts were applied manually. Experience scheme is shown in Table 3.
Each year soil samples were collected from fixed points on the plots for laboratory

analysis. Soil maintenance practices are performed in accordance with the recommendations of technological maps for growing bearing vines. There is liquid wine yeast that results after alcohol extraction and solid yeast obtained after filtration (pressing). In our case were incorporated solid wine yeasts (Figure 2).

Solid wine yeast has a content of 48% water, 46.8% minerals, 5.3% organic matter (Table 2). Among the biofile elements dominate potassium, nitrogen and total phosphorus. One ton of yeast contains 48 kg NPK.

The ratio of these elements is approximately 1.0:0.5:1.7 that corresponds to the needs of vine plant. Carbon-nitrogen index is 16:1, being similar, by capacity to release nitrogen, with mixed manure (17:1).

Chemical and physico-chemical analysis of solid wine yeast, soil, grapes and wines were made by the standards adopted or approved in the Republic of Moldova. Statistical analysis was performed using the method of dispersion and correlation using MS Excel program.

Figure 1. Experimental plot

Figure 2. Solid wine yeast used in the experiment

Table 1. Physical-chemical characteristics of cambic chernozem from the Experimental Station „Codru"

Horizon and depth, cm	**pH (H_2O)**	**$CaCO_3$**	**Humus content**	**total N**	**C:N**	**Mobile forms, mg/100 g sol**		**Exchangeable cations, me/100 g sol**		
		%				**P_2O_5**	**K_2O**	**Ca^{2+}**	**Mg^{2+}**	**Suma**
Ap1 0-16	6.8	0	4.64	0.22	12.2	3.42	43	25.2	3.2	28.4
Ap2 16-43	6.6	0	3.97	0.20	11.5	1.76	16	24.8	4.0	28.8
A 43-80	6.6	0	3.59	0.18	11.4	1.23	15	24.4	4.8	29.2
B1 80-97	6.8	0	1.92	0.11	10.1	0.72	14	23.6	2.8	26.45
B2 97-114	7.6	4.7	1.41	0.08	10.2	0.60	14	24.0	4.0	28.0
BC 114-150	8.0	16.1	0.85	0.06	8.2	0.36	12	20.0	4.0	24.0
BCk 150-195	8.1	14.3	0.56	0	0	0.20	12	18.8	5.2	24.0
Ck 195-205	8.2	13.2	0.36	0	0	0	11	18.0	5.2	23.2

Table 2. Chemical composition of solid wine yeast from wine-making plants used during the experiment (2011-2012), by weight with natural moisture content

Index and measure unit	**x**	**min**	**max**	**S**	**Vm, %**	**Sx**	**Sx%**	**Δx (+,-)**
pH	3.5	3.2	3.7	0.1	3.5	0.1	2.0	0.2
Moisture content, %	48.0	42.0	58.9	9.6	20.0	5.5	11.6	18.0
Organic matter content, %	46.8	38.3	50.3	9.5	20.3	5.5	11.7	17.6
Ash, %	5.3	2.8	8.8	3.1	55.0	1.7	32.0	5.1
Carbon, %	23.4	19.2	25.5	1.2	5.2	0.6	2.6	2.0
Total nitrogen, %	1.5	0.8	1.81	0.6	40.0	0.4	23.0	1.1
$N\text{-}NO_3$, mg/100 g	1.6	0.7	2.8	0.7	42.5	0.3	0.002	1.0
$N\text{-}NH_4$, mg/100 g	32.9	26.9	51.7	2.4	7.3	1.1	3.3	3.6
Total phosphorus, %	0.70	0.6	0.8	0.1	18.5	0.1	10.6	0.2
Total potassium, %	2.6	2.3	2.7	0.3	10.2	0.2	5.8	0.5

RESULTS AND DISCUSSIONS

The research shown that fertilization of cambic chernozem wine yeast led to a significant increase of humus content (Table 3).

At the second year of the experiment humus content increased by 0.11-0.18% in comparison with its initial content (before the incorporation of wine yeast). Also in variants fertilized with yeast increased content of mobile forms of phosphorus and potassium, respectively from 0.47 to 0.72 and from 4.8 to 5.0 mg/100 g soil.

Application of different doses of solid wine yeast did not essentially change the content of soluble salts, soil reaction and aqueous extract composition (Table 4).

The composition of soluble salts remained the same, which is determined by the presence of calcium bicarbonate [$Ca(HCO_3)_2$] and less by magnesium sulfate ($MgSO_4$). Stability of the saline indices and soil pH of cambic chernozem to the action of wine yeasts can be explained by the high buffering capacity of the soil.

Table 3. Modification of agrochemical indices in the 0-30 cm layer of cambic chernozem at the application of solid wine yeast, 2012 (Experimental Station "Codru")

Fertilization variant	Humus content	$N\text{-}NO_3$	P_2O_5	K_2O
2011 (before incorporation of wine yeast)				
1. Unfertilized control	4.28	0.74	2.03	28
2. Wine yeast (N_{100}), 13 t/ha	4.44	0.70	2.21	27
3. Wine yeast (N_{200}), 26 t/ha	4.45	0.90	2.21	28
2012 (increase in comparison with initial content)				
1. Unfertilized control	0.03	0.07	0.05	-0.04
2. Wine yeast (N_{100}), 13 t/ha	0.11	0.47	0.47	4.8
3. Wine yeast (N_{200}), 26 t/ha	0.18	0.51	0.72	5.0
DL 0.5%	0.06	0.12	0.19	3.2

Table 4. Influence of wine yeast on ionic composition of aqueous extract of cambic chernozem in arable layer, 2012 (Experimental Station "Codru")

Fertilization variant	pH (H_2O)	Dry residue, %	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	K^+	Na^+
			me/100 g sol						
1. Unfertilized control	7.3	0.039	0.36	0.07	0.22	0.38	0.19	0.02	0.06
2. Wine yeast (N_{100}), 13 t/ha	7.2	0.041	0.24	0.07	0.33	0.35	0.18	0.02	0.09
3. Wine yeast (N_{200}), 26 t/ha	7.0	0.046	0.15	0.07	0.48	0.39	0.19	0.02	0.10

Application of solid wine yeast in doses 13 and 26 t/ha provided an increase of grape harvest on average in two years 1.05-1.15 t/ha or with 12-13% more than at the unfertilized control 8.7 t/ha (Table 5). Total yield at the incorporation of solid wine yeast in two years was in average 19.5-19.7 t/ha of Sauvignon grapes.

Table 5.Influence of solid wine yeast on the grapes yield grown on the cambic chernozem at the Experimental Station "Codru", 2011-2012

Fertilization variant	2011			2012			total yield		
	t/ha	increase		t/ha	increase		t/ha	increase	
		t/ha	%		t/ha	%		t/ha	%
1. Unfertilized control	9.8	-	-	7.6	-	-	17.4	-	-
2. Wine yeast (N_{100}), 13 t/ha	10.8	1.0	10	8.7	1.1	14	19.5	2.1	12
3. Wine yeast (N_{200}), 26 t/ha	10.9	1.1	11	8.8	1.2	15	19.7	2.3	13
DL 0.5%		0.6			0.7				

To conduct oenological research on wine quality from the experimental vine plantation were harvested grapes from all three variants. In the extracted juice were determined alcohol concentration, sugar content, titratable and volatile acidity, mass concentration of the sulfuric acid and pH of wines. The obtained results are shown in Table 6.

White wine obtained from Sauvignon yield of 2011 is characterized by high values of alcohol concentration (12.6-12.6% vol.) and moderate values of titratable acidity (8.1-8.6 g/dm^3).
It should be mentioned that fertilization of vine plantations with wine yeast had a insignificant influence on physical-chemical indices of wine.
Organoleptic analysis of white wine from Sauvignon variety revealed its beneficial quality, score rating in limits of 7.79-7.88 of points.
On the basis of the obtained results and the results of tasting session it should be mentioned that use of wine yeast as fertilizer in doses of 13-26 t/ha, in the second year of the experiment did not diminished quality of the obtained wine.

Table 6. Physical-chemical indices of wine from variety of white grapes Sauvignon, 2012

Characteristics / **Variant**	**Unfertilized control**	**Wine yeast (N_{100}), 13 t/ha**	**Wine yeast (N_{200}), 26 t/ha**
Grapes yield, kg	50	50	50
Sugars concentration, g/dm^3	206	226	231
Alcohol, % Vol.	12.61	12.64	12.84
Titratable acidity, g/dm^3	8.55	8.55	8.10
Volatile acidity, g/dm^3	0.66	0.66	0.79
Total sulfur dioxide, mg/dm^3	89.6	153.6	153.6
Free sulfur dioxide, mg/dm^3	11.52	15.36	14.08
pH	3.10	3.12	3.15
Organoleptic score	7.88	7.83	7.79

CONCLUSIONS

Application of wine yeast in doses 13-26 t/ha on cambic chernozem in the second year of the experience contributed to a moderate increase of humus content in arable layer (0.11-0.18%).
A significant increase of mobile phosphorus (0.47-0.72 mg/100 g soil) and exchangeable potassium (4.8-5.0 mg/100 g soil) was established.
Incorporation of doses 13-26 t/ha of wine yeast in the second year of action did not modified soluble salts content, soil pH and aqueous extract composition. Fertilization with wine yeast in doses 13-26 t/ha at vine cultivation during two years formed the total yield of 19.5-19.7 t/ha, ensuring a growth of grapes yield about 2.1-2.3 t/ha (or 12-13%).
Incorporation of wine yeast as a fertilizer on cambic chernozem did not have a negative action on white wine quality obtained from Sauvignon variety. The researches in that direction are going to be continued.

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INFLUENCE OF TREATED WASTEWATER IRRIGATION ON WHITE-CORN PLANT

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Abstract

Water shortage and environmental hazards of wastewater have increased the need of wastewater reuse to be used for agricultural irrigation. Experimental approach was used in order to examine the influence of applying treated wastewater as a source of irrigation on physical properties and chemical composition of white-corn, this experiment was performed on a land with an estimated area about 100 m^2 behind the main wastewater treatment plant. The land was divided into three equal cells with different water irrigation types, fresh water, Treated wastewater, and finally alternating irrigation equally with both fresh water and treated wastewater. Physical and chemical tests for white-corn plant were conducted and then analyzed statistically. As a result of analysis, alternating irrigation with water and treated wastewater do not recorded significant difference in term of the physical properties comparing with water irrigation; nevertheless, the wastewater irrigation showed lower physical properties with significant differences. On the other hand, high level of the Total Kjehldal Nitrogen (TKN), Total Phosphorus (TP) and Potassium (K) concentrations found in plant's leaves in case of alternating irrigation. They were evidenced during chemical analyses as the following, 14%, 20% and 33%, respectively.

Key words: *treated wastewater, white-corn, alternating irrigation.*

INTRODUCTION

Gaza Strip lies on the southwestern part of the Palestinian coastal plain. It is very crowded place with an area of 378 km^2 (Mogheir et al., 2005), and it's expected to reside a population of over two million Palestinians by 2020 (Metcalf and Eddy, 2000). The annual average rainfall varies from 400 mm at the north to about 200 mm at south of the Strip (Palestinian Water Authority, 2007). The entire population depends totally upon groundwater as a source of potable water not only for domestic use, but also for agricultural and industrial activities which put more stress on the existing scarce resources (Shomar et al., 2004). The agriculture abstraction alone consumes around two thirds of groundwater which pumped through more than 4000 wells located overall Gaza Strip. The gap between water demand and water supply is currently 55-60 million cubic meters (MCM) per year (Nassar et al., 2009), and is expected to increase with time as a result of rapid population growth in this small area.

The main objective of this study is to estimate the effects of using treated wastewater as a source of irrigation in term of both physical properties and chemical composition of white-corn, by using pilot project.

MATERIALS AND METHODS

A land of 100 m^2 was used in order to carry out the experiment; it was divided into nine district cells grouped later in three equal sets according to the irrigation water type, the nine cells were distributed as a Latin square. First group was irrigated with Fresh Water (FW), second with Treated Wastewater (TW), and last one with both FW and TW in an alternating way (AW). Surface drip irrigation system was used for irrigation in the experiment.

For both FW and TW, three time-difference grab samples were obtained from the end of a dripper line to have one representative composite sample of each water type. Each grab sample was 500 ml in volume. The following parameters considered to be analysed were, Biological Oxygen Demand (*BOD)*, Chemical Oxygen Demand *(COD)*, Total Suspended Solid *(TSS)*, Electrical Conductivity *(EC)*, Potential Hydrogen *(pH)*, Sodium

Adsorption Ratio *(SAR)* and finally with a biological test which was Fecal Coliform *(FC)*.
Plant Height, Plant Thickness and Number of Leaves measurements were conducted for the half of the plants once per week for a period of two and a half months. The measurements were started in the third week after planting and stopped when the fruits started to appear. These parameters were used as an indicator of plants health and the capability of the plant to produce and hold the fruits.

Figure 1. Surface drip irrigation system

Figure 2. Plant height measurement

RESULTS AND DISCUSSIONS

A. Water and Wastewater analyses

The following table (Table 1) shows the concentration of BOD, COD, TSS, EC, pH and SAR of the effluent of Gaza wastewater treatment plant (GWWTP) and the world health organization (WHO) standards for treated wastewater reuse in irrigation.
The table clearly illustrates that the TW used in the experiment meets the WHO standards regarding the reuse issues except the Fecal Coliform concentrations and the salinity.

Table 1. Wastewater parameters (BOD, COD, TSS, EC, PH and SAR and F.C.)

Parameter	FW	TW	WHO standards*
BOD (mg/l)	<10	<10	< 100
BOD (mg/l)	<10	<10	< 150
TSS (mg/l)	0.5	17.4	< 100
EC (µS/cm)	2500	3010	< 2500
pH	7.17	7.64	6.5-9.5
SAR	4.5	8	< 9
F.C	0	1x105	< 2x102

* World Health Organization (WHO), 2006.

B. Physical parameters

1. Plant Height.

Figure 3 shows the average heights of white-corn plants through 7-weeks period of measurements from the beginning of the experiment to the eight week.

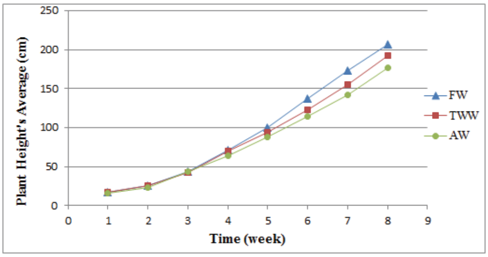

Figure 3. The average heights of white-corn plant of each irrigation type with time

After three weeks of measurements (six weeks after planting), a visible difference among the three groups were observed. FW irrigation recorded the highest height followed by TW irrigation. Alternating water irrigation (AW) recorded the least heights.

2. Plant Thickness.

Figure 4 shows the average thicknesses of white-corn plants through 7-weeks period of measurements for each group.
The figure shows that both FW and TW irrigation were approximately the same in terms of plant thickness from the beginning to the end, whereas after three weeks of measurements (six weeks after planting); AW irrigation started to show different records away from the others. FW and group TW recorded the highest thickness, and AW recorded the lowest.

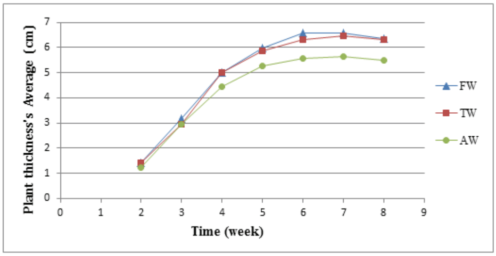

Figure 4. The average plant thicknesses with time of each group

3. Number of Leaves.

Figure 5 shows the average number of leaves of the white-corn plants in each group.

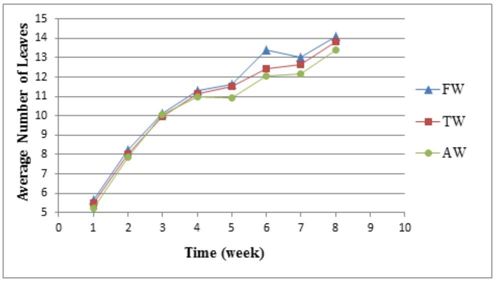

Figure 5. The average number of leaves of each group's plants

In other words, the use of the treated wastewater in irrigation would pose no change on the number of leaves of the plants. This is very important since the leaves in the plant are the places in which the photosynthesis process occurs.

4. Number of Fruits.

Figure 6 shows the number of fruits of each group.

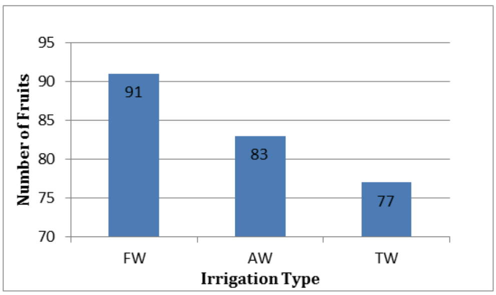

Figure 6. Number of Fruits in each irrigation type

As shown above that the highest number of fruits were recorded for the FW irrigated group, while the lowest number was recorded for the TW irrigated group.

It is clear from Figure 6 that the yield of the white-corn that was irrigated with treated wastewater is lesser than those with tap water.

C. Chemical Analyses Results

Figure 7 presents the results of the chemical analyses for each component.

As demonstrated in Figure 7 each of TKN, TP and K concentrations in white-corn plant's tissue of the AW irrigation, increased by 14%, 20% and 33% respectively as compared to the FW irrigation. Also, it appeared that the AW set was the closest to the FW, which mean that the fresh water can be replaced by the treated wastewater in irrigation in alternating way which is capable of providing the plant with the needed nutrients.

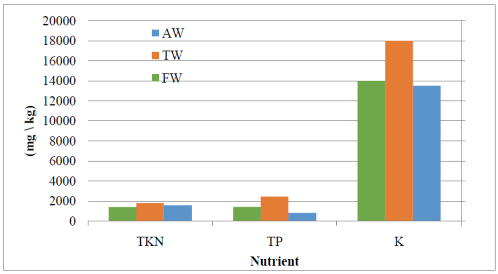

Figure 7. Concentrations of TKN, TP and K in each irrigation type sample

CONCLUSIONS

The results of the statistical and chemical analyses regarding the irrigation with treated wastewater were positive in term of plant's productivity, therefore the treated wastewater can be used in agricultural irrigation with emphasis on the WHO guidelines and regulations regarding the reuse of treated wastewater in agriculture. Since the treated wastewater from GWWTP was in compliance with the WHO standards regarding the reuse of treated wastewater in irrigation, huge amounts of the wasted treated wastewater can serve as a source of water to fulfill the needs of the agriculture sector in Gaza Strip.

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OILCROP-SUN MODEL APPLICATION FOR AGRONOMIC STRATEGIES OF SUNFLOWER CROP

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Abstract

The experiments were carried out to evaluate the performance of DSSAT (OILCROP-SUN) model to simulate growth and development of sunflower hybrids under irrigated conditions in semi arid environment of Sargodha and to determine the impact of varying planting densities and nitrogen levels on achene yield and economic return. The model was evaluated with experimental data collected in trial conducted during spring season in 2010 and 2011. Split split plot design was used in layout of experiment with three replications. The treatments comprised of two hybrids (Hysun-33 and S-278), three planting densities (83,333, 66,666 and 55,555 plants ha^{-1}), with three levels of nitrogen (100, 125 and 150 kg ha^{-1}). The results showed that the model was able to simulate growth and yield of sunflower, with MPD (mean percentage difference) of 5.94% between observed and simulated achene yield. The management strategy consisted of 8.33 plants m^{-2} along with 150 kg N ha^{-1} was the best for high yield and monitory return of sunflower hybrids as simulated by model.

***Key words**: crop management, decision support system for agro-technology transfer, planting densities, nitrogen, achene yield, simulate.*

INTRODUCTION

Per acre achene yield of sunflower in Pakistan is very low and possible reason for it is the non-adoption of new developed short stature hybrids with high fertilizer requirements.

During the last decade, a rising number of researchers throughout the world have invested in plants growth modeling and applications (Fourcaud and Zhang, 2008; Li et al., 2010). Evaluation of a crop simulation model involves establishing confidence in its capability to predict outcomes experienced in the real world. A frequently used method for evaluation of models involves comparing observed values with simulated results in a scatter diagram. Normally a linear regression is used to fit a straight line between observed and simulated values (Smith and Rose, 1995).

The objectives of this study therefore, were, to evaluate the performance of OILCROP-SUN model for management of agronomic practices (planting density and nitrogen) performed under irrigated conditions in semi arid environment of Sargodha and to determine the best management option to increase sunflower productivity.

MATERIALS AND METHODS

The Experiments were conducted at the Research Area of University College of Agriculture, Sargodha (32.05^{o}N, 72.67^{o}E, and 188 m altitude) during the spring seasons of 2010 and 2011.

The experiment was laid out in split split plot design. Sunflower hybrids (Hysun-33, S-278) were kept in main plots, planting densities (83,333, 66,666 and 55,555 plants ha^{-1} by maintaining plant to plant distance 20, 25 and 30cm, respectively) randomized in sub plots and nitrogen rates (100, 125 (standard), 150 kg ha^{-1}) in sub sub plots. 1/3rd dose of nitrogen and all of P and K fertilizer was applied at the time of sowing and remaining 2/3 rd of N was applied in two splits, at first irrigation and flowering stage. All other cultural practices such as hoeing, irrigation and plant protection measures were kept normal for the crop.

Plant sampling and measurements

Phenology and development were recorded during both the vegetative and reproductive phases in both years. An area meter (JVC Model TK-S310EG) was used for the measurement of leaf area and dry weights, leaf area index and total dry matter (gm^{-2}) were recorded at each harvest as explained by Cantagallo et al. (2002), and Hunt et al., (2002).

At final harvest, three rows with a length of 6 m for each plot were harvested. All the head were threshed mechanically to determine achene yield of entire plot and converted into kg ha^{-1}. All weather data was obtained from measurements made at the crop physiology meteorological observatories site.

Weather station provided daily maximum and minimum air temperature (ºC) i.e mean temperature, total rainfall (mm) and mean relative humidity.

Calibration and evaluation of OILCROP-SUN

Data collected during 2010 and 2011 was used as input data for calibration and evaluation of the crop-model.

The model simulation was performed under optimum growth conditions. The comparison of model simulations with the observations assesses accuracy of the model (Hoogenboom et al., 2004).

Standard meteorological, soil, plant characteristics and crop management data was obtained from each site and used as input data for the model (Pereya-Irujo, 2007; Pereya-Irujo et al., 2009). Crop genetic inputs i.e. genetic coefficients was calculated by decision support system for agro-technology transfer (DSSAT V 4.5), by using observed data of two years trial (Tyagi et al., 2000).

he model simulation was performed under optimum growth conditions. The comparison of model simulations with the observations will assess accuracy of the OILCROP-SUN Model (Rinaldi et al., 2003; Hoogenboom et al., 2004).

The experimental files that were used as inputs files includes, weather data file for the experimental period (WeatherMan), soil data of respective experiment (SBuild), crop management data file (XBuild) and crop cultivar coefficients filed (Diodato and Bellocchi, 2007; Trnka et al., 2007). As a part of calibration and evaluation process the simulated data for anthesis date, maturity date, achene yield, and total biomass were compared with the observed values.

Statistical indices

Simulation performance was evaluated by calculating different statistic indices like root mean square error (RMSE), mean percentage difference (MPD), error % and index of agreement (Wallach and Goffinet, 1989). The Index of Agreement (*d*) as described by Willmott et al. (1985) that if the *d*-statistic value is closer to one, then there is good agreement between the two variables that are being compared and vice versa, so it is very important that if value is varies from value of one then there will be weak agreement of the variable that we are being compared with each other.

RESULTS AND DISCUSSIONS

Model calibration

The OILCROP-SUN model was calibrated with experimental data collected during 2010 sunflower crop season.

The cultivar coefficients of Hysun-33 and S-278 were estimated through trial and error and comparison of simulated and observed data. The final values for the two cultivar coefficients that determine vegetative and reproductive growth and development are presented in Table 1.

A close agreement was obtained between simulated and observed values for sunflower phenology.

The model predicted the dates for days to anthesis and physiological maturity with a slight difference between observed and simulated dates for Hysun-33 and S-278 hybrids, respectively.

The simulated and observed values were in good agreement for Leaf area index and above ground biomass at different phonological stages for different combinations of plant density and nitrogen levels (Figures 1 and 2).

The lower values for RMSE and higher d-values close to one reflected that model predicted LAI and above ground biomass quite well.

Table 1. Cultivar coefficients used with OILCROP- SUN Model for sunflower hybrids

Genotype	P_1 (^{0}Cdays)	P_2 (days)	P_5 (^{0}Cdays)	G_2 (Nr)	G_3 (mg day^{-1})	O_1 (%)
Hysun-33	275.0	2.65	580	20	2.99	7
S-278	250.0	2.50	565	75	3.87	0

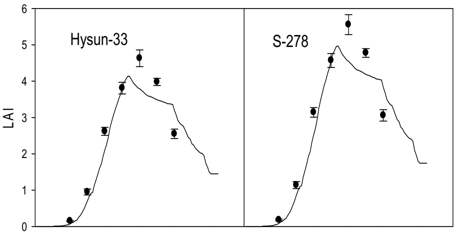

Figure 1. Comparison of simulated and observed values of LAI for sunflower hybrids during modelling calibration against 20 cm plant spacing and 150 kg N ha^{-1} under Sargodha conditions during the year, 2010

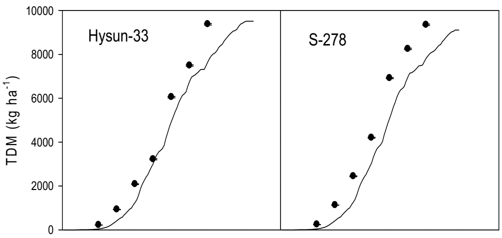

Figure 2. Comparison of simulated and observed values of TDM for sunflower hybrids during modeling calibration against 20 cm plant spacing and 150 kg N ha^{-1}during the year, 2010

Model evaluation

The OILCROP-SUN model was evaluated with experimental data collected during 2011 sunflower crop season. The model predicted the dates for anthesis with RMSE values from 1.65 and 2.20 days for sunflower hybrids Hysun-33 and S-278, respectively with average RMSE value of 1.89 days. Similarly, Mean Percentage Difference (MPD) values were 2.03 and 3.17 for sunflower hybrids Hysun-33 and S-278, respectively with average MPD value of 2.60 (Table 2). The model predicted the dates for physiological maturity with RMSE values from 1.74 and 3.45 days for sunflower hybrids Hysun-33 and S-278, respectively with average RMSE value of 2.60 days. Similarly, Mean Percentage Difference (MPD) values were 1.34 and 2.66 for sunflower hybrids Hysun-33 and S-278, respectively with average MPD value of 2.00 (Table 3). The predicted and observed values for LAI and total above- ground biomass at different phonological stages for different combinations of planting density and nitrogen levels were in a good agreement (Fig 3 and 4). The value for the d-value for LAI and above-ground biomass were ranged from 0.95 and 0.99 (Table 5). The lower values for RMSE and higher d-values close to one revealed that model predicted LAI and above ground biomass quite well. However, the RMSE values for achene yield at final harvest were 194.30 to 214.10 kg ha^{-1} for Hysun-33 and S-278 hybrids, respectively with average RMSE value of 204.20 kg ha^{-1}. Similarly, Mean Percentage Difference (MPD) values were 5.83 and 6.04 for sunflower hybrids Hysun-33 and S-278, respectively with average MPD value of 5.94 (Table 4). In general, the results for model evaluation with the observed data sets indicated the OILCROP-SUN model was able to simulate yield accurately for sunflower hybrids for treatment combinations of plant density and N rates under irrigated conditions for a semi arid environment in Sargodha, Pakistan.

Model application

An analysis for identifying the best agronomic practices (optimum combination of plant density and N levels) for sunflower production was done. The OILCROP-SUN model was used to simulate achene yield for sunflower.

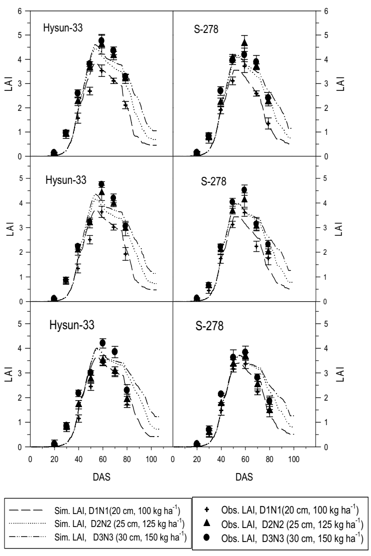

Figure 3. Comparison of simulated and observed values of leaf area index of different sunflower hybrids at varying planting densities and nitrogen rates during 2011

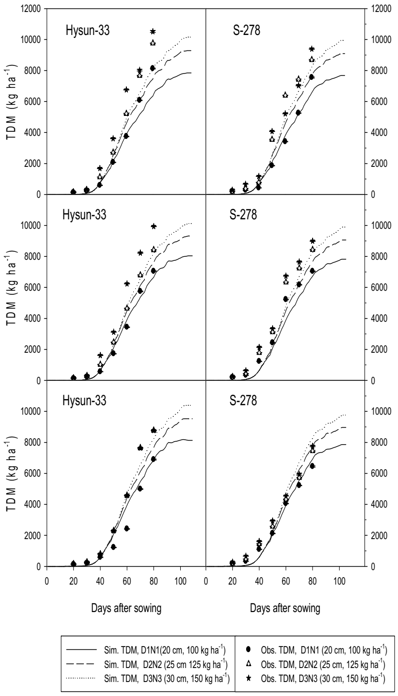

Figure 4. Comparison of simulated and observed values of total dry matter of different sunflower hybrids at varying planting densities and nitrogen rates during the year, 2011

Table 5. d-statistics of time course simulation of LAI and TDM at varying planting densities and nitrogen rates of sunflower hybrids at Sargodha during 2011

Treatments	**d-statistics value (LAI & TDM for Hysun-33)**		**d-statistics value (LAI &TDM for S-278)**	
	LAI	TDM	LAI	TDM
D1N1	0.96	0.98	0.98	0.99
D1N2	0.98	0.98	0.98	0.99
D1N3	0.98	0.98	0.98	0.99
D2N1	0.96	0.98	0.98	0.99
D2N2	0.97	0.99	0.99	0.99
D2N3	0.97	0.99	0.99	0.99
D3N1	0.95	0.95	0.95	0.99
D3N2	0.95	0.95	0.98	0.98
D3N3	0.97	0.99	0.99	0.99

Table 2. Comparison of simulated and observed days to anthesis at different planting densities and nitrogen levels during year, 2011

Location	**Spacing**	**N rates**	**Hysun-33**			**S-278**			**Average**		
	(cm)	**(Kg ha^{-1})**	**Sim**	**Obs.**	**Error (%)**	**Sim**	**Obs**	**Error (%)**	**Sim**	**Obs**	**Error (%)**
Sargodha	**20**	**100**	65	64	1.56	62	60	3.33	64	62	2.45
		125	65	66	-1.52	62	61	1.64	64	64	0.06
		150	65	67	-2.99	62	61	1.64	64	64	0
	25	**100**	65	66	-1.52	62	60	3.33	64	63	0.91
		125	65	66	-1.52	62	61	1.64	64	64	0.06
		150	65	68	-4.41	62	61	1.64	64	65	-1.39
	30	**100**	65	63	3.17	62	58	6.9	64	61	5.04
		125	65	64	-1.56	62	59	5.08	64	62	3.32
		150	65	65	0	62	60	3.33	64	63	1.67
RMSE (days)				1.65			2.2			1.89	
MPD				2.03			3.17			2.6	

Table 3. Comparison of simulated and observed days to anthesis at different planting densities and nitrogen Levels during year, 2011

Location	**Spacing**	**N rates**	**Hysun-33**			**S-278**			**Average**		
	(cm)	**(Kg ha^{-1})**	**Sim**	**Obs.**	**Error (%)**	**Sim**	**Obs.**	**Error (%)**	**Sim**	**Obs.**	**Error (%)**
Sargodha	**20**	**100**	106	107	-0.93	100	97	3.09	103	102	1.08
		125	106	108	-1.85	100	100	0	103	104	-0.93
		150	106	109	-2.75	100	100	0	103	105	-1.38
	25	**100**	106	106	0	100	98	2.04	103	102	1.02
		125	106	108	-1.85	100	98	2.04	103	103	0.09
		150	106	109	-2.75	100	101	0	103	105	-1.87
	30	**100**	106	105	0.95	100	94	6.38	103	100	3.67
		125	106	106	0	100	95	5.26	103	101	2.63
		150	106	107	-0.93	100	96	4.17	103	102	1.62
RMSE (days)				1.74			3.45			2.6	
MPD				1.34			2.66			2	

Table 4. Comparison of simulated and observed achene yield kg ha^{-1} at different planting densities and nitrogen levels during year, 2011

Location	**Spacing**	**N rates**	**Hysun-33**			**S-278**			**Average**		
	(cm)	**(kg ha^{-1})**	**Sim**	**Obs.**	**Error (%)**	**Sim**	**Obs.**	**Error (%)**	**Sim**	**Obs.**	**Error (%)**
Sargodha	**20**	**100**	2542	2569	-1.05	2803	2794	0.32	2673	2682	-0.36
		125	3168	2981	6.27	3448	3424	0.7	3308	3203	3.49
		150	3511	3319	5.78	3740	3610	3.6	3626	3465	4.69
	25	**100**	2446	2438	0.33	2740	2589	5.83	2593	2514	3.08
		125	3091	2889	6.99	3378	3182	6.16	3235	3036	6.58
		150	3384	3195	5.92	3601	3395	6.07	3493	3295	5.99
	30	**100**	2389	2275	5.01	2692	2463	9.3	2541	2369	7.15
		125	3017	2690	12.16	3305	2989	10.7	3161	2840	11.36
		150	3224	2958	8.99	3530	3157	11.2	3377	3058	10.4
RMSE (kg ha^{-1})				194.3			214.1			204.2	
MPD				5.83			6.04			5.94	

CONCLUSIONS

OILCROP-SUN model did well to serve as a tool for determining agronomic practices (the best combination of plant density and nitrogen rates for sunflower cultivation under irrigated semi-arid environment. This study illustrates the potential for using crop simulations models as an information technology for determining suitable management strategies for sunflower production in Sargodha, Punjab, Pakistan. Therefore, we can conclude that the OILCROP-SUN model could potentially assist resource-poor farmers in providing them with alternate management options. However, we suggest that a few years of actual field experiments should be conducted for model evaluation in order to be able to identify the optimum management practices for a specific region and for a specific crop.

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RESEARCH ON THE BEHAVIOR OF SOYBEAN VARIETIES TO BACTERIAL ATTACK CAUSED BY *Pseudomonas savastanoi* pv. *glycinea*

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Abstract

Bacterial burning is a widespread disease in soybeans, which occurs most frequently under cold and wet climate. The objective of this research was to estimate the degree of attack of bacterial burn in soybeans. The goal was to have the necessary information in making decisions applying for phytosanitary treatments.
Twenty-five varieties were tested: Columna, Condor, Daciana, Diamant, Dukatt, Eugen, Felix Novisad, Felix PR, Fortezza, Galina, Julija, Merkur, Onix, Perla, PR 20, Procera 12-2, Rubin, Sultana, Sponsor, Tea, Triumf Fundulea, Triumf Novisad, Venera, Victoria and Zora, and observations were made under natural contamination on the 13th of July and August 28, 2013.
The research was conducted in the experimental fields without irrigation, in I. C. Bratianu city, county of Tulcea. From this paper it can be concluded that one of the main limiting factors in soybean crop is found in a very large extent of the phytosanitary nature, like the attack of the bacteria Pseudomonas savastanoi pv. glycinea. The degree of infection varied from one variety to another.
The study was developed during the proces of doctoral studies.

Key words**:** *attack, disease, bacterial burning, soybean, cultivars.*

INTRODUCTION

Native to the eastern half of northern China, where it was reported around the eleventh century BC (Shang Dynasty), soybeans were introduced and expanded in culture in Romania, much later, since 1911 (Dencescu and Popa, 1973).
Widely cultivated soybean is susceptible to diseases, the most common being the bacterial ones (Kennedy and Tachibana, 1973; Jagtap and Dey, 2012).
In 1908, Smith named „*Bacterium savastanoi*" the bacterium which causes knots on several plants belonging to the family *Oleaceae*. This species was later transferred to the genus *Pseudomonas* as "*Pseudomonas savastanoi*" by Stevens.
In 1978, Young et al. proposed a new nomenclature and classification for plant-pathogenic bacteria and introduced the concept of pathovar, and all fluorescent oxidasenegative *Pseudomonas* species (except *Pseudomonas viridifrava*) were considered to be members of a single species, *Pseudomonas syringae*, which had a number of pathovars.
Thus, *Pseudomonas savastanoi* became *Pseudomonas syringae* pv. *savastanoi*.
Pseudomonas savastanoi pv. *glycinea* (Janse, 1982; Gardan et al., 1992) synonymous *Pseudomonas syringae* pv. *savastanoi* (Coerper, 1919) Young, Dye et Wilkie (1978) is a biotic factor, which plays a limiting role soybeans under favorable conditions, the attack decreasing the production.
Pseudomonas savastanoi pv. *glycinea* (Janse, 1982) is a *Proteobacteria*, class: *Gamma Proteobacteria*, order: *Pseudomonadales*, family: *Pseudomonadaceae*, a Gram-negative, rod-shaped, aerobic and motile possessing several polar flagella (Garrity et al., 2005).
Under certain environmental conditions, serious economic losses can occur.
The research was conducted in the experimental fields without irrigation, in I. C. Brătianu city, county of Tulcea.
The results of this paper are part of doctoral thesis.

The objective of this research was to estimate the degree of attack of bacterial burning in soybeans.

MATERIALS AND METHODS

Twenty-five cultivars were tested: Columna, Condor, Daciana, Diamant, Dukatt, Eugen, Felix Novisad, Felix PR, Fortezza, Galina, Julija, Merkur, Onix, Perla, PR 20, Procera 12-2, Rubin, Sultana, Sponsor, Tea, Triumf Fundulea, Triumf Novisad, Venera, Victoria and Zora.

Visual observation is the fastest method to identify a disease based on signs and symptoms shown by infected soybean plants. This method involves a high degree of subjectivity, depending largely on the diagnosing person's level of knowledge.

Scouting for *Pseudomonas savastanoi* pv. *glycinea* attack has a particular importance in soybean to 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 plant attacked out of 100 examined soybean plants.

Intensity indicates the degree to which the soybean plant is attacked under examination. Intensity was noted directly in percentage.

The attack degree present severity of bacterial burning in the crop and was calculated using the frequency (disease incidence) and intensity (severity).

Attack degree was calculated using the formula:

$$A.D. = \frac{F\%\ x\ I\%}{100}$$

The experimental block surface was placed in three repetitions.

Observations were made under natural contamination on the 13th of July, at growth stage R1 and August 28, 2013, at growth stage R4 (Fehr et al., 1971).

RESULTS AND DISCUSSIONS

Diseased plants manifested only lesions on the leaves. The lesions of bacterial burning usually begin as small, angular and yellow.

Lesions progress in color from yellow to light brown and eventually to a dark reddish brown. Older lesions have a dark center surrounded by a water-soaked margin and a yellow halo.

Angular lesions may enlarge and merge, producing large, irregular dead areas in the leaf. With wind and rain these large dead areas drop out or tear away, giving the leaf a ragged appearance (Figure 1).

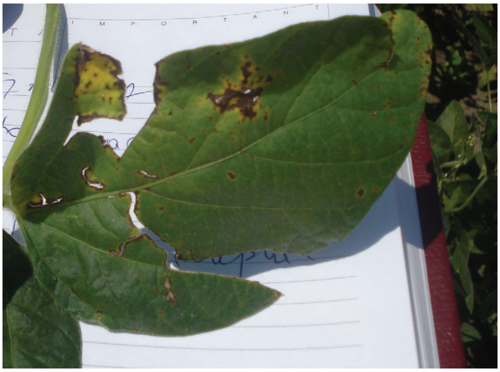

Figure 1. Ragged appearance of foliage resulting from bacterial burning

Scouting in growth stage R1.

The data presented in Table 1 show the results on the behaviour of some soybeans cultivars to the pathogen *Pseudomonas savastanoi* pv. *glycinea* under natural contamination.

It is noteworthy that there was no attack of *Pseudomonas savastanoi* pv. *glycinea* in Sponsor cultivar during years 2013.

The cultivars Dukatt, Eugen, Julija, Perla and Procera 12-2 showed no symptoms of bacterial burning at first scouting.

At the same scouting stage cultivars Onix and PR 20 showed the lowest attack degree (0.01%) *Pseudomonas savastanoi* pv. *glycinea*.

Low values of the attack degree presented the cultivars Triumf Novisad (0.15%), Sultana (0.25%), Condor and Diamant (0.5%).

Table 1. Scouting the attack of bacterial burn on tested soybean cultivars investigated
(I. C. Brătianu city, county of Tulcea, 2013)

Cultivars	Scoring growth stage					
	R1			R4		
	F[1] (%)	I[2] (%)	AD[3] (%)	F (%)	I (%)	AD (%)
Columna	10	10	1	70	15	10.5
Condor	10	5	0.5	10	5	0.5
Daciana	33.3	15	5.02	95	20	19
Diamant	10	5	0.5	80	30	24
Dukatt	0	0	0	30	2	0.6
Eugen	0	0	0	95	35	33.25
Felix Novisad	30	20	6	30	25	7.5
Felix PR	21.6	20	4.3	95	35	33.25
Fortezza	31.6	10	3.16	80	5	4
Galina	80	45	36	90	65	58.5
Julija	0	0	0	80	5	4
Merkur	10	10	1	85	24	20.4
Onix	1	1	0.01	65	3	1.95
Perla	0	0	0	100	40	40
PR 20	1	1	0.01	10	1	0.1
Procera 12-2	0	0	0	5	5	0.25
Rubin	20	10	2	85	10	8.5
Sultana	5	5	0.25	95	30	28.5
Sponsor	0	0	0	0	0	0
Tea	33.3	9	3.0	95	15	14.25
Triumf Fundulea	13.3	25	3.32	35	35	12.25
Triumf Novisad	3	5	0.15	15	5	0.75
Venera	15	10	1.5	45	30	13.5
Victoria	20	5	1.0	40	5	2
Zora	45	5	2.25	100	35	35

[1]F (%) = Frequency; [2]I (%) = Intensity; [3]AD (%) = Attack degree.

Galina cultivar showed at first scouting the highest attack degree of bacterial burning (36%).

Scouting at growth stage R4.

In the second scouting stage frequent plants attacked by bacterial burning ranged from 0% (Sponsor cultivar) to 100% (Perla and Zora cultivars), and the intensity of the attack ranged from 0% (Sponsor cultivar) to 65% (Galina cultivar).

Like in the case of first scouting, Galina cultivar showed the highest attack degree of bacterial burning (58.5%) at this growth stage also.

Perla and Eugen cultivars had a spectacular evolution to *Pseudomonas savastanoi* pv. *glycinea* attack from the first scouting to the second one. Thus, if the first scouting no attack was recorded, it reached 33.25% for Eugen cultivar and 40% for Perla cultivar in the growth stage R4.

Very low values of the attack degree of bacterial burning in both two scouting had PR 20 (0.1%), Procera 12-2 (0.25%), Condor (0.5%), Dukatt (0.6%) and Triumf Novisad (0.75%) cultivars.

In our opinion, a good behavior against *Pseudomonas savastanoi* pv. *glycinea* attack manifested Victoria (2%), Fortezza and Julija cultivars with 4% attack degree.

If Galina cultivar was very sensitive to *Pseudomonas savastanoi* pv. *glycinea*, it can be said that Eugen (33.25% attack degree), Felix PR (with the same percentage of attack) and Sultana (28.5%) cultivars cultivars were sensitive.

Mention that in the case of Galina, Dukatt, Fortezza and Venera cultivars symptoms of bacterial burning occurred on the lower leaves of the plant floor. The other cultivars had symptoms on the leaves of the upper floor.

CONCLUSIONS

Bacterial burning in soybeans was limited to leaves.

Sponsor cultivar showed that was not susceptible to *Pseudomonas savastanoi* pv. *glycinea* during years 2013.

Galina cultivar showed the highest attack degree of bacterial burning during years 2013.

Very low values of the attack degree of bacterial burning were registered for PR 20 (0.1%), Procera 12-2 (0.25%), Condor (0.5%), Dukatt (0.6%) and Triumf Novisad (0.75%) cultivars.

Galina, Dukatt, Fortezza and Venera cultivars symptoms of bacterial burning occurred on the lower leaves of the plant floor while the other cultivars had symptoms on the leaves of the upper floor.

ACKNOWLEDGEMENTS

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ABOVE-GROUND BIOMASS OF SUNFLOWER PLANT UNDER DIFFERENT PLANTING PATTERNS AND GROWING CONDITIONS

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Abstract

Studies regarding the effect of different planting patterns are of great interest and importance, especially when they are performed in different growing conditions. Plant growth, plant biomass and plant yield are conditioned by factors such as row spacing and plant population, which are of great importance.
The aim of this study was to identify how the planting patterns, respectively row spacing and plant population, associated with diferent soil and climatic conditions, and sunflower hybrid are influencing the above-ground dry biomass of the whole plant and of the plant components. Also, the objective was to identify the share of dry biomass on different plant components, as well as the moisture content of the whole plant and its components. The determinations were performed in the early dough - dough growth stage of the sunflower plants.
Researches were performed in field experiments in the year 2013, in two locations from South Romania, respectively Fundulea (44°28' N latitude and 26°27'56" E longitude), and Moara Domneasca (44°29' N latitude and 26°15' E longitude). The studied sunflower hybrids were the followings: Pro 111, LG56.62, P64LE19, Pro 953. Each hybrid in the two locations was studied under three row spacing (75 cm, 50 cm, and twin-rows of 75/45 cm) and three plant populations (50,000, 60,000, and 70,000 plants ha^{-1}).

Key words: *sunflower, plant biomass, row spacing, plant population, soil conditions.*

INTRODUCTION

Plant growth, plant biomass and plant yield are conditioned by different factors, amoung which the planting patterns are of great importance, respectively row spacing and plant population. Thus, Barros et al. (2004) revealed that uniform adjustment of the crop spacing in the field is one of the most important factors determining yield and quality of sunflower (Asghar et al. 2007).

Plant population based on row and plant spacing is a major part of agronomic practices (Beg et al., 2007). Increasing of plant population from 35,000 to 65,000 plants ha^{-1} led to the diminishing of dry biomass of sunflower plant (Ion et al., 2004; Stefan et al., 2008).

Barros et al. (2004) revealed that the highest plant density presented a significantly lower mean seed weight, probably this behaviour may be the result of a lower dry matter weight per plant in this plant density with the consequence of a reduced assimilate translocation during the seed filling period.

Romania has favourable conditions for growing sunflower (*Helianthus annuus* L.), this being the most important oil crop (Ion et al., 2013). From this perspective, studies regarding the effect of different planting patterns are of great interest and importance.

The aim of this study was to identify how the planting patterns, respectively row spacing and plant population, associated with diferent soil and climatic conditions, and sunflower hybrid are influencing the above-ground dry biomass of the whole plant and of the plant components. Also, the objective was to identify the share of dry biomass on different plant components, respectively leaves, stalk, and head, as well as to identify the moisture content of the whole plant and its components.

MATERIALS AND METHODS

Researches were performed in field experiments in 2013, in two locations from South Romania, respectively Fundulea (44^{o}28' N latitude and 26^{o}27'56" E longitude), Calarasi County, and Moara Domneasca (44^{o}29' N latitude and 26^{o}15' E longitude), Ilfov County. The soil from Fundulea area is chernozem (cambic chernozem soil), and the soil from Moara Domneasca area is reddish preluvosoil.
From September 2012 to August 2013, in Fundulea area the average temperature was of 12.0^{o}C and the sum of rainfall of 700.6 mm, and in Moara Domneasca area the average temperature was of 12.6^{o}C and the sum of rainfall of 288.0 mm.
The studied sunflower hybrids were the followings: Pro 111, LG56.62, P64LE19, Pro 953. Each hybrid in the two locations was studied under three row spacing (75 cm, 50 cm, and twin-rows of 75/45 cm) and three plant populations (50,000, 60,000, and 70,000 plants ha^{-1}).
The field experiments were performed in four replications, with a number of variants of 36. The sowing was performed on 17th of April at Fundulea and on 25th of April at Moara Domneasca. The cultivation technology was a regular one for South Romania, under rainfed conditions.
In each location and from each variant a number of three sunflower plants were cut at soil level and analyzed for determining the fresh biomass (above-ground biomass). The plants were weighed directly into the field as total and plant components, respectively leaves, stalk, and head. The components of one sunflower plant for each variant were taken into the laboratory for determining the dry biomass by oven drying at 80^{o}C for 24 hours. The determinations were performed in the early dough - dough plant growth stage, respectively on 2nd of August at Fundulea (chernozem soil), and on 1st of August at Moara Domneasca (reddish preluvosoil).
Based on dry biomass of the plant components, it was established the share of the dry biomass on these components, respectively leaves, stalk, and head. Also, based on fresh and dry matter values, moisture content of the whole plant and plant components was calculated.
The obtained data were statistically processed by analyses of variance.

RESULTS AND DISCUSSIONS

1. **Dry biomass of sunflower plant.**
   a. **Dry biomass of sunflower plant at different row spacing.**

On chernozem soil, which was associated in our study with favourable growing conditions for sunflower plants, compared to the row spacing of 75 cm, the dry biomass of sunflower plant at narrow rows (50 cm and twin-rows of 75/45 cm) registered negative differences statistically significant (Figure 1.a). The most negative significant difference was registered at row-spacing of 50 cm. This situation is found out at all sunflower plant components, respectively leaves, stalk, and heat.
On reddish preluvosoil, which was associated in our study with less favourable growing conditions for sunflower plants, compared to the row spacing of 75 cm, the dry biomass of sunflower plant at narrow rows (50 cm and twin-rows of 75/45 cm) registered positive differences (Figure 1.b). The differences were statistically significant at twin-rows of 75/45 cm, both for the whole plant and its components (leaves, stalk, and heat).
Under favourable growing conditions, it seems to be more suitable the row spacing of 75 cm, while under less favourable growing conditions, the sunflower plants are using better the growth factors at narrow rows, especially at twin-rows of 75/45 cm.

   b. **Dry biomass of sunflower plant at different plant population.**

On chernozem soil, compared to the plant population of 50,000 plants ha^{-1}, the increasing of plant population determined the decreasing of dry biomass of sunflower plant (Figure 2.a). The differences were negative statistically significant at plant population of 70,000 plants ha^{-1}. Concerning the sunflower plant components, only the dry biomass of leaves registered negative differences statistically significant at 70,000 plants ha^{-1}.
On reddish preluvosoil, compared to the plant population of 50,000 plants ha^{-1}, the increasing of plant population determined the decreasing of dry biomass of sunflower plant, but without registering any differences statistically

significant (Figure 2.b). So, it can be concluded that once with less favourable growing conditions, the increasing of plant population is determining a less important decreas of dry biomass of sunflower plant. But, less favourable growing conditions is associated with smaller values of dry biomass of sunflower plant compared to the favourable growing conditions. Thus, i.e. the dry biomass of sunflower plant registered at plant population of 50,000 plants ha^{-1} under favourable growing conditions was of 300.97 g (Figure 2.a), while under less favourable growing condition the value was of 233.25 g (Figure 2.b).

c. **Dry biomass of plant at different sunflower hybrids.**

On chernozem soil, compared to the average value of the four studied sunflower hybrids, the hybrid Pro 111 registered positive differences statisticaly significant for plant dry biomass, this being due to the dry biomass of leaves and stalk (Figure 3.a). Negative differences statisticaly significant for plant dry biomass were registered at hybrid Pro 953, this being due mainly to the dry biomass of head.

On reddish preluvosoil, because of the less favourable growing conditions, the values of dry biomass of sunflower plant were smaller and without differences statisticaly significant (Figure 3.b).

It can be concluded that differences concerning plant dry biomass between sunflower hybrids are more evident under favourable growing conditions, which give to the sunflower plants the possibility to express their genetic potential.

2. **Share of dry biomass on sunflower plant components.**

a. **Share of dry biomass at different row spacing.**

On chernozem soil, the narrow rows determined an increase of the share of dry biomasss of stalk from the whole sunflower plant biomass, the highest value being obtained at twin-rows of 75/45 cm (39.34%) (Figure 4.a). Also, the highest value of the share of dry biomass of leaves was registered at twin-rows of 75/45 cm (19.37%). But, the highest value of the share of dry biomass of head was registered at row spacing of 50 cm (43.65%).

On reddish preluvosoil, the highest value of the share of dry biomass of stalk was registered at row spacing of 75 cm (38.31%) (Figure 4.b). As in the case of chernozem soil, the highest value of the share of dry biomass of leaves was registered at twin-rows of 75/45 cm (22.93%), while the highest value of the share of dry biomass of head was registered at row spacing of 50 cm (42.76%).

b. **Share of dry biomass at different plant population.**

On chernozem soil, the increasing of plant population determined an increase of the share of dry biomass of head, but a decrease of the share of dry biomass of leaves from the whole sunflower plant biomass (Figure 5.a). The highest values of the share of dry biomass of leaves and stalk were registered at 50,000 plants ha^{-1}. The highest value of the share of dry biomass of head was registered at 70,000 plants ha^{-1}. Even the share of dry biomass of stalk registered the highest value at 50,000 plants ha^{-1}, the values at 60,000 and 70,000 plants ha^{-1} are slightly different.

On reddish preluvosoil, the increasing of plant population determined an increase of the share of dry biomass of stalk, but a decrease of the share of dry biomass of leaves from the whole sunflower plant biomass (Figure 5.b). The highest value for the share of head was registered at 60,000 plants ha^{-1}.

c. **Share of dry biomass at different sunflower hybrids.**

On chernozem soil, the highest value of the share of dry biomass of leaves was registered at hybrid Pro 953, the highest value of the share of dry biomass of stalk was registered at hybrid Pro 111, and the highest value of the share of dry biomass of head was registered at hybrid P64LE19 (Figure 6.a).

On reddish preluvosoil, the highest values of the share of dry biomass of leaves and stalk were registered at hybrid Pro 111, while the highest value of the share of dry biomass of head was registered at hybrid P64LE19 (Figure 6.b).

3. **Moisture content of the sunflower plant.**

a. **Moisture content of the sunflower plant at different row spacing.**

On chernozem soil, the narrow rows determined a decrease of the moisture content of sunflower plant (Figure 7.a). The smallest moisture content was registered at row spacing of 50 cm (80.14%), this being determined especialy by the moisture content of the head (76.92%).

On reddish preluvosoil, the narrow rows determined an increase of the moisture content of sunflower plant (Figure 7.b). The highest values of the moisture content of sunflower plant were registered at row spacing of 50 cm (80.99%), this being determined especialy by the moisture content of the stalk (83.64%).

b. Moisture content of the sunflower plant at different plant population.

On chernozem soil, the increasing of plant population decreased the moisture content of the sunflower plant (Figure 8.a), this being due to the decreasing of moisture content of all the plant components (leaves, stalk, and head). The smallest values for the moisture content of the sunflower plant and its components were registered at 70,000 plants ha^{-1}.

On reddish preluvosoil, opposite the situation found on chernozem soil, the increasing of plant population increased the moisture content of the sunflower plant, the differences being statisticaly significant (Figure 8.b), both for the whole sunflower plant and its components. The highest values for the moisture content of the sunflower plant and its components were registered at 70,000 plants ha^{-1}.

c. Moisture content of the plant at different sunflower hybrids.

On chernozem soil, the highest value of the moisture content of the sunflower plant was registered at hybrid Pro 111, this being due to the moisture content of the stalk and head (Figure 9.a). The smallest value of the moisture content of the sunflower plant was registered at hybrid LG56.62, this being also due to the moisture content of the stalk and head, which registered negative differences statistically significant compared to the average values of the four studied sunflower hybrids.

On reddish preluvosoil, opposite the situation found on chernozem soil, the highest value of the moisture content of the sunflower plant was registered at hybrid Pro 953, this being due to the moisture content of the stalk (Figure 9.b). As in the case of the chernozem soil, the smallest value of the moisture content of the sunflower plant was registered at hybrid LG56.62, this being due to the moisture content of the head and leaves, which registered negative differences statistically significant compared to the average values of the four studied sunflower hybrids.

4. Average values of share of dry biomass on sunflower plant components.

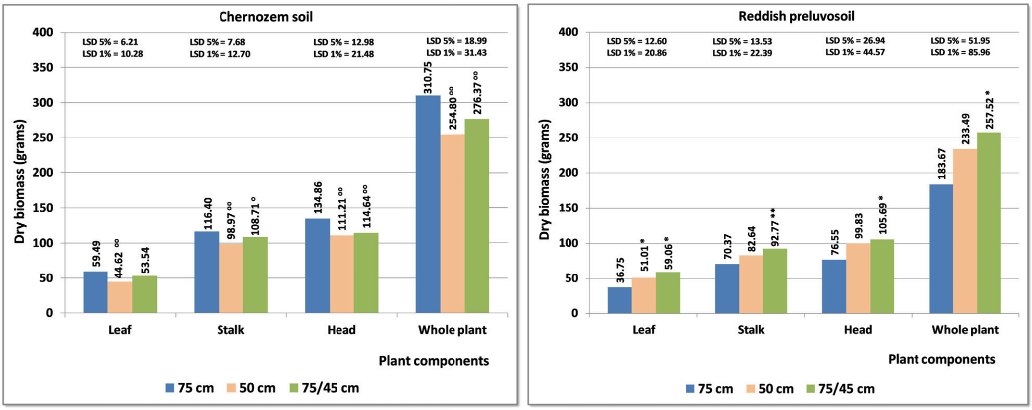
On chernozem soil, respectively on favourable growing conditions for sunflower plants, the average share of the dry biomass of the stalk and head (as average values for all the row spacing, plant population, and sunflower hybrids) registered higher values than on reddish preluvosoil, respectively on less favourable growing conditions for sunflower plants. But, the average share of the dry biomass of leaves registered higher values on less favourable growing conditions for sunflower plants (Figure 10.a).

The average values for the share of the dry biomass for all the experimental conditions, including the soil and climatic conditions, were the followings: 20.16% for leaves, 37.47% for stalk, and 42.36% for head.

5. Average values of moisture content of the sunflower plant components.

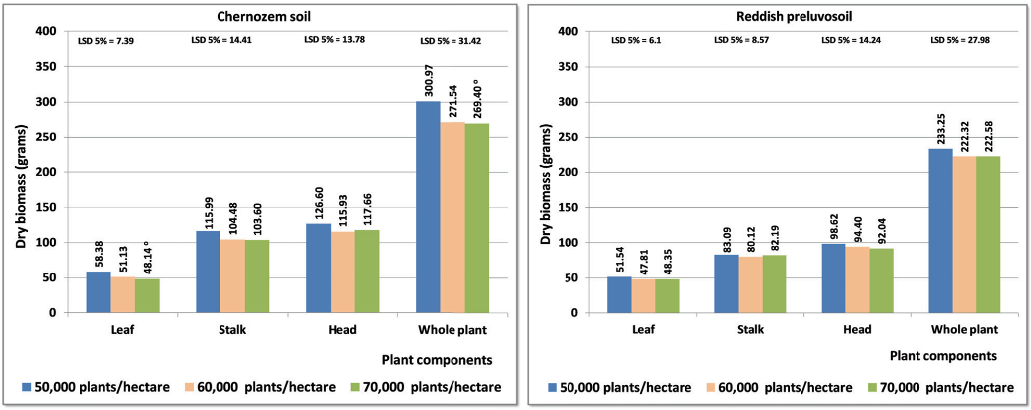
The average values of the moisture content of the whole sunflower plant were practicaly the same on chernozem soil and reddish preluvosoil, respectively 80.2% (Figure 10.b). On chernozem soil, respectively on favourable growing conditions for sunflower plants, the average moisture content of the stalk and leaves (as average values for all the row spacing, plant population, and sunflower hybrids) registered higher values than those on reddish preluvosoil, respectively on less favourable growing conditions for sunflower plants. But, the average moisture content of head registered higher values on less favourable growing conditions for sunflower plants (Figure 10.b).

The average values for the moisture content for all the experimental conditions, including the soil and climatic conditions, were the followings: 77.5% for leaves, 82.44% for stalk, and 78.8% for head.



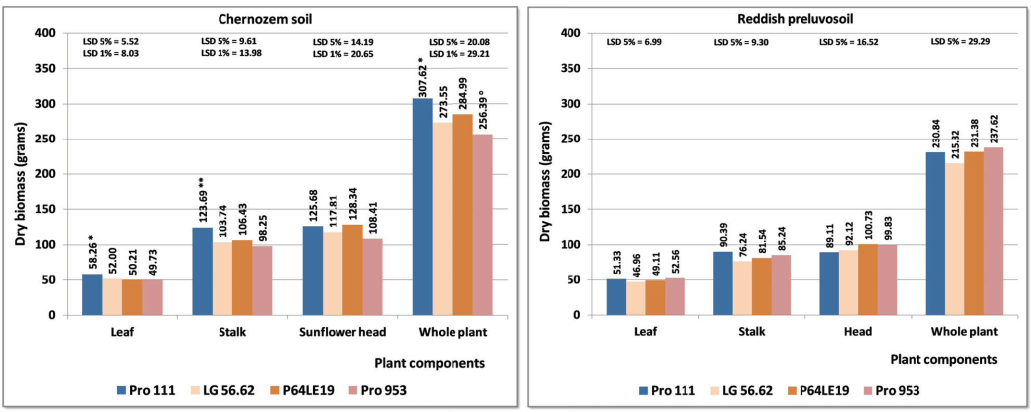
a) b)

Figure 1. Dry biomass on sunflower plant components at different row spacing and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



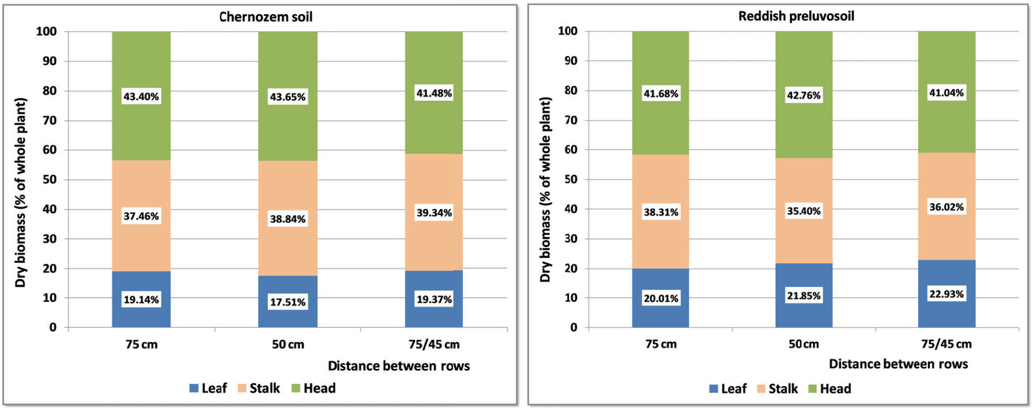
a) b)

Figure 2. Dry biomass on sunflower plant components at different plant population and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



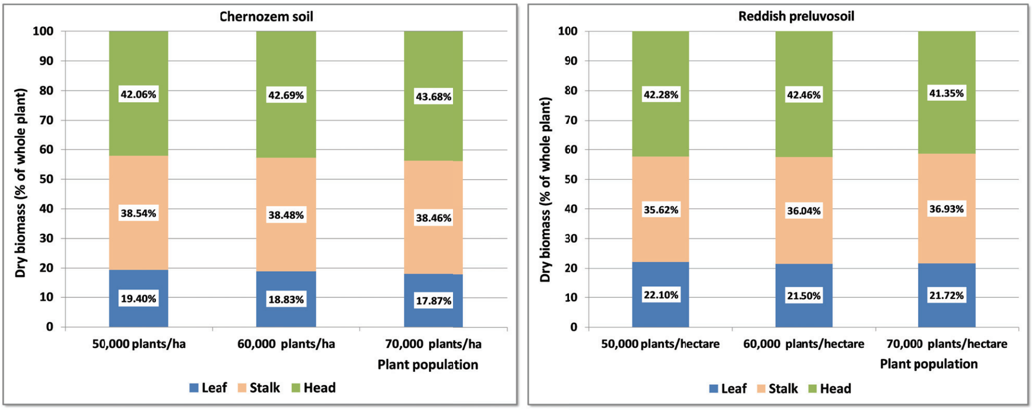
a) b)

Figure 3. Dry biomass on plant components at different sunflower hybrids and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



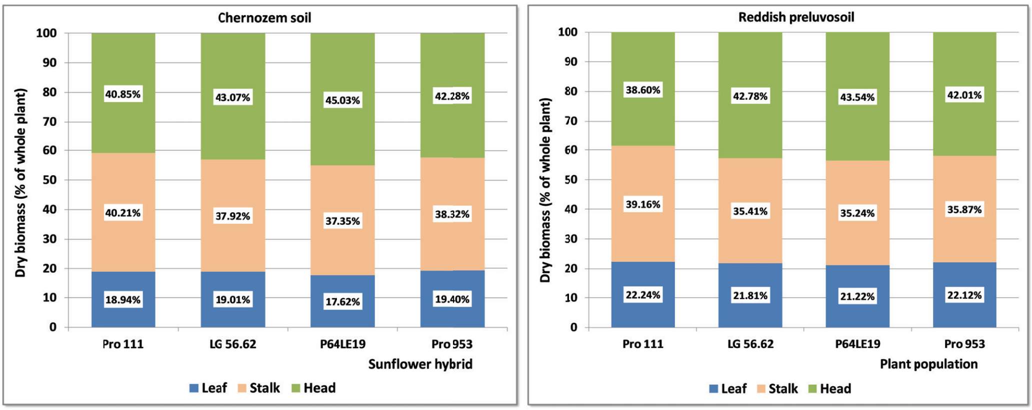
a) b)

Figure 4. Share of dry biomass on sunflower plant components at different row spacing and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



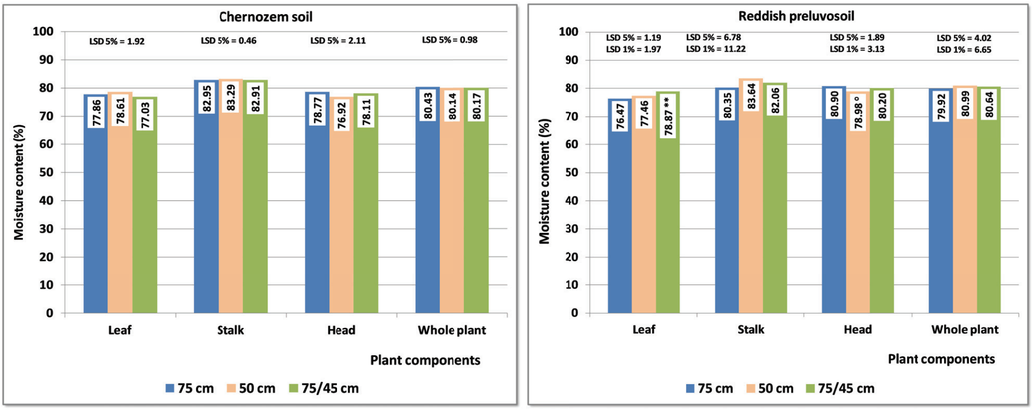
a) b)

Figure 5. Share of dry biomass on sunflower plant components at different plant population and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



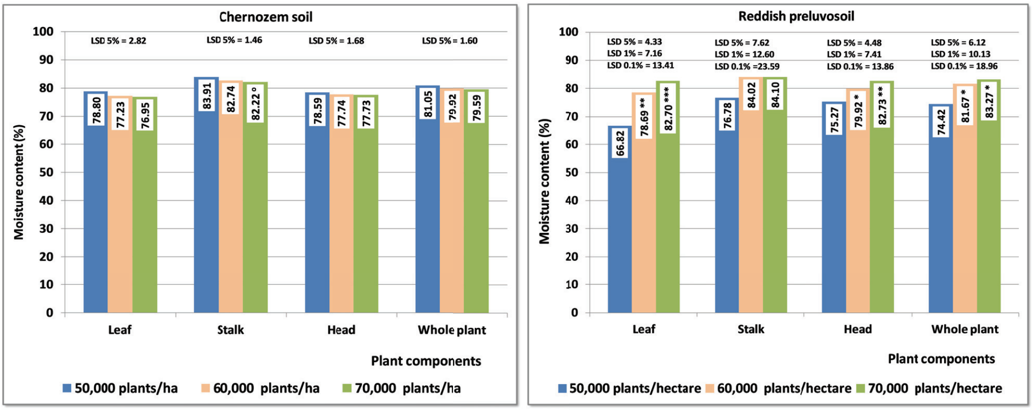
a) b)

Figure 6. Share of dry biomass on plant components at different sunflower hybrids and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



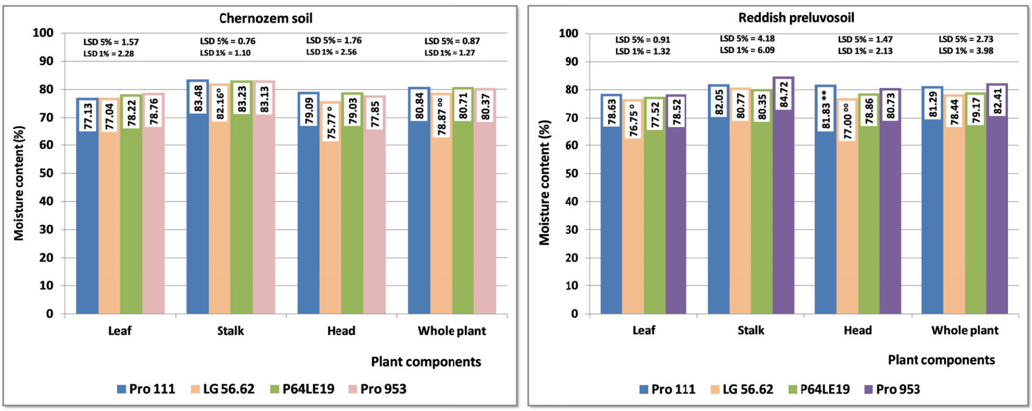
a) b)

Figure 7. Moisture content of the sunflower plant components at different row spacing and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



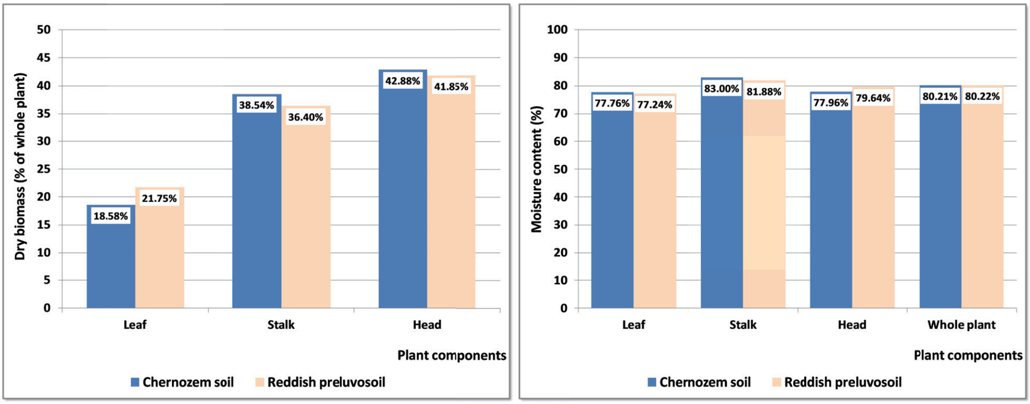
a) b)

Figure 8. Moisture content of the sunflower plant components at different plant population and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



a) b)

Figure 9. Moisture content of the plant components at different sunflower hybrids and in different soil and climatic conditions in South Romania, in the early dough-dough plant growth stage



a) b)

Figure 10. Average values of share of dry biomass on sunflower plant components (a) and moisture content of the sunflower plant components (b) in different soil and climatic conditions in South Romania, in the early dough-dough growth stage of the sunflower plant

CONCLUSIONS

The dry biomass of the sunflower plant in the early dough-dough growth stage was positively influenced by wide rows (75 cm) under favourable growing conditions, and by narrow rows under less favourable growing conditions (especially twin-rows of 75/45 cm).

The increasing of plant population decreased the dry biomass of the sunflower plant in the early dough-dough growth stage.

Differences between sunflower hybrids concerning the dry biomass of the plant in the early dough-dough growth stage are more evident under favourable growing conditions. This is due to the fact that the sunflower plants have the possibility to express better their genetic potential.

The row spacing of 50 cm determined the highest share of dry biomass of head from the whole dry biomass of the sunflower plant, and the twin rows of 75/45 cm determined the highest share of dry biomass of leaves, both under favourable and less favourable growing conditions.

The plant population of 50,000 plants ha^{-1} determined the highest share of dry biomass of leaves. The increasing of plant populations determined the highest share of dry biomass of stalk and head, especially under less favourable growing conditions.

Under favourable growing conditions for sunflower plants, the share of the dry biomass of the stalk and head registered higher values than under less favourable growing conditionsm, while for the dry biomass of leaves is on the contrary.

The narrow rows and the increasing of plant population determined a deacreas of the moisture content of sunflower plant in the early dough-dough growth stage under favourable growing conditions, and an increase of the moisture content of sunflower plant under less favourable growing conditions.

The average moisture content of the whole sunflower plant in the early dough-dough growth stage was almost the same (80.2%) in different growing conditions. But, under favourable growing conditions for sunflower plants, the moisture content of the stalk and leaves registered higher values than those under less favourable growing conditions, while for the moisture content of head is on the contrary.

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ESTIMATES FOR BROAD SENSE HERITABILITY AND HETEROSIS OF AGRONOMIC AND QUALITY CHARACTERS OF SAFFLOWER (*Carthamus tinctorius* L.)

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Abstract

The present research was conducted in between 2008 and 2011 at Suleyman Demirel University, Faculty of Agriculture, Department of Field Crops, Isparta Turkey (latitude 37°45'N, longitude 30°33'E, altitude 997 m). In study was estimated to genotypic (σ_g^2) and phenotypic (σ_p^2) variances, broad sense heritability (h^2_b) and heterosis value of agronomic and quality characters of F_1 and F_2 plants derived from a cross between Dinçer 5-118 and Montola 2000 cultivars. In F_1 generation, heterosis and heterobeltiosis were high and positive for plant height, head number per plant, 1000 seed weight, seed yield per plant, palmitic acid and linoleic acid. In addition, heterosis and heterobeltiosis were low and positive for branches number, harvest index and oil content. On the other hand, heterobeltiosis was negative for seed number per head and oleic acid. The highest broad sense heritability was estimated seed number per head, 1000 seed weight, oleic acid and linoleic acid (80.1, 81.1, 99.4 and 99.3%, respectively). The broad sense heritability were estimated as 64.1% for plant height, 54.3% for primary branches, 74.7% for head number per plant, 72.1% for harvest index, 55.2% for seed yield per plant, 67.6% for oil content, 47.3% for palmitic acid and 48.2% for stearic acid. The results of this study indicated that plant height, head number per plant, 1000 seed weight, seed number per head, harvest index, oil content, oleic acid and linoleic acid firstly be evaluated for increase to succeed in practical selection in early generation.

Key words: *safflower, yield and quality characters, broad sense heritability, heterosis.*

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is one of the humanity's oldest oilseed crops and has been grown commercially for edible oil and natural dye source throughout around the world. Although it is cultivated in more than 20 countries worldwide, although Mexico, India, USA, Ethiopia, and Argentina account for 95% of world's production. Safflower was cultivated in 812.195 ha in the world and 780.677 tonnes seed was harvested in 2012. Cultivation of safflower in Turkey has been increasing during the last decade from 40 ha in 2002 to over 15,600 ha in 2012 (Anonymous, 2014).

As safflower is more tolerant to drought and salinity than some other oilseed crops, it is especially suited for dry and salty areas where other oilseeds are difficult to grow (Weiss, 2000). However, seed yield and oil content of safflower is generally lower than the other oil crops, such as soybean, rapeseed, groundnut and sunflower. For this reason, introduction of a crop depends on economic value of the crop. Therefore it is necessary to improve modern growing systems and but also necessary to obtain new cultivars with high oil content and seed yield by using advanced to breeding methods (Baydar and Erbaş, 2007).

The seed yield and oil content are the mainly selection criteria for safflower breeding programs. A successful safflower breeding program enables select is not the superior genotypes from the hybrid populations. But the performance of selected genotypes change at different environments (Toker, 2004; Çamaş and Esendal, 2006). Plant breeders are challenged with different environments or years to achieve their targets (Welsh, 1981). Therefore the information of character associations between the traits themselves and with the yield is important for the breeding material subjected to selection for yielding genotypes (Iqbal et al., 2006). Plant height, primary branches number per plant, head number per plant, head diameter, seed number per head, seed weight per plant, harvest index, 1000 seed weight and husk ratio are the main traits in safflower improvement for increasing seed yield and oil content (Ramachandram and

Goud, 1981; Reddy et al., 2004; Arslan, 2007; Mohammadi and Pourdad, 2009; Rudra Naik et al., 2009; Eslam, 2010; Golkar et al., 2011). Therefore, heritability estimate should be determined for traits in a safflower breeding program (Aslan, 2007), and highly heritable traits allow better selection in early generations thus reduce cost, material and time (Mary and Gopalan, 2006). Because heritability vary among traits, within population heritability estimates among the characters could be used to identify indirect selection schemes that may be more effective than direct selection schemes (Holland et al., 2003). In present study, genotypic (σ_g^2) and phenotypic (σ_p^2) variances, broad sense heritability (h^2_b) and heterosis value for agronomic and quality characters were determined using F_1 and F_2 plants derived from a cross between Dinçer 5-118 and Montola 2000 cultivars.

MATERIALS AND METHODS

This study was carried out in 2011 at the experimental area of Department of Field Crops in Faculty of Agriculture at Suleyman Demirel University, Isparta Turkey (latitude 37°45'N, longitude 30°33'E, altitude 997 m).

The parents [Dinçer 5-118 (non-spiny capitulum's-*ss*, orange petal-*OO*) x Montola 2000 (spiny capitulum's-*SS*, yellow petal-*oo*)], and their F_1 and F_2 generations were obtained by synthetic male sterility induction by gibberellic application (Baydar and Gökmen 2003). These lines were obtained as following: In 2008, Dinçer 5-118 selected as female parent and sprayed with 3x100 (three sprays each with 7 days interval), ppm (mg/l) concentrations of gibberellic acid (GA_3) (Merck) during budding stage before flowering (with <0.5 cm diameter capitulate). Pollinations were done among the pollen fertile spiny (Montola 2000) and chemically pollen sterile non-spiny (Dinçer 5-118) cultivars. At maturity, heads of the non-spiny female parent plants exposed to GA_3 were harvested (F_1). In 2009, F_1 seeds were grown and non-spiny types have been removed, in this way, F_1 plants were all true hybrids (*SsOo*). In 2010, four different phenotypes (*SSoo, ssOO, SsOo, ssoo*) were selected based on Mendelian digenic heritability in F_2 generations. In 2011, parents (20 plants per parent) and their F_1 (17 plants) and F_2 (256 plants) progeny were sown at the end of March. Spacing between rows was 0.50 m and within rows was 0.25 m. Fertilization was applied 15 kg nitrogen (Ammonium sulfate) and 10 kg phosphorus (Diammonium phosphate) per decare. Weed control was performed by mechanical rotary tillage and manual weeding. When the crop reached maturity (in the second week of October), rows were harvested by hand.

All agronomic and quality characters were determined by mean using parents and F_1 plants and F_2 plants. The following observations were taken: plant height (PH, cm), primary branches number per plant (PBN, no/plant), head number per plant (HNP, no/plant), head diameter (HD, mm), seed number per head (SNH, no/head), seed weight per plant (SWP, g/plant), harvest index (HI, %), 1000 seed weight (1000 SW, g), husk ratio (HR, %), seed yield (SY, kg ha^{-1}), oil content (OC, %), oil yield (OY, kg ha^{-1}), palmitic acid content (PA, %), stearic acid content (SA, %), oleic acid content (OA, %) and linoleic acid content (LA, %). The oil content and fatty acid composition were determined in Nuclear Magnetic Resonance (NMR, Oxford) and Gas chromatography (GC, Perkin Elmer Auto System XL), respectively. GC analysis was carried out as follows: capillary column, MN FFAP (50 m×0.32 mm i.d., film thickness, 0.25 m), oven temperature was kept at 120 °C for 1 min and programmed to 250 °C at a rate of 6 °C/min, and then constant at 240 °C for 15 min, total run time 60 min, injector temperature, 250 °C, detector (70 eV) temperature, 260 °C, flow rate for helium, 40 ml/min, split ratio, 1/20 ml/min, injection volume, 0.5 µl. Broad sense heritability (h^2_b), genotypic (σ_g^2) and phenotypic (σ_p^2) variances were calculated following equations reported by Poehlman and Sleper (1995).

$$\boldsymbol{\sigma_e^2} = (\sigma_{P1}^2 + \sigma_{P2}^2 + \sigma_{F1}^2)/3$$

$$\boldsymbol{\sigma_{F2}^2} = \sigma_g^2 + \sigma_e^2, \quad \boldsymbol{\sigma_p^2} = \sigma_{F2}^2, \quad \boldsymbol{\sigma_g^2} = \sigma_{F2}^2 - \sigma_e^2$$

$$\mathbf{h^2_b} = \sigma_g^2 / \sigma_p^2 = (\sigma_{F2}^2 - \sigma_e^2) / \sigma_{F2}^2$$

(σ_e^2= Environment variance, σ_{P1}^2 = P_1 variance, σ_{P2}^2 = P_2 variance, σ_{F1}^2 = F_1 variance, σ_{F2}^2 = F_2 variance)

Percent heterosis over midparent (MP) and percent heterobeltiosis over the better parent

(BP) were estimated using the formulas, [(F_1-MP)/MP]/100 and [(F_1-BP)/BP]/100, respectively for all the agronomic and quality characters measured. Their significance was determined with f-test using MSTAT-C package programme (Freed et al., 1989) and orthogonal contrast comparisons described between hybrid and its parents for heterosis and between hybrid and better parent for heterobeltiosis.

RESULTS AND DISCUSSIONS

A wide genetic variability in the base population after crossbreeding plays an important role for a successful breeding program. The extent of diversity in a crop species determines the limits of selection for improvement. The most of economic characters are generally quantitatively inherited and show genotype x environment interactions. Therefore, it is necessary to determine variability in the base breeding material. The variance, range, means and coefficient variation of agronomic and quality characters in safflower genotypes are given Table 1. While seed yield per plant ranged from 10.82-27.27 g in P_1 plants, 6.75-18.66 g in P_2 plants, 9.33-32.77 g in F_1 plants, this character ranged from 4.82-45.36 g in F_2 plants. Oil content, oleic acid and linoleic acid in F_2 plants showed more wide variation than parents and F_1 plants. The magnitude of variation in this population was 25.5-36.5%, 8.68-77.85% and 13.11-81.22%, respectively. In F_2 population, while mean oleic acid content close to parent with low oleic acid, mean linoleic acid content of genotypes was similar to parent with high linoleic acid.

Table 1. Variance, range, means and coefficient variation of agronomic and quality characters in safflower genotypes

Variance components	Seed yield per plant (g)				Oil content (%)			
	P_1	P_2	F_1	F_2	P_1	P_2	F_1	F_2
Range	10.82-27.27	6.75-18.66	9.33-32.77	4.82-45.36	24.5-28.7	31.1-35.6	29.9-33.1	25.5-36.5
Means ± SE	16.7 ± 1.16	10.6 ± 0.90	19.8 ± 1.87	16.0 ± 0.48	26.4 ± 0.33	33.5 ± 0.38	31.4 ± 0.24	31.1 ± 0.14
σ^2	21.57	12.91	45.32	59.34	1.84	1.98	0.73	4.68
CV	27.70	33.80	34.00	48.20	5.10	4.20	2.70	7.00
Variance components	**Oleic acid (%)**				**Linoleic acid (%)**			
	P_1	P_2	F_1	F_2	P_1	P_2	F_1	F_2
Range	8.64-12.21	73.95-78.91	18.23-35.16	8.68-77.85	75.96-79.92	11.79-16.61	53.27-71.12	13.11-81.22
Means ± SE	10.84 ± 0.28	76.89 ± 0.74	26.98 ± 3.02	25.95 ± 2.86	77.95 ± 0.35	13.84 ± 0.76	62.12 ± 3.12	62.97 ± 2.75
σ^2	1.59	3.31	45.73	523.97	2.00	3.49	48.57	484.73
CV	11.60	2.42	25.13	88.24	1.82	13.52	11.23	35.04

σ^2: variance, CV: Coefficient variation.

The characters showing significant heterotic effects at 0.05 and 0.01 significance levels for F_1 progeny and broad-sense heritability, phenotypic and genotypic variance for parents, F_1 and F_2 progeny are given in Table 2. The highest significant negative heterosis (-38.5%) was estimated for oleic acid. However, the lowest significant positive heterosis (44.6%) was determined for seed yield per plant followed by that for linoleic acid (35.4%), 1000 seed weight (26.8%), head number per plant (18.7%), plant height (14.6%) and palmitic acid (14.4%). The highest significant positive heterobeltiosis of 18.2% was observed for seed yield per plant. This was followed by head number per plant and plant height. The highest significant negative heterobeltiosis was observed for oleic acid (-64.9%). Present characters are in conformity with the earlier findings of Manjare and Jambhale (1995) Singh et al. (2008) and Shivani et al. (2010) who reported positive heterosis and heterobeltiosis for plant height, head number per plant, 1000 seed weight, and seed yield per plant. On the other hand, heterosis and heterobeltiosis for branches number was statistically not significant. Ranga et al. (1982) reported to be low heterosis for branches number. While, heterosis for oleic acid was statistically significant positive (5.0%), heterobeltiosis value of this characters was significant negative (-6.1%). Occurrence of low and positive heterosis estimates was also reported by Shivani et al. (2010). While, the low heterosis estimate was found for oleic acid, high heterosis estimate was linoleic acid. The negative correlation between oleic and linoleic acid in safflower was reported by Knowles (1989) and Erbaş (2012). Joksimovic (2006) reported to be low heterosis for oleic acid and high heterosis for linoleic acid in sunflower.

Table 2. Statistical analysis of variance components, heterosis and heritability values of agronomic and quality characters

Characters	Heterosis	Heterobeltiyosis	σ_p^2	σ_g^2	h^2_b
Plant height	14.6**	12.6**	11.9	21.3	64.1
Branches number	3.2	-2.9	2.0	2.4	54.3
Head number per plant	18.7**	13.4**	10.1	29.8	74.7
Seed number per head	-0.7	-12.4**	44.1	185.1	80.8
Harvest index	5.38*	-7.8*	13.9	35.8	72.1
1000 seed weight	26.8**	7.8*	5.8	24.8	81.0
Husk ratio	-1.1	-8.7*	2.3	6.1	72.6
Seed yield per plant	44.6**	18.2**	26.6	32.7	55.2
Oil content	5.0*	-6.1*	1.5	3.2	67.6
Palmitic acid	14.4**	2.5	0.2	0.2	47.3
Stearic acid	1.7	-6.5*	0.1	0.1	48.2
Oleic acid	-38.5**	-64.9**	3.3	520.7	99.4
Linoleic acid	35.4**	-20.3**	3.4	481.3	99.3

A large portion of total variation in population was determined by genotypic and phenotypic variances for all the characters. The genotypic variance was higher than the phenotypic variance for all the characters and showing the predominant role of the environment. Although the genotypic variance was greater than the phenotypic variance, the difference between these two parameters was minor, except for branches number, palmitic acid and stearic acid, indicating that the characters were stable between years but still influenced slightly by the environment. Moreover, the large differences between phenotypic and genotypic variance indicated that the variability in population was owing to genetic effects. Especially, differences between genotypic and phenotypic variance were large for seed number per head, 1000 seed weight, oleic and linoleic acid. Similar results have also been reported by Reddy et al. (2004), Arslan (2007), Mohammadi and Pourdad (2009) and Safavi et al. (2011).

Genotypic variance was not enough to determine the amount of variation present in genetic resources (Mohammadi and Pourdad, 2009). The heritability is determined by the ratio of genotypic variance to phenotypic variance and shows the association between genetic factors and environment (Arslan, 2007). The low heritability estimates were found for palmitic acid (47.3%), stearic acid (48.2%), branches number (54.3%) and seed yield per plant (55.2%). Heritability was high for oleic acid (99.4%), linoleic acid (99.3%), 1000 seed weight (81.0%) and seed number per head (80.8%). Also, the medium heritability values were showed for plant height, head number per plant, harvest index, husk ratio and oil content, 64.1%, 74.7%, 72.1% and 67.7%, respectively. The medium and high heritability for plant height were reported by Reddy et al. (2004), and Mohammadi and Pourdad (2009). Also, heritability for harvest index and oil content were medium, this characters generally was less affected by environmental factors and variations in population were due to genetic factors (Parameshwar, 2009; Golkar et al., 2011). Parameshwar (2009) reported that heritability for harvest index was 67.3%. Increasing seed yield of safflower is one of the most important breeding objectives. But the heritability of seed yield per plant has been reported to be low (Çamaş and Esendal, 2006), medium (Reddy et al., 2004) and high (Mohammadi and Pourdad, 2009).

In this study, seed yield per plant was influenced by both genetic factors and environmental factors. 1000 seed weight in safflower breeding is one of the significant selection criteria's. The most research reported to be was high heritability for 1000 seed weight of safflower (Reddy et al., 2004; Çamaş and Esendal, 2006; Pahlavani, 2007; Golkar et al., 2011). Examined inheritance of fatty acid, in the present study, effect of environment was more pronounced on palmitic and stearic acids than oleic and linoleic acids. Erbaş (2012) reported that heritability was medium for palmitic and stearic acids, and high for oleic and linoleic acids. Bartolomew (1971) found that palmitic and stearic acids content were changed at different temperatures during safflower seed development. Golkar et al. (2011) indicated that additive and dominance gene action in genetic controlling oleic acid were played an important role. Thus, heritability for this character was high (broad and narrow sense heritability, 92.0-81.0% in F_1 progeny and 93.0-73.0% in F_2 progeny, respectively)

CONCLUSIONS

As a result, head number per plant, seed number per head, harvest index, 1000 seed weight, husk ratio, oil content, oleic and linoleic acid were the least affected characters over environment and variations in the population due to genetic factors. So these characters firstly be evaluated for increase to succeed in practical selection in early generation.

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EFFECTS OF SEED DETERIORATION AND INOCULATION WITH *Mesorhizobium ciceri* ON CHICKPEA PLANT PERFORMANCE UNDER LABORATORY CONDITIONS

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Abstract

Deterioration of seeds during storage can cause significant declines in seedling vigor and crop yield, particularly in less developed regions. This project compared seedling vigor and field performance of two chickpea (Cicer arietinum) cultivars (Arman and Hashem), subjected to 0 (control), 7, 14, 21 and 28 days of deterioration (DOD) in 40°C storage. Percent seed germination, radical length, seedling length, root weight and seedling weight were recorded. Seeds of both varieties declined in germination and growth with increasing deterioration. Seed germination and growth declined with increasing storage, and germination was zero after 21 or 28, DOD.

***Key words**: Chickpea, Deterioration, Germination.*

INTRODUCTION

Cicer is one of the most important pulse crops, providing high quality protein for human nutrition. Cicer is suitable for regions with warm weather and semi-dry conditions. Cicer is also cold tolerant, surviving to -9ºC. In most regions cicer is planted in spring but in warmer regions it is planted in autumn. Seed is the basic agricultural input, and access to preferred and adapted seed is a prerequisite for sustainable production.

Formal seed systems produce and diffuse modern varieties and certified seed, but there is growing research and policy interest in informal seed systems, as informal channels provide 80-90% of the materials farmers sow in their fields worldwide (Cooper, 1993). During seed storage between field seasons, seed stocks can suffer deterioration due to heat, humidity, and biotic agents. In 2008, 92% of the world's chickpeas were produced in developing countries (FAO, 2009; IMF, 2010).

Storage of seed in developing areas is often less than ideal, and deterioration of seed can be significant.

Sustainable mechanisms to improve seed storage and reduce the impact of seed deterioration on yield are needed to improve global food security.

Seed deterioration can be defined as the loss of quality, viability and vigor either due to aging or effect of adverse environmental factors.

The rates of deterioration rapidly increase with increase in either seed moisture content or temperature of storage (Ellis et al., 1985). The use of healthy seeds may lead to an increase of yield for two reasons. The percentage emergence of healthy seeds is greater than that of weaker seeds.

Therefore, healthy seed may provide a higher crop density than deteriorated seed even when conditions are not ideal.

The subsequent plant growth rate is also greater in plants that have originated from healthy seed.

MATERIALS AND METHODS

This study was carried out in both laboratory and field. In the lab experiment seeds of Hashem and Arman were treated to deteriorate during 0, 7, 14, 21 and 28 days at 40ºC. Groups of seeds were placed in mesh bags.

Every bag was placed on a sieve suspended within a closed container above water.

The bags did not contact the water at any point, but seeds could absorb the humidity in the dish.

After treatment the seeds were placed between 2 sheets of moist germination paper for testing germination. The paper was rolled and tied it in place with a rubber band. Rolls containing seeds were placed in plastic bags and put into the germination box at 20º C and 70% humidity for 10 days. Seed germination percentage, radicle and seedling length, radicle and seedling weight were determined

Data were analyzed using SAS (SAS Institute, 1990). Effects were considered significant at P values ≤ 0.05. Duncan multiple range tests were conducted for mean comparison.

RESULTS AND DISCUSSIONS

Treatments of cultivar, deterioration and interaction between them had a significant effect on germination percent, cotyledon length, cotyledon weight, radicle length, and radicle weight (Table 1). The control (non-deteriorated seeds) performed best in all germination and seedling characteristics (Table 2). Seeds of both varieties declined in germination and growth with increasing deterioration. After 21 or 28 DOD no seeds germinated (data not shown). Seven and 14 DOD reduced germination on average by 57% and 80%, respectively. After 14 DOD only radicles were present on 10-day old germinated seedlings.

Seedlings of Hashem cultivar generally performed better than Arman (Table 2). In non-deteriorated seed Hashem produced more cotyledon length and radicle length and weight than Arman. After 7 DOD germinated Hashem seed produced more cotyledon length and weight than Arman, but less radicle weight. Response to 14 DOD was similar in both cultivars.

Table1- Analysis of variance of germination percent, cotyledon length and weight, radicle length and weight of Hashem and Arman chickpeas varieties after 0, 7, or 14 days storage at 40°C.

Sources of Variation	Degrees of freedom	Mean squares				
		Germination percent	Cotyledon length	Cotyledon weight	Radicle length	Radicle weight
Cultivar (C)	1	133**	6.1**	0.0007*	3.5**	0.0001**
Deterioration (D)	2	1221**	7.1**	0.025**	25**	0.02**
C × D	2	49**	1.6**	0.0001*	1.9**	0.004**
Error	12	10.6	0.03	0.00008	0.19	0.00007
Coefficient of Variation		6.6	17.6	11.3	12.2	12.7

*, ** significant at the 0.05 and 0.01 probability levels, respectively.

Table 2 - Means of germination percent, cotyledon length and weight, radicle length and weight of Hashem and Arman chickpeas varieties after 0, 7, or 14 days storage at 40°C.

Cultivar	Deterioration (days)	Germination (%)	Cotyledon length (cm)	Cotyledon weight (g)	Radicle length (cm)	Radicle weight (g)
Hashem	0	100 a	3.1 a	0.14 a	6.2 a	0.16 a
	7	42 b	1.8 b	0.10 b	2.7 c	0.02 d
	14	19 c	0.0 d	0.0 d	1.1 d	0.03 d
Arman	0	100 a	1.3 c	0.12 a	4.0 b	0.10 b
	7	43 b	0.14 d	0.08 c	2.2 c	0.07 c
	14	21 c	0.0 d	0.0 d	1.1 d	0.02 d

Values within the same column followed by the same letters are not significantly different according to Duncan's multiple range test (*P* =0 .05).

CONCLUSIONS

Sustaining and increasing production of high quality protein foods for the growing human population will require efficient use of resources in both ideal and non-ideal conditions. High seed quality should be maintained to minimize the quantity of seed and other resources needed for planting and production. However, given that many regions do not have ideal seed storage facilities, information is needed about crop varieties that maintain seed health in deteriorating conditions, as well as potential seed treatments to counteract deterioration. In this study we found that Hashem variety cultivar had not only good field performance by non-deteriorated seed, but substantial resilience to seed deteriorating conditions. Inoculation of chickpea seeds with M. ciceri provided the greatest benefit to non-deteriorated Hashem seed, but also provided moderate remediation of deterioration treatments. Increased use of varieties that with stand non-ideal seed storage conditions, and consistent use of proper rhizobial inoculants, should be recommended particularly for regions without ideal storage facilities.

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PRODUCTIVITY AND QUALITY OF WINTER TRITICALE (X *Triticosecale* Wittmack) IN MULTIFACTORIAL EXPERIMENTS

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Abstract

This article presents the 3-year yield data of two winter triticale varieties depending on the forerunner plants (grain pea and vetch + oats), planted in three different sowing periods (early, optimal, acceptable) and according to three sowing rates - 4.0, 5.0 and 6.0 million of viable seeds per 1 ha. In the multifactorial experiment, the greatest influence on the yield of the studied varieties of winter triticale was recorded by the sowing period (Factor B) – 54.06 – 61.53%, followed by the used forerunner plants (Factor A) – 10.48 – 28.15%, the sowing rate (Factor C) – 9.11 – 18.89%, and the last was the interaction of Factors AB – 6.16 – 8.00%. The highest quality of grain and crude protein content was recorded by Ingen 93 variety where grain pea was used as a forerunner plant. The sowing period of both winter wheat varieties contributed to the mass increase of 1,000 seeds by 0.3-0.7 g on average in 3 years for both forerunner plants. Over the years of research the size of seeds ranged from 37.2 g in 2011 up to 49.4 g in 2013.

Key words: *density, forerunner plant, sowing period, triticale, yield.*

INTRODUCTION

Triticale is a new cereal, characterized by a high yield of grain and green mass exceeding the indices of wheat and rye. The interest in triticale increases due to the unique combination of a number of economic characteristics: high yield of grain, significant amount of the accumulated protein with a high content of essential amino acids, and primarily lysine, as well as high degree of adaptive capacity. It is a valuable source of protein both for human consumption and animal feed (Zelenskaia and Proshina, 2002; Zelenskaia and Pigunova, 2004). This culture is of great practical interest for Moldova, where winter wheat yields are poorer than triticale yields.

MATERIALS AND METHODS

We studied the following aspects in the multifactorial experiments:

- two varieties of winter triticale: Ingen 35 and Ingen 93;
- two forerunner plants: grain pea (control group) and vetch + oats;
- three different sowing periods: early 12.X (control group), optimal 24.X and acceptable 01.XI;
- three sowing rates: 4.0, 5.0 (control group) and 6.0 million viable seeds per 1 ha.

The experiments were carried out at the Didactic Experimental Station "Chetrosu" in 2011-2013. The experiment was repeated 3 times and the area of the plot was 40 square meters. The winter triticale was sown in rows with row spacing of 12.5 cm and the sowing depth of 5-6 cm. It was used Gossortoseti methodology to experimentally conduct phenological observations of the winter triticale plants. There were defined the elements of plant productivity. The harvest was gathered plot by plot and it was counted for 100% of purity and 14% of humidity. The total nitrogen was determined by Kjeldahl method, the crude protein content was calculated with factor 5.73. Statistical processing of the yield data was performed by the analysis-of-variance method of the multifactorial experiment according to Dospekhov (1985).

RESULTS AND DISCUSSIONS

The winter triticale yield ranged from 1549 to 5108 kg/ha due to the various precipitation amounts during the three years of investigations. The average yield of Ingen 35 variety, with pea as forerunner plant, was of

2,717 kg/ha (Table 1), which is by 113 kg lower than with vetch + oats as forerunner plants, i.e. it was of 2,830 kg/ha. However, the resulting difference of grain yield was not significant, as it was within the LSD_{05} (Least Significant Difference) -134 kg/ha. In terms of planting dates, we can notice higher productivity rate in the first sowing period (12.X) which constituted 3191 kg/ha with peas as forerunner plant, yield that was significantly higher than in the second (24.X) (by 326 kg/ha) and in the third (01.XI) (by 1095 kg/ha) sowing periods. The resulting increase in the crop yield depending on the sowing period was trustworthy and significantly higher than the value of the LSD_{05} - 164 kg/ha.

Table 1. Grain yield of the winter triticale variety Ingen 35, 2011-2013, kg/ha

Seeding rate, million/ha (Factor C)	**Forerunner plant (Factor A)**						**The average for Factor C LSD_{05} C -164**	**± to the control group**
	vetch + oats			**grain pea (control group)**				
	Sowing period (Factor B)							
	12. X (Control)	**24. X**	**01. XI**	**12. X (Control)**	**24. X**	**01. XI**		
4.0	3210	2820	2170	3206	2735	1958	2683	-62
5.0 (HTC)	3310	2929	2279	2981	2850	2122	2745	-
6.0	3395	3045	2311	3385	3010	2207	2292	147
The average for Factor A	2830			2717				
LSD_{05} A -134	113							
The average for Factor B	3305	2931	2253	3191	2865	2096		
LSD_{05} B -164	-	-374	-1052	-	-326	-1095		
LSD_{05} of the experiment	402							

The highest grain yield with vetch + oats as forerunner plants was also obtained in the first sowing period (12.X) – 3305 kg/ha. A later sowing, in the third decade of October (the second period) and early November (the third period) led to lower yields of winter triticale, by 374 and 1,052 kg/ha respectively. This decrease depending on the sowing period was reliable too, and exceeded the value of the LSD_{05}.The change of the seeding rate per 1 ha had also influenced the amount of the resulting grain yield. On average, the lowest yield was obtained with the seeding rate of 4.0 million seeds/ha and it constituted 2,683 kg/ha, while the highest yield was received with the seeding rate of 6.0 million seeds/ha – 2,892 kg/ha. Yield differences depending on the experiment options were not significant ranging within the limits of LSD_{05} -164 kg/ha. The studied forerunner plants used in the experiments had a significant impact on the grain yield of Ingen 93 variety (Table 2).

Table 2. Grain yield of the winter triticale variety Ingen 93, 2011-2013, kg/ha

Seeding rate, million/ha (Factor C)	**Forerunner plant (Factor A)**						**The average for Factor C LSD_{05} C - 164**	**± to the control group**
	grain pea (control group)			**vetch + oats**				
	Sowing period (Factor B)							
	12. X (Control)	**24. X**	**01. XI**	**12. X (Control)**	**24. X**	**01. XI**		
4.0	3281	2907	2,100	3250	3018	2136	2782	-58
5.0 (control group)	3347	2906	2244	3223	3039	2278	2840	-
6.0	3380	2952	2388	3401	3090	2351	2927	87
The average for Factor A	2834			2865				
LSD_{05} A -134	31							
The average for Factor B	3336	2922	2244	3291	3049	2255		
LSD_{05} B -164	-	-414	-1092	-	-242	-1036		
LSD_{05} of the experiment	139							

The yield of winter triticale with vetch + oats as forerunner plants was of 2,865 kg/ha which exceeds the control value by 31 kg – 2,834 kg/ha. The yield of the winter triticale variety with vetch + oats as forerunner plants ranged from 2255 to 3291 kg/ha depending on the sowing period, while the figure with grain pea as forerunner plant ranged from 2224 to 3336 kg/ha. The highest yield was obtained with both forerunner plants in the first sowing period (12.X) due to greater tillering capacity of plants and spike size. Thus, during the first sowing period under conditions of insufficient moisture, namely the sowing period ensured a more vigorous tillering capacity of plants and the formation of larger spikes. The study of the experiment factors influence on the grain yield of the two winter triticale varieties showed the following: the degree of the forerunner plant influence on Ingen 35 variety yield was of 10.85%, while on Ingen 93 variety yield - almost 3 times more - 28.15% (Table 3).

Table 3. The degree of factors influence on winter triticale grain yield, 2011-2013, %

Factors	Symbols	Ingen 35	Ingen 93
Forerunner plant	A	10.48	28.15
Sowing period	B	61.53	54.06
Seeding rate	C	18.89	9.11
Interaction: the forerunner plant + the sowing period	AB	6.16	8.00
Interaction: the forerunner plant + the seeding rate	AC	0	0
Interaction: the sowing period + the seeding rate	BC	1.97	0.66
Interaction: the forerunner plant + the sowing period + the seeding rate	ABC	1.00	0
Total		100	100

The sowing periods had almost the same effect on the productivity of the studied winter triticale varieties - 61.33% and 53.06% respectively. The effect of the seeding rate was twice as high for Ingen 35 variety (18.89%), while for Ingen 93 variety it constituted only 9.11%. The influence of the forerunner plant and the sowing period were noticed as a result of double interaction of factors, 6.16% and 8.00% respectively. The double and triple interaction of other factors was not significant. The study of the crude protein content in the winter triticale grain showed that for Ingen 35 variety it ranged from 10.59% in the third sowing period (1.XI) to 11.15% in the first sowing period (12.X) with grain pea as forerunner plant (Table 4). On average, it amounts to 10.79% depending on the sowing period. The protein content ranged from 10.29% to 11.37% when vetch + oats were used as forerunner plants and on average, it amounted to 10.68% depending on the forerunner plant. The yield of crude protein was of 223.4 kg/ha when grain pea used as forerunner plant, and 236.0 kg/ha – when vetch oats were used as forerunner plants.

Table 4. Content and yield of crude protein in the grain harvest of winter triticale, 2011-2012

Varieties	Ingen 93				Ingen 35			
Forerunner plant	grain pea (control group)		Vetch + oats		grain pea (control group)		Vetch + oats	
Sowing period	Protein content and yield				Protein content and yield			
	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha
12.X	11.50	240.5	10,90	241.9	11.15	236.8	11.37	273.9
24.X (control group)	12.27	278.1	11.27	255.5	10.64	233.3	10.29	229.5
01.XI	11.81	266.9	11.02	232.7	10.59	200.2	10.39	204.5
The average	11.86	261.8	11.06	243.3	10.79	223.4	10.68	236.0
± to pea as forerunner plant	-	-	-0.80	-27.5	-	-	-0.11	12.4

Table 5. The weight of 1000 seeds of winter triticale variety Ingen 93, 2011-2013, g

Sowing period (Factor B)	Seeding rate, million seeds/ha (Factor C)	Grain pea (control group) Factor A			Vetch + oats, Factor A		
		g	± to the control group C		g	± to the control group C	
			g	%		g	%
The first period	4.0	41.5	0.6	101.5	41.2	1.0	102.5
	5.0 (control group)	40.9	-	100.0	40.2	-	100.0
	6.0	40.3	-0.6	98.5	39.6	-0.6	98.5
	The average	40.9			40.3		
The second period	4.0	43.0	3.1	107.8	40.7	0.5	101.2
	5.0 (control group)	39.9	-	100.0	40.2	-	100.0
	6.0	42.0	2.1	105.3	40.3	0.1	100.3
	The average	41.6			40.4		
The third period	4.0	39.2	-1.7	95.8	40.8	0	100.0
	5.0 (control group)	40.9	-	100.0	40.8	-	100.0
	6.0	40.1	-0.8	98.0	40.2	-0.6	98.5
	The average	40.1			40.6		
The average for the forerunner plant		40.9			40.4		
± to the control group A					-0.5		

Ingen 93 variety accumulated more crude protein amounting to 11.86% when grain pea was used as forerunner plant and 11.06% when vetch + oats were used as forerunner plants.

The amount of crude protein with grain yield was of 261.8 kg/ha in case of grain pea as forerunner plant and 243.3 kg/ha - for vetch + oats as forerunner plants. Studies showed that there was a slight influence of the studied factors on the seed size of winter triticale variety Ingen 93 (Table 5). Under the influence of the sowing period (Factor B) there was observed a slight increase of 0.7 g in the mass of 1000 seeds when pea was used as forerunner plants and of 0.3 g with vetch + oats as forerunner plants. The average weight of 1000 seeds amounted to 40.9 g and 40.4 g for pea and vetch + oats used as forerunner plants respectively. The research data on this index ranged from 37.2 g in 2011 to 49.4 g in 2013. The average weight of 1000 seeds of Ingen 35 variety was 41.8 g for pea and 41.3 g for vetch + oats used as forerunner plants (Table 6). Later sowing periods provided larger grains that were heavier by 0.5 - 0.7 g. Also, larger grains were formed by the plants where grain pea was used as forerunner plant.

Table 6. The weight of 1000 seeds of winter triticale variety Ingen 35, 2011-2013, g

Sowing period (Factor B)	**Seeding rate, million seeds/ha (Factor C)**	**Grain pea (control group) Factor A**			**Vetch + oats, Factor A**		
		g	**± to the control group C**		**g**	**± to the control group C**	
			g	**%**		**g**	**%**
The first period	4.0	42.6	2.3	105.7	41.3	0.1	100.2
	5.0 (control group)	40.3	-	100	41.2	-	100
	6.0	41.3	1.0	102.5	41.8	+0.6	101.5
	The average	41.4			41.4		
The second period	4.0	41.4	-1.0	97.6	41.1	0.5	101.2
	5.0 (control group)	42.4	-	100	40.6	-	1
	6.0	42.1	-0.3	99.3	39.2	-1.4	96.6
	The average	42.0			40.3		
The third period	4.0	42.9	-0.1	100.2	42.1	0.6	101.5
	5.0 (Control group)	42.8	-	100	41.5	-	100
	6.0	39.9	-2.9	93.2	42.8	+1.3	103.1
	The average	41.9			42.1		
The average for the forerunner plant		41.8			41.3		
± to the control group A					-0,5		

CONCLUSIONS

As we found out in the multifactorial experiments, grain yield of the studied winter triticale varieties is mostly influenced by the sowing period (Factor B) -54.06-61.53%, followed by the forerunner plants (Factor A) - 10.48-28.15%, the seeding rate (Factor C) – 9.11-18.89% and the interaction of AB factors - 6.16 - 8.00%. Ingen 93 variety, with grain pea used as forerunner plant, demonstrated the highest grain quality and crude protein yield. Seed size of winter triticale varieties in later sowing periods increased by 0.3-0.7 g for both forerunner plants.

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GENOTYPE AND CONDITIONING METHOD INFLUENCE ON SOWING MATERIAL QUALITY FOR WINTER WHEAT

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Abstract

Within modern agriculture, the yearly use of some seeds and sowing material with superior biological traits represents one of the basic conditions to obtain an important and constant production, adequate to the genetic potential of cropped hybrids and varieties.
In this context, an important part in getting crops at the foreseen level, as well as their surpassing, is performed by the action of yielding, control and supervision of the seeds meant to be sowed.
If this action isn't coordinated and adequately achieved, taking into account principles, the decrease of biologic potential production is rapid and unavoidable, being joined by less valuable quality and quantity crops.
Before valorizing seeds in different areas, these ones are submitted to some conditioning operations such as unknown matters cleaning, moisturizing etc. In order to obtain superior quality products, it is necessary to eliminate unknown matters from the cereals mass if possible, in a total amount. Practically, all impurities can't be eliminated and technical measures which are taken aim at their minimum reduction in the grains mass.
The research results carried out on samples of 4 of winter wheat seed genotypes have shown that the three types of conditionality have a positive influence on the physical and biological properties of the seed.
The effect of each machine is cumulative and very significantly higher than previous equipment, thus among the 4 analysed genotypes Mulan variety proved to be superior in terms of quality indices in all variants of conditioning, compared to other studied varieties of winter wheat.

***Key words**: conditioning, sowing material, quality physical indexes, quality biological index, winter wheat.*

INTRODUCTION

Seeds conditioning, stocking and preserving are absolutely compulsory processes which interfere during seed's existence until final consumption. These processes are continuous concerns since the oldest times till present. The continuous characteristics of these processes request their non-dissociated study and influence upon each other. That's why they receive a particular attention, in order to improve the seeds quality genetically determined (Borcean and Imbrea, 2005).
All conditioning and stocking techniques and technologies have at their basis a complex of different phenomena (biological, physiological, biochemical, physico-chemical etc.) which take place in the seeds mass (Bucurescu et al., 1992). These concerns have appeared out of the necessity of elongating the seeds use period long time, after the period they were produced in, because agricultural production lasts only for one season and after harvesting till use, the seeds mass is submitted to some stressful factors which can determine seeds quality indexes deterioration (Buricescu, 2014).

MATERIALS AND METHODS

For winter wheat we effected a bi-factorial trial, the studied factors being the following:
A Factor – the analysed winter wheat with four levels:
- a_1 – DROPIA variety;
- a_2 – GLOSA variety;
- a_3 – GK PETUR variety;
- a_4 – MULAN variety.

B Factor – conditioning method with four levels:

- b_1 – unconditioned;
- b_2 – conditioned with the selecting device;
- b_3 – conditioned with the selecting and screening machines;
- b_4 – conditioned with the selecting and gravitator machines.

Out of the two tested factors combination, there resulted 16 experimental variants, the results registered within each variant being statistically interpreted by variability method analysis according to bi-factorial trials.

Laboratory analysis effected within research

Quality analysis (physic purity, weight of 1000 grains, total mass, specific mass, hectolitrical mass, germination) for experimental variants proper to the trial were effected for the crops harvested during 2010-2012 in four replicates over one year.

Statistical interpretation and calculus by variance analysis method the moment when the mixed effect of experimental analysis was effected for the unconditioned variant proper to each winter wheat genotype tested during research.

Measurement technique

Weight of 1000 grains determinations are effected only for the pure seed obtained by the early physical purity analysis.

In order to determine the weight of 1000 grains, in the research there was used the method of determining the weight of 1000 grains by counting all the samples to be analysed, which involves counting sample of pure seed resulting from the determination of physical purity or passing the sample through the included seeds. After counting them, samples are weighed and the results are to be expressed in grams, with the same number of decimal places in the determination of physical purity weight of 1000 grains is calculated by comparing the result to 1,000 grains.

Absolute mass determinations were effected on the mass of 1000 seeds dry matter content according to the relationship (Epure et al., 2011):

$$M_a = 100 – U/100 \text{ x } M_r$$

Where:

M_a –1.000 seeds mass (g);

M_r – 1.000 seeds relative mass (g);

U – seeds present moisture (%).

In order to calculate the specific mass, there was determined 1000 seeds mass (MMB) and their volume (Vs)

The volume was determined by the introduction of 500 seeds in a graded cylindre which contains 500 cm^3 oil. The difference between the liquid level from the cylindre, obtained after seeds introduction and their initial level, represents the seeds volume.The result was recalculated for 1000 grains according to the formula (Roman et al., 2012):

$$d = MMB/V_S$$

Where:

MMB – 1.000 seeds mass (g);

V_S – seeds volume (cm^3).

In order to determine the volume weight of winter wheat and sun-flower seeds meant to be sowed, the hectolitrical balance was used, having 0.25 l volume. For statistical analysis, there were effected every four parallel determinations for the same seeds sample. In order to determine the germinative capacity of winter wheat sowing material, there were taken at random four samples (replicates) of 100 seeds, seeds which were to germinate, using as a vegetal bed filtring folded paper (BP method) and watered until receiving no more, seeds being arranged as uniformous as possible on the vegetal bed. Samples, prepared this way were introduced into a thermostat, then we followed constantly the temperature and moisture degree of the vegetal bed.

For the calculation of germination there was done the arithmetic average of the 4 repetitions results after extracting from the table differences between rehearsals, admitted to the germination percentage and calculated depending on the average percentage obtained rounded to the nearest whole number.

RESULTS AND DISCUSSIONS

Conditioning method influence on phisical purity for winter wheat sowing material

After determining wheat grains physical purity (Table 1), it is acknowledged that this quality physical index is significantly improving in comparison with the control unconditioned variant due to the fact that after every conditioning stage, machines used in this process specifically remove the foreign bodies present in the seeds mass.

Table 1. Conditioning method influence over winter wheat sowing material purity (2010 – 2012 average)

EXPERIMENTAL VARIANT		*PURITY (%)*	*DIF. (%)*	*SIGN.*
a_1	b_1 - unconditioned	**84.30**	**-**	**$Mt._1$**
	b_2 - selecting machine	88.80	4.5	***
DROPIA	b_3 - selecting and screening machines	93.60	9.3	***
	b_4 - selecting, screening and gravitator machines	97.30	13.0	***
a_2	b_1 - unconditioned	**88.40**	-	**$Mt._2$**
	b_2 - selecting machine	95.70	7.3	***
GLOSA	b_3 - selecting and screening machine	98.90	10.5	***
	b_4 - selecting, screening and gravitator machines	99.80	11.4	***
a_3	b_1 - unconditioned	**89.90**	-	**$Mt._3$**
	b_2 - selecting	97.60	7.7	***
PETUR	b_3 - selecting and screening machine	98.70	8.8	***
	b_4 - selecting, screening and gravitator machines	99.90	10.0	***
a_4	b_1 - unconditioned	**88.75**	-	**$Mt._4$**
	b_2 - selecting	97.60	8.85	***
MULAN	b_3 - selecting and screening machines	98.70	9.95	***
	b_4 - selecting, screening and gravitator machines	99.90	11.15	***

$DL_{5\%} = 0.45$; $DL_{1\%} = 0.60$; $DL_{0.1\%} = 0.79$

Differences in comparison with the control variant recorded values comprised 4.5-13.0% for *Dropia variety*, 7.3-11.4% for *Glosa variety*, 7.7 - 10,0% for *Petur variety* and 8.85 – 11.15% for *Mulan variety*, being statistically ensured as significantly positive (***) for all four varieties of winter wheat, when within the conditioning process appear adequate machines, the biggest values of physical purity being recorded the moment when for seeds conditioning was used the complex machine formed of selecting, screening and gravitator machines *Glosa*, *Petur* and *Mulan* varieties are to be remarked, where the value of physical purity after using the three conditionning machines reached 99.8% for *Glosa* variety and 99.9% for *Petur* and *Mulan* varieties being statistically ensured as significantly positive (***).

Conditioning method influence determination on 1000 seeds mass for winter wheat sowing material

In Table 2 there are gathered the experimental results after having determined 1000 seeds mass for winter wheat sowing material.

The differences are statistically recorded and were between 0.4-3.3 g for *Dropia variety*, being statistically ensured as significantly positive (-) in conditional variants with selecting device, selecting device + screening machine very significant positive (***) for screening machine, 1.2-2.1 g for *Glosa variety* being statistically ensured as distinct significantly positive (**) in the selector and very significant (***) in the case of variants conditioning with the screening machine, 0.3 to 3.8 g to ensure statistical insignificant with *Petur* (-) in the selector and very significant (***) in the case of variants selecting and screening machines and selecting, screening and gravitator machines and 1.8-4.3 g, with very significant statistical assurance (***) in all variants of wrapping, the variety of winter wheat *Mulan variety*, which values are superior to other varieties tested.

Increasing the values of this indicator of quality is due in particular to eliminate light fixtures and mass residues of seed grain by using the selecting, screening and gravitator devices.

Conditioning method influence on absolute mass of winter wheat sowing material

In Table 3 absolute mass evolution is presented as a result of the combined action of the two factors are (genotype x method of conditioning).

Absolute mass is a parameter of quality of wheat seeds which vary significantly throughout the process of conditioning.

This is due to the increase in the share of the mass of seeds, seed-filled with high value. Thus, the higher values of this parameter are recorded in the selecting, screening and gravitator machines at all 4 wheat cultivars tested.

Absolute mass is a parameter of quality of wheat seeds that varies very significantly positive (***) in a manner (***) throughout the process of conditioning.

Table 2. Conditioning method influence determination on 1000 seeds mass for winter wheat sowing material (average 2010 – 2012)

EXPERIMENTAL VARIANT		*1000 Seeds Mass (g)*	*DIF. (g)*	*SIGN.*
a_1 ***DROPIA***	b_1 - unconditioned	**34.5**	**-**	**Mt.$_1$**
	b_2 - selecting machine	34.9	0.4	-
	b_3 - selecting and screening machines	35.2	0.7	-
	b_4 - selecting, screening and gravitator machines	37.8	3.3	***
a_2 ***GLOSA***	b_1 - unconditioned	**37.6**	-	**Mt.$_2$**
	b_2 - selecting machine	38.8	1.2	**
	b_3 - selecting and screening machine	39.3	1.7	***
	b_4 - selecting, screening and gravitator machines	39.7	2.1	***
a_3 ***PETUR***	b_1 - unconditioned	**38.9**	-	**Mt.$_3$**
	b_2 - selecting	39.2	0.3	-
	b_3 - selecting and screening machine	40.5	1.6	***
	b_4 - Selecting, screening and gravitator machines	42.7	3.8	***
a_4 ***MULAN***	b_1 - unconditioned	**39.8**	-	**Mt.$_4$**
	b_2 - selecting	41.6	1.8	***
	b_3 - selecting and screening machines	43.8	4.0	***
	b_4 - selecting, screening and gravitator machines	44.1	4.3	***

$DL_{5\%} = 0.74$; $DL_{1\%} = 0.99$; $DL_{0.1\%} = 1.31$

This is due to the increase in the share of the seeds mass, seed-filled with high value. Thus, the highest values of this parameter are recorded in selecting, screening and gravitator machines at all 4 wheat cultivars tested.

Conditioning method influence on specific mass of winter wheat sowing material

In table 4 centralized experimental results are obtained as a result of the determination of specific mass based on the combined action of the two factors which are tested in the research. In all variants of the mass-specific, conditioning has provided statistically significant positive values (*) and very significantly positive (***) compared to the control.

This variation is due to light fixtures, high volume, mass of seeds. As a result, the increases in this parameter compared with 0.02-0.04 g/cm^3 selecting device usage, 0.05-0.06 g/cm^3 after using the selecting, screening machines and 0.06-0.08 g/cm^3 using complex machines consisting of selecting, screening and gravitator machines (Table 4).

Analyzing separately the four wheat cultivars under study, it is observed that the maximum value of the specific mass is obtained after using the selecting, screening and gravitator machines in the case of the variety of *Mulan.*

Conditioning method influence on hectolitrical mass for winter wheat sowing material

The combined influence of factors are tested as part of the research is summarized in table 5.

During the conditioning process, the value of MH ranged between 74.12 and 78.24 kg/hl after the first variant of conditioning 74.34 kg/hl 78.44 and after the second variant, namely 75.54 and 78.63 kg/hl after the third variant of conditioning (Table 5), the highest values were recorded in the case of *Mulan variety*.

Thus, we can say with certainty, that from the point of view of the seeds volumetric weight, *Mulan* winter wheat variety is superior the other three analysed varieties differences recorded in comparison to unconditioned variant between 0.71 and 1.10 kg/hl reaching very significantly positive (***).

Conditioning method influence on germination capacity of winter wheat sowing material

In Table 6 there are summarized the results achieved as a result of the determination of seed germination, as a result of the combination of those two factors.

Determinations relating to the winter wheat seeds germination have revealed that this quality indicator of the recorded variations depend on the grown genotype and depend on the used conditioning method.

Table 3. Conditioning method influence over the absolute mass of winter wheat sowing material (average 2010 – 2012)

EXPERIMENTAL VARIANT		*ABSOLUTE MASS (g)*	*DIF. (g)*	*SIGN.*
a_1	b_1 - unconditioned	**30.5**	**-**	**Mt.$_1$**
DROPIA	b_2 - selecting machine	30.9	0.4	-
	b_3 - selecting and screening machines	31.2	0.7	**
	b_4 - selecting, screening and gravitator machines	33.8	3.3	***
a_2	b_1 - unconditioned	**33.6**	-	**Mt.$_2$**
GLOSA	b_2 - selecting machine	34.8	1.2	***
	b_3 - selecting and screening machines	35.3	1.7	***
	b_4 - selecting, screening and gravitator machines	36.2	2.6	***
a_3	b_1 - unconditioned	**34.9**	-	**Mt.$_3$**
PETUR	b_2 - selecting	35.2	0.3	-
	b_3 - selecting and screening machines	36.5	1.6	***
	b_4 - selecting, screening and gravitator machines	37.8	2.9	***
a_4	b_1 - unconditioned	**35.8**	-	**Mt.$_4$**
MULAN	b_2 - selecting	36.6	0.8	**
	b_3 - selecting and screening machines	37.8	2.0	***
	b_4 - selecting, screening and gravitator machines	39.1	3.3	***

$DL_{5\%} = 0.50$; $DL_{1\%} = 0.67$; $DL_{0.1\%} = 0.89$

Table 4. Conditioning method influence over wheat sowing material specific mass (average 2010 – 2012)

EXPERIMENTAL VARIANT		*SPECIFIC MASS (g/cm^3)*	*DIF. (g/cm^3)*	*SIGN.*
a_1	b_1 - unconditioned	**1.34**	**-**	**Mt.$_1$**
DROPIA	b_2 - selecting machine	1.36	0.02	*
	b_3 - selecting and screening machines	1.39	0.05	***
	b_4 - selecting, screening and gravitator machines	1.40	0.06	***
a_2	b_1 - unconditioned	**1.41**	-	**Mt.$_2$**
GLOSA	b_2 - selecting machine	1.43	0.02	*
	b_3 - selecting and screening machines	1.46	0.05	***
	b_4 - selecting, screening and gravitator machines	1.49	0.08	***
a_3	b_1 - unconditioned	**1.43**	-	**Mt.$_3$**
PETUR	b_2 - selecting	1.47	0.04	***
	b_3 - selecting and screening machines	1.49	0.06	***
	b_4 - selecting, screening and gravitator machines	1.50	0.07	***
a_4	b_1 - unconditioned	**1.44**	-	**Mt.$_4$**
MULAN	b_2 - selecting	1.48	0.04	***
	b_3 - selecting and screening machines	1.50	0.06	***
	b_4 - selecting, screening and gravitator machines	1.52	0.08	***

$DL_{5\%} = 0.02$; $DL_{1\%} = 0.03$; $DL_{0.1\%} = 0.04$

Table 5. Conditioning method influence over wheat sowing material hectolitric mass (average 2010 – 2012)

EXPERIMENTAL VARIANT		*HECTOLITRICAL MASS (kg/hl)*	*DIF. (kg/hl)*	*SIGN.*
a_1	b_1 - unconditioned	**73.00**	**-**	**Mt.$_1$**
DROPIA	b_2 - selecting machine	74.12	1.12	***
	b_3 - selecting and screening machines	74.34	1.34	***
	b_4 - selecting, screening and gravitator machines	75.54	2.54	***
a_2	b_1 - unconditioned	**76.25**	-	**Mt.$_2$**
GLOSA	b_2 - selecting machine	76.78	0.53	***
	b_3 - selecting and screening machines	76.83	0.58	***
	b_4 - selecting, screening and gravitator machines	77.32	1.07	***
a_3	b_1 - unconditioned	**77.47**	-	**Mt.$_3$**
PETUR	b_2 - selecting	77.87	0.40	***
	b_3 - selecting and screening machines	78.17	0.70	***
	b_4 - selecting, screening and gravitator machines	78.47	1.00	***
a_4	b_1 - unconditioned	**77.53**	-	**Mt.$_4$**
MULAN	b_2 - selecting	78.24	0.71	***
	b_3 - selecting and screening machines	78.44	0.91	***
	b_4 - selecting, screening and gravitator machines	78.63	1.10	***

$DL_{5\%} = 0.21$; $DL_{1\%} = 0.28$; $DL_{0.1\%} = 0.37$

It is found that, in all the studied genotypes the germination capacity increases with the complexity of the wrapping method, the highest values are recorded when the wrapping was used consisting of complex - selecting, screening and gravitator machines - in the case of *Dropia* and *Glosa* varieties the values are very significant positive (***) when using and testing winter wheat genotype.

Thus, in case of conditional variants, germination was recorded with 86% about 89% with *Glosa*, and *Dropia* varieties, 84% to 90% with *Petur* and *Mulan* varieties. Overall, it appears that this quality indicator of the recorded maximum value in conditional complex machine.

Mulan variety proved to be superior to the other tested varieties, the germination capacity increased by 2 percentage points in the case of compliance with the 5 percentage points of the selecting machine, respectively, in the case of compliance with the complex selecting, screening and gravitator machines, compared to the unconditioned control group.

Table 6. Conditioning method influence on germinated capacity for winter wheat sowing material (average 2010 – 2012)

EXPERIMENTAL VARIANT		*GERMINATION (%)*	*DIF. (%)*	*SIGN.*
a_1	b_1 - unconditioned	**86**	**-**	**$Mt._1$**
DROPIA	b_2 - selecting machine	88	2.0	**
	b_3 - selecting and screening machines	92	6.0	***
	b_4 - Selecting, screening and gravitator machines	92	6.0	***
a_2	b_1 - unconditioned	**89**	**-**	**$Mt._2$**
GLOSA	b_2 - selecting machine	90	1.0	-
	b_3 - selecting and screening machines	92	3.0	**
	b_4 - selecting, screening and gravitator machines	94	5.0	***
a_3	b_1 - unconditioned	**84**	**-**	**$Mt._3$**
PETUR	b_2 - selecting	85	1.0	-
	b_3 - selecting and screening machines	89	5.0	***
	b_4 - selecting, screening and gravitator machines	90	6.0	***
a_4	b_1 - unconditioned	**90**	**-**	**$Mt._4$**
MULAN	b_2 - selecting	92	2.0	*
	b_3 - selecting and screening machines	95	5.0	***
	b_4 - selecting, screening and gravitator machines	95	5.0	***

$DL_{5\%} = 1.75$; $DL_{1\%} = 2.35$; $DL_{0.1\%} = 3.10$

CONCLUSIONS

From the obtained results analysis, the conclusions drawn emphasized the most important aspects of winter wheat and sunflowers seeds conditioning and storage process in terms of qualitative parameters of seed.

The research results carried out on samples of 4 of winter wheat seed genotypes have shown that the three types of conditionality have a positive influence on the physical and biological properties of the seed.

It was found that a very significant improvement of all seed weight properties, purity, 1000 grains mass, absolute mass, specific mass, volumetric weight and germination capacity increase significantly improving properties since passing through the separator and the gradual increase of values to the complexes formed from separator - screening – gravitator machines, respectively.

The effect of each machine is cumulative and very significantly higher than previous equipment, thus among the 4 analysed genotypes *Mulan*, variety proved to be superior in terms of quality indices in all variants of conditioning, compared to other studied varieties of winter wheat.

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GENOTYPE AND CONDITIONING METHOD INFLUENCE ON SOWING MATERIAL QUALITY FOR SUNFLOWER

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Abstract

The syntagm ''quality seed'' is ever often used, relative notion which, on the one hand is defined by the ever growing demands of the seed final consumers, and on the other hand by laws and standards development, these ones establishing the minimum requests to be accomplished, ever higher and more restrictive once with every year, concept which supposes that this one to belong to some performant varieties and hybrids whose identity should be defined by: authenticity and variety purity, specific morphological characteristics and by phisiological and physic characteristics which will certify an adequate cultural value. Conditioning, stocking and preserving seeds are totally compulsory processes which interfere during the seed existence until the consumption. These processes are continuous concerns since the oldest times till nowadays. The continuous character of these processes involves their undissociated study, these ones carrying influences one upon the other. Hence, the attention which is transferred to them, ever higher to improve the seeds quality which is genetically determined.
All techniques and technologies of conditioning and stocking carry at their basis a complex of various origins phenomena (biological, physiological, biochemical, physic-chemical etc.) which take place in the seeds mass.
These concerns appeared as a consequence of the necessity to elongate the using period of seeds, long after they are produced, as the yield is seasonal and after the harvesting till the use, the seeds mass is submitted to some stressing factors which can lead to seeds quality indexes deterioration.
The most effective variant of conditioning has proved to be the one that used complex machinery consisting of separating - screening - gravitators, complex image which is indispensable when choosing a seed of the highest quality, the success of the next crop directly depending on the values of seeds quality indicators. The hybrid Paraiso 1000 CL P is remarkable, this one registering the highest values of the quality indicators, the differences observed having very significant positive statistical ensurance compared to the other three analyzed hybrids.

Key words: *conditioning (packaging), genotype, sunflower, quality physical indexes, quality biological indexes.*

INTRODUCTION

Before valorizing seeds in different areas, these ones are submitted to some conditioning operations such as unknown matters cleaning, moisturizing etc. In order to obtain superior quality products, it is necessary to eliminate unknown matters from the cereal crops mass, if possible, in a total amount (Buricescu, 2014). Practically, all impurities can't be eliminated and technical measures, which are taken, aim at their minimum reduction in the grains mass.
In fact, by conditioning method, removal of unknown light matters is foreseen (powders, dust), foreign bodyes larger than seeds (fragments of vegetal remains, pieces of wood, string, paper, stones, lumps of soil etc.) and unknown matters smaller than seeds (sand, weeds seeds, small particles of soil) (Borcean and Imbrea, 2005).
In order to elaborate this work, the following objectives were aimed at:

a- testing the behavior of 4 sunflower genotypes in terms of physical and biological indicators in different systems;
b- establishment of the most valuable sunflower genotype in terms of behaviour conditioning method.

MATERIALS AND METHODS

For sunflower, the studied factors were the following:

A Factor – the analysed sunflower hybrid, with 4 degree:

- **a_1** – *FAVORIT hybrid*;
- **a_2** – *SUPERSOL hybrid*;
- **a_3** – *PARAISO 102 CL hybrid*;
- **a_4** – *PARAISO1000 CL P hybrid*.

B Factor – the conditioning method with four degrees:

- **b_1** - unconditioned;
- **b_2** - conditioned with the selecting device;
- **b_3** - conditioned with the selecting and screening devices;
- **b_4** - conditioned with the selecting, screening and gravitator devices.

Out of the two tested factors combination, there resulted 16 experimental variants, the results registered within each variant being statistically interpreted by variability method analysis according to bi-factorial trials.

Laboratory analysis effected within research

Quality analysis (physic purity, weight of 1000 grains, total mass, specific mass, hectolitrical mass, germination) for experimental variants proper to the trial were effected for the crops harvested during 2010-2012 in four replicates over one year.

Statistical interpretation and calculus by variance analysis method the moment when the mixed effect of experimental analysis was effected for the unconditioned variant proper to each winter wheat genotype tested during research.

Measurement technique

Weight of 1000 grains determinations are effected only for the pure seed obtained by the early physical purity analysis.

In order to determine the weight of 1000 grains, in the research there was used the method of determining the weight of 1000 grains by counting all the samples to be analysed, which involves counting sample of pure seed resulting from the determination of physical purity or passing the sample through the included seeds. After counting them, samples are weighed and the results are to be expressed in grams, with the same number of decimal places in the determination of physical purity weight of 1000 grains is calculated by comparing the result to 1,000 grains.

Absolute mass determinations were effected on the mass of 1000 seeds dry matter content according to the relationship (Epure Lenuţa Iuliana and all, 2011):

$$M_a = 100 – U/100 \text{ x } M_r$$

Where:

M_a –1.000 seeds mass (g);

M_r – 1.000 seeds relative mass (g);

U – seeds present moisture (%).

In order to calculate the specific mass, there was determined 1000 seeds mass (MMB) and their volume(Vs)

The volume was determined by the introduction of 500 seeds in a graded cylindre which contains 500 cm^3 oil. The difference between the liquid level from the cylindre, obtained after seeds introduction and their initial level, represents the seeds volume.The result was recalculated for 1000 grains according to the formula (Roman et al., 2012):

$$d = MMB/V_S$$

Where:

MMB – 1.000 seeds mass (g);

V_S – seeds volume (cm^3).

In order to determine the volume weight of winter wheat and sun-flower seeds meant to be sowed, the hectolitrical balance was used, having 0.25 l volume. For statistical analysis, there were effected every four parallel determinations for the same seeds sample. In order to determine the germinative capacity of winter wheat sowing material, there were taken at random four samples (replicates) of 50 seeds, seeds which were to germinate, using as a vegetal bed filtring folded paper (BP method) and watered until receiving no more, seeds being arranged as uniformous as possible on the vegetal bed. Samples, prepared this way were introduced into a thermostat, then we followed constantly the temperature and moisture degree of the vegetal bed.

For the calculation of germination there was done the arithmetic average of the 4 repetitions results after extracting from the table differences between rehearsals, admitted to the germination percentage and calculated depending on the average percentage obtained rounded to the nearest whole number.

RESULTS AND DISCUSSIONS

Conditioning method influence on physical purity of sunflower sowing material

The mixed effect of the two studied factors is rendered in Table 1.

The mixed influence of experimental factors (Table 1) highlights the fact that, following the determination of the sunflower seed natural purity, the successive growth of this indicator is observed both between the studied hybrids and between variants of the conditioning test.

Thus, in the case of the unconditioned value, the physical purity value was of 84.10% for the *Favorit hybrid* and 88.36% for *Supersol hybrid*, maximum values being derived from hybrids *Paraiso 102 hybrid* and *Paraiso 1000 hybrid* where physical purity was 89.44% and 90.55% respectively.

Table 1. Conditioning method influence over sunflower sowing material purity (2010 – 2012 average)

EXPERIMENTAL VARIANT		*PURITY (%)*	*DIF. (%)*	*SIGN.*
a_1 *FAVORIT*	b_1 - unconditioned	**84.10**	**-**	**Mt.$_1$**
	b_2 - selecting machine	96.45	12.35	***
	b_3 - selecting and screening machiness	98.64	14.54	***
	b_4 - selecting, screening and gravitator machines	99.00	14.90	***
a_2 *SUPERSOL*	b_1 - unconditioned	**88.36**	-	**Mt.$_2$**
	b_2 - selecting machine	97.56	9.20	***
	b_3 - selecting and screening machines	98.93	10.57	***
	b_4 - selecting, screening and gravitator machines	99.67	11.31	***
a_3 *PARAISO 102 CL*	b_1 - unconditioned	**89.44**	-	**Mt.$_3$**
	b_2 - selecting	97.36	7.92	***
	b_3 - selecting and screening machines	98.75	9.31	***
	b_4 - selecting, screening and gravitator machines	99.87	10.43	***
a_4 *PARAISO 1000 CL P*	b_1 - unconditioned	**90.55**	-	**Mt.$_4$**
	b_2 - selecting	98.97	8.42	***
	b_3 - selecting and screening machines	99.46	8.91	***
	b_4 - selecting, screening and gravitator machines	99.86	9.31	***

$DL_{5\%} = 0.17$; $DL_{1\%} = 0.23$; $DL_{0.1\%} = 0.30$

The wrapping with the selecting device, the first place is taken by *Paraiso hybrid* 1000 with 98.97% purity, followed by the 97.56% for *Supersol* and 102 for *Paraiso* but also 97.36% and the *Favorit hybrid* with 96.45%.

Compared to the unconditional variant, the differences recorded by this physical quality indicator have very significant positive statistical assurance for all analyzed hybrids, for all the variations of conditioning, maximum values being recorded in the case of *Paraiso 1000 hybrid*.

The most effective conditioning variant has proved to be the one where it has been used complex machinery consisting of selecting, screening and gravitator devices, complex which is indispensable when wanting to obtain highest quality sowing material, next crops success directly depending on the purity of seeds.

Conditioning method influence determination on 1000 seeds mass of sunflower sowing seeds

It results out of this table that by getting out the light bodies of the seeds mass by their conditioning, 1000 grains mass improves significantly in comparison with the unconditioned control element, this parameter values increasing successively once with the increase of the number of used machines in the conditioning process (Table 2).

This time too, *Paraiso 1000 hybrid* has proven to be significantly superior to the other hybrids, the 1000 seeds mass recorded values being the following: 68.37 g for the unconditioned variant, 69.97 g, when within the conditioning process the selecting device was used, 70.12 g when using selecting and screening machines and 70.43 g when within the conditioning flow the gravitator is used too (Table 2).

The recorded differences among the experimental variants in comparison with the control variants are, in all cases, statistically ensured, being comprised between 0.40-1.10 g for *Favorit*, *hybrid*, 0.20 with unsignificant statistical ensurance (-) for selecting device variant and 2.60 g in the case of *Supersol hybrid*, 1.52-2.73 g for *Paraiso 102* şi 1.60-2.06 for *Paraiso 1000 hybrid*, being very significantly statistically ensured (***).

Table 2. Conditioning method influence on 1000 seeds mass for sunflower sowing material (average 2010 – 2012)

EXPERIMENTAL VARIANT		*1000 SEEDS MASS (g)*	*DIF. (g)*	*SIGN.*
a_1	b_1 - unconditioned	**67.00**	-	**Mt.$_1$**
FAVORIT	b_2 - selecting machine	67.40	0.40	***
	b_3 - selecting and screening machines	67.80	0.80	***
	b_4 - selecting, screening and gravitator machines	68.10	1.10	***
a_2	b_1 - unconditioned	**67.50**	-	**Mt.$_2$**
SUPERSOL	b_2 - selecting machine	67.70	0.20	-
	b_3 - selecting and screening machines	69.60	2.10	***
	b_4 - selecting, screening and gravitator machines	70.10	2.60	***
a_3	b_1 - unconditioned	**67.35**	-	**Mt.$_3$**
PARAISO 102 CL	b_2 - selecting	68.87	1.52	***
	b_3 - selecting and screening machines	69.94	2.59	***
	b_4 - selecting, screening and gravitator machines	70.08	2.73	***
a_4	b_1 - unconditioned	**68.37**	-	**Mt.$_4$**
PARAISO 1000 CL P	b_2 - selecting	69.97	1.60	***
	b_3 - selecting and screening machines	70.12	1.75	***
	b_4 - selecting, screening and gravitator machines	70.43	2.06	***

$DL_{5\%} = 0.22$; $DL_{1\%} = 0.30$; $DL_{0.1\%} = 0.40$

Conditioning method influence on absolute mass of sunflower sowing material

Within the conditioning process of sunflower seeds, as a consequence of the mixed effect of the two tested experimental factors within the research, the absolute mass records significant positive values (*), in the case of *Favorit* and *Supersol hybrids* within the conditioning variant which uses the selecting device and very significant positive (***), for all studied hybrids, when when within the conditioning process there are used selecting + screening devices, respectively selecting + screening + gravitator devices, with differences of this parameter comprised between 4.54-4.66 g for *Favorit hybrid*, 1.74-3.10 g for *Supersol hybrid*, 2.01-3.68 g for *Paraiso 102*, respectively 1.18-1.16 g for *Paraiso 1000*, in comparison with the unconditioned control variants specific to each tested hybrid (Table 3).

Conditioning method influence on specific mass of sunflower sowing material

Results achieved as a consequence of the determination of sunflower seeds specific mass, as an effect of the combined action of the studied factors taken into the research study are summarized in Table 4.

Following the conditional operations, it can be said that the specific weight of sunflower seeds improve significantly by eliminating light factions, since the first variant of conditioning with the selecting device together with the wind, remove light mass bodies from the seed (Table 4).

The highest values of this indicator have been physically registered with the *Favorit hybrid*, followed by *Supersol*, *Paraiso 102* and *Paraiso 1000 hybrids*, each genotype exceeding the values recorded in the case of conditional variants.

Differences recorded compared with the control unconditioned variants recorded respect for each tested hybrid were between 0.20 and 0.34 g/cm3 for *Favorit hybrid*, 0.20 and 0.07 g/cm^3 for *Supersol hybrid* 0.07 and 0.17 g/cm^3 for *Paraiso 102 hybrid* and 0.04-0.18 g/cm^3 for hybrid *Paraiso 1000*, the differences statistically assured being significantly positive (*).

Table 3. Conditioning method influence over the absolute mass of sunflower sowing material (average 2010 – 2012)

EXPERIMENTAL VARIANT		ABSOLUTE MASS (g)	DIF. (g)	SIGN.
a_1 *FAVORIT*	b_1 - unconditioned	**52.87**	**-**	**$Mt._1$**
	b_2 - selecting machine	53.70	0.83	*
	b_3 - selecting and screening machines	57.41	4.54	***
	b_4 - selecting, screening and gravitator machines	57.53	4.66	***
a_2 *SUPERSOL*	b_1 - unconditioned	**54.67**	-	**$Mt._2$**
	b_2 - selecting machine	54.70	0.03	*
	b_3 - selecting and screening machines	56.41	1.74	***
	b_4 - selecting, screening and gravitator machines	57.77	3.10	***
a_3 *PARAISO 102 CL*	b_1 - unconditioned	**54.65**	-	**$Mt._3$**
	b_2 - selecting	55.43	0.78	***
	b_3 - selecting and screening machines	56.66	2.01	***
	b_4 - selecting, screening and gravitator machines	58.33	3.68	***
a_4 *PARAISO 1000 CL P*	b_1 - unconditioned	**56.78**	-	**$Mt._4$**
	b_2 - selecting	56.87	0.09	***
	b_3 - selecting and screening machines	57.96	1.18	***
	b_4 - selecting, screening and gravitator machines	57.94	1.16	***

$DL_{5\%} = 0.03$; $DL_{1\%} = 0.04$; $DL_{0.1\%} = 0.06$

Table 4. Conditioning method influence over wheat sowing specific mass (average 2010 – 2012)

EXPERIMENTAL VARIANT		SPECIFIC MASS (g/cm^3)	DIF. (g/cm^3)	SIGN.
a_1 *FAVORIT*	b_1 - unconditioned	**0.86**	**-**	**$Mt._1$**
	b_2 - selecting machine	1.06	0.20	***
	b_3 - Selecting and screening machines	1.14	0.28	***
	b_4 - Selecting, screening and gravitators	1.20	0.34	***
a_2 *SUPERSOL*	b_1 - unconditioned	**0.98**	-	**$Mt._2$**
	b_2 - selecting machine	1.18	0.20	***
	b_3 - Selecting and screening machine	1.22	0.24	***
	b_4.- selecting, screening and gravitators	1.05	0.07	***
a_3 *PARAISO 102 CL*	b_1 - unconditioned	**1.09**	-	**$Mt._3$**
	b_2 - Selecting	1.16	0.07	***
	b_3 - Selecting and screening machine	1.23	0.14	***
	b_4 - Selecting, screening and gravitators	1.26	0.17	***
a_4 *PARAISO 1000 CL P*	b_1 - unconditioned	**1.10**	-	**$Mt._4$**
	b_2 - Selecting	1.14	0.04	***
	b_3 - Selecting and screening machines	1.23	0.13	***
	b_4.- Selecting, screening and gravitators	1.28	0.18	***

$DL_{5\%} = 0.02$; $DL_{1\%} = 0.03$; $DL_{0.1\%} = 0.04$

Tabelul 5. Conditioning method influence over hectolitric mass sunflower sowing material (average 2010 – 2012)

EXPERIMENTAL VARIANT		HECTOLITRICAL MASS (kg/hl)	DIF. (kg/hl)	SIGN.
a_1 *FAVORIT*	b_1 - unconditioned	**38.96**	**-**	**$Mt._1$**
	b_2 - selecting machine	39.13	0.17	***
	b_3 - selecting and screening machines	40.12	1.16	***
	b_4 - selecting, screening and gravitator machines	40.86	1.90	***
a_2 *SUPERSOL*	b_1 - unconditioned	**40.11**	-	**$Mt._2$**
	b_2 - selecting machine	40.87	0.76	***
	b_3 - selecting and screening machines	40.95	0.84	***
	b_4 - selecting, screening and gravitator machines	41.11	1.00	***
a_3 *PARAISO 102 CL*	b_1 - unconditioned	**40.56**	-	**$Mt._3$**
	b_2 - selecting	40.89	0.33	***
	b_3 - selecting and screening machines	41.32	0.76	***
	b_4 - selecting, screening and gravitator machines	41.44	0.88	***
a_4 *PARAISO 1000 CL P*	b_1 - unconditioned	**40.73**	-	**$Mt._4$**
	b_2 - selecting	40.87	0.14	***
	b_3 - selecting and screening machines	41.47	0.74	***
	b_4 - selecting, screening and gravitator machines	41.62	0.89	***

$DL_{5\%} = 0.02$; $DL_{1\%} = 0.03$; $DL_{0.1\%} = 0.04$

Conditioning method influence on hectolitrical mass of sunflower sowing material

Table 5 centralized experimental results which are obtained from the hectolitrical standard mass determination of sunflower seed material, the effect of the combined action of the two factors being tested in the research.

One acknowledges, as a result of the determination of the sunflower seeds volumetric weight that the values of this indicator increases very significantly (***) for all experimental variants considered in the study (Table 5), compared with the unconditional hybrid-specific tested control variants, the increases are due to the way of setting seed in bulk, which make up a large and inter-granular space of dry seeds.

Compared with unconditional control variant, research results have shown that hybrids of sunflower taken into study were of a different behavior, increasing the standard mass values together with the increase in the number of machines used in the conditioning process.

Conditioning method influence on the germination capacity of sunflower sowing material

The results obtained following the determination of sunflower seeds germination capacity, as a result of the combined action of the two factors which are tested in the research are summarized in table 6.

Analyzing the results obtained as a consequence of the determination of germination capacity of sunflower seeds, as a result of the combined action of two experimental tested factors in the research, it is found that the entry values are growing once with the increase in the number of machines that are used in the process of conditioning, maximum values being recorded in the case of using a complex selecting device formed of selecting, screening and gravitator devices, no matter the tested genotype. Thus, in the case of this conditioning method for *Favorit hybrid* was recorded a germination of 85%, 91% for *Supersol hybrid*, while for *Paraiso 102* and *Paraiso 1000 hybrid*, the germination values were of 90 and respectively 93%, with very significant positive ensurance (***) in the variant selecting + screening + gravitator devices, in comparison with unconditioned control variants, where seeds germination percent was of 78% for *Favorit hybrid* and 86% *Supersol*, *Paraiso 102* and *Paraiso 1000 hybrids*.

Table 6. Conditioning method influence on germinated capacity for sunflower sowing sowing material (average 2010 – 2012)

EXPERIMENTAL VARIANT		*GERMINATION (%)*	*DIF. (%)*	*SIGN.*
a_1	b_1 - unconditioned	**78**	-	**$Mt._1$**
FAVORIT	b_2 - selecting machine	79	1.0	-
	b_3 - selecting and screening machines	82	4.0	**
	b_4 - selecting, screening and gravitator machines	85	7.0	***
a_2	b_1 - unconditioned	**86**	-	**$Mt._2$**
SUPERSOL	b_2 - selecting machine	87	1.0	-
	b_3 - selecting and screening machines	88	2.0	-
	b_4 - selecting, screening and gravitator machines	91	5.0	***
a_3	b_1 - unconditioned	**86**	-	**$Mt._3$**
PARAISO 102 CL	b_2 – selecting machine	87	1.0	-
	b_3 - selecting and screening machines	88	2.0	-
	b_4 - selecting, screening and gravitator machines	90	4.0	**
a_4	b_1 - unconditioned	**86**	-	**$Mt._4$**
PARAISO 1000 CL P	b_2 – selecting machine	89	3.0	*
	b_3 - selecting and screening machines	90	4.0	**
	b_4 - selecting, screening and gravitator machines	93	7.0	***

$DL_{5\%} = 2.33$; $DL_{1\%} = 3.13$; $DL_{0.1\%} = 4.13$

CONCLUSIONS

The most effective variant of conditioning has proved to be the one that used complex machinery consisting of separator - screening – gravitator machines, complex image which is indispensable when chasing a seed of the highest quality, the success of the next crop directly depending on the values of seeds quality indicators.

The *Paraiso 1000 CL P hybrid* is remarked, this one registered the highest values of the quality indicators, the differences observed having very significant positive statistical assurance (***) compared to the other three analyzed hybrids.

For cleaning, appropriate preservation and long term storage, conditioning of seeds is absolutely mandatory, in this respect the use of the complex machines consisting of separator, screening machine and gravitator being recommended.

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CHANGES IN MACRO AND MICRO PLANT NUTRIENTS OF SUNFLOWER (*Helianthus annuus* L.) UNDER DROUGHT STRESS

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Abstract

Determination of the ability to leverage of plants from nutrients found in the soil in irrigation and dry conditions contributes to the work done. The objective of this study was to determine the effect of drought stress on macro and micro plant nutrients of the leaves of three sunflower genotypes (Tarsan, Sanbro and TR-3080) at 30% (drought stress) and 60% (well-watered) irrigation from soil water capacity. Stress treatment where starting with emergence until R1 stage (bud visible) in pods under controlled conditions of greenhouse. Drought stress significantly affected by changing P, K, Mg, Ca, Fe, Zn, Cu, Mn, Na contents of sunflower leaves. The results of our study under conditions of drought stress indicating that there were significantly differences among the all sunflower cultivars in terms of plant nutrients concentrations response to drought stress. Leaf P, Mg and Cu contents tend to decrease in the leaves of all sunflower genotypes under drought stress. Overall, on the basis of percent reduction consistently in accumulation plant nutrients in leaves, Sanbro cv. showed minimum reduction of percentage among the others under drought stress condition. However, differences in macro and micro nutrients used among all sunflower cultivars may also be related to differences in photosynthetic capacity under drought stress condition. It could also be confirmed that measuring macro and micro nutrients of leaves can be used to selection criterion for developing sunflower drought tolerance genotypes.

Key words: *sunflower, drought stress, plant nutrients.*

INTRODUCTION

Drought stress cause low productivity in crop production because of commonly limited mineral supply (Canavar et al., 2014). Micro nutritional disorders are common nutritional imbalance in plants and affect greatly plant performance and their response to surrounding environment (Hajiboland 2012). Many studies have explained that drought stress is caused by limited rainfall during the growing season that affects plants biochemical, molecular, and physiological attributes and influences various cellular and whole plant processes, which significantly reduces crop yield and quality (Andrich et al., 1996; Krizmanic et al., 2003). Therefore, drought resistance and its components are almost constantly being redefined to express the outstanding inventive capacity for terminology. Hu et al. (2007) point outed that under drought stress, nutrient uptake by the roots is reduced, in part because the decline in soil moisture results in a decreased rate of diffusion of nutrients from the soil matrix to the absorbing root surface (Viets, 1972 and Pinkerton and Simpson, 1986). Moreover, nutrient transport from the roots to the shoots is also restricted by the reduced transpiration rates and impaired active transport and membrane permeability, altogether resulting in a reduced root adsorbing power of crop plants (Kramer and Boyer, 1995). Thus, the reduced nutrient availability is one of the most important factors limiting plant growth under drought.

The objective of this study was to investigate the effect of these conditions on the spatial distribution of macro- and micronutrients along the growing leaves of sunflower under drought stress condition.

MATERIALS AND METHODS

Plant material and experiment establishment

The greenhouse experiment was carried out at the research greenhouse of the Crop Science department of the Agriculture and Horticulture Faculty in Humboldt University, Germany in 2012. Tarsan and TR-3080 sunflower genotypes, which were improved by Directorate Trakya Agricultural Research Institute in Turkey and Sanbro sunflower genotype was adapted by Syngenta®, were tested for variation under controlled drought stress and well-watered environmental conditions of approximately light/dark regime 12/12 h, at 25/15 ±3°C and relative humidity 30-50% respectively. The sunflower cultivars were planted in Mitschelin pots (30-cm deep 25 cm dia.) the plant populations were maintained (3 plants in a pot) in the greenhouse with only the natural sunlight of the summer months. Clay loam soil was used to fill pods and the cultivars were arranged completely in a randomized block design with five replications. Required amounts of chemical fertilizers were applied according to the instructions from 1 g nitrogen from 3.70 g KAS fertilizer as the field condition and then the seeds were sown. The soil water factor included two irrigation regimes including irrigation at 30% (water deficit) and 60% (well-watered) of field capacity.

Determination of water holding capacity of soil

To determine the field capacity of soil, the field soil which had already been taken from the field experiment area was air-dried and ground to pass through a 5 mm sieve at room temperature. Water holding capacity was determined using a gravimetric method with five replicates as the amount of moisture (percentage). Firstly the bottoms of 100 cm^3 five cylindrical tubes were covered with paper and a plastic strap for the filter and they were tared without soil and then filled completely with soil (by compression). Each cylindrical tube with soil was weighed and settled in a tray, which was approximately as deep as the height of the cylindrical tube. The tray was fully filled with water up to the top of the cylindrical tube and 3 h were allowed for saturation. Then, all cylindrical tubes were left on the quartz soil for 2 h (for drainage and filtering). After that, all the saturated cylindrical tubes were cleaned and weighed again (wet weight). Then all the tubes were oven-dried at 105 °C 24 h and the weight of the oven-dry soil samples was measured (dry weight). The field capacity of undisturbed soil was calculated according to the following formula;

$$\text{F.C.\%} = \frac{\text{wet soil weight (saturated)} - \text{dry weight}}{\text{dry weight}} * 100$$

Drought stress treatment

To adjust for the amount of watering of the pots in terms of the 30% and 60% irrigation regimes of field capacity, the soil water content was continuously monitored and maintained by watering at 30% and 60% levels of field capacity during the experiment. Changes in the soil water of each pod were measured and checked daily by weighing each pod at the beginning and end of the removed plant. Plants were harvested 50 days after sowing when plants were at the R3 stage (bud visible).

Plant Nutrients analysis

Before the plant nutrients analysis, when all the plants were harvested, 5-6 leaves fully developed leaves were collected from the middle of plant (neither young nor old leaves) for each replicate in all cultivars from both water treatments. All leaves were immediately settled in an ice box for transfer and stored at -20°C. The frozen leaves were directly dried using the method of lyophilization, which is 5 or 10 heated shelves Ø 200 mm, freezing separately, drying outside the ice condenser chamber with CHRIST Lyophilizer GAMMA 1-16 LSC model (London, England) with 5 temperature shelves Ø 200 mm, temperature range -40°C to +50° C.

Dry leaves were ground in a Retsch ball milling machine (Germany) and weighed (0.5 g). The mineral composition (P, K, Ca, Mg, Na, Fe, Zn, Cu, Mn,) of the leaves was digested by dry ashing method (Kacar and İnal, 2008). The digested sample was filtered and used for the determination of nutrients. Phosphorus (P) was analyzed by spectrophotometer (Shimadzu, UV-160A), (Jackson, 1958). K, Na and Ca were determined by flame photometer (Jenway, PFP-7) and Mg, Fe, Zn, Cu and Mn was determined by atomic absorption

spectrophotometer (Varian, 220FS) (Kacar and İnal, 2008). Leaf nutrient concentrations derived from the leaf nutrients analysis, were calculated by leaf dry weight (data were not shown).
The results were analyzed using the TARIST package software (Açıkgöz et al., 1994) to determine the effect of nitrogen and water dosages on the sunflower genotypes.

RESULTS AND DISCUSSIONS

It was determined that drought stress had a statistically significant impact on the all leaf nutrients analyzed in the sunflowers in Table 1 (ANOVA table). Drought stress × genotype interaction was also statistically significant in terms of the all nutrients (Table 1). Table 2 shows that sunflower cultivars response differently to in terms of leaf nutrient contents against the drought stress condition. (Table 2). On the contrary, under drought stress condition leaf Fe and Mn contents of all sunflower genotypes tend to increase. In terms of K, Ca, Na and Zn contents in Sanbro cv. tend to increase, whereas Tarsan tend to decrease. On the other hand, TR-3080 sunflower cv. tends to decrease except Zn under drought stress condition (Table 2).

Table 1. The result of variance analyses for all leaf nutrients measured of three sunflower genotypes under drought and well watered conditions

Variance Source	d.f	Calculated of mean square								
		P	K	Ca	Mg	Na	Fe	Zn	Cu	Mn
G	2	**	**	**	**	**	**	**	**	**
C	1	**	*	**	**	**	**	**	*	**
GxC	2	**	**	**	**	*	**	**	**	**

* $P<0.05$, ** $P<0.01$; ns: non-significant, G: Genotype, C: Condition, d.f: degree of freedom.

Table 2. The effect of drought stress on leaf nutrients contents of three sunflower cultivars (mg LDW^{-1})

Cultivars	Conditions	P (mg)	K (mg)	Ca (mg)	Mg (mg)	Na (mg)	Fe (mg)	Zn (mg)	Cu (mg)	Mn (mg)
Sanbro	WW	16.965	142.470	45.290	17.773	0.099	0.400	0.101	0.060	0.103
	DS	15.002	158.576	53.403	14.096	0.199	1.258	0.333	0.057	0.559
Tarsan	WW	22.526	195.920	75.020	25.228	0.570	0.742	0.224	0.072	0.190
	DS	11.999	145.464	46.664	15.354	0.198	0.946	0.219	0.050	0.344
TR-3080	WW	18.183	135.276	48.115	20.436	0.248	0.624	0.164	0.053	0.148
	DS	8.388	80.136	29.770	8.460	0.110	0.795	0.248	0.029	0.364

As compared with the well watered and drought stress condition, under the drought stress condition, the highest P, K, Ca, Na, Fe, Zn, Cu and Mn contents were determined except Mg in Sanbro sunflower cv. The highest Mg content was found in Tarsan sunflower cv. The lowest P, K, Ca, Mg, Na, Fe and Cu contents were found in TR-3080 cv. while the lowest Zn and Mn contents were found Tarsan cv. (Table 2).
It was observed under drought stress condition that percentage of reduction in terms of leaf P, Mg and Cu contents in TR-3080 was higher than that of Sanbro and Tarsan sunflower cv. Sanbro cv. showed minimum reduction of percentage among the others.
It could be considered in our research that induced leaf nutrients such as P, Mg and Cu under drought stress due to the uptake of nutrients usually decreased due to diminishing absorbing power of roots (Dunham and Nye (1976) or hindered the nutrient uptake process (Honda 1971). Especially, Tarsan and TR-3080 sunflower cultivars showed higher decline than Sanbro cv. in terms of many leaf nutrients under drought stress. These findings are corroborated with previous research Nahar and Gretzmacher, (2002), who pointed out that there is a tendency of diminishing concentrations of N, P, K, S, Na, Ca and Mg with increasing water stress by the tomato plants.

In addition to sugars and osmolyte, some plants also accumulate other low or high molecular mass compounds such as K is the main osmotic solute in plants (Fournier et al., 2005). Its accumulation in the cell leads to osmotic water uptake and generates the cell turgor required for growth and stomatal opening (De La Guardia and Benlloch 1980). Therefore, it may be considered that the photosynthesis capacity of Sanbro cv. was higher than that of Tarsan and TR-3080 because of the high K accumulation in leaves of Sanbro cv. under drought stress.

CONCLUSIONS

Since water is essential for plant growth, it is axiomatic that water stress, depending on its severity and duration, will affect plant growth, yield and quality of yield. The osmotic adjustment as accumulation of solutes within the cell helps in maintaining turgor at decreasing water potentials. On the basis of percent reduction consistently in accumulation plant nutrients in leaves, Sanbro cv. showed minimum reduction of percentage among the others under drought stress condition. However, differences in macro and micro nutrients used among all sunflower cultivars may also be related to differences in photosynthetic capacity under drought stress condition. It could also be confirmed that measuring macro and micro nutrients of leaves can be used to selection criterion for developing sunflower drought tolerance genotypes.

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INFLUENCE OF GRAIN TYPE ON THE EFFICACY OF SOME FORMULATIONS OF DIATOMACEOUS EARTH AGAINST THE RICE WEEVIL (*Sitophilus oryzae* L.)

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Abstract

The paper aimed to present the effect of grain type on the insecticidal efficacy of the diatomaceous earth (DE) formulations, applied on wheat, barley, maize and paddy rice against adults of the rice weevil, Sitophilus oryzae L. *The formulations used in the bioassays were two local DEs deposits from Romania (Buzău Valey-Pătârlagele and South of Dobroudja-Adamclisi), two from Greece (Elassona region) and two comercial products (SilicoSec and PyriSec). The bioassays were done in laboratory conditions set at 25°C and 60±5%relative humidity in 3 series with 3 replicates. The DEs were applied at the dose rates of 100, 300, 500 and 900 ppm (mg DE per Kg of grain), while mortality of the exposed adults was recorded after 7, 14 and 21 days of exposure. Among the tested DEs, the most effective of all, was the commercial formulation of PyriSec witch manage to total control the adults of S. oryzae in half of the tested grains (wheat and maize) after 7 days of exposure in dose rates above 100 ppm. Between the tested grains, DEs were most effective when applied on wheat and totally ineffective on paddy rice. Furthermore for wheat, the two DEs from Romania and one from Greece (Elassona 1), at the highest dose rate, had the same high performance with the commercial formulation of SilicoSec, while for the other grains all of the no commercial DEs was ineffective and performed the same with SilicoSec formulation. These findings lead us to conclude that our no commercial DEs are competitive with the SilicoSec formulation, and can sufficient protect wheat in doses above 900 ppm.*

Key words*: diatomaceous earth, Sitophilus oryzae, stored grains (wheat, barley, rice, maize).*

INTRODUCTION

The use of diatomaceous earths (DEs), a naturally silicaceous dust formed by the fossilized remains of unicellular algae species namely diatoms, represents a promising alternative to chemical insecticides in stored-product protection. For a while, DE was intensively investigated for stored product protections (Korunic, 1998; Athanassiou et al., 2003, 2004, 2005; Kavallieratos et al., 2005).
DE has a several advantages above traditional grain protectants, because it has low mammalian toxicity, does not break down rapidly and does not affect end-use product quality (Korunic, 1998), it can be applied to the commodity with approximately the same technology as traditional residual insecticides, and can provide long-term protection against insects pest (Athanassiou et al., 2005).

Deposits from south-eastern Europe appeared to be very effective against stored grain infested with coleopterons species such as the rice weevil, *Sitophilus oryzae* L., which is a cosmopolitan pest, considered to be one of the most destructive and widespread species in stored grains. Several researchers have investigated local DEs formulations (Rojht et al., 2010; Vayias et al., 2009).
In this context, the paper presents the results obtained in the trials with Romanian and Greek formulations of DEs from local deposits. This research work was carried out in Bilateral Cooperation Project Romania-Greece.

MATERIALS AND METHODS

Diatomaceous Earth Formulations
The amorphous DE samples from two local DEs deposits from Romania (Buzău Valey-Pătârlagele and South of Dobroudja-

Adamclisi), named PatRom and AdRom respectinely, and two others from Greece (Elassona region) were processed at the University of Thessaly in Greece. DEs samples were dried to 3-5% moisture content (m.c.). Then, the moist, soft small pieces were dried in a ventilated oven set at 40°C for 24 h. After drying, small pieces were ground in a laboratory mill at full speed for 10 sec. All samples were shifted through a standard sieve of 100 meshes. The obtained formulations were compared in the trials with commercial products SilicoSec (Biofa, Germany) and PyriSec (Agrinova, Germany). SilicoSec contains approx. 90% SiO_2, while PyriSec contains SilicoSec with natural pyrethrum and piperonyl butoxide.

Commodities

DEs formulations were tested in different grains, since the DE efficacy is determined by the type of the commodity. The grains used were wheat, barley, maize and paddy rice. Wheat, barley and maize were produced in 2012 in Mizil surroundings (latitude 45° 0' 0'' N and longitude 26° 25' 25'' E, about 130 m above sea level). Wheat cultivar was Miranda and barley cultivar was Laverda. Corn hybrid was Fundulea 322. The paddy rice (var. Melas) provenience was Greek. The grains were left previously for 7 days at the appropriate conditions to equilibrate with the desired relative humidity level.

Insects and bioassays

The rice weevil (*Sitophilus oryzae* L.) adults which were used for the trials were taken from a population that was kept in the Laboratory for Entomology of the Research Development Institute for Plant Protection Bucharest.

The bioassays were carried out in laboratory conditions, in 3 series with 3 replicates. The DEs were applied in 1 kg lots of each at the dose rates of 100, 300, 500 and 900 ppm (mg DE per kg of grain). The lots were placed in glass jars, and shaken manually for approx. 3 min. to achieve equal distribution of the DE dust to the entire grain mass. Untreated lot of grains were used, which served as a control. Then, 3 samples (replicates), of 50 g each, were taken from each lot, and these samples were placed in small glass vials, which were closed, apart from a 1.5 cm hole at the top, covered with fine mesh for ventilation. After that, 30 adults (<21 days old) were placed in each vial. The lots were placed in controlled room at temperature of 25°C, and relative humidity level of 60±5%. Mortality in DE-treated commodities was recorded after 7, 14 and 21 days of exposure.

Data analysis

The data were analysed by using the software Graph Pad Prism 5. Adult mortality data were corrected using Abbott's formula (Abbott, 1925). Adult mortality was analysed separately for each grain.

RESULTS AND DISCUSSIONS

Insecticidal efficacy of DE is highly influenced by several factors such as the type of commodity to which it is applied (Athanassiou et al., 2003) and the origin or formulation (Korunic, 2013). The results of our study are presented in the graph from Figures 1-12.

The insecticidal efficacy of DE is determined by the degree of adherence to the kernel, a physical characteristic of each type of grain (Korunic, 1997, 1998).

In Figures 1-3 it can be seen, that mortality of *S. oryzae* adults exposed to treated maize was low, with only exception the mortality levels of PyriSec. Mortality of the exposed adults did not exceed 20% in all dose rates and exposure intervals for the two Romanian and Greek DEs, as well as for SilicoSec. On the other hand, for the improved formulation of PyriSec which additionally contains natural pyrethrum, mortality level was high and the adults totally controlled after 7 days of exposure from dose rates above 100 ppm. Our findings for PyriSec stand in accordance with the work done by Athanassiou and Kavallieratos (2005). The reduced efficacy of DEs applied on maize was also reported from Chintzoglou et al. (2008) for spinosad dust, and can be partially explained with the characteristics of the external surface of the maize, which is smooth and probably reduced retention of the dust particles.

Figures 4-6 present the mortality levels of *S. oryzae* adults exposed on paddy rice treated with all dose rates of DEs. With the exception of PyriSec, where mortality reached 90% in the two higher doses, all the others DEs were ineffective. For paddy rice treated with SilicoSec, Athanassiou et al. (2003) reported that doses above 1000 ppm needed for a satisfactory level of control of *S.oryzae*

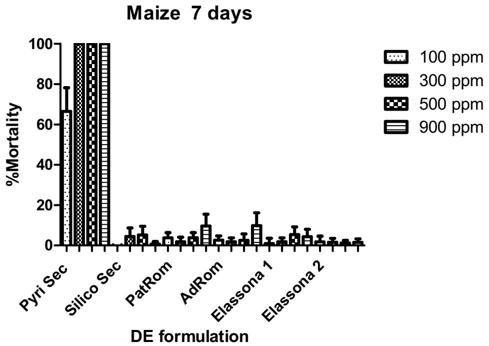

Figure 1. Mortality of *S. oryzae* adults on maize treated with DEs from different origins in four dose rates, at 7 days

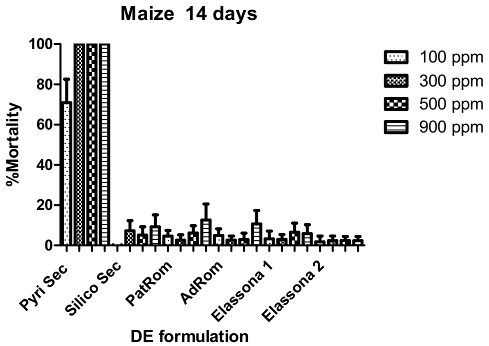

Figure 2. Mortality of *S. oryzae* adults on maize treated with DEs from different origins in four dose rates, at 14 days

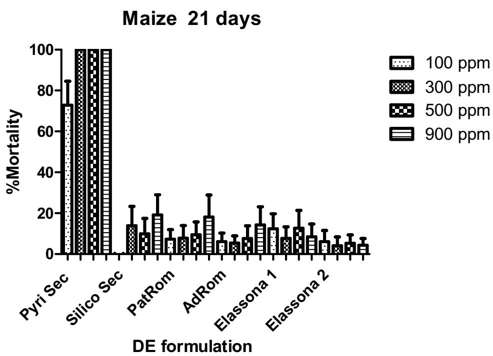

Figure 3. Mortality of *S. oryzae* adults on maize treated with DEs from different origins in four dose rates, at 21 days

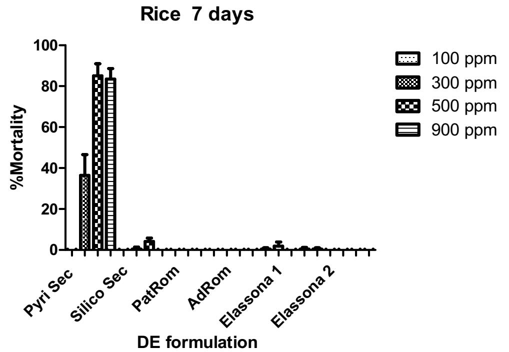

Figure 4. Mortality of *S. oryzae* adults on rice treated with DEs from different origins in four dose rates, at 7 days

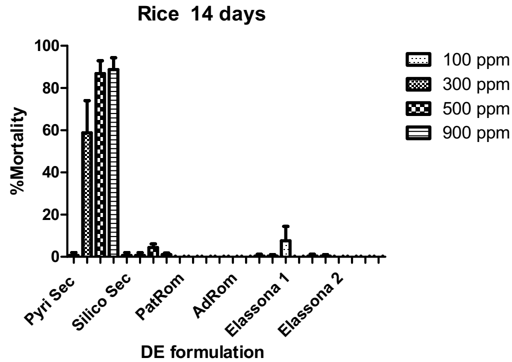

Figure 5. Mortality of *S. oryzae* adults on rice treated with DEs from different origins in four dose rates, at 14 days

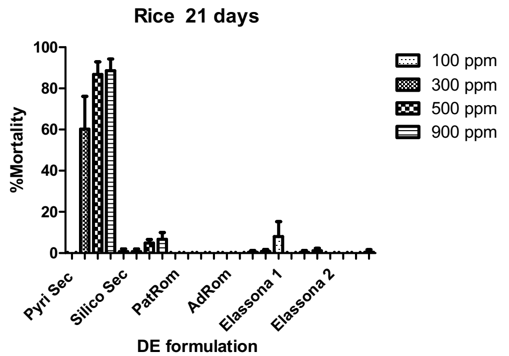

Figure 6. Mortality of *S. oryzae* adults on rice treated with DEs from different origins in four dose rates, at 21 days

In our case the highest dose was 900 ppm which can partially explain this reduced efficacy. Reduced efficacy on paddy rice, as compared to wheat was also reported from Vassilakos and Athanassiou (2013) for the spinosyn-based insecticide spinetoram.

In Figures 7-9, it becomes evident that the most effective was PyriSec, with mortality levels close to 80% after 7 days of exposure at the dose rates of 300, 500 and 900 ppm.

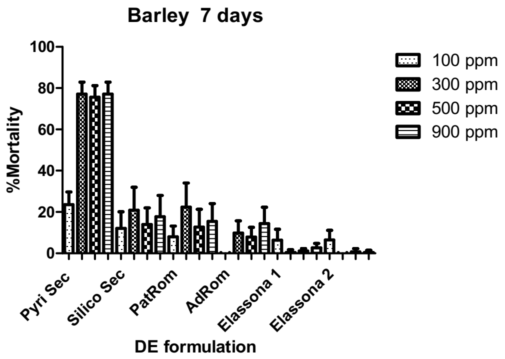

Figure 7. Mortality of *S. oryzae* adults on barley treated with DEs from different origins in four dose rates, at 7 days

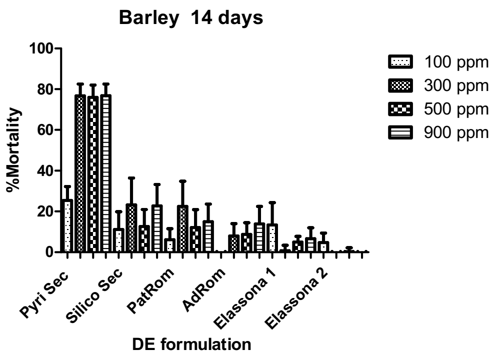

Figure 8. Mortality of *S. oryzae* adults on barley treated with DEs from different origins in four dose rates, at 14 days

The reduced efficacy of PyriSec on peeled barley against *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) was also reported from Athanassiou and Kavallieratos (2005). From the other DEs tested, mortality levels were close to 60%, and achieved only in the highest dose of the commercial formulation SilicoSec, while the DEs from Romania and Greece had the same reduced efficacy. For SilicoSec applied on barley, Athanassiou et al. (2003) reported complete control of *S. oryzae* adults for doses above 1000 ppm. Consequently, higher doses are needed for the control of this species.

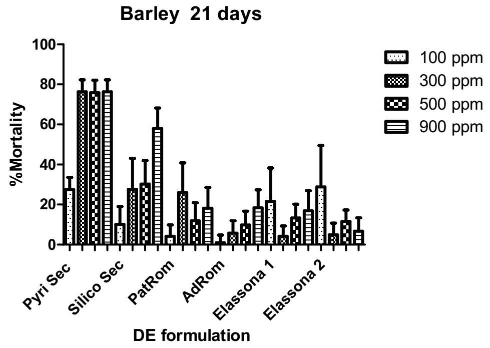

Figure 9. Mortality of *S. oryzae* adults on barley treated with DEs from different origins in four dose rates, at 21 days

Mortality of *S. oryzae* adults on wheat treated with DEs in different dose rates is presented in Figures 10-12. For this grain, DEs were more effective compared to the other substrates tested. PyriSec totally controlled *S. oryzae* adults after 7 days of exposure at 300, 500 and 900 ppm; at the lowest dose mortality reached 100% only after 21 days of exposure. For the other commercial formulation, SilicoSec, mortality increased with the increase of exposure. After 21 days mortality was 100% at the highest dose and above 95% for the doses of 300 and 500 ppm, while at 100 ppm the DE was ineffective.

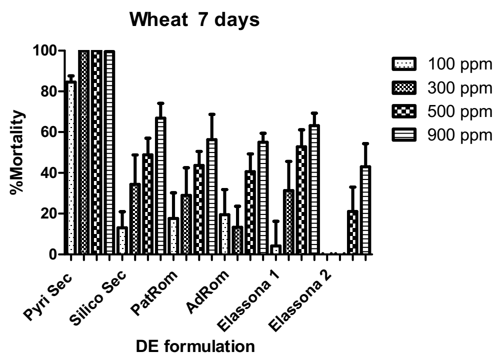

Figure 10. Mortality of *S. oryzae* adults on wheat treated with DEs from different origins in four dose rates, at 7 days

From the Romanian and Greek DEs and for the two higher doses, the two DEs from Romania and one from Greece (Elassona 1) had the same efficacy. Mortality levels for these DE were close to 100% at the highest dose and above 80% for the dose of 500 ppm. At 300 ppm higher mortality levels (above 65%) recorded for PatRom and Elassona 1. Wheat kernels, seems to have greater adherence ability which maybe explains the differences in efficacy, in comparison with the other grains (Athanassiou and Kavallieratos, 2005).

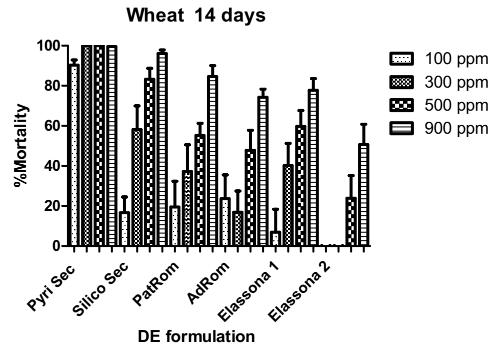

Figure 11. Mortality of *S. oryzae* adults on wheat treated with DEs from different origins in four dose rates, at 14 days

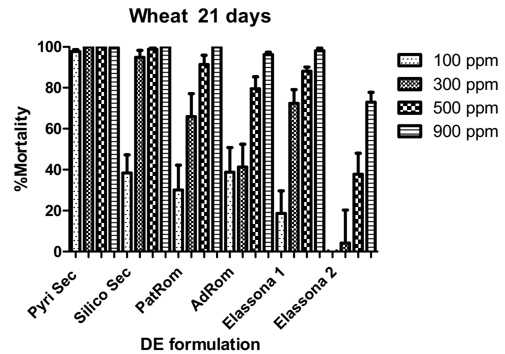

Figure 12. Mortality of *S. oryzae* adults on wheat treated with DEs from different origins in four dose rates, at 21 days

CONCLUSIONS

Based on our results, among the tested DEs, the most effective, was the commercial formulation PyriSec which totally controlled *S. oryzae* adults, in half of the tested grains (wheat and maize) after 7 days of exposure in dose rates above 100 ppm. Among the tested grains, DEs were most effective on wheat and totally ineffective on paddy rice. Furthermore for wheat, the two DEs from Romania and the one from Greece (Elassona 1), at the highest dose rate, had the same performance with the commercial formulation of SilicoSec. Hence, some of the natural DE deposits tested here are comparable with SilicoSec, but further experimentation with higher doses rates and adherence ability are needed to clarify this hypothesis.

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IN VITRO COMPATIBILITY BETWEEN CHEMICAL AND BIOLOGICAL PRODUCTS USED FOR SEED TREATMENT

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Abstract

The study reveals the possibility to use simultaneously biological and chemical control products as efficient and environmental friendly seed treatment for pest and disease control, which could provide a decrease of the chemical dose needed for plant protection. This phytosanitary strategy promotes microbial strain from Beauveria, Bacillus and Pseudomonas genera that can be used together with some chemical products for plant protection in order to decrease the amount of chemical product per unit area. Therefore, two chemical insecto-fungicides were selected based on the ecotoxicological risk assessment and legislation related to plant protection products (Regulation (EC) No 1107/2009 and Directive 2009/128/EC). The compatibility studies between the bio-control microorganisms and chemical pesticides were based on the microbial strains interaction with the active substance from the chemical insecticide and insecto-fungicides (imidacloprid 600g/l and mix of imidacloprid 460 g/l with thiram 176 g/l, respectively). The viability of the microbial strains was studied under laboratory conditions. The entomopathogenic fungi Beauveria bassiana (Bals.) Vuill. exhibit good compatibility with imidacloprid insecticide (600 g/L a.s. in comercial product), which does not affects the biological parameters of the beneficial microorganism. However, B. bassiana exhibits high sensitivity towards insecto-fungicide mixture, which inhibits completely the spore germination at the recommended concentrations. The results on the bacterial compatibility with the chemical phytosanitary products (at different concentration) did not inhibit completely the bacterial growth. The insecticide based on imidacloprid 600 g/l, did not affect the growth of any Bacillus biocontrol strains, when it was tested at 20% concentrations. Only the insecto-fungicides mixture, in 20% concentration, caused moderate growth inhibition (less than 5 mm) to some of the bacterial strains tested.

Key words: *pesticide, microbial compatibility.*

INTRODUCTION

The new plant protection products must fulfill increasingly higher efficacy with minimal environment impact in order to satisfy both farmers and consumers. A major requirement for every company producing chemical or biological pesticides is to ensure plant protection products for plant health without any environmental risks. Before pesticide registration, every plant protection product is thoroughly tested in greenhouses and in the field conditions in order to establish their efficacy, according to the Good Experimental Practices and OECD guidelines. They are also ecotoxicologically evaluated, according to Good Laboratory Practices and Regulation no. 440/2008, in order to establish their evolution in soil, water and air, and their effects on beneficial flora and fauna.

Ensuring food quality, human health and environmental protection are key considerations to develop the compatibility studies between chemical and biological pesticides. Compatible phytosanitary products are useful for the sustainable pest and disease management.

Given the importance of successful implementation of chemical pesticides with biological control agents in the Integrated Pest Management programs, there have been recently published results regarding the influence of common pesticides on the biological parameters of useful microorganisms (Rajanikanth et al., 2010; Ramazan-Asl. et al., 2010; Golshan et al., 2013). There were also developed *in vitro* testing protocols for compatibility evaluation between the entomopathogenic fungus *Beauveria bassiana* and different phytosanitary products (Da Silva and Neves, 2005). Results on the biocontrol bacteria and their compatibility with several chemical pesticides, such as captan, thiram, mancozeb, carbendazim, nemacur and azoxystrobin, were also mentioned in several studies (Frances et al., 2002; Omar et al., 2006; Mohiddin and Khan, 2013; Ahila Devi and Prakasam, 2013).

MATERIALS AND METHODS

Microbial strains

Six bacterial biocontrol strains, *Bacillus subtilis* 98a and Us.a2, *Bacillus amyloliquefaciens* OS17 and BW, *Bacillus pumilus* OS15 and *Pseudomonas chlororaphis* ssp. *aurantiaca* Sal.c2 were used in this study. These strains were previously identified as biocontrol bacteria that could suppress different soil borne phytopathogenic fungi such as *Rhizoctonia solani* (Sicuia et al., 2012), *Fusarium oxysporum* (Constantinescu et al., 2010) *Sclerotium bataticola* (Dinu et al., 2012) or *Pythium debaryanum* (Constantinescu, 2000). Routinely, these strains were grown on Luria Bertani agar medium at 28ºC.

The enthomopathogenic fungi used in the study was *Beauveria bassiana* Bals.(Vuill.) ICDPP#1 strain from the Enthomopathogenic Fungi Collection of the Research-Development Institute for Plant Protection, Bucharest - Department of Useful Organisms, also deposited in NCAIM, Budapesta, with the accession number (P) F001353. This strain was routinely grown on potato-dextrose-agar (PDA) medium, at 26ºC.

Chemical pesticides

Taking into consideration the legislation for placing plant protection products on the market and the sustainable use of pesticides, two chemical products for seed treatment were selected to be used in this study. These pesticides were imidacloprid 600 g/l, a systemic insecticide, and an insecto-fungicide mixture of imidacloprid 460 g/l with thiram 176 g/l.

Fungal compatibility evaluation with pesticides

Beauveria bassiana was multiplied on PDA medium using conidia from pure mature cultures. After 14 days of incubation at 25±1ºC, in the dark, the fungal material was suspended in sterile distilled water supplemented with 0.01% Tween 80 emulsifier.

The pesticides were tested in three concentrations: field recommended concentration (FR), 80% of FR and 120% of FR. These tested concentrations were noted as c1 = 120% FR, c2 = FR (using 800µl pesticide +200 µl pure water), c3 = 80% FR.

In order to test the influence on fungal viability, the pre-established concentrations were mixed in aqueous conidial suspensions and left to rest for one hour. After demarcation of three areas on the surface, disinfected microscope slides were placed in Petri dishes; humidity was maintained by filter paper moistened with distilled water. Each slide was covered with ~ 4 ml PDA medium (Sigma, Fluka) and one drop of the conidial suspension- test pesticide mix was placed in each demarcated area. Three repetitions were experienced for each concentration. Quantification of viability (germination %) was made after germination which was stopped by dripping a lactophenol-blue cotton solution after 18 hours of incubation (at 25±1º C, in darkness). Germination analysis was performed by light microscopy.

To express the percentage of germination, 200 germinated and non-germinated conidia were observed from three microscopic fields. Results were used to calculate the percentage of germination inhibition using the following formula:

$$\text{Inhibition of germination (\%)} =$$
$$= (G\%C - G\%var) / G\%C \times 100$$

where: G% C is the germination percentage in the control, and G%var is the germination percentage in experimental variants.

Vegetative growth and sporulation tests were assessed only for treatments with at least 60% conidia viability. The pesticides were individually tested for antimicrobial activity using the impregnated discs method.

PDA medium (Fluka) was poured into sterile Petri dishes. After solidification, 0.5 ml of fresh conidial suspension were inoculated and dispersed with a Drigalski spatula (Figure 1).

Figure 1. *Beauveria bassiana* test cultures preparation

Separately, sterile filter paper discs (6 mm Ø) were individually impregnated with 50µl of test pesticides and placed on the surface of the culture medium respecting the distance of 15 mm between disc and the edge of the plate and 30 mm between discs (Figure 2). Plates were incubated at 26°C.

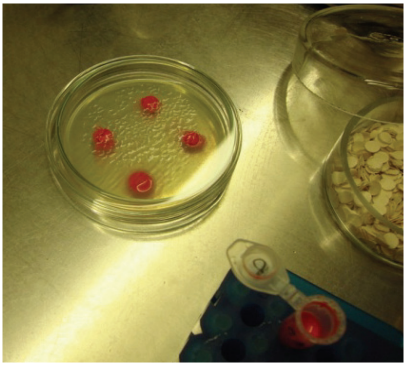


Figure 2. Testing pesticides towards *Beauveria bassiana* growth

Vegetative growth was evaluated at 10 days after fungal inoculation by measuring the inhibition area. The fungus sensitivity was assessed as follows: very sensitive if the inhibition zone diameter was greater than 2 mm, sensitive if the inhibition was between 2-4 mm and resistant when the inhibition zone was smaller than 2 mm or even absent.

To quantify the spores production, three discs per Petri dish containing sporulated mycelia were cut, using a glass tube (d = 7 mm). These were distributed in test tubes with 10 ml sterile distilled water and Tween 80 (0.01%), and then homogenized until conidia were separated completely from the surface of the media. The resulting suspension was appropriately diluted to be counted using a Burker chamber. Two readings (24 squares) for each repetition were performed and their average was used for statistical analysis.

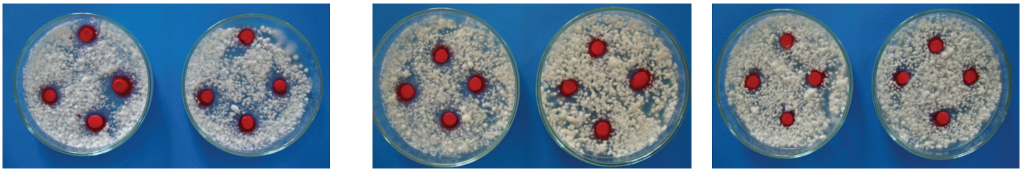
Bacterial compatibility evaluation with pesticides

The bacterial strains were multiplied in LB broth, and incubated for 48 hours at 28°C with 150 rpm rotary shaking. The bacterial cultures were than centrifuged at 3750 rpm for 20min at 10°C, in order to eliminate the supernatant and harvest the bacterial cells. The bacterial sediment was resuspended in sterile phosphate buffer, in order to prepare a suspension of 10^8 cfu/ml concentration. The pesticides were tested in four concentrations: 100%, 80%, 60% and 20% commercial pesticide. The compatibility evaluation between the chemicals and bacterial strains was studied *in vitro*. Petri dishes with LB-agar were inoculated with 100µl bacterial suspension, uniformly distributed on the surface of the medium using a Drigalski spatula. Subsequently, Whatmann paper plugs of 6 mm in diameter were moist with 50µl pesticide, at the mentioned concentration, and placed on the surface of bacteria inoculated plates. Control plates were similarly prepared, using sterile distilled water for paper plugs moistening. All plates were incubated at 28°C for 72h and than analyzed in order to evaluate the inhibition of bacterial growth. Bacterial strain sensitivity to pesticides was appreciated using the following index: 0 - for no bacterial growth, 1 - for inhibition zone greater than 5 mm, 2 - for inhibition zone less than 5mm, and 3 - when no inhibition hallo was present and the bacterial growth was not influenced by the pesticide.

RESULTS AND DISCUSSIONS

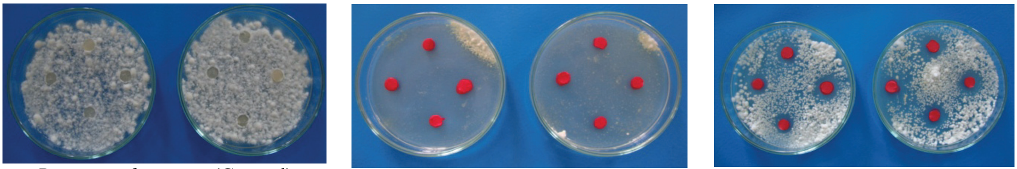
***In vitro* compatibility between *Beauveria bassiana* entomopathogenic fungi and two chemical pesticides used as seed treatments**

The tested pesticides did not significantly inhibit the conidial germination of *Beauveria bassiana* in any of the concentrations used (Figures 3 and 4). Comparing with the control, the differences were very small (Table 1).



Imidacloprid (C1) Imidacloprid (C2) Imidacloprid (C3)

Figure 3. *Beauveria bassiana* vegetative growth in treatment variants with imidacloprid insecticide (10 days after inoculation)



Beauveria bassiana (Control) Imidacloprid + thiram (C2) Imidacloprid + thiram (C3)

Figure 4. *Beauveria bassiana* vegetative growth in treatment variants with insecto-fungicide (10 days after inoculation)

Table 1. Pesticides influence on *Beauveria bassiana* biological parameters

Pesticide	**Tested conc.**	**Fungal spore germination**		**Vegetative growth reduction**		**Fungal sporulation**	
		Average %	**% of inhibition**	**Average (cm)**	**Sensitivity**	**Average % (conidia x 10^8)**	**% of inhibition**
Insecto-fungicide mixture of imidacloprid 460g/l + thiram 176g/l	C1	93.65±1.80	5	-	Very sensitive	-	-
	C2	92.80±3.27	6	-	Very sensitive	-	-
	C3	92.10±2.95	6	1.38±0.08	Sensitive	6.6±0.9	83
Imidacloprid 600g/l insecticide	C1	94.63±0.45	4	1.40±0.04	Sensitive	32.61±4.3	18
	C2	95.25±0.25	3	1.04±0.11	Sensitive	33±1.8	17
	C3	97.65±1.86	1	0.91±0.03	Sensitive	35.8±1.7	10
Control		98.78±0.54	0	0	0	40±0.03	0

Regarding the insecto-fungicide treatment, the concentration tested were not directly related to the percentage of germination, the difference between them being statistically insignificant ($p = 0.29$). When the imidacloprin insecticide was tested, the last concentration, C3, revealed a similar value as in the control.

Although the fungal germination was not so significantly influenced, the vegetative growth in the presence of insecto-fungicide treatment proved to be completely inhibited at C1 and C2 concentrations, demonstrating a fungistatic effect. The sporulation percent was reduced with 83% when the insecto-fungicide was used at C3 concentration. *Beauveria bassiana* showed sensitivity also to imidacloprid treatments, at all three concentrations.

***In vitro* compatibility between several biocontrol bacterial strains and two chemical pesticides used for seeds treatment**

The results revealed that none of the pesticides tested inhibited totally the bacterial growth at the tested concentration (Table 2).

In case of *Pseudomonas chlororaphis* ssp. *aurantiaca* Sal.c2 strain, there was no inhibition of bacterial growth at any of the tested pesticides concentrations (Figure 5). Likewise, in the presence of imidacloprid insecticide, at 20% concentration, all tested bacterial strains were able to grow without any inhibition (Figure 6).

Table 2. *In vitro* compatibility between the biocontrol bacteria and the tested pesticides

Biocontrol bacterial strain	Imidacloprid 600g/l				Imidacloprid 460g/l + thiram 176g/l			
	Bacterial growth at different pesticide concentrations (%)							
	100	***80***	***60***	***20***	***100***	***80***	***60***	***20***
Pseudomonas chlororaphis ssp. *aurantiaca* Sal.c2	3	3	3	3	3	3	3	3
Bacillus subtilis Us.a2	2	2	2	3	1	1	2	2
Bacillus subtilis 98a	2	2	2	3	2	2	2	2
Bacillus pumilus OS15	2	2	2	3	1	1	1	2
Bacillus amyloliquefaciens OS17	2	2	2	3	1	2	2	2
Bacillus amyloliquefaciens BW	2	2	3	3	1	2	2	2

were: 1 = inhibition hallo greater than 5 mm; 2 = inhibiton hallo less than 5mm; 3 = no inhibition hallo, uninfluenced bacterial growth.

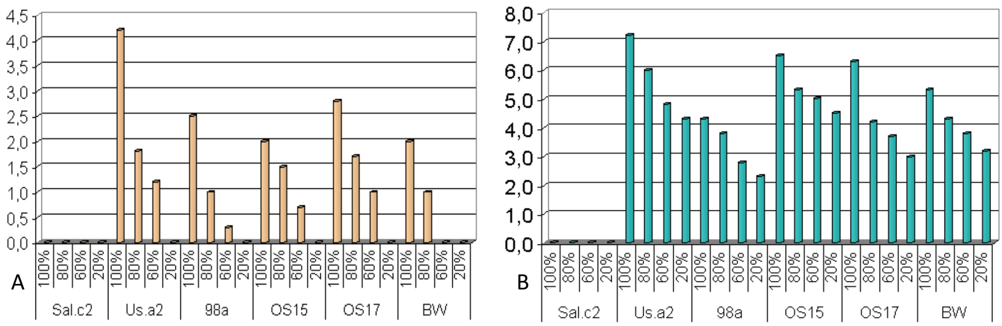


Figure 5. Pesticides influence on the bacterial growth inhibition.
A) Imidacloprid 600g/l and B) Imidacloprid 460g/l + thiram 176g/l.
Ordinate – average of the growth inhibition hallo (mm), Abscissa – bacterial strains and pesticide concentrations

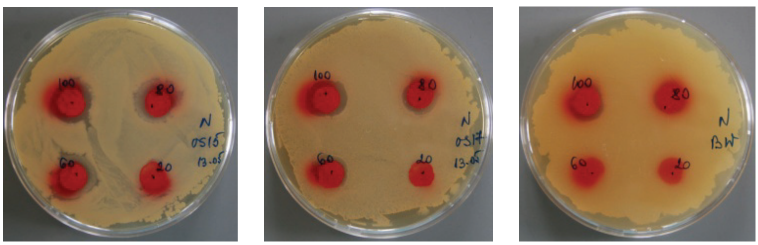


Figure 6. Bacterial growth in the presence of imidacloprid insecticide

Results showed that the imidacloprid insecticide was less toxic to the microbial strains analyzed compared to the insecto-fungicide mixture. However, the biocontrol activity of these microbial strains in pest and disease management, when used in combination with chemical pesticides, allow lowering the recommended dose of chemicals. This hypothesis should resolve the compatibility problems, taking into consideration that the pesticide applied in low doses did not visibly affect the microbial strains. On the other hand, such phytosanitary strategy that promotes biocontrol microbial strains used together with lower doses of chemical pesticides are one of the most promising strategies for plant protection in the Integrated Pest Management programs.

CONCLUSIONS

Pest biocontrol products based on *Beauveria bassiana* could be used together with chemical insecticides based on imidacloprid, since this chemical does not affect the biological parameters of the entomopathogenic fungus.

Beauveria bassiana entomopathogenic fungi exhibit very high sensitivity towards insecto-fungicide mixture of imidacloprid 460 g/l and thiram 176 g/l at the concentration recommended for use, this pesticide completely inhibit fungal spore germination.

The biocontrol bacterial strain *Pseudomonas chlororaphis* ssp. *aurantiaca* Sal.c2 could be used together with any of the mentioned pesticides, since the tested concentration of chemical did not affect the bacterial development.

The imidacloprid 600 g/l insecticide used at 20% concentration did not inhibit the biocontrol *Bacillus* sp. strains used in this study.

The pesticide mixture of imidacloprid 460 g/l and thiram 176 g/l, tested at 20% concentration, determined a moderate bacterial inhibition (with less than 5mm hallo around the chemical spots).

Phytosanitary strategy based on combined biocontrol and chemical treatments are promising strategies for plant protection within the Integrated Pest Management programs.

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RESEARCH REGARDING OILSEEDS CROPS SPECIES GROWING IN ECOLOGIC AGRICULTURE PRODUCTION SYSTEM, IN NORTH DOBRUDJA

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Abstract

The importance of this academic paper comes from the present role of ecologic agriculture and from its perspectives on a global, european and national basis, on the grounds of protecting the environment and the biodiversity of natural ecosystems. The present project aims to study the spreading possibilities of oilseeds crops a species like Helianthus annuus L., Brassica napus L. ssp. oleifera Metzg, Glycine max L. Merr., Carthamus tinctorius L., Camelina sativa L. Crantz, Lallemantia iberica,. The main goal of the research carried out in the South-East region of Romania, in North Dobrudja, Tulcea County, it was to study the behaviour of these oilseeds crops, the existent damaging organisms (weeds, diseases and pests) and the ways for fully control them. During the research, experimental research has been made in field conditions in order to study the biology and ecology of the crops, pointing out their role in the ecologic agriculture production system. Furthermore, there has been made laboratory analysis regarding the seeds chemical composition, the seeds harvest and quality, in order to obtain high quality ecological products.

Key words: *ecologic agriculture, oilseeds crops, crop biodiversity, North Dobrudja.*

INTRODUCERE

Ecologic agriculture represents a relatively new sector, but it has a wide perspective in Romania. Our country has proper conditions in order to develop ecologic agriculture, including fertile and productive soils and a reduced level of pollution in comparison with the developed countries, which have a high degree of urbanisation and industrialisation and which use super intensive technologies, based mainly on chemical fertilizers and synthesis pesticides.

In the last 10 years, the ecologically cropped Romanian territory has grown more than ten times, from 17,438 ha in 2000 to almost 200,000 ha in 2010. In Romania, ecological crops are mainly represented by forage crops and pastures, cereals, oilseeds crops and grain legumes, plus, fruits, mushrooms, medicinal and aromatic plants harvested from the wild flora.

From the ecologic crops, the industrial crops group includes crops that supply raw materials oriented towards industrialization in order to produce food (oils, proteins, sugar, and starch) and other non-food products.

For Romanian agriculture and economy, the most important industrial crops are sunflower, soybean, rapeseed, potato and sugar beet.

It must be pointed out that ecological agriculture is not a “simplistic” type of agriculture, a come back to the “traditional agriculture”, nor is it similar to “poverty agriculture”. On the contrary, it is based on strict and rigorous rules and principles, in accordance with national and internationals guides and standards.

Ecologic agriculture is based on a series of principles and ideas like: conservation of natural systems of cyclical transformation, use of renewable resources in the production and processing systems, protection of vegetal habitats and of wild animals, increase of biodiversity, rational use of water, and support of creating a socially integrated cropping system which is protects the environment.

Carthamus tinctorius L. is cropped for this achenes rich in oil (37-42%) semisiccative, iodine index of 140-152. The oil is high-quality and dietetic, having a high content of linoleic acid (74%), oleic acid (21%) and saturated acids (3%).

In our country, safflower can be extended on less rich soils from the droughty regions, where it can have better crops than the sunflower.

Figure 1. Aspect from *safflower* experiment (Topolog Experimental Field, 2010)

From an economic point of view, *Camelina sativa* L. Crantz is important because it is used in human nutrition due to the potential of its oil. Camelina was traditionally grown as an oleaginous crop aiming to produce vegetable oil.
The interest in this plant is increased in some areas because the cold, dry and high altitude clime limits the growth capacity for a wide variety of crops. According to Zohary and Hopf, *Camelina sativa* L. Crantz was an important crop for oil in Eastern and Central Europe until 1940 and, at present, it continues to be cultivated in some parts of Europe for its seeds, which are used in oil extraction and it was used in petrol lamps (until the modern spread of natural gas, propane, and electrical energy) and as an eatable oil, as well. Recent studies showed that the natural oil made of Camelina seeds contains an excellent balance of fatty acid, who are not present in any other oleaginous crops (for instance omega-3 and essential fatty acids), and a high level of tocopherols, with a unique stability to oxidation.
The main components are alpha-linolenic acid - (omega-3 fatty acid about 35-45%) and linoleic acid - (omega-6 fatty acid about 15-20%).
The oil is also rich in natural oxidants like tocopherols, making this oil very stable and resistant to oxidation and to growing rancid. It contains 3% erucic acid.

The oil has an almond flavour and it can become an important and famous alimentary oil in the future.

Figure 2. Aspect from *camelina* experiment (Topolog Experimental Field, 2010)

Lallemantia iberica, its eatable parts are the leafs and the seeds.
The leafs are used for tea. The seeds are rich in lipids and eatable oil is made of them. After having been dried out, the seeds contain 30% oil. The oil is used for lighting, for paint and as grease.

Figure 3. Aspect from *lallemantia* experiment (Topolog Experimental Field, 2010)

Lallemantia may be a replacement of flax oil and it has the same purposes.
The oil has a wide range of purposes: it is the basic ingredient of paint, it is used in wood conservation, in furniture furbishing products, in printing inks, in the production of soap and also in the production of linoleum.
It is cropped for the seeds from which oil is extracted. The oil can also be used in food products and as a tanning agent.
Glycine max L. Merr., soybean oil is used in alimentation, in the process of obtaining margarine, in plastic production, in linoleum

production. Soybean is also characterized by a high lipid content, which is regularly between 13-27%.

In their chemical composition, there are palmitina, stearin, olein, linoleina, fitosterina, cholesterin and lecithin. The lecithin content of the beans is 2-4%. Semisiccative oil with iodine index 107-139, solidifies at -8…-16°C. In the global oil production, soybean has the first place with about 30%, being followed by sunflower, with about 15%.

In Romania, the first attempts to introduce soybean crops, dating from 1911-1913, have failed due to the lateness varieties tested.

Helianthus annuus L.is the most important oil crop in Romania and one of the most important oil plants at a global level.

In Romania, sunflower represented in 2010 78% of oil production, having the first place and being followed by rapeseed with 11.4% and soybean with 10.3%.

Figure 4. Aspect from *sunflower* experiment (Topolog Experimental Field, 2010)

Sunflower oil is considered to be a valuable eatable oil due to its high level of linoleic acid and oleic acid (unsaturated fatty acids), which represent together 85-90% of fatty acids composition. It can be added the low content of saturated fat and cholesterol, as well as a high content of vitamins (E, B_5, B_3, B_1, K, D, A) and the lack of toxic or anti-nutritional substances.

Brassica napus L. ssp. *oleifera* Metzg has now an extremely important place in world economy, as a source of vegetable oil. The seeds contain 42-48% oil used in alimentation, in the production of margarine, as well as in industry. Lately, the rape oil has a greater percent in human nutrition or in biodiesel processing industry. Rape seeds have a high lipids content of 37.2-49.6%. In the chemical composition of rape oil, for the traditional oils, there is a high proportion of erucic acid and eicosenoic acid.

MATERIALS AND METHODS

The main goal of the research was the study of biology, ecology and productivity of some oleaginous species in order to find their adaptability to the pedoclimatic conditions from the Kastanozion soil region from North-West part of Tulcea County and to crop them in the ecologic agriculture system.

During these experiences, an observation programme has been developed, as well as measurements regarding: morphological and biological particularities of the studied species, productivity elements and the seed production, chemical composition and harvest quality.

The field research has been done on the Didactic Field of Agricultural School Group Topolog, which is situated at 60 km from Tulcea City, in the region of Kastanoziom soil from the North West past of Tulcea County, North Dobrogea, during 2009-2011. In the field research, there has been made an experiment with some oleaginous species. It was a monofactorial experience, being made by multiple-stage blocs method.

The tested biologic material:

- Safflower (*Carthamus tinctorius* L.), variety CW 1221 (NARDI-Fundulea); varieties 2106, 354 and 351 (SAATEN UNION).
- Camelina (*Camelina sativa* L. Crantz), varieties: Camelumba, Lindo, Calena (from NARDI-Fundulea).
- Soybean (*Glycine max L. Merr*), variety Columna (NARDI-Fundulea).
- Lalemanţia *(Lallemantia iberica),* local variety (Department of Field Crop Production, University of Agronomic Sciences and Veterinary Medicine of Bucharest).
- Sunflower *(Helianthus annuus* L.*),* hybrids: Arena, Flux MS SIRENA
- 9AG1811 (AGRICOVER); hybrids: MAS 92 B, MAS 94 C, MAS 96 A
- (MAISADOUR SEMINCES, Mont-de-Marsan).
- Rapeseed *(Brassica napus* L. ssp. Oleifera Metzg*),* variety Heros (SAATEN UNION).

Protective tape sunflower																
Repetition 1																
S. t. sunf	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	S. t. sunf
Repetition 2																
S. t. sunf	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_1	V_2	V_3	V_4	V_5	S. t. sunf
Repetition 3																
S. t. sunf	V_{12}	V_{13}	V_{14}	V_{15}	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	S. t. sunf
Protective tape sunflower																

Figure 5. Experimental scheme of oilseed crops
(Topolog Experimental Field, 2010-2011)

RESULTS AND DISCUSSIONS

Table 1. Experimental results concerning oilseed crops productions in 2010

Nr. crt.	Variety / hybrid	Production kg/ha	Production %	Diff. limit
1.	**Arena**	2467	100	Control
	Flux	2311	93.67	-156
	MAS 92B	1480	59.99	-987
	MAS 94C	2623	106.32	156
	MAS 96A	2033	82.40	-434
2.	**Heros**	1638	66.39	-829
3.	**Lalemantia**	1268	51.39	-1199
4.	**Columna**	2458	99.63	-9
5.	**Calena**	1208	48.96	-1259
	Camelumba	1516	61.45	-951
	Lindo	1362	55.20	-1105
6.	**CW 1221**	2304	93.39	-163
	345	2105	85.32	-362
	2106	1936	78.47	-531
	351	1906	77.38	-558

Table 1 shows the seed production of oil crops in 2010, in kg/ha. From this table, it may be concluded that the maximum production of the sunflower crop was registered at MAS 94 C hybrid, being 2623 kg/ha, and the minimum production at MAS 92 B hybrid, of 1480 kg/ha. At the camelina crop, the maximum production was 1516 kg/ha at Camelumba variety and the minimum was 1208 kg/ha at Calena variety. For safflower crop maximum was 2304 kg/ha, at CW 1221 variety and the minimum was 1906 kg/ha at variety 351.

From Figure 6, it turns out that the maximum productions were registered in sunflower hybrids (Arena, Flux, MAS 94 C), soybean (Columna), and safflower (CW 1221). The medium productions were in sunflower hybrids (MAS 96 A), rapeseed (Heros) and safflower (2106, 345 and 351). The minimum productions were in sunflower hybrids (MAS 92 B), lalemantia and camelina (Calena, Camelumba and Lindo).

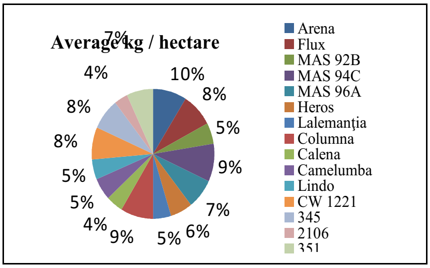

Figure 6. Graphical representation of oils crops seeds production in 2010

Making a comparison between 2010 and 2011, we will notice that the production increased in the majority of crops. In sunflower, the maximum production was at Arena hybrid, being 3165 kg/ha, and the minimum was still at MAS 92 B hybrid, being 2325 kg/ha. Data indicates that camelina crop production decreased to 1412 kg/ha for Camelumba, and to 1108 kg/ha for variety Calena.

Safflower crop production was maximum in variety CW 1221, at 2412 kg/ha and minimum production was recorded at variety 2016, was of 2066 kg/ha.

Figure 7 show that, just like in 2010, the highest production was in sunflower hybrids (Arena, Flux, MAS 94 C) and soybean (Columna). The medium productions were in sunflower hybrids (MAS 92 B and MAS 96 A), in safflower (CW 1221, 2106, 345 and 351) and in rapeseed (Heros). The lowest productions were in lalemantia and camelina (Calena, Lindo and Camelumba).

Table 2. Experimental results concerning oil crops seeds production in 2011

Nr. crt.	Variety / hybrid	Production		Diff. limit
		kg/ha	%	
1.	Arena	3165	100	Control
	Flux	2864	90.48	-301
	MAS 92B	2325	73.45	-840
	MAS 94C	3079	97.28	-86
	MAS 96A	2392	75.57	-773
2.	Heros	1881	59.43	-1284
3.	Lalemantia	1148	36.27	-2017
4.	Columna	2875	90.83	-290
5.	Calena	1108	35.00	-2057
	Camelumba	1412	44.61	-1753
	Lindo	1262	39.87	-1903
6.	CW 1221	2412	76.20	-753
	345	2264	71.53	-901
	2106	2066	65.27	-1099
	351	2318	73.23	-847

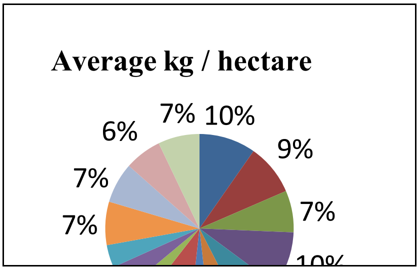

Figure 7. Graphic representation of the seeds productions oil crops in 2011

Table 3. Experimental results concerning seeds oil content

Nr. crt.	Species	Variety / hybrid	Average (% s.u.)
1.	Sunflower	Arena	50.37
		Flux	46.43
		MAS 92B	51.28
		MAS 94C	45.99
		MAS 96A	46.64
2.	Rapeseed	Heros	43.43
3.	Lalemanţia	Lalemanţia	45.58
4.	Soybean	Columna	30.97
5.	Camelina	Calena	31.70
		Camelumba	32.06
		Lindo	31.77
6.	Safflower	CW 1221	28.63
		345	27.77
		2106	27.46
		351	28.01

As far as the oil content of the seeds is concerned, sunflower, lalemantia and rape have the highest percentage, as follows: at sunflower seeds, MAS 92B hybrid has a 51.30% oil content (dry matter), the lalemanţia seeds have a 45.63% oil content (d.m.), and the rape crop seeds from the Heros species have a 43.92% oil content (d.m.).

The lowest oil content was in the seeds of following crops: camelina Camelumba variety (32.09% oil content in d.m.), followed by soybean Columna variety (31.24% oil content in d.m.) and safflower: (27.09% oil content in d.m.).

CONCLUSIONS

The research area is characterized by favourable natural conditions 2011 for oil crops growing.

In the two experimental years, the seeds yields ranged between 1480 and 3079 kg/ha for sunflower, 1638 and 1881 kg/ha for rape, 1148 to 1268 kg/ha for lallemantia, 2458 to 2875 kg/ha for soybean, to 1108 to 1516 kh/ha for camelina and 1906 to 2412 kg/ha for safflower.

Experimental year 2011 was was a favourable agricultural year for tested oil crops, except camelina for which seeds production decreased slightly compared to 2010.

Starting from the fact that vegetable oils have an essential role in human nutrition and an agro-food product dedicated to international trade, it is necessary that agriculture delivers the industry increased quantities of raw materials, provided by a oleaginous plant range as wide as possible.

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AN INVENTORY OF FLORISTIC COMPOSITION IN PERMANENT GRASSLANDS OF RUCĂR-BRAN CORRIDOR: APPLICATION AND PERSPECTIVES OF MELLIFEROUS POTENTIAL

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Abstract

The paper presents the melliferous and landscaping inventories in the Rucăr-Bran Corridor to assess the corresponding non-pastoral utilization values for complementary valorization of grassland herbaceous canopies. The space occupied by permanent grasslands in the study area is home to 235 species of plants, which shows an increased biodiversity. The inventories showed that 36 species were grasses, 29 species were legumes, 12 species were sedges and bulrushes, and 158 species were from other botanical families. A number of 72 melliferous species was identified, most of them having also forage utilization. GIS analysis showed that the total area occupied by permanent grasslands in Rucăr-Bran Corridor and neighboring landforms based on Corine data is 5007.6 ha. Consequently, the honey production potential was evaluated between 5 and 10 t of honey. Depending on the number of species that form the heterogeneous canopy and their color of flowers, the ordering of dominant colors and tones was as follows: yellow (24.3%), green (21.3%), white (17.3%), red (14%), pink (8.1%), purple (7.2%), blue (6.4%), and brown (1.3%).

Key words: *flower color, melliferous potential, non-pastoral utilization value, floristic composition.*

INTRODUCTION

A basic principle of sustainable agriculture is the exploitation of natural resources to allow their regeneration and to maintain the resilience and stability of natural ecosystems. In agropastoral domain, this goal requires the use of herbaceous canopies for fodder purposes only up to the limit of resilience capacity (Puia et al., 2001). This signifies the knowing of the tolerance of permanent grassland ecosystem to anthropogenic actions, so that it does not suffer significant or irreversible modifications, which excludes the intensive operations and cropping practices, especially for the medium and long-term applications (Motcă et al., 2009). In the Rucăr-Bran Corridor, the economic efficiency of grasslands operations based usually on extensive cropping practices, can be achieved not only by using differentiated prices for ecological animal products, but also by valorizing complementary potentials in the system of grassland multifunctional utilization.

According to the concept of grassland multifunctional utilization (Motcă et al., 2010; Huyghe, 2009; Barrio and Vounouki, 2002) concomitant with the primary use of grasslands as a food source for livestock, either mowed or grazed, the valorization of the secondary potentials of floristic composition needs to be addressed, namely melliferous, medicinal, tourism-related, environmental protection-related, biodiversity conservation, and landscaping potentials.

Among the abovementioned potentials, the paper presents the melliferous and landscaping inventories to assess the corresponding non-pastoral utilization values for complementary valorization of grassland herbaceous canopies in the Rucăr-Bran Corridor. In the first step, biodiversity status was assessed by establishing the total number of species, the floristic composition based on their utilization, on spatial distribution (widely distributed, rare or endemic species), the species protected by law, and the species flower color.

The melliferous utilization potential was determined by identifying the melliferous species in the canopy structure based on the floristic composition, and by estimating the production of honey. Landscape potential was quantified using the structure and participation of species with colorful flowers and the color range.

Colors of species in a bee visual system, scent and phenology have potential key roles in attracting pollinators, which also have influence on honey production. Arnold et al. (2009) found that a foraging bee will not necessarily remain loyal to a color or species of flower indefinitely, and might shift to other species if the previously visited variety is not available in the immediate vicinity. A flower colors' classification of the species occurring in the studied grasslands was performed to support future studies related to the melliferous utilization potential.

MATERIALS AND METHODS

The objectives of the study were carried out by performing inventories on the established itineraries in the central and northern districts of the Rucăr-Bran Corridor. During field surveys, floristic compositions were performed recording fodder, honey and medicinal utilization of species, stationary conditions for each survey, plant phenological stage, color of flowers, canopy height and other descriptive ecological and biological characteristics. The maintenance status of investigated grasslands and improvement operations applied in the year of observations were also investigated. Dry matter determinations and calculations of potential honey production of analyzed grasslands were carried out in the laboratory.

The real potential for honey production of each melliferous species is reduced because of the primary use of vegetation for fodder purposes. Therefore, an appropriate average production to the honey production potential of the less productive species was considered (Motcă, 2010). Quantities of 1-2 kg honey ha^{-1} depending on the equivalent of 0.1 to 0.2 kg ha^{-1} for each canopy coverage percent were adequate for the envisaged area of study.

Vector data from Corine land cover - version 16 (04/2012) was overlapped on the CGIAR SRTM 90 m digital elevation model in ESRI ArcGIS 9.3 to obtain a general map of permanent grassland distribution in Rucăr-Bran Corridor. Figure 1 presents the polygons of the delineated natural grasslands and of woodland shrubs existent in the region.

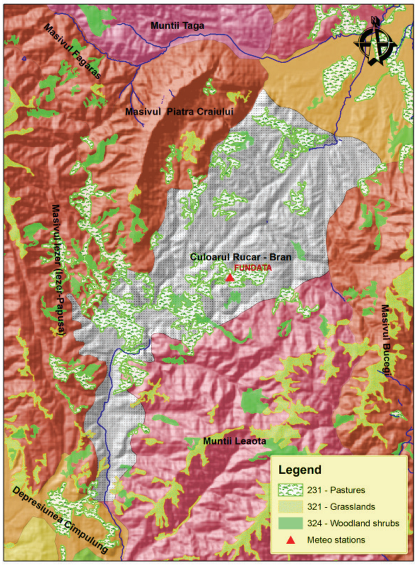

Figure 1. Distribution of grasslands and woodland shrubs in Rucăr-Bran Corridor and neighboring landforms

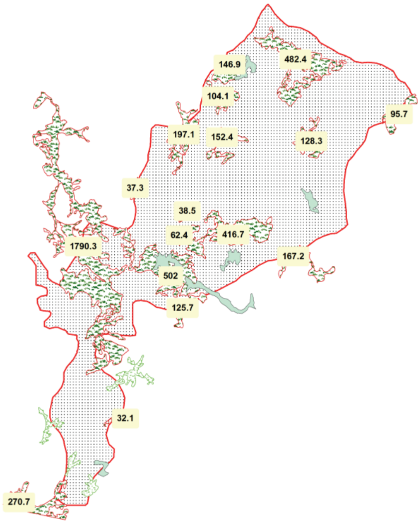

Figure 2. Areas in hectares (ha) occupied by pastures in Rucăr-Bran Corridor and neighboring landforms

RESULTS AND DISCUSSIONS

In the studied area, four groups of zonal grassland types were identified as follows: *Agrostis capillaris* with mesophilic character on flat surfaces, *Agrostis capillaris* with meso-xerophilic on slopes, *Festuca rubra* and *Agrostis capillaris*, and *Festuca rubra* and *Nardus stricta* grasslands.

Figure 2 presents the areas in hectares occupied by pastures in Rucăr-Bran Corridor and neighboring landforms resulted in GIS.

A number of 235 species was found in all the grasslands of these groups (Table 1), from which: 36 species of grasses (15.3%), 29 species of legumes (12.3%), 12 species of sedges and bulrushes (5.1%), and 158 species from other botanical families (67.3%).

Table 1. Floristic composition based on the potential utilization of grassland vegetation (number of species)

Utilization	Grasses	Legumes	Sedges	Other families	Total species	Percentage %
Fodder (F)	36	22	-	21	69	29
Medicinal (M)	-	3	-	41	44	19
Melliferous (MF)	-	22	-	50	72	31
Total, from which	36	47	-	112	185	79
F+M	-		-	7	7	15
F+MF	-	17	-	5	22	47
F+M+MF	-	1	-	3	4	8
M+MF	-	2	-	12	14	30
Multifuncțional use - Total	-	20	-	27	47	20
Landscaping	36	29	12	158	235	100
Total of species in the canopy	36	29	12	158	235	100

The floristic composition surveys performed in the Rucăr-Bran Corridor based on species potential utilization and importance, have identified 69 forage species (29%), 72 melliferous species (31%), 44 medicinal species (19%), 47 multifunctional utilization species (20%), and 2 natural monuments species (1%) i.e. *Lilium martagon* (Turk's cap lily) and *Trollius europaeus* (globe-flower).

A number of 72 melliferous species was identified on the permanent grasslands, most of them having forage utilization. Because of their main use as fodder, the honey production potential of these species is diminishing accordingly. On the average, data for all the grasslands area in Romania showed that the melliferous potential is between 2.0 and 6.0 kg honey ha^{-1}. Other influencing factors are the altitude and the canopy cover percentage. We have found that the permanent grasslands in Rucăr-Bran Corridor have a potential of 1-2 kg ha^{-1} corresponding to 10-20% canopy cover.

GIS analysis showed that the total area occupied by permanent grasslands in Rucăr-Bran Corridor and neighboring landforms based on Corine data is 5007.6 ha. The spatial analysis was performed considering the polygons from 231 and 321 categories that are contained entirely or some portions within the Rucăr-Bran Corridor. Consequently, the honey production potential was evaluated between 5 and 10 t of honey.

The chromatic diversity of grasslands in various stages of flowering was observed because this trait is related to the landscape aspect, but also because flower colors attract pollinators, which also have influence on honey production.

Through their bright colors, the flowers of species located in the grasslands of Rucăr-Bran Corridor (central and northern districts) range within the whole spectrum of colors in visible, which favors an attractive landscape of inner natural grasslands (Table 2).

Due to the high degree of grass species participation in the canopy (50-80%), whose flowers have greenish color, this color is dominant in the areas of studied permanent grasslands. Therefore, the dominance of colors depends on the number of species with the same color in the heterogeneous canopy and the phenophase of development. Spatial and temporal repartition of foliage biomass and caulinar biomass is influencing the evolution of canopy architecture, which is a summing junction of the individual component forms pertaining to various species that form the heterogeneous canopy (Dunea and Moise, 2008).

Numerically, the predominant colors in the 6-7 months of growth season are shown in Table 2. Depending on the number of species that form the heterogeneous canopy and their color of flowers (Table 3), the ordering of dominant colors and corresponding tones was as following: yellow (24.3%), green (21.3%), white (17.3%), red (14%), pink (8.1%), purple (7.2%), blue (6.4%), and brown (1.3%).

Table 2. Floristic composition based on the color of the flowers in the permanent grasslands of Rucăr-Bran Corridor

Pollinator-perceived color	Human-perceived color	Color Tone	Number of species	Participation (%)
Blue; UV-Blue	Blue	-	8	3.4
		Purplish	7	3.0
		Total	15	6.4
Blue-green	White	-	37	15.7
		Yellowish	2	0.8
		Greenish	2	0.9
		Total	41	17.4
Ultraviolet (UV)	Brown	Total	3	1.3
Green; UV-Green	Yellow	-	55	23.4
		Greenish	2	0.9
		Total	57	24.3
Ultraviolet (UV)	Red	-	21	8.9
		Orange	1	0.4
		Purplish	11	4.7
		Total	33	14.0
Blue; UV-Blue	Pink	-	14	6.0
		Reddish	2	0.9
		Purplish	3	1.2
		Total	19	8.1
Green	Green	Greenish	49	20.9
		Greenish-purplish	1	0.4
		Total	50	21.3
Blue; UV-Blue; UV-Green	Purple	-	8	3.4
		Blueish	2	0.9
		Purplish	5	2.1
		Purplish-reddish	1	0.4
		Pinkish	1	0.4
		Total	17	7.2
Main Color Total			235	100.0
Color Tone Total			92	39.1

Table 3. Identified species and corresponding human-perceived flower color in the permanent grasslands of Rucăr-Bran Corridor

Grasses	Human-perceived color	Other families	Human-perceived color	Other families	Human-perceived color
Agrostis capillaris	greenish	*Achillea distans*	white	*Knautia arvensis*	lilac-pink
Agrostis rupestris	greenish	*Achillea lingulata*	white	*Knautia longifolia*	red-lilac
Agrostis stolonifera	greenish	*Achillea millefolium*	white	*Leontodon autumnalis*	yellow
Alopecurus pratensis	greenish	*Achillea setacea*	white	*Leucanthemum vulgare*	white
Anthoxanthum odoratum	greenish	*Achillea stricta*	white	*Leucanthemum waldsteineii*	white
Apera spica venti	greenish	*Agrimonia eupatoria*	yellow	*Ligusticum mutellina*	pink
Arrhenatherum elatius	greenish	*Alchemilla flabellata*	yellow-greenish	*Lilium martagon*	pink-purple
Avenula versicolor	greenish	*Alchemilla vulgaris*	yellow-greenish	*Linum catharticum*	white-yellowish
Brachypodium pinnatum	greenish	*Antennaria dioica*	white	*Lychnis flos-cuculi*	pink
Briza media	greenish	*Arnica montana*	yellow	*Lychnis viscaria*	pink
Bromus arvensis	greenish	*Artemisia austriaca*	yellow	*Lysimachia vulgaris*	yellow
Bromus commutatus	greenish	*Astrantia major*	white-greenish	*Melampyrum pratense*	pink-purple
Bromus hordeaceus	greenish	*Bellis perennis*	white	*Mentha_pulegium*	purple-lilac
Bromus japonicus	greenish	*Bruckenthalia spiculifolia*	pink-violet	*Myosotis sylvatica*	bluish
Cynosurus cristatus	greenish	*Campanula abietina*	violet	*Origanum vulgare*	purplish (lilac)
Dactylis glomerata	greenish	*Campanula glomerata*	violet	*Parnasia pallustris*	white
Danthonia decumbens	greenish	*Campanula persicifolia*	bluish-violet	*Pedicularis verticillata*	red
Deschampsia caespitosa	greenish	*Campanula rotundifolia*	bluish-violet	*Peucedanum oreoselinum*	white
Deschampsia flexuosa	greenish	*Cardus acanthoides*	red-violet	*Phyteuma spicatum*	white
Dichanthium ischaemum	greenish	*Carlina acaulis*	white	*Pimpinella saxifrage*	white
Elymus hispidus	greenish	*Carum carvi*	white	*Plantago laceolata*	white
Festuca pratensis	greenish	*Centaurea jacea*	red-violet	*Plantago media*	white
Festuca pseudovina	greenish	*Centaurea mollis*	bluish	*Polygala vulgaris*	bluish-purple
Festuca rubra	greenish	*Centaurea phrygia*	red-violet	*Polygonum bistorta*	pink
Festuca rupicola	greenish	*Centaurea scabiosa*	red-violet	*Potentilla argentea*	yellow
Festuca valesiaca	greenish	*Centaurea triumfetti*	bluish-violet	*Potentilla aurea*	yellow

Holcus lanatus	greenish	*Centaurium erythraea*	red	*Potentilla cinerea*	yellow
Lolium perenne	greenish	*Cerastium arvense*	white	*Potentilla erecta*	yellow
Nardus stricta	greenish	*Cerastium fontanum*	white	*Potentilla reptans*	yellow
Phleum phleoides	greenish	*Chaerophyllum aromaticum*	white	*Potentilla ternate*	yellow
Phleum pratense	greenish	*Cichorium intybus*	bluish	*Potentilla thuringiaca*	yellow
Poa compressa	greenish	*Cirsium canum*	red	*Primula veris*	yellow
Poa nemoralis	greenish	*Cirsium erisithales*	yellow	*Prunella vulgaris*	bluish-violet
Poa pratensis	greenish	*Cirsium vulgare*	red	*Pseudorchis whiteida*	white
Trisetum flavescens	greenish	*Colchicum autumnale*	violet	*Pteridium aquilinum*	brownish
Vulpia myuros	greenish	*Crataegus monogyna*	white	*Pulsatilla whitea*	white
Legumes		*Crepis biennis*	yellow	*Ranunculus acris*	yellow
Anthyllis vulneraria	yellow	*Dactylorhiza cordigera*	pink	*Ranunculus montanus*	yellow
Astragalus onobrychis	purple	*Dactylorhiza maculata*	pink	*Ranunculus polyanthemos*	yellow
Coronilla varia	pink	*Daucus carota*	white	*Ranunculus repens*	yellow
Dorycnium pentaphyllum	white	*Dianthus barbatus*	red	*Ranunculus sardous*	yellow
Genista tinctoria	yellow	*Dianthus carthusianorum*	red	*Rhinanthus alectorolophus*	yellow
Genistella sagittalis	yellow	*Dianthus superbus*	pink	*Rhinanthus angustifolius*	yellow
Lathyrus nissolia	red	*Digitalis grandiflora*	yellow	*Rhinanthus major*	yellow
Lathyrus pratensis	yellow	*Dipsacus fullonum*	purple	*Rumex acetosa*	reddish
Lathyrus sylvestris	pink	*Echium vulgare*	bluish	*Rumex acetosella*	reddish
Lotus corniculatus	yellow	*Erodium cicutarium*	purple	*Rumex crispus*	reddish
Medicago falcata	yellow	*Eryngium campestre*	whitish-greenish	*Salvia nemorosa*	purple-bluish
Medicago lupulina	yellow	*Eupatorium cannabium*	red	*Salvia officinalis*	purple-bluish
Melilotus officinalis	yellow	*Euphorbia cyparissias*	yellow	*Salvia verticillata*	purple
Onobrychis viciifolia	red-violet	*Euphrasia rostkoviana*	white	*Sanguisorba officinalis*	red
Ononis arvensis	pink	*Euphrasia stricta*	white	*Scabiosa ochroleuca*	yellow
Trifolium alpestre	red	*Fragaria vesca*	white	*Scleranthus annuus*	green
Trifolium arvense	reddish	*Galium mollugo*	white	*Scorzonera rosea*	pink
Trifolium campestre	yellow	*Galium odoratum*	white	*Silene dioica*	red
Trifolium dubium	yellow	*Galium verum*	yellow	*Silene nutans*	white
Trifolium hybridum	pink	*Gentiana asclepiadea*	bluish	*Silene vulgaris*	white
Trifolium medium	red	*Gentiana utriculosa*	bluish	*Stachys germanica*	red
Trifolium montanum	white	*Gentianella austriaca*	purple	*Stachys officinalis*	purplish
Trifolium ochroleucon	yellow	*Geranium pratense*	bluish	*Stellaria graminea*	white
Trifolium pannonicum	white-yellowish	*Geum montanum*	yellow	*Succisa pratensis*	bluish-violet
Trifolium pratense	red-violet	*Gnaphalium sylvaticum*	brownish	*Symphytum officinale*	red-violet
Trifolium repens	white	*Gymnadenia conopsea*	pink-reddish	*Taraxacum officinale*	yellow
Vicia cracca	bluish-violet	*Helianthemum nummularium*	yellow	*Thalictrum simplex*	greenish-purple
Vicia grandiflora	yellow	*Hieracium aurantiacum*	red-orange	*Thymus glabrescens*	pink-reddish
Vicia striata	violet-red	*Hieracium bauhinii*	yellow	*Thymus montanus*	red-violet
Sedges and bulrushes		*Hieracium lactucella*	yellow	*Thymus pannonicus*	red-violet
Carex caryophyllea	greenish	*Hieracium pilosella*	yellow	*Thymus serpyllum*	red-violet
Carex ovalis	greenish	*Holosteum umbellatum*	white	*Tragopogon dubius*	yellow
Carex panicea	greenish	*Homogyne alpina*	red	*Tragopogon pratensis*	yellow
Carex spicata	greenish	*Hypericum maculatum*	yellow	*Trollius europaeus*	yellow
Carex tomentosa	greenish	*Hypericum montanum*	yellow	*Vaccinium myrtillus*	pink
Juncus articulatus	greenish	*Hypericum perforatum*	yellow	*Vaccinium vitis-idaea*	pink
Juncus conglomeratus	greenish	*Hypochaeris maculata*	yellow	*Veratrum whiteum*	white
Luzula alpinopilosa	greenish	*Hypochaeris radicata*	yellow	*Veronica chamaedrys*	bluish
Luzula campestris	greenish	*Hypochaeris uniflora*	yellow	*Veronica officinalis*	violet
Luzula luzuloides	greenish	*Inula britannica*	yellow	*Viola canina*	purple
Luzula sudetica	greenish	*Juniperus sibirica*	brownish	*Viola declinata*	violet
Luzula sylvatica	greenish	*Jurinea mollis*	red	*Viola hirta*	purple

Table 3 presents the identified species and corresponding human-perceived flower color in the permanent grasslands of Rucăr-Bran Corridor. Green color and its tones characterize mostly the flowers of grasses and sedges species. Maximum abundance of flowers was recorded between May and July.

Flower species that are closely related may share both similar flowering times and similar pigmentation, possibly resulting in apparent abundances of particular colors, as perceived by humans, at particular times of year. However, this pattern is not reflected in the trends in flower color as perceived by various pollinators (Arnold et al., 2009). Table 2 shows also the floristic composition based on the pollinator-perceived color, because patterns in flower color based on human perception alone are insufficient. Bees perceive blue, ultraviolet, green, and various combinations of these color.

CONCLUSIONS

In ecological technologies, utilization of grassland canopies extends from the pastoral scope to complementary areas such as multifunctional utilization of natural flora as medicinal and melliferous resources in the context of biodiversity and natural ecosystems conservation, ecotourism and rural tourism development in the space of pastoral heritage.

The melliferous potential of permanent grasslands in Rucăr-Bran Corridor established using GIS support is 5 to 10 t, considering 1-2 kg honey ha^{-1} corresponding to 10-20% canopy cover.

In terms of biodiversity, the space occupied by permanent grasslands in the study area is home to 235 species of plants, which shows an increased complexity. The maximum number of species was recorded at altitudes below 1000 m, in the *Fagus silvatica* sublevel, where *Agrostis capillaris*, and *Agrostis capillaris* + *Festuca rubra* grasslands prevail.

From the total number of species, 36 species were grasses, 29 species were legumes, 12 species were sedges and bulrushes, and 158 species were from other botanical families.

The flowers of species in the grasslands of Rucăr-Bran Corridor create an attractive landscape covering completely the visible spectrum. The predominant color and its corresponding tones in the flowering phenophase were yellow (24.3% of species), followed by green (21.3%), white (17.3%), and red (14%).

The unconventional system of grasslands multifunctional utilization from central and northern sectors of Rucăr-Bran Corridor requires the consideration of new technological sequences regarding the harvesting of medicinal plants and practicing of pastoral beekeeping, the implementation of measures to conserve the landscape and biodiversity.

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RESEARCHES ON THE EFFECT OF PHYTOSANITARY TREATMENTS TO GRAIN SORGHUM IN SANDY SOIL CONDITIONS

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Abstract

*The pest and pathogens control is an essential requirement for sorghum, especially in the early stages of vegetation and at grain formation to waxi stage grain. Our results highlights the existence closely between the degree of pathogen attack and plant resistance to drought conditions. Thus, through the loss a quantity of water higher than 2.8 mmol $H_2O/m^2/s$, was registered increasing the attack produced by Hadrotrichum sorghi and Fusarium moniliforme Sheld. Significant (r = 0.595 *) and distinctly significant (r = 0.811 **) correlations between plant transpiration and the pathogens degree of attack were established. Two treatments at 4-5 leaves and 6-8 leaves with Topsin 500 SC (0.07%), had determined the lowest degree of attack produced by Hadrotrichum sorghi (17.11%) and Fusarium moniliforme Shedd (3.72%). Treatment with Calypso 480 EC, at a dose of 80 ml / ha has reduced with 81.4% the frequency of grain aphid (Schizaphis graminum) compared to untreated control. The quality of sorghum grain, respectively protein content was influenced both by the phytosanitary treatment and the climatic conditions during the growing season (high temperatures during the summer - autumn and precipitation almost nonexistent).*

Key words: *diseases, pests, grain sorghum, phytosanitary treatments, sandy soil.*

INTRODUCTION

Sorghum crop success is frequently conditioned by the occurrence of various diseases and pests, which can reduced the production potential of plant varieties and hybrids. In many cases, the production losses may be appreciable (Barbulescu, 1985).

Sorghum has a high starch, sugar and fiber, and is one most important crops energy of world's. However the attack of insect pests may cause great damage to this plant (Chunshan et al., 2011).

Research conducted on sorghum protection have led to elaboration of control methods with a rol in increase production of sorghum.

Grain sorghum is considered a drought-resistant plants and outlook for the future in dry areas in Romania (Antohe, 2007; Draghici, 2009), based on the accentuation of atmospheric and soil drought in the last period, which compels us to finding alternatives to the assortment of plants that are presently cultivated.

MATERIALS AND METHODS

The research was conducted in 2012-2013 at Research - Development Center for Field Crops on Sandy Soils, Dabuleni, and the aim was the prevention and control of the pest and diseases on grain sorghum.

Experience has been placed in subdivided parcels with 2 factors, under field conditions, on sandy soils with low natural fertility (humus from 0.38 to 0.72%, and a pH_{H2O} = 6.8-7.1).

A number of 16 phytosanitary treatment variants (systemic and contact insecticides and fungicides) were tested and compared to the untreated control (Table 1).

The phytosanitary treatments (Figure 1) were applied at two phases, as follows: treatment 1 was applied at to the 4-5 leaf stage and the second one was applied at the stage 6-8 leaf stage. Pathogens frequency, intensity and the degree of attack were determined.

Physiological determinations were carried out at the stage of grain forming, using the LCpro + Photosynthesis Portable System. Determination of the quality of sorghum grain were carried out at harvest. The results were calculated and interpreted based on statistical and mathematical functions, using analysis of variance.

Table 1. Experimental variants

A. Fungicides / concentration		B. Insecticides/dose/concentration	
Untreatedt Dithane M-45 Shavit F72 WP Topsin 500 SC	- 0.2% 0.2% 0.07%	Untreated Faster 10 CE Confidor Energy Calypso 480 CE	- 0.03% 0.1% 80 ml/ha

Figure 1. Stage of sorghum plant vegetation for phytosanitary treatments

RESULTS AND DISCUSSIONS

The evolution of monthly temperature and precipitation during the period 2012-2013, emphasizes accentuation the drought phenomenon, compared to the annual average (Figure 2), an added reason for further research on grain sorghum, considered a drought-resistant plant with prospects for the future in drought areas in Romania.

The average monthly temperature recorded in the 2012-2013 period, from April to September, was 20.59^{o}C, with 1.73^{o}C higher than the annual average, and precipitation sum was 269.3 mm, by 41.2 mm less.

Of the two years studied, climatic conditions were poor in 2012 when, in the period of intensive growth and differentiation of sorghum plant productivity (June to August), 62.4 mm rainfall, and a temperature average of 24.7^{o}C, with a maximum of 42.6^{o}C were recorded.

The climatic conditions in 2012-2013 have created favorable environment for the infection of sorghum plant with *Hadrotrichum sorghi*, manifested on the leaves as circular spots with black center and red-brown edge.

Also, starting with the earliest phases of growth and the grain formation by the grains of wax stage, a background of the average amount of precipitations of 83.1 mm, during in the period from May to June, created a favorable short time for infection plant with *Fusarium moniliforme sorghum* (Sheld). Those infections can be influenced by high doses of nitrogen applied to cultures on sandy soils (Cojocaru Doina et al. 1994, Drăghici I., 2003).

Observations made during the growing season have signaled infestation with aphids, especially grain aphid (*Schizaphis graminum*) starting with plantlet stage, until physiological maturity (Figure 3).

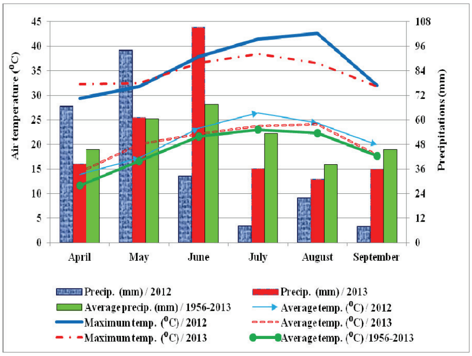


Figure 2. Evolution of climatic conditions registered in the area, on sandy soils, during sorghum vegetation period

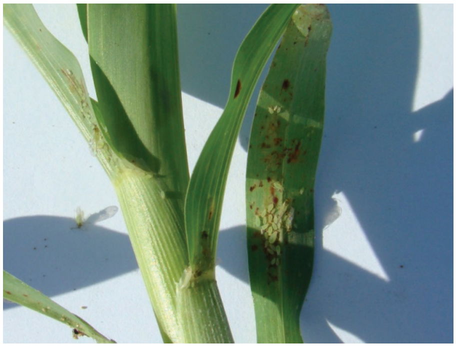


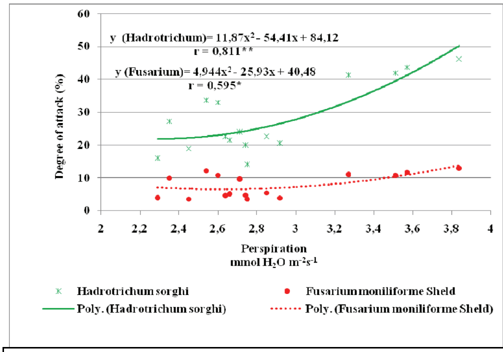
Figure 3. Sorghum plants infested with *Schizaphis graminum*

The results obtained in sorghum grain emphasizes the close relationship between the degree of attack of pathogens and plant resistance to drought conditions.

Thus, at an intense plant transpiration through the loss of a quantity of water greater than 2.8 mmol $H_2O/m^2/s$, there was an increase in the attack degree of *Hadrotrichum sorghi* and *Fusarium moniliforme*. Under the temperatures of 31.9 to 32.5°C recorded on the surface of leaf, the transpiration rate has led to an increased attack of pathogens.

Significant and distinct significant correlations between plant transpiration and the degree of attack of these pathogens have been established (Figure 4). The damage caused by foliar pathogens reduced the area for photosynthesis, which means that the plant can no longer produce enough nutrients to support the optimal growth. Also, hydration of the leaves decreased, because the quantity of water is lost by plant transpiration.

The preventive use of fungicides and insecticides leads to conservation of production and quality potential of sorghum (Table 2).



Air temperatures at the surface of the leaf = 31.9-32.5°C
Atmospheric pressure = 1020-1021 atm

Figure 4. Correlation between plant transpiration and the degree of attack of pathogens

Table 2. Influence of phytosanitary treatments on the pest and diseases control in grain sorghum, on sandy soils

No. var.	Fungicides	Insecticides	***Hadrotrichum sorghi*** **(Da%)**	***Fusarium moniliforme*** **(Da%)**	***Schizaphis graminum*** **(F%)**	**Kg/ha**	**Difference from control Kg/ha (significance)**	**Protein %**	**Fats %**
1	Untreated	Untreated	43.9	12.8	49.7	3285	Control	15.8	4.2
2		Faster 10 CE	41.85	11,7	20.4	3967.5	682.5	15.9	4.2
3		Confidor Energy	40.2	10.8	10.65	4279	994*	16.5	4.1
4		Calypso 480 CE	39.3	10.9	10.2	4284	999*	16.1	4
5	Dithane M-45	Untreated	32	11.2	49.2	4051	Control	15.4	4
6		Faster 10 CE	30.05	10.8	18.35	4810.5	759.5*	15.5	4.1
7		Confidor Energy	28.45	10	10.9	5058.5	1007.5*	16.1	4
8		Calypso 480 CE	24.05	10.5	10.25	5314	1263**	15.8	4.3
9	Shavit F72 WP	Untreated	19.2	5	45.9	4285.5	Control	16.4	4.5
10		Faster 10 CE	19.7	5.4	19.7	5218	932.5*	16.1	4.2
11		Confidor Energy	17.45	4.8	11.3	6051.5	1766***	16	4.3
12		Calypso 480 CE	18.3	4.5	8.05	6330.5	2045***	15.9	4.1
13	Topsin 500 SC	Untreated	19.45	3.9	44.95	4431	Control	15.5	3.9
14		Faster 10 CE	17.85	3.6	14.55	5357	926*	15.8	4.2
15		Confidor Energy	15	3.6	8.6	5978.5	1547.5***	16.1	4.2
16		Calypso 480 CE	16.2	3.8	7.45	6536	2105***	16.6	4.5

LSD 5% = 755.5 kg/ha
LSD 1% = 1027 kg/ha
LSD 0.1% = 1376 kg/ha

The results on the effect of the phytosanitary treatments on sorghum highlights good efficacy for the systemic products, followed by those with the dual action (systemic + contact).

Thus, Topsin 500 SC and Shavit F72WP stood out from the rest of fungicides tested to control *Hadrotrichum sorghi* and *Fusarium moniliforme* Sheld.
Good efficacy in controling *Schizaphis graminum*, were registered with Calypso 480 EC (systemic action) and Confidor Energy (systemic + contact).
The production obtained at harvest was negatively correlated with the degree and frequency of attack of the pest and pathogens.
The maximum of production (6536 kg/ha) was achieved in the variant treated with Topsin 500 SC (0.07%) + Calypso 480 EC (80 ml/ha), where the frequency and degree of attack of the pathogens and pests was minimal (Figure 5).

Figure 5. Phytosanitary treatment to sorghum with Topsin 500 SC 0.07%+ Calypso 480 CE 80 ml/ha

Treatment of sorghum during vegetation, at the 4-5 leaves and 6-8 leaves stages, with these products with systemic action, led to registration of an increased production, very significant compared to the untreated control (2105 kg/ha)
The phytosanitary treatment had positive influence on the grain quality, respectively protein and fat content. Grain quality was influenced by the treatment as well as climatic conditions during the growing season (high temperatures during the summer - autumn and precipitations almost non-existent).
The percentage of protein ranged from 15.5%, in the variant treated with Topsin 500 SC (0.07%) and no insecticide and 16.6%, in the variant treated with Topsin 500 SC (0.07%) and Calypso 480 EC (80 ml/ha).
The fat content ranged from 3.9% in the variant treated with Topsin 500 SC and no insecticide treatment and 4.5% in the variant treated with Topsin 500 SC (0.07%) + Calypso 480 EC (80 ml/ha).
The infection of sorghum with pathogenss emphasizes values of attack degree from 17.11 to 41.31% for *Hadrotrichum sorghi* and from 3.73 to 11.55% for *Fusarium moniliforme Sheld* (Figure 6).

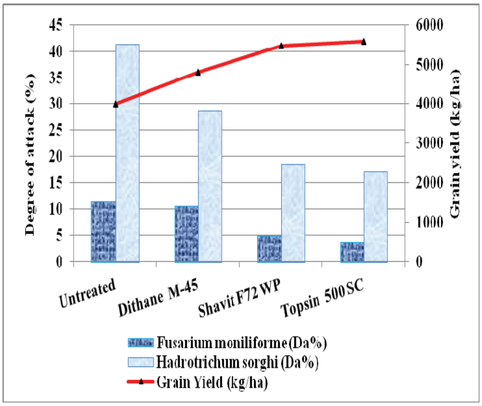


Figure 6. Influence of fungicide treatment on pathogens of grain sorghum

Compared to untreated control (41.3%, attack degree), *Hadrotrichum sorghi* infection was reduced by 54.8-58.6% was in variant with two treatments with systemic fungicide Topsin 500 SC (0.07%), or systemic + contact (Shavit F72WP (0. 2%) decreased .
The same treatment reduced with 57.3-67.7% the attack degree of *Fusarium moniliforme* Sheld, compared to untreated, .
The production realized in the phytosanitary treatment options ranged within the limits 5471.5-5575.5 kg/ha.
An important role in the stability of of sorghum yields is the control of *Schizaphis graminum*, favored by the climatic conditions of the area.
Application of phytosanitary treatments with insecticides has reduced with 60 to 85.8% the frequency of attack this pest, compared with untreated control where of attack frequency was 48.27% (Figure 7).
The lowest frequency values (8.99 to 10.36%) of *Schizaphis graminum* was recorded when treated with Calypso 480 (80 ml/ha) and with Confidor Energy (0.1%). These results were positively correlated with grain yield obtained (5342-5600 kg/ha).

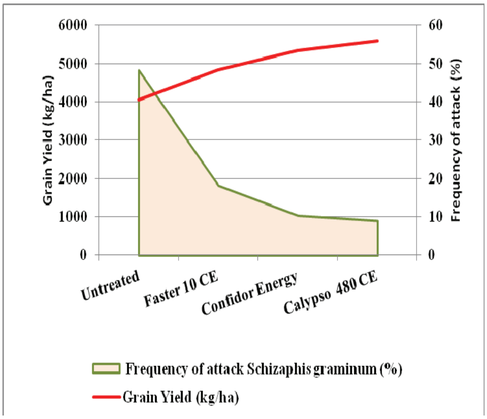


Figure 7. Influence of insecticide treatment on aphids in grain sorghum

The relationship between production and the degree and frequency of attack (Figure 8), highlighted distinct significant negative correlation: r = - 795 ** (*Hadrotrichum sorghi* x Production), r = - 0.705 ** (*Fusarium moniliforme* x Production), r = - 0.694 ** (*Schizaphis graminum* x Production).

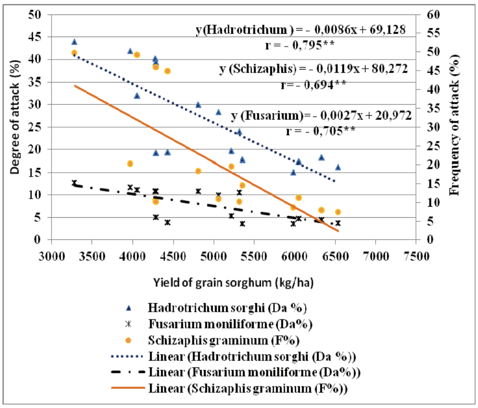


Figure 8. Correlations between the sorghum grain yield and the degree and frequency of attack of the pest agents

CONCLUSIONS

Preventive use of fungicides and insecticides leads to conservation of production and quality potential of sorghum. The degree attack of *Fusarium moniliforme* Shedd and *Hadrotrichum sorghi* on sorghum plants are positively correlated with plant transpiration, in significantly distinct and significantly (r = 0.811 **, r = 0.595 *).

The maximum of production (6536 kg/ha) was achieved in the variant treated with Topsin 500 SC in concentration of 0.07% + Calypso 480 EC at a dose of 80 ml / ha, where the degree and frequency of attack of pathogens and pests was minimal.

The application of two phytosanitary treatments with Topsin 500 SC (0.07%) or Shavit F72 WP (0.2%) at 4-5 leaf and 6-8 leaf stages has reduced the degree of attack of *Hadrotrichum sorghi* with 54.8-58.6% compared to control and with 57.3 to 67.7% degree of attack of *Fusarium moniliforme.*

Frequency of *Schizaphis graminum* was reduced by 60 to 85.8%, compared to the untreated control, by the application of two phytosanitary treatments with Calypso 480 EC (80 ml/ha) or Confidor Energy (0.1%).

The production obtained of grain sorghum was correlated negatively, significantly distinct with degree and frequency attack of pest agents.

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VULNERABILITY TO CONTAMINATION WITH PLANT PATHOGENS AND PESTS IN SPECIFIC CROP ROTATIONS OF AGROFORESTRY HOLDINGS ON SANDY SOILS

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Abstract

*Researches regarding contamination with plant pathogens and pests, in specific rotation of agroforestry holdings on sandy soils, revealed the biological material and the climatic conditions as vulnerable points to infection. Determinations on Cowpea aphid borne virus infection in 144 cowpea genotypes, showsed a negative correlation between production and plant resistance to this pathogen, at 3-4 true leaves and flowering stages (r = - 0.792 **, r = - 0.744 **). In peanut the presence of f fusarium wilt, produced by Fusarium oxysporum f.sp. vasinfectum, that caused sporadic drying plant, was signaled with a frequency of 2.25 to 22%, depending on the genotype. In maize symptoms of infection caused by Fusarium moniliforme, Ustilago maydis and attack produced by Rhopalosiphum maidis and Ostrinia nubilalis were signaled, the degree and frequency of attack being in relation to genotype. The climatic conditions of the years 2012 and 2013 have influenced in different ways the cowpea plants infection with Pseudomonas syringae pv. vignae (Da = 18.85 to 20.64%) and Uromyces appendiculatus (Da = 12.6 to 34.7%).*

Key words: *diseases, genotype, pests, plants, sandy soils.*

INTRODUCTION

Crop rotation as an agricultural practice is the cultivation of certain species into a well-determined succession, so that the resources of the soil may be depleted as little as possible, and risk of developing pests and diseases to be minimized.
The cultivation of leguminous plants (cowpea, peanuts) in crop rotation on sandy soils together with sorghum, maize, wheat and rye results in reductions the pathogens reserve and favors the development of subsequent crops of some vigorous plants with a well developed system of its own defense against pests and diseases. Agricultural ecosystems of sandy soils is an unfavorable environment for natural enemies like pathogens because of the high degree of disequilibrium as a result of anthropogenic perturbations and interventions (Cojocaru et al., 1996).
Studies show that the appearance and the development of pathogens can be determined by the coexistence of three factors: host, pathogen and external environment (Subrahmanyam et al., 2008, Newton et al., 2010).
The results obtained on sandy soils show that frequently climatic conditions at plant level can be changed compared to the data recorded by weather stations, significantly influencing infection and degree of plant pathogens attack (Oprea and Cojocaru, 1998; Draghici et al., 2013).
Thus, due to plant transpiration and large capacity of leaves to absorb direct sunlight in the leaves, humidity and temperature are higher than values in the rest of the atmosphere or soil, significantly influence the pathogen development and plant receptivity to infection produced by them.
The aim of our research was to establish the vulnerability points to contamination with plant pathogens in sandy soils

MATERIALS AND METHODS

In order to determine the points of vulnerability to contamination with pathogens from specific crop rotations of agroforestry holdings on sandy soils, observations and determinations were performed regarding the influence of biological material on the behavior of plants to the pathogen attack and the influence of climatic conditions on the behavior of plants to the pathogens attack. In this context, in 2012-2013, at the Research - Development Center for Field Crops on Sandy Soils, Dabuleni reserch was focused on:

a- the behavior of 144 genotypes of cowpea germplasm collection to *Cowpea aphid - borne* virus using the FAO scoring scale (1-9), in different stages of plants vegetation;
b- the behavior of five maize hybrids to *Fusarium moniliforme* and *Ustilago maydis* and to *Rhopalosiphum maidis* and *Ostrinia nubilalis*;
c- the behavior of 10 genotypes of peanuts studied in germplasm collection to *Fusarium oxysporum* f.sp. *vasinfectum*;
d- the implications of climatic conditions of the years 2012 and 2013 on the attack of *Pseudomonas syringae pv. vignae* and *Uromyces appendiculatus* (Pers.), on the cowpea. Sixteen observations were made in different plant treatment variants (Table 1).

Table 1. Experimental variants

Number of observation	Fungicides trade name	Dose/ concentration
1,2,3,4	Untreated	
5,6,7,8	Dithane M-45	0.2%
9,10,11,12	Shavit F72WP	0.2%
13,14,15,16	Topsin 500 SC	0.07%

The phytosanitary treatments were applied at two stages of cowpea vegetation: 3-4 true leaf stage and flowering stage. Frequency, intensity and degree attack of pathogens the pesting agents were determined. The tolerance of maize hybrids to *Ostrinia nubilalis* were appreciated by the formula: average length of cavity minus the cavities minimum length of each hybrid ≤ 50% of average length of cavity minus the cavities minimum length of all hybrids (Bărbulescu and Cosmin, 1997). Climatic factors (air temperature, relative humidity and precipitations) registered at the weather station of RDCFCSS Dăbuleni were monitored and compared to the multiannual average.

RESULTS AND DISCUSSIONS

Evolution of the monthly temperature and precipitation registered during 2012-2013 highlights the accentuation of drought phenomenon, compared to the multiannual average (Table 2). The average monthly temperature recorded in the 2012-2013 period, from April to September was 20.61^{o}C, with 1.75^{o}C higher than the multiannual average, and the precipitation sum was 269.3 mm, less with 43.65 mm. Of those two years studied, the climatic conditions were deficient in 2012, when in the period of intensive growth and differentiation of plant productivity elements (June to August) were recorded 62.4 mm precipitations and a temperature average of 24.7^{0}C, which resulted in a very low relative air humidity with an average of 55.72%.

The microclimate created at the plant level has influenced differently the occurrence of diseases and pests on the three plant species studied. One of the vulnerable points of crops from agroforestry holdings on sandy soils to infection with the pathogens and pest is represented by biological material used for sowing. Analyzing the resistance of 144 cowpea genotypes to *Cowpea aphid - borne* virus, in the phases of 3-4 true leaves and flowering, very a good resistance of the majority of the studied cowpea genotypes was recorded (notes 1-2). In the 3-4 true leaves phase, 7% of cowpea genotypes with high sensitivity (notes 5-7) and 17.3% with an sensitivity (notes 3-4) were identified.

Disease was manifested as leaves mosaic, with deformation and reduction of the leaf lamina, plants with bush aspect and which remained small.

The observations made at flowering phase, compared to those at for 3-4 leaves stage, emphasizes a higher resistance of the plant, in the sense that the plant developed lush leaves which has not been entirely affected.

Analyzing the dependence between the cowpea production and the plant resistance to infection with virus *Cowpea aphid borne* in the 3-4 leaves and flowering stages (Figure 1) is noticed a distinct significant negative correlation (r = - 0.792 **, r = - 0.744 **). The results are confirmed by researches conducted in 1989 by Doina Cojocaru et al., which revealed the presence by cowpea mosaic produced by *Cowpea aphid borne mosaic,* which is transmitted by aphids.

Table 2. The climatic conditions registered at RDCFCSS Dăbuleni weather station

Decade	Climate	Year	The months						Average / Sum
			April	May	June	July	August	September	
I	Average temperature (^{0}C)	2012	11.5	19.3	21.8	26.7	26.5	21.8	21.27
		2013	10	21.5	20.2	21.8	26.9	19.3	19.95
	Precipitations (mm)	2012	1	12	10.8	0	0	0	23.8
		2013	34.4	0	2	32.6	0.2	1	70.2
	Relative air humidity (%)	2012	58.4	64	71	54.27	55.76	47.17	58.43
		2013	90.24	64	77.06	84.5	63.3	69.2	74.72
II	Average temperature (^{0}C)	2012	13.2	15.8	24.1	26.5	21.7	18,8	20.02
		2013	13.4	20	23.9	23.3	25,2	18.1	20.65
	Precipitations (mm)	2012	65.2	17.6	16.2	0.6	21.2	7.8	123.9
		2013	4.2	7.6	26.8	0	12.2	7.4	58.2
	Relative air humidity (%)	2012	67.7	80.38	62	46.92	58.24	65.62	63.48
		2013	77.3	69.4	73.11	71,9	65,1	70,0	71.14
III	Average temperature (^{0}C)	2012	17	16.6	24	27,2	24,6	19,2	21.43
		2013	19.5	18.5	22.2	25,5	20,6	15,9	20.37
	Precipitations (mm)	2012	0,4	64.2	5.4	7.6	0.6	0,2	78.4
		2013	0	53.4	76.4	3.6	18.4	27.4	179.2
	Relative air humidity (%)	2012	60.3	85.96	61.7	41.7	49.65	62.76	60.39
		2013	64.32	79.2	80.17	64,8	75	78.1	73.60
Average multiannual temperature (^{0}C) /1956-2013			11.7	16.7	21.6	23.1	22.33	17.7	18.86
Average multiannual precipitations (mm) / 1956-2013			45.5	60.6	67.4	53.3	38.2	45.5	310.5

Table 3. Frequency of attack produced by *Rhopalosiphum maidis* and *Ostrinia nubilalis* to maize hybrids studied under conditions of sandy soils

Maize hybrid	Frequency of attack - Rhopalosiphum maidis (%)	Frequency of attack - *Ostrinia nubilalis* (%)	The length of the cavity produced by *Ostrinia nubilalis* (cm/plant)			Behavior to *Ostrinia nubilalis*
			minimum	maximum	average	
Milcov	15.1	13.6	3.2	4.9	3.6	Tolerant
Mostiştea	15.5	15	3.6	5.2	4	Tolerant
Paltin	15.8	10	2.5	4	2.9	Tolerant
Crişana	13.05	21.7	2.6	6.9	5.2	Sensitive
F 376	11.6	14.2	2.7	4.7	3.1	Tolerant
x	x	x	2.92	x	3.76	x

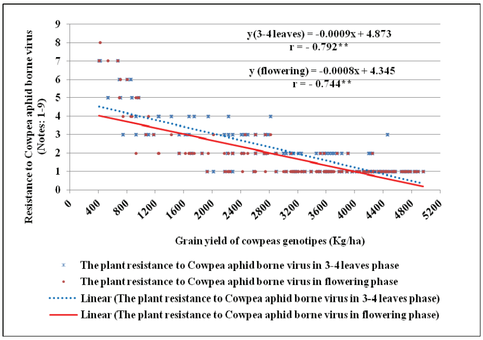

Figure 1. Correlation between *Cowpea aphid borne virus* infection and grain yield obtained from 144 cowpea genotypes

The aphids attack (*Rhopalosiphum maidis*) was recorded on leaves, stem and cob of maize plants at cob - grain formation phase, with a frequency between 11.6 to 15.8%, depending on the hybrid (Table 3).

In climatic conditions of 2013 observations have highlighted the presence of *Ostrinia nubilalis* with a frequency of attack between 10 to 21.7% on stems and cob. The tolerance of maize hybrids, appreciated by the formula: average length of cavity minus the cavities minimum length ≤ 50% (3.76 - 2.92 = 0.84), emphasizes good behavior at four from the five hybrids studied in which was recorded a difference between the average and the minimum length cavities produced by *Ostrinia nubilalis* less than 0.42 cm. The maize hybrid tolerance was positively correlated with the attack frequency of this pest. The highest frequency of *Ostrinia nubilalis* was registered at Crişana hybrid (21.7%) and the lowest values were recorded at Paltin and Milcov hybrids (10 to 13.6%). In 2012 at the end of July and in August have been identified plants with *Ustilago maydis* (common corn smut) symptoms. The disease manifests as tumors on the stems and cob and had a degree of attack varying between 0-12.5%, which was negatively correlated with the grain production obtained (Figure 2).

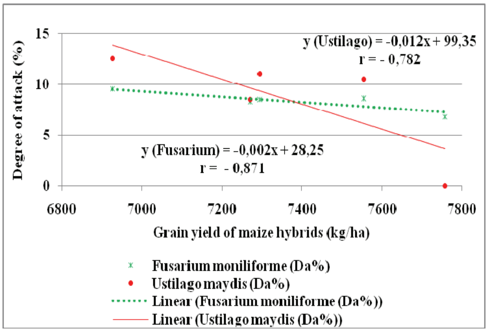

Figure 2. Correlations between the degree of attack of *Fusarium moniliforme* and *Ustilago maydis* and grain yield obtained in five maize hybrids

Although in this year (2012) were recorded average temperatures of 24.3 to 26.4°C, favorable to *Ustilago maydis* infection, lack of precipitations have limited the attack. The observations of harvested maize cob emphasises symptoms of infection caused by *Fusarium moniliforme*, the degree of attack of the five studied hybrids of maize, correlating negatively with production (Figure 2). Known as the „white flowering of grains", the disease was favored by high temperatures registered in the two years, the attack level is between 6.8 to 9.6%.

In peanut crop, the specific environmental conditions of sandy soils have favored the spread and evolution of a broad spectrum of pathogenic fungi belonging to the genus *Fusarium*, the most common being *Fusarium oxysporum f.sp. vasinfectum* (Şearpe et al., 2001). The attack was favored by high soil temperature (the optimal threshold of 27°C), possibly by alternation of soil moisture and not least by the lack of organic matter, microclimate which was present during the studied period. The observations performed from 10 peanut genotypes have shown the presence of *Fusarium oxysporum* as total or partial drying plants, with an average of 13.41% (Figure 3).

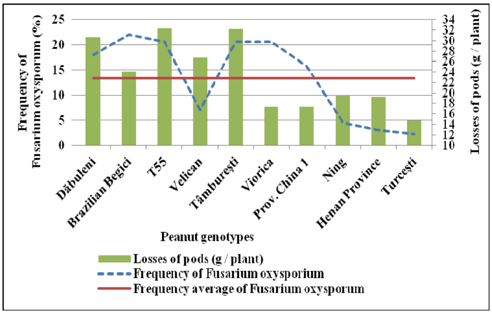

Figure 3. Frequency attack of *Fusarium oxysporum f.sp. vasinfectum* on peanut genotypes cultivated on sandy soils

The symptoms of peanuts plant infection with this fungus were present with a higher frequency during August-September (F% = 2.25 to 22). Infection of the plant with *Fusarium oxysporum* has reduced the number of pods per plant, the losses ranging from 14.7 to 32.3%, depending on the genotype.

The microclimate created at the level of leaves was a vulnerability factor to contamination with pathogens, respectively *Pseudomonas syringae pv. vignae* and *Uromyces appendiculatus (Pers.)*. Analyzing the cowpea plant resistance to *Pseudomonas syringae* and *Uromyces appendiculatus*, differences in the degree of attack, were recorded depending on climatic conditions (Figures 4 and 5).

The high air temperatures, with an average of 16.6 to 18.5°C and the maximum 31.8 to 32.5°C associated with a high relative air humidity (79.2 to 85.96%), in the last decade in May, have created favorable conditions in the two years of study for plant infection with *Pseudomonas syringae pv. vignae* (Figure 4).

The attack continued throughout the month of June, when bacteria has found favorable climatic conditions deployment the biological cycle (20.2 to 21.8°C air temperatures and quantity of precipitations summed from 32.4 to 105.2 mm). In these conditions, in 2013 the degree of attack on cowpeas was between 15.9 to 33.6%, with 5.65 to 19.5% higher than the attack recorded in 2012.

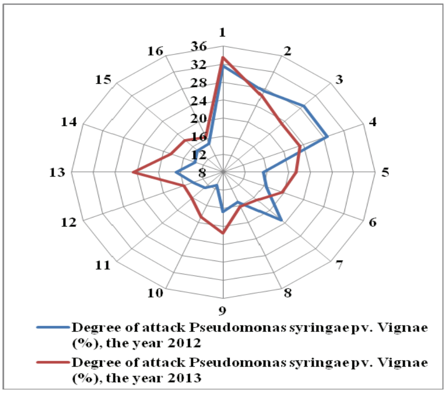

Figure 4. The influence of climatic conditions and phytosanitary treatment on the degree attack of *Pseudomonas syringae* pv. *vignae* on cowpea

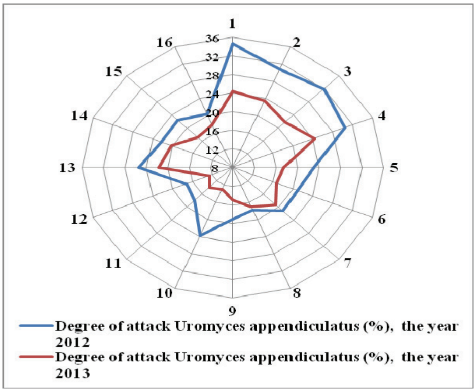

Figure 5. The influence of climatic conditions and phytosanitary treatment on the degree attack of *Uromyces appendiculatus* on cowpea

It showed an average degree of attack produced by bacteriosis 18.85% in 2012 and 20.64% in 2013, being known the fact that the bacteria grow at temperatures of 26-28°C and high relative humidity.

In the stage of differentiation the rods floral of cowpeas crop were observed rust infections, produced by *Uromyces appendiculatus* (Pers.), manifested with virulence during flowering phenophase-formed pods, a period which coincided with the end of June - first half of July. Observations made on rust attack is on cowpea crop, have shown values ranging from 12.6 to 24.5% in 2013 and 17.3 to 34.7% in 2012 (Figure 5).

The average of degree of attack of *Uromyces appendiculatus* (Pers.) was 23.75% in 2012 and 18.54% in 2013. Although the climatic conditions created in the period June-July 2013 were more favorable to infection caused by this pathogen (22.2 to 23.3°C average temperature in air with a relative humidity of 80.17 to 84.5%) compared to those recorded in 2012 (average temperatures 24-26.7°C and relative humidity of 46.9 to 61.7%), however, the degree of attack registered in 2012 it was with 28.1% higher than that recorded in 2013. The explanation lies in maintaining a higher humidity at leaves level, created through sprinkler irrigation applied more frequently in 2012, as a result of persistent drought. High temperatures of 24 to 26.7°C, associated with prolonged wetting of leaves, has created a favorable environment for the development the fungus spores and producing the successive infections in foliar apparatus.

Legend of Figures 4, 5:	
1,2,3,4………..	Untreated
5,6,7,8………..	Dithane M-45 - 0.2%
9,10,11,12…….	Shavit F72WP - 0.2%
13,14,15,16…...	Topsin 500 SC - 0.07%

The phytosanitary treatments applied in cowpea crop with Shavit F72WP, in concentration of 0.02% (average of observations 9,10,11,12) had the best efficacy in preventing and controling *Pseudomonas syringae pv. vignae*, the degree attack recording an average of 15.86%, with 43.21% less, compared to the untreated variant, where the degree of attack was 27.93% (average of observations 1, 2, 3, 4).

Also systemic and contact action of the Shavit F72WP, applied at 0.2%, was highlighted through reducing with 40.3% the attack of *Uromyces appendiculatus* (Pers.), compared with untreated variant, where the degree attack was 27.8% (Figure 5).

CONCLUSIONS

The biological material used in seeding is one vulnerable points to infection with plant pathogens and pests in agroforestry holdings on sandy soils.

Out of the 144 genotypes of cowpeas, 75.7% were characterized as highly resistant (notes 1-2) to infection produced by *Cowpea aphid borne virus,* 7% with high sensitivity (notes 5-8) and 17% with sensitivity (notes 3-4), with a negative correlation between production and plant resistance to this pathogen at 3-4 true leaves and flowering phases (r = - 0.792 **, r = - 0.744 **).

In peanut, the presence of fusarium wilt caused by *Fusarium oxysporum f.sp.vasinfectum*, was signaled, with dried plants symptoms and with 2.25 to 22%, frequency depending on the genotype.

In maize, symptoms of infection caused by *Ustilago maydis* (Da 0-12.5%) and by *Fusarium moniliforme* (Da 6.8 to 9.6%) were signaled, as well as *Rhopalosiphum maidis* and *Ostrinia nubilalis* attack. A good behavior to Rhopalosiphum and Ostrinia and to pathogens also showing the hybrids Milcov, Mostiştea, Paltin şi F 376.

The climatic conditions of the years 2012 and 2013 influenced differently the degree of attack of *Pseudomonas syringae pv vignae* on cowpea (Da = 18.85% in 2012; Da = 20.64% in 2013) and *Uromyces appendiculatus* (Da = 23.75% in 2012; Da = 18.53% in 2013).

The phytosanitary treatment of the cowpea crop with Shavit F72WP (0.2%) had the best efficacy in preventing and controling *Pseudomonas syringae pv. vignae* and *Uromyces appendiculatus.*

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RESULTS REGARDING YIELD AND YIELD COMPONENTS AT DIFFERENT TRITICALE VARIETIES

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Abstract

Triticale (Triticosecale Wittm.) is more and more of interest for the Romanian farmers, the harvested area being increasing in the last years. In South Romania this is used both for grain yield and biomass, which is more and more of interest as fodder, but also as raw material for producing biogas. The cultivated varieties have to be tested and known as yielding capacity in different growing conditions. The South Romania has favourable conditions for growing triticale.
Researches were performed in the agricultural year 2012-2013, in field experiments located in South Romania at Moara Domneasca Experimental Farm (44°30' N latitude and 26°14' E longitude). Researches were performed at an assortment of 10 triticale varieties, respectively: Mezin, Stil, Titan, Oda, Negoiu, Cascador, Haiduc, Tulus, Polego, and Gorun 1. The aim of researches that conduced to the elaboration of the present paper was to present the results regarding yield components and grain yield obtained at an assortment of triticale studied under soil and climatic conditions from South Romania.

Key words: *triticale, varieties, yield, yield components, comparative crops, ecological plasticity.*

INTRODUCTION

Triticale (*Triticosecale* Wittmack) is a new cereal crop resulted from wheat and rye crossing for the better use of poor sandy soils, water stress and excessive temperature, in order to produce large yields under pedoclimatic conditions that are unsuitable for other agricultural crops (Gaspar and Butnaru, 1985).
According to FAO database, in 2012 triticale was grown on 3.69 million ha all over the world, of which 86% in Europe. In Romania, in 2012 triticale was grown on 48 thou ha. Triticale is more and more of interest for the Romanian farmers, the harvested area being increasing in the last years. It is possible to extend the crop up to 160 thou ha (Ştefan et al, 2011).
Triticale is a plant species which is characterised by high genetic potential for grain yield, as well as good nutritive properties of its grain, while it is not as demanding as wheat in regard to agrotechnic measures and ecological conditions, so it is regarding as a very promising crop (Biberdžic et al., 2012).
Triticale has demonstrated high yield potential even under the marginal growing conditions and could be attractive alternative for raising cereal production globally (Kutlu and Kinaci, 2010).
New triticale varieties have been created over the past decade; they now compete with other cereals and even maize, particularly in the hilly areas, on soils of low fertility and acid pH (Ittu et al., 2005). New varieties of triticale are equal or superior to other crops for grain yield, forage and biomass production for human food, animal feed or industrial applications (Nefir and Tabără, 2012).
The new varieties are characterized by high capacity to use the environmental and technological conditions with top agronomic characteristics concerning the use of unfavourable climate and soil conditions, spike fertility, grain size and fill, and spike germination (Ittu et al., 2006).
The competitiveness of the Romanian triticale varieties has led to the certification of the Titan variety in Canada, France and Hungary, and the Decor line in the U.S.
The study of the triticale varieties in comparative crops allows hierarchization according to their production performances for crop purposes.

In South Romania triticale is used both for grain yield and biomass, which is more and more of interest as fodder, but also as row material for producing biogas. The cultivated varieties have to be tested and known as yielding capacity in different growing conditions. The South Romania has favourable conditions for growing triticale.

Yield components of triticale crop are developed successively during the vegetation period, as follows:

- number of emergent plants/m^2;
- number of tillers/m^2 at beginning of spring;
- number of ears/m^2.

The ear yield components are recorded from the phase of "1 cm" to harvest maturity, and refer to the following:

- ear length;
- total number of spikelets on ear;
- number of fertile spikelets on ear;
- number of sterile spikelets on ear;
- number of grains on ear;
- number of grains on spikelet;
- grain weigh on ear;
- thousand grain weight (TGW).

Grain yield is usually positively correlated with all its components (Kozak et al., 2007).

The aim of the paper was to present the results regarding yield components and grain yield obtained at an assortment of triticale studied under soil and climatic conditions from South Romania.

MATERIALS AND METHODS

Researches were performed in the agricultural year 2012-2013, in field experiments located in South Romania at Moara Domneasca Experimental Farm (44^{o}30' N latitude and 26^{o}14' E longitude) belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

The soil from Moara Domneasca area is reddish preluvosoil. In the period September 2012 - August 2013, in Moara Domneasca area the average temperature was of 12.6^{o}C and the sum of rainfall of 288 mm.

Researches were performed at an assortment of 10 triticale varieties, respectively: Mezin, Stil, Titan, Oda, Negoiu, Cascador, Haiduc, Tulus, Polego, Gorun 1. Each variety was sown on 144.8 m^2 (3.62 m of width and 40 m of length). The sowing was performed on 16th of October 2012, at 12.5 cm row spacing. The preceding crop was rapeseed. The fertilization was performed with 86 kg ha^{-1} of nitrogen and 40 kg ha^{-1} of phosphorus. The weed control was performed by the help of herbicides.

To the studied triticale varieties, determinations were performed in view to establish the yield components and the grain yield. Thus, it was determined the number of ears per square meter. The ears from one square meter were harvested for determining the grain yield. The grain moisture content was determined by the help of a portable moisture analyser. A total of twenty ears were picked and analysed for determining the ear yield components, respectively: ear length; number of spikelets on ear (total, fertile and sterile spikelets), number of grains on ear, number of grains on spikelet, grain weight on ear. Also, it was determined the thousand grain weight and the hectoliter weight.

The obtained data were statistically processed by analyses of variance (Anova-single factor).

RESULTS AND DISCUSSIONS

Under the same pedoclimatic and technological conditions, each variety recorded different values for yield and yield components.

Number of ears/m^2

The analysis of the yield components indicates that the number of ears per square meter was in average of 337, with a wide variation between the analysed varieties (Figure 1).

The Cascador variety recorded the highest number of ears per square meter, i.e. 369.3 ears/m^2, while the Haiduc variety recorded the lowest number of ears per square meter, i.e. 309.3 ears/m^2. High values of the number of ears per square meter were also recorded in the Gorun variety (362.7 ears/m^2), and the Tulus variety (348 ears/m^2).

Most varieties under study recorded lower values of the number of ears per square meter than the average value of the ten studied varieties, as follows: Haiduc – 309 ears/m^2, Negoiu – 317 ears/m^2, Oda – 326.7 ears/m^2, and Mezin – 329.3 ears/m^2.

The number of ears per square meter had a direct influence on the ear yield components.

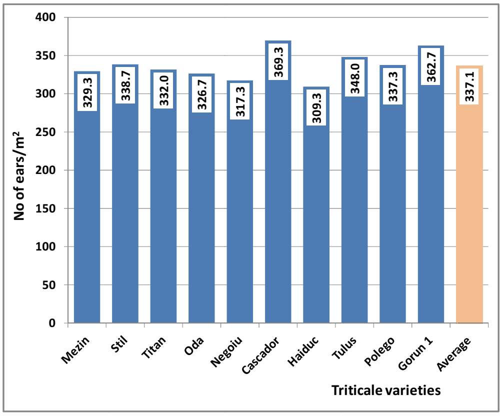

Figure 1. Average number of ears per square meter at studied triticale varieties

Ear length

Concerning ear length, there was a direct correlation with the number of ears per square meter; however, it had no direct influence on the grain yield. The ears were smaller in the varieties that recorded the highest number of ears per square meter (Figure 2). In the Cascador variety, the ear length was 7.27 cm, with a negative very distinct significant difference compared to the average value of the studied varieties. Also, the Stil variety recorded a 7.98 cm ear length, with a negative significant difference compared to the average value of the studied varieties

There were two remarkable varieties: Tulus, with a 10.92 cm ear length, and Polego, with a 10.32 cm ear length, both of them registering very distinct significant differences compared to the average value of the studied varieties.

Number of spikelets on ear

Ear length had a direct influence on the ear yield components; thus, the total number of spikelets on ear was determined by the ear length and compactness.

Long-eared varieties recorded a high number of spikelets on ear: Haiduc – 31.43 spikelets, Tulus – 30.63 spikelets, and Negoiu – 30.37 spikelets. Short-eared varieties recorded a low number of spikelets on ear: Cascador – 22.43 spikelets, and Stil – 27.20 spikelets (Figure 3).

The number of fertile spikelets on ear was influenced by the number of ears per square meter and the presence of several limiting factors during the critical period which determined the formation of sterile spikelets at the ear base.

The number of fertile spikelets on ear was correlated with the number of ears per square meter. There were remarked the following varieties: Haiduc – 29.43 fertile spikelets, Tulus – 28.90 fertile spikelets, and Negoiul – 28.83 fertile spikelets. The Cascador variety recorded the highest number of ears per square meter and only 21 fertile spikelets on ear, with a negative very distinct significant difference compared to the average value of the ten studied varieties.

The number of sterile spikelets on ear was influenced by several factors during grain formation and fill phases; at the same time, it was correlated with the ear length. Thus, most sterile spikelets occurred in the Titan, Oda and Haiduc varieties, while the least sterile spikelets occurred in the Gorun, Cascador and Stil varieties.

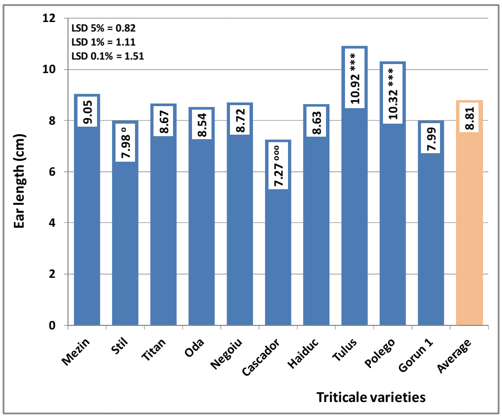

Figure 2. Average ear length at studied triticale varieties

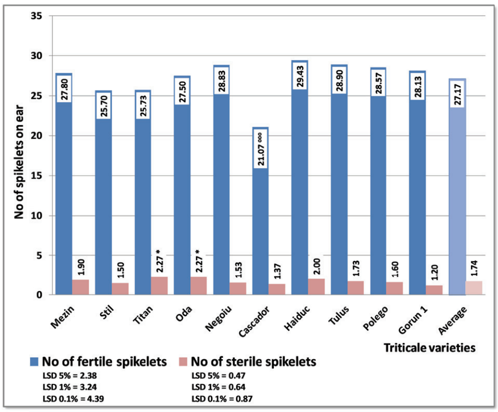

Figure 3. Average number of fertile and sterile spikelets on ear at studied triticale varieties

Number of grains on ear and on spikelets

The analysis of the number of grains on ear showed that it was influenced by the number of ears per square meter, the low competitiveness in the plant population, the absence of water and thermal stress during the grain formation and fill phase, the presence of the leaf diseases and pests after the ear-formation phase.

The average recordings consisted in 36 grains on ear for the ten triticale varieties (Figure 4).

The highest number of grains on ear resulted from the Haiduc variety (40.3 grains on ear) while the lowest number of grains on ear was recorded in Cascador (29.6 grains on ear). A large number of grains on ear were also recorded in the following varieties: Mezin (39.4 grains on ear), Negoiu (38.7 grains on ear) and Oda (38.4 grains on ear).

The average number of grains on spikelet was correlated with the number of ears per square meter and the number of spikelets on ear. Thus, the average number of grains on spikelet was different in the varieties under study. Most varieties recorded 1.4 grains on ear, the lowest number being recorded in the Tulus and Gorun varieties (Figure 4).

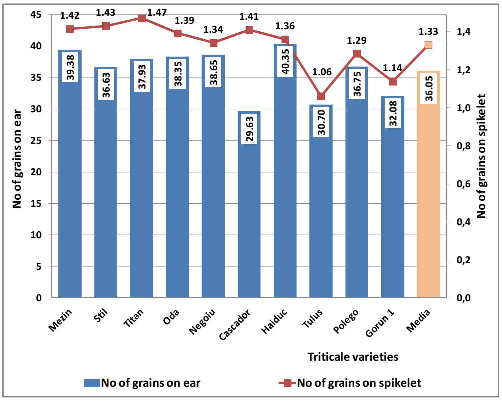

Figure 4. Average number of grains on ear and average number of grains on spikelet at studied triticale varieties

Grain weight on ear

Grain weight on ear had a direct influence on the yield resulted from the experiment.

In the ten triticale varieties under study, the average grain weight on ear was 2.18 g, with slight variations between the varieties, resulting from the number of ears per square meter (Figure 5). Grain weight on ear was influenced by the number of grains on ear and their size. The most productive varieties were the following: Mezin (2.51 g on ear), Haiduc (2.34 g on ear) and Gorun (2.28 g on ear). The lowest productivity was recorded in Tulus (1.96 g on ear) and Stil (1.99 g on ear).

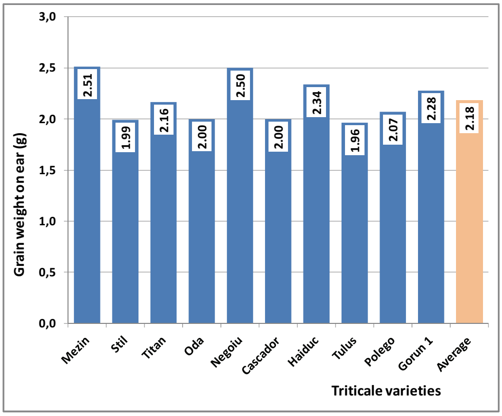

Figure 5. Average number of grain weight on ear at studied triticale varieties

Thousand grain weight (TGW)

TGW was influenced by water stress and high temperatures in the grain formation and fill phase, presence of leaf diseases and pests, as well as nitrogen amount, as shown in Figure 6.

The analysis of the data presented in the Figure 6 indicates that the average TGW was 51.5 g, with an evident variation between the varieties included in the experiment. The highest values were recorded in the following varieties: Negoiu (56.0 g), Haiduc (55.7 g) and Mezin (52.5 g). The lowest TGW was recorded in Polego – 47.8 g, Oda – 48.6 g and Stil – 48.3 g.

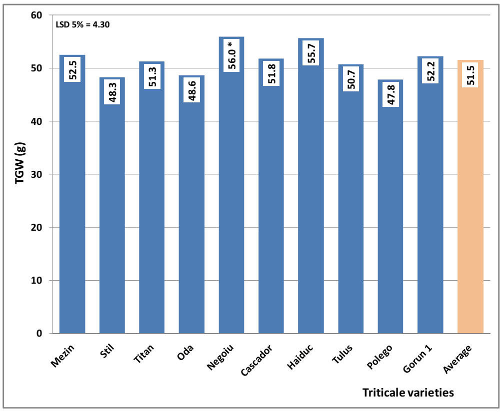

Figure 6. Average thousand grain weight (TGW) at studied triticale varieties

Grain yield at 14% moisture

The average grain yield at 14% moisture for the entire experiment was 8,337 kg/ha, with no significant differences between the ten triticale varieties under study. The Cascador variety recorded the highest yield (9,300 kg/ha), while Titan recorded the lowest yield (7,552 kg/ha). High productions were also recorded in the following varieties: Tulus (9,224 kg/ha), Mezin (8,775 kg/ha), Negoiu (8,714 kg/ha), and Haiduc (8,845 kg/ha).

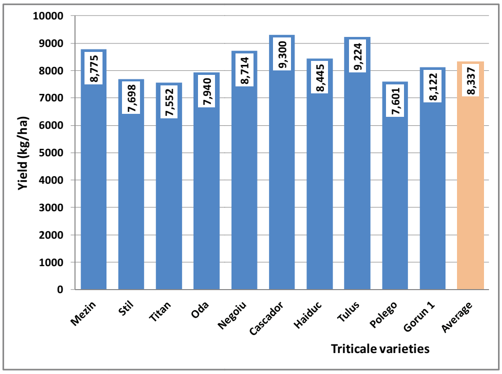

Figure 7. Average yield at 14% moisture at studied triticale varieties

Hectolitre weight

The quality indice that was measured at harvest time was hectolitre weight. The average hectolitre weight was 74.8 kg/100 l (Figure 8). The highest hectolitre weight was recorded in the Oda variety (76.5 kg/100 l), while the lowest was 73.0 kg/100 l in the Haiduc variety.

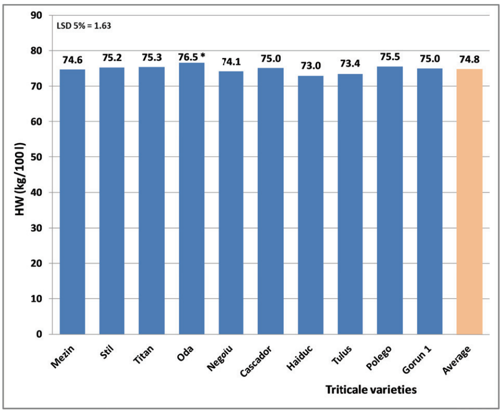

Figure 8. Average hectolitre weight at studied triticale varieties

CONCLUSIONS

- Triticale is a new cereal with high ecological plasticity which valorises the environment conditions less favourable to other crops.
- The varieties studied in the comparative crops achieved yields of over 7 t/ha, variable from one variety to another, under the favourable climate conditions of 2013 on the reddish preluvosoil from South Romania.
- The new triticale varieties valorise in a superior way the soil and climate conditions from the hilly area, less favourable to other crops;
- The studied triticale varieties in the specific conditions of 2013 and on reddish preluvosoil achieved higher grains productions than wheat and most of corn hybrids under identical environmental and technological conditions.
- Triticale is a grains species belonging to the future for areas with limiting soil and climate conditions but also for intensive technological conditions.

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SPATIO-TEMPORAL CHARACTERIZATION OF NATURAL GRASSLANDS FROM BUCEGI NATURAL PARK USING REMOTE SENSING RESOURCES

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Abstract

The present paper presents a spatio-temporal characterization of the natural grasslands from Bucegi Natural Park using remote sensing resources such as radiometric information from the multispectral satellite images – S10 MERIS of ENVISAT, and aerial high-resolution orthophotos, to provide the Normalized Difference Vegetation Index (NDVI) of the natural grasslands and their delineation. The sampled data were georeferenced in stereographic 1970 coordinate system and were used to create thematic layers in GIS environment and to perform statistic inferences. A procedure that correlates and reclassifies radiometric data was developed using previous terrestrial observations and thematic information from the satellite images of the studied area. The multispectral images photointerpretation allowed the generation of thematic maps with attributes from database and radiometric information between 2010 and 2011 vegetation seasons, which were correlated using multi-temporal archives of NDVI values. In our study based on two subsequent years of satellite observations in the vegetation seasons, a NDVI threshold of 0.45 seemed to be appropriate to be considered as a start of season in the Bucegi Natural Park. NDVI weighted averages were computed based on available pixels for each month of the studied years as follows: 0.38 in March, 0.54 in April, 0.60 in June, 0.75 in July, 0.74 in August, and 0.71 in September. The lowest NDVI values were recorded in the northern part of Bucegi Natural Park, while the southern grasslands presented higher values correlated with earlier start of vegetation growth.

Key words: *canopy reflectance, GIS analysis, natural grasslands, NDVI, satellite images.*

INTRODUCTION

Forage resources that are available from Romanian grasslands provide, on average, over 50% of fodder requirements for sheep and cattle in green fodder equivalent. In hilly and mountainous areas, this proportion exceeds 60% of forage consumption (Vîntu et al., 2004). This potential depends on a number of measures of which the most important are the improvement or maintenance of herbaceous closed canopy with valuable forage species, grazing rationalization, and proper water sources and access roads in the productive grasslands (Motcă et al., 1994). The efficient application of these measures strictly necessary to meet the goals of functional and stable forage systems requires the information support of a multi-criteria decision-making system with geospatial analysis functions. On this line, the purpose of this paper is twofold. Firstly, it presents the use of aerial high-resolution orthophotos in delineating updated boundaries of natural grasslands from Bucegi Natural Park, together with their geospatial classification based on previous inventories for phytosociological associations' distribution. Secondly, it provides a spatio-temporal characterization of vegetation cover by using information extracted from S10 MERIS 10-days composite images acquired in the vegetation seasons (April - September) of 2010 and 2011 by the ENVISAT satellite.

Previous inventories of Bucegi Natural Park (Maruşca, 2012) have established the status of grasslands' degradation revealing that only 6,275 ha had herbaceous canopy justifying their membership in this cadastral class of use. The remaining 1,071 ha belonged to another category of use as they were covered with over

60-80% woody vegetation, denuded or eroded land. Moreover, from 6,275 ha established in field on the map, 15% were affected by surface and depth erosion, 13% were on rocks, 12% were covered in varying degrees with bushes of juniper and spruce in areas where pastures were in various stages of abandonment. The grasslands' inventory performed in 2008 also identified 250 ha (4% of the surface) invaded by nitrophile weeds because of overgrazing (Maruşca et al., 2013).

These surveys have concluded that the grasslands of Bucegi Natural Park are in an advanced stage of degradation, requiring further detailed studies of grasslands' boundaries, types and productivity, to determine the possible loading with animals and other measures to stop the degradation, to reconstruct ecologically the degraded herbaceous canopy.

The rules that regulate the environmental factors action in correlation with the technological ones, especially in natural grasslands are little known and studied. On the biological efficiency of the species that form the phytosociological associations of natural grasslands, acts genetic factors related to the characteristics of each species, eco-climatic conditions and anthropic factors related to grasslands' field operations (e.g. grazing, fertilization, weeding etc.). It is well known that a larger amount of photosynthetically active solar radiation (PAR) captured by the canopy means greater amount of dry matter synthesized from it (Dunea and Moise, 2008). Satellite observations improve and update the knowledge regarding the land surface characteristics, the structure of vegetation and other biophysical properties such as PAR, LAI, chlorophyll etc. (Darvishzadeh et al., 2008). Franklin (2009) made an extensive review of the remote sensing applications in mapping and surveying of the habitat and species distribution. Reflectance, surface temperature, *Normalized Difference Vegetation Index* (NDVI) summaries, and other spectral indices from a variety of sensors have been used in many studies to predict the species richness of different taxonomic groups. Three growth parameters from 15 alpine and subalpine grassland sites were investigated between 2001 and 2005 in a study that evaluated the ability to track grassland growth phenology in the Swiss Alps with NOAA-16 Advanced Very High Resolution Radiometer (AVHRR) NDVI time series (Fontana et al., 2008). Findings showed that the application of various thresholds to NDVI time series allows the observation of the temporal progression of vegetation growth at the selected sites with high consistency.

MATERIALS AND METHODS

In the first phase, aerial high-resolution orthophotos were used to delineate the perimeter of natural grasslands in Bucegi Mountains through raster-vector conversion and digitization. The resulted vectors were compared and combined with 2006 Corine Land Cover layers (version 16; 04/2012) that corresponded to the natural grasslands and related categories (e.g. 321, 231, and 324). The general thematic layer was populated with the phytosociological associations' distributions using data from previous inventories (Maruşca et al., 2013). The sampled data were georeferenced in stereographic 1970 coordinate system and were used to create thematic layers in GIS environment and to perform statistic inferences. Remote sensing resources such as radiometric information from the satellite images (in this paper ENVISAT-MERIS S10 images were used) provided the *Normalized Difference Vegetation Index* (NDVI) of the natural grasslands and its spatio-temporal fluctuations in the envisaged area. The NDVI provides an index to present the vitality of the vegetation on the earth's surface being a measure of the photosynthetic activity within the area covered by a pixel of image. The algorithm uses the abrupt rise of the reflection level of 0.7 mm. The NDVI is computed using the following equation:

$NDVI = (R_{s,NIR} - R_{s,RED})/(R_{s,NIR} + R_{s,RED})$,

where $R_{s,RED}$ and $R_{s,NIR}$ are the atmospherically corrected surface reflectances in the RED and Near Infrared (NIR) bands. The ENVISAT-MERIS S10 are near global 10-daily composite images synthesized from the adequate observations registered in the course of every decade by the orbiting earth observation system ENVISAT-MERIS.

All the daytime spectral registrations of ENVISAT-MERIS were further processed into

global, 10-daily synthesis images, comparable with the S10 of SPOT-VEGETATION from SPOT-5 satellite. Within this paper, only the TOC NDVI (Top of Canopy) was processed out of the MERIS Reduced Resolution data.
All geo-referencing operations, conversions, statistical analysis, and mapping were performed with ESRI ArcGIS 9.3.

RESULTS AND DISCUSSIONS

In Romania, most researches conducted on mountainous grassland productivity till present, were aimed at the influence of technological factors, considered as factors with direct influence on the yield formation and less on finding out rules between growth and development factors (natural and plant-related) and yield components using spatio-temporal characterizations. In this stage, the research results have a reduced degree of generalization, and grasslands management practices have a weak scientific foundation. Research objectives should be oriented towards increasing net efficiency, competition capacity, persistence and viability of the valuable forage species in the mixed canopy of natural grasslands. Global land monitoring using orthoimagery and photointerpretation can actively support the assessment of productivity, vegetation structure, habitat stability and heterogeneity, and biochemical diversity of natural grasslands.
The results obtained in the first phase were related to the distribution of natural grasslands in the envisaged region (Figure 1).
Vector data from Corine land cover - version 16 (04/2012) was overlapped on the SRTM 90 m digital elevation model. Figure 1 presents the areas (ha) of the delineated natural grasslands (INSPIRE 321 category) existent in the region. The areas of interest were the polygons having 5,570.6, 853.9, 93.9, and 65.9 ha.
Aerial orthoimagery (Figure 2) was used to obtain a more detailed delineation of the boundaries of these areas using conventional raster-vector transformations. Figure 3 presents the resulted new vector layers, which were used to locate the boundaries of six previous established on ground phytosociological associations.

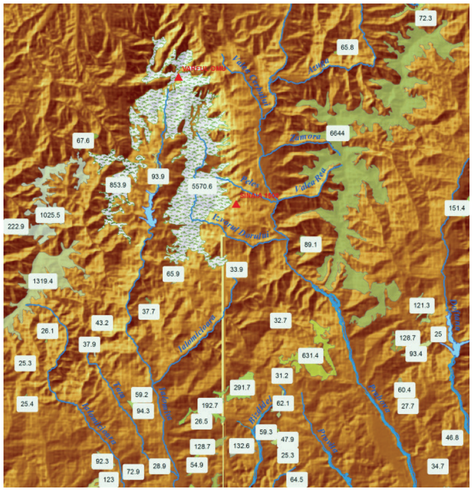

Figure 1. Distribution of natural grasslands in the envisaged region and their corresponding areas (ha)

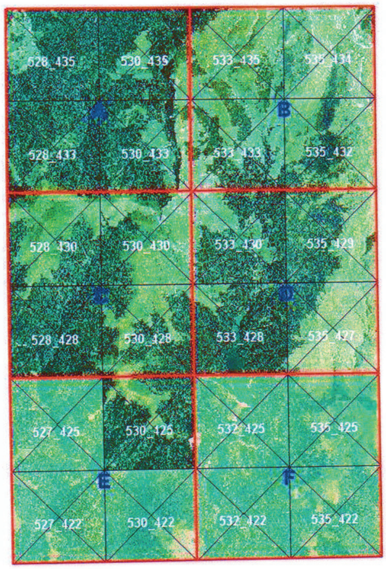

Figure 2. Ortho-photo with raster tiles used for raster-vector conversion to obtain grasslands delineation

The delineated herbaceous associations were as follows: *Potentillo ternatae – Nardion* (PON), *Seslerion bielzii* (SEB), *Oxytropis-Elynion* (OXE), *Junicion trifidi* (JUN), and *Cynosurion* (CYN). A shrub category present in the area was Kotschy's alpenrose heaths (RHV) of the subalpine and lower alpine levels (1700-2000 m) occupying small surfaces (138.5 ha), being dominated by *Rhododendron myrtifolium*, *Vaccinium gaultherioides* and *Vaccinium vitis-idaea* (Figure 3).

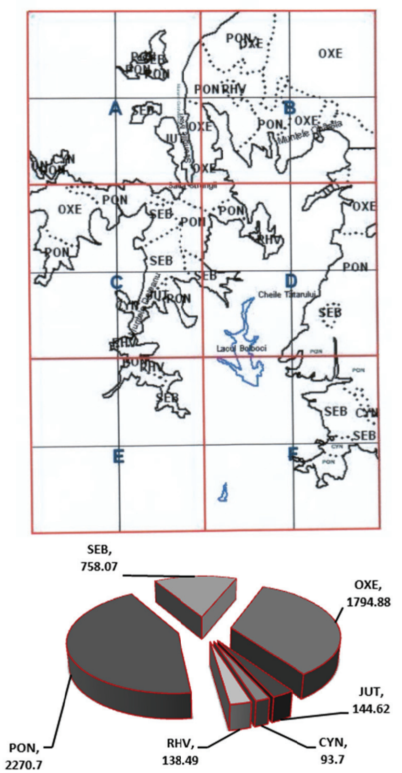

Figure 3. Resulted distribution of phytosociological associations in Bucegi Natural Park – Carpathian Mountains using raster-vector conversion and by merging typology inventory performed by Maruşca et al. (2013); Areas are expressed in hectares (ha)

Figure 3 shows that the PON grasslands dominated by *Nardus stricta* and *Festuca airoides* species had the highest percentage on the resulted map, occupying around 45% of the area. This indicates the advanced stage of degradation of herbaceous canopy. The next categories were the alpine meadows on the highest peaks (OXE) with 34%, SEB rocky meadows with 14%, and the rest of JUT and CYN with 4.4%. RHV reached 2.6% of the total grassland area. The reclassification of grasslands distribution based on dominant species provided general information regarding the phenology of canopy growth and development, which can be correlated with NDVI fluctuations during the vegetation season or between different years. Vegetation indices rely on the reflectance characteristics of various surfaces for different types of light spectrum. Photosynthetically active canopies absorb the incident red light and reflect the near infrared (NIR) light. Consequently, NDVI provides a good approximation of the absorbed PAR fraction (fAPAR) by the plant canopies. NDVI values range from -1.0 to +1.0, but S10 MERIS composite images have physical values from -0.08 to 0.92 associated to digital numbers from 0 to 250. Values less than zero did not have an ecological significance, and were excluded from map (i.e. clouds and snow cover). Very low and low NDVI values characterized areas with little NIR light reflectance or with little photosynthetic activity (e.g. water bodies, bare soils, and stressed vegetation). Superior values occurred in PAR active canopies when the ENVISAT-MERIS sensor recorded larger differences between the red and NIR radiation. Previous study (Fontana et al., 2008) established three suitable thresholds to determine grassland growth phenology in the Swiss Alps with NDVI time series such as melt-out (0.6), start of growth (0.75), and end of growth (0.98). In other approach, Stöckli and Vidale (2004) applied a threshold of 0.4 to the entire Alps to derive start of season dates for a period of 20 years.

In our study, based on two subsequent years of satellite observations in the vegetation seasons (i.e. 2010 and 2011) a NDVI threshold of 0.45 seemed to be appropriate to be considered as a start of season in the Bucegi Natural Park.

Figure 4 presents the thematic maps of each corresponding decade of the month between April and September periods of 2010 and 2011. It can be observed that in 2010 the vegetation season of the grasslands was tardier than in 2011. However, NDVI maps of June month in both years have similitudes concerning the NDVI spatial distributions. The phenological advancing was faster in 2011 comparing with 2010 taking into account August and September months.

Table 1 presents the statistics of the NDVI data extracted from S10 MERIS during 2010 and 2011 vegetation seasons. Count column presents the available number of pixels for analysis after excluding redundant values (snow cover and clouds). A general comparison between 2010 and 2011 vegetation seasons for the natural grasslands of Bucegi Natural Park was difficult to perform since there are differences between the available numbers of pixels for the same month of each year.

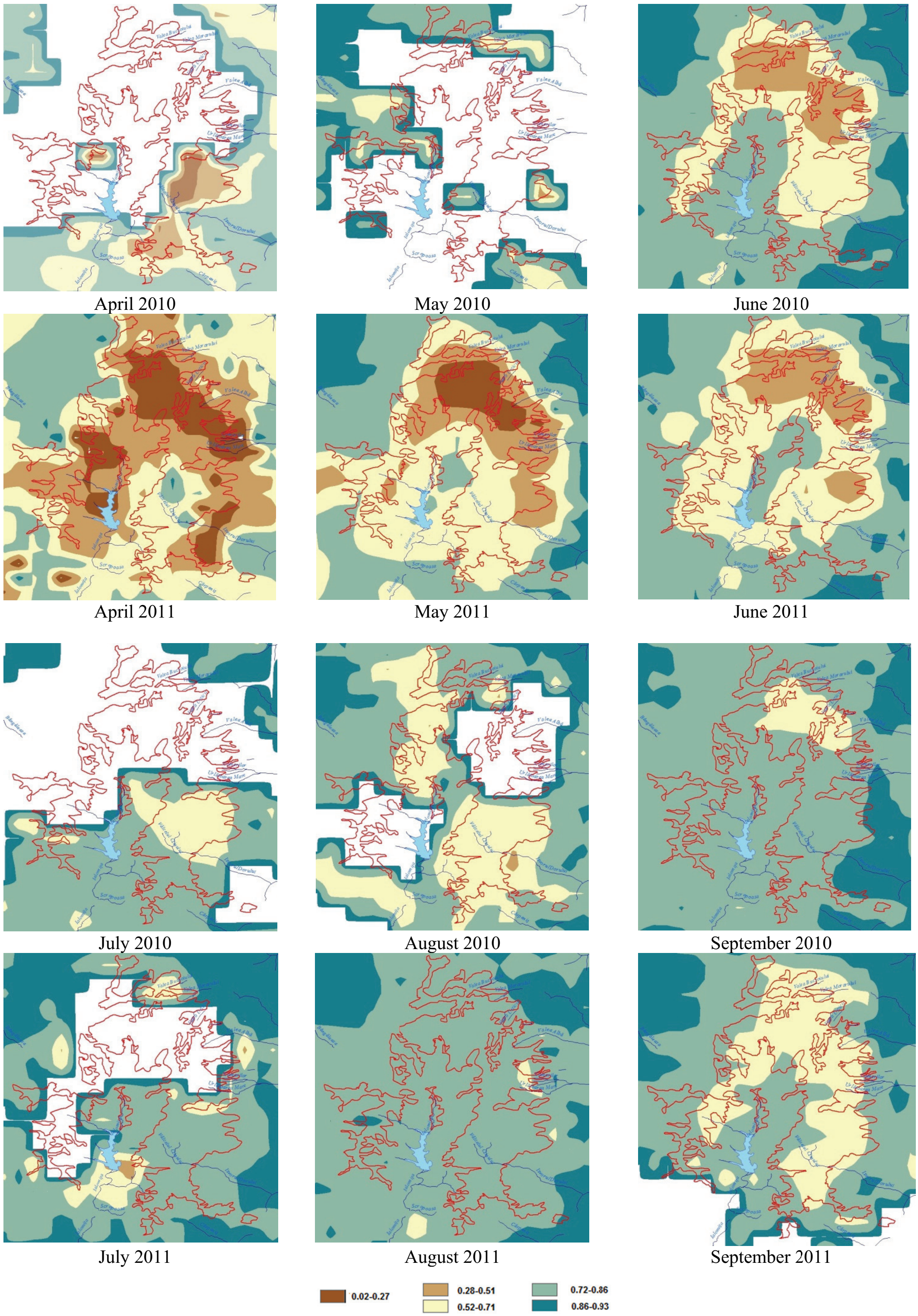

Figure 4. NDVI extracted from S10 MERIS 10-days composite images, courtesy of the CVB project produced by VITO

Table 1. Descriptive statistics of the NDVI results obtained from S10 MERIS composite images

Month	Count	Minimum	Maximum	Sum	Mean	Std. deviation
April 2010	28	0.04	0.77	11.05	0.39	0.20
April 2011	97	0.05	0.84	36.15	0.37	0.18
May 2010	27	0.38	0.93	20.60	0.76	0.14
May 2011	97	0.13	0.81	49.47	0.51	0.18
June 2010	97	0.36	0.87	57.56	0.59	0.12
June 2011	97	0.34	0.84	58.63	0.60	0.13
July 2010	41	0.59	0.88	29.43	0.72	0.08
July 2011	49	0.64	0.88	38.14	0.78	0.05
August 2010	60	0.49	0.88	40.69	0.68	0.10
August 2011	97	0.68	0.86	74.64	0.77	0.03
September 2010	97	0.61	0.84	71.16	0.73	0.05
September 2011	95	0.54	0.81	64.33	0.68	0.06

Table 1 highlights useful information regarding NDVI temporal distribution for each year. We have computed NDVI weighted averages based on available pixels for each month of the studied years as follows: 0.38 in March, 0.54 in April, 0.60 in June, 0.75 in July, 0.74 in August, and 0.71 in September. The lowest NDVI values were recorded in the northern part of Bucegi Natural Park, while the southern grasslands presented higher values correlated with earlier start of vegetation growth. From the grassland typology point of view, *Oxytropis-Elynion* (OXE) association had the lowest NDVI values as compared to other types, being alpine grasslands located at higher altitudes. Future assessments will be necessary to determine better NDVI thresholds for each grasslands type of Bucegi Natural Park using larger intervals of time and by employing images from other sensors such as AVHRR, SPOT-5 and PROBA-V (from October 2013).

CONCLUSIONS

NDVI has a significant relationship to many grassland ecosystem parameters such as vegetation presence, net primary productivity, and photosynthetic efficiency, which can provide information concerning the ecological status and changes due to grazing impact, or can facilitate a rational grazing management. The observed NDVI chronology was in agreement with canopy growth phenology.

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DRAUGHT INFLUENCE CONCERNING MAIZE LEAF WEEVIL (*Tanymecus dilaticollis* GYLL) ATTACK ON MAIZE CROPS AT NARDI FUNDULEA

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Abstract

In this paper, authors collective present draught effects concerning evolution of the maize leaf weevil (Tanymecus dilaticollis Gyll), in period 2010-2013, at NARDI Fundulea, both at untreated and treated plants. From the years taken in study, the most favourable for the pest attack at untreated maize plants were 2012 and 2013. However in last years, rainfall distribution is not similarly then in the past. In same months we can have periods with draught (more then 10 days without rain) and air high temperatures followed by days with heavy rainfalls and moderate air temperatures. As result, maize leaf weevil attack in 2012 was higher even if total rainfall amount registered in last decade of April and first two decades of May were higher from all four years taken in study. Seed treatment provide good protection for the maize plants in first vegetation stages against this pest, in different climatic conditions from the spring period.

Key words: *daily distribution, draught, maize, weevil*

INTRODUCTION

With a maize grains production of 10.72 million tones, Romania occupy in 2013, second place in EU-27, after France (MADR data, 2013; FAOSTAT database, 2013). This data confirm once again that maize is one of the most important crops from our country (Has et al., 2010). However maize production per hectare can decrease because of the biotic stress such as weeds, pathogens or pests. According Trotus et al. (2011) only because of the pests attack, maize yield losses in Romania can arrive at 23%. Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is the main pest of this crop in south and south-east of the Romania, but many areas from the south-west or west of the country can be affected by this insect (Cristea M. et al., 2004). The pest is dangerous for maize when plants are in first phases of vegetation, between plant emergences until four leaf stage (Popov et al., 2007). According Paulian F. (1972), maize leaf weevil is a thermo- and xerophytes insect and the adults are very active at high temperatures and low air relative humidity, while low temperatures and high rainfall interfere very much with their activity. Many studies effectuated at NARDI Fundulea demonstrate that drought from last decade of April and first two decades of May, period that coincide with first vegetation stages of maize plants (BBCH 10-14), favourite maize leaf weevil attack. According Vasilescu et al. (2005) and Popov et al. (2006) in 1985, 1986, 1989 or 1995 due to reduced rainfalls in the spring period (last decade of April-first two decades of May) the attack of the pest on maize untreated plants was maximum or almost maximum, while in 1984, 1999 or 2000 higher rainfalls from the spring period has reduced attack at untreated plants.

According Čamprag (2007) climate changes can favour xerothermophilous pests such as *Tanymecus dilaticollis*. New researches show that climate changes can have negative impact on agriculture, such as increased incidents of heat waves and droughts for the countries with continental climate from the Pannonian zone, which includes Hungary, Serbia, Bulgaria and Romania (Olesen et al., 2011). Long term studies on precipitation evolution show a decreasing trend, especially in spring period (Bozo, 2011). Same author mentioned that sometime, increasing precipitations is visible as a shorter term tendency.

Seed treatments provide satisfactory protection for maize crop in first vegetation stages against maize leaf weevil (Barbulescu et al., 2001; Krusteva et al., 2006; Popov et Barbulescu, 2007; Keszthelyi et al., 2008). Mass insecticidal seed treatment of maize in the period 2001-2010 contributed in reducing harm of *Tanymecus dilaticollis* Gyll., and other field crop pests (Čamprag, 2011). However, losses occurred especially at small farmers who practice traditional cultivation of maize after maize many years and do not uses seed treatments (Barbulescu et al., 2001; Popov, 2007). Recently farmers from Dolj county report that maize from untreated seeds was destroyed by *T. dilaticollis* attack (Orjanu, 2013). According EU decision 485/2013, from 1 December 2013, the use of neonicotinoids insecticides are restricted for seed treatment on maize crop. In this paper, authors collective study rainfall distribution from the spring period and temperature influence concerning *T. dilaticollis* attack on maize plants emerged both from the untreated and treated seeds.

MATERIALS AND METHODS

The observations were carried at the experimental field of the Plant Protection Laboratory from NARDI Fundulea, Calarasi County, between 2010 and 2013. Maize plants were sowed during the third decade of April, each year. Attack intensity is evaluated when the maize plants are in BBCH stage 14 (four leaf stage), according a scale from 1 to 9, elaborated by Paulian F. (1972), as follows:

• Note 1: plant not attacked;
• Note 2: plant with 2-3 simple bites on the leaf edge;
• Note 3: plants with bites or clips on leaf edge;
• Note 4: plants with leafs chafed in proportion of 25 %;
• Note 5: plants with leafs chafed in proportion of 50 %;
• Note 6: plants with leafs chafed in proportion of 75 %;
• Note 7: plants with leafs chafed almost at the level of the stem;
• Note 8: plants with leafs completely chafed and beginning of the stem destroyed;
• Note 9: plants destroyed, with stem chafed close to soil level.

After 30 days from plant emergence, the saved plants percentage was evaluated by counting all the emerged plants from a plot and comparing them with the sowing seeds number/plot.

Climatic data were provided by meteorological station from NARDI Fundulea.

The data were statistical analyzed through the analysis of variance method by using of the Microsoft Excel 2003 and ARM 8.5 software.

RESULTS AND DISCUSSIONS

Data from Tables 1-6 show high climatic variability, during third decade of April and first two decades of May. Rainfalls registered in last decade of April were low in all study years at NARDI Fundulea. At first decade of May, in 2010 and 2013, rainfall amount has low values, while in 2011, rainfall amount was of 48.4 mm and in 2012 was of 14.2 mm. High value of the rainfall amount were registered in last decade of May, year 2012 (87.8 mm). Summarized data from tables 1-3, rainfalls registered in period April (third decade) and May (decades I-II), when maize plants are the most susceptible for *T. dilaticollis* attack, were over multiyear average in 2011 and 2012 and below multiyear average in 2010 and 2013 (Figure 1).

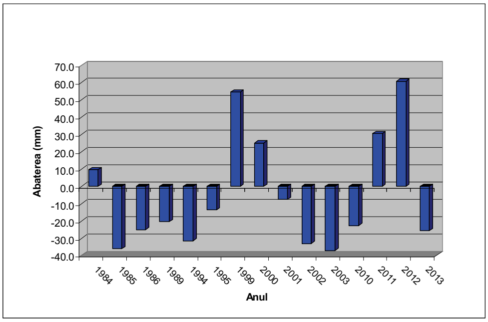

Figure 1. Diference between rainfalls registered in April (decade III)-May (decade I-II) and multiyear average, at NARDI Fundulea

In this climatic conditions, the attack of *T. dilaticollis* on maize untreated plants, at NARDI Fundulea, on a scale from 1 to 9, was 5.15 in 2010, 5.80 in 2011, 6.69 in 2012 and 6.25 in 2013 while saved plants percent, varied between 64.75 % in 2012 and 82.5 % in 2010.

Historical data from NARDI Fundulea show that higher attack values of maize leaf weevil occurs in case of low rainfall amount level while lower values of the attack occur in case of high rainfalls amount (Paulian, 1972; Vasilescu et al., 2005; Popov et al., 2006). However, if we compare data from last years (2010-2013) with historical data we don't find similar correlations (Figure 2). Thus, attack values at maize untreated plants are higher in 2012, even if rainfalls level is with 60.8 mm over multiyear average (Table 1).

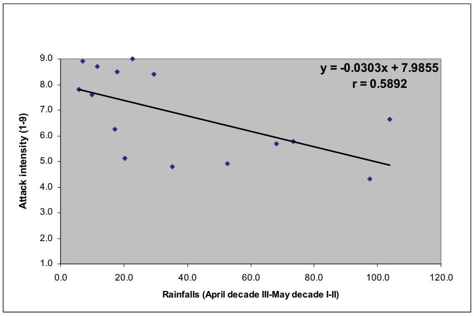

Figure 2. Relation between rainfalls level from spring and T. dilaticollis attack intensity at maize untreated plants at NARDI Fundulea (period 1984-2013)

Analysing data from table 7, it has ascertained that, in spring period of 2012, between 21 April and 8 May it has registered 2,6 mm of rainfalls, and 11 days without any rainfall. In the same time, data from tables 4-6 show that in third decade of April and first decade of May, average air temperature, were over the multiyear average. These climatic conditions were favourable for maize leaf weevil (*T. dilaticollis*) attack at plants emerged from untreated seeds. In spring period of 2012, rainfall amount occurred in second decade of May were higher comparative with multiyear average. But, from total rainfalls amount occurred in second decade of May (Table 7), 52,7 mm were registered only in one day, at the end of the decade (19 May), which represent 66,8 % from total decade amount. That means in May 2012, we have drought conditions at the beginning of the month followed by days with high rainfall level. Analysing data from other years taken in study, it has ascertained that in last decade of April, rainfalls level are below multiyear average (Figure 3). In first decade of May, registered rainfalls are bellow multiyear average, except year 2011. In second decade of May, rainfalls registered are below multiyear average in 2010 and 2013. In last years, in period April (third decade)-May (decades I-II), when maize plants are most susceptible for *T. dilaticollis* attack, it has registered long periods without rains or low level of precipitations.

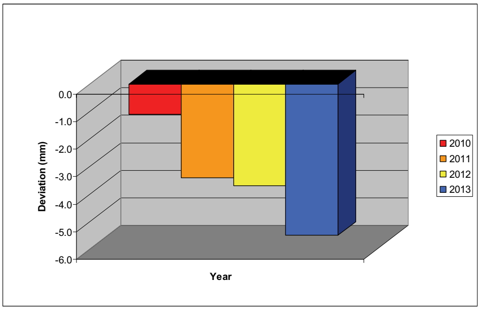

Figure 3. Diferences between rainfalls registered in third decade of April and multiyear average, at NARDI Fundulea (2010-2013)

Regard as air temperature evolution, in first vegetation stages of the maize plants, data from Tables 4-6 show that in 2010 the temperatures were over multiyear average. In 2012 and 2013, average temperature values from period April (decade III)-May (decade I-II) were with 4.0°C respectively 4.7°C over multiyear average. Higher air temperatures comparative with multiyear average in last decade of April and first decade of May and rainfalls amount registered in similar period, bellow multiyear average has result increasing of the maize leaf weevil attack (*T. dilaticollis*) on maize plants emerged from untreated seeds.

Rainfall evolution from spring period at NARDI Fundulea is not similar with some climatic models (Bozo, 2011) that show a decreasing trend in this period, but seems that rainfall distribution can favoured insect attack, even in the years with rainfalls amount over multiyear average. At similar conclusion arrive other authors (Olesen et al., 2011).

In case of maize plants emerged from seeds treated with Poncho 600 FS (clothianidin active ingredient) and Cruiser 350 FS (thiametoxan active ingredient), *T. dilaticollis* attack have low values, bellow 2.60 on a scale from 1 to 9.

Table 1. Influence of the rainfalls from spring concerning the attack of the *T. dilaticollis* on maize plants emerged from untreated seeds, at NARDI Fundulea

Year	Attack intensity (1-9)	Saved plants percent (%)	April	May		Total (mm)	Multiyear average (mm)	Deviation (mm)
			Decade III	Decade I	Decade II			
2010	5.15	82.50	4.4	2.6	13.3	20.3	**43.0**	**-22.7**
2011	5.80	76.00	2.1	48.4	23.0	73.5		**+30.5**
2012	6.69	64.75	1.8	14.2	87.8	103.8		**+60.8**
2013	6.25	77.50	0	5.8	11.4	17.2		**-25.8**

Table 2. Influence of the rainfalls from spring concerning the attack of the *T. dilaticollis* on maize plants emerged from seeds treated with Poncho 600 FS, at NARDI Fundulea

Year	Attack intensity (1-9)	Saved plants percent (%)	April	May		Total (mm)	Multiyear average (mm)	Deviation (mm)
			Decade III	Decade I	Decade II			
2010	2.41	98.50	4.4	2.6	13.3	20.3	**43.0**	**-22.7**
2011	2.39	99.00	2.1	48.4	23.0	73.5		**+30.5**
2012	2.45	96.25	1.8	14.2	87.8	103.8		**+60.8**
2013	2.53	98.75	0	5.8	11.4	17.2		**-25.8**

Table 3. Influence of the rainfalls from spring concerning the attack of the *T. dilaticollis* on maize plants emerged from seeds treated with Cruiser 350 FS, at NARDI Fundulea

Year	Attack intensity (1-9)	Saved plants percent (%)	April	May		Total (mm)	Multiyear average (mm)	Deviation (mm)
			Decade III	Decade I	Decade II			
2010	2.35	98.75	4.4	2.6	13.3	20.3	**43.0**	**-22.7**
2011	2.30	99.50	2.1	48.4	23.0	73.5		**+30.5**
2012	2.39	98.50	1.8	14.2	87.8	103.8		**+60.8**
2013	2.40	99.25	0	5.8	11.4	17.2		**-25.8**

Table 4. Influence of the air temperatures from spring concerning the attack of the *T. dilaticollis* on maize plants emerged from untreated seeds, at NARDI Fundulea

Year	Attack intensity (1-9)	Saved plants percent (%)	April	May		Average T (°C)	Multiyear average (°C)	Deviation (°C)
			Decade III	Decade I	Decade II			
2010	5.15	82.50	13.4	15.9	16.4	15.2	**14.2**	**+1.0**
2011	5.80	76.00	12.2	11.8	17.1	13.7		**-0.5**
2012	6.69	64.75	17.4	16.6	20.8	18.3		**+4.0**
2013	6.25	77.50	18.1	19.3	19.4	18.9		**+4.7**

Table 5. Influence of the air temperatures from spring concerning the attack of the *T. dilaticollis* on maize emerged from seeds treated with Poncho 600 FS, at NARDI Fundulea

Year	Attack intensity (1-9)	Saved plants percent (%)	April	May		Average T (°C)	Multiyear average (°C)	Deviation (°C)
			Decade III	Decade I	Decade II			
2010	2.41	98.50	13.4	15.9	16.4	15.2	**14.2**	**+1.0**
2011	2.39	99.00	12.2	11.8	17.1	13.7		**-0.5**
2012	2.45	96.25	17.4	16.6	20.8	18.3		**+4.0**
2013	2.53	98.75	18.1	19.3	19.4	18.9		**+4.7**

Table 6. Influence of the air temperatures from spring concerning the attack of the *T. dilaticollis* on maize emerged from seeds treated with Cruiser 350 FS, at NARDI Fundulea

Year	Attack intensity (1-9)	Saved plants percent (%)	April	May		Average T (°C)	Multiyear average (°C)	Deviation (°C)
			Decade III	Decade I	Decade II			
2010	2.35	98.75	13.4	15.9	16.4	15.2	**14.2**	**+1.0**
2011	2.30	99.50	12.2	11.8	17.1	13.7		**-0.5**
2012	2.39	98.50	17.4	16.6	20.8	18.3		**+4.0**
2013	2.40	99.25	18.1	19.3	19.4	18.9		**+4.7**

Table 7. Daily rainfalls amount registered in period April (third decade)—May (decades I-II), versus the monthly means, at NARDI Fundulea, between 2010 and 2013 multiyear average

Day/Year	April (decade III)				Day/Year	May (decade I)				Day/Year	May (decade II)			
	2010	**2011**	**2012**	**2013**		**2010**	**2011**	**2012**	**2013**		**2010**	**2011**	**2012**	**2013**
21	4.4				1					11		0.1		
22					2		1.5			12	0.2	6.5		
23					3		5.1			13	6.6		0.0	0.0
24					4		7.5		5.0	14	1.5	0.1		9.2
25					5		6.2		0.8	15	2.9		13.7	2.0
26			1.8		6		0.2			16	0.3	1.2		0.2
27					7	0.8				17	0.3	3.6	10.0	
28		0.9			8	1.0	17.3	0.8		18	0.0		2.5	
29		0.0			9	1.3	9.3	7.4		19	1.5	11.5	52.7	
30		1.2			10	0.4	1.3	6.0		20	0.0			
Average (mm)	4.4	2.1	1.8	0.0	**Average (mm)**	3.5	48.4	14.2	5.8	**Average (mm)**	10.4	23.0	78.9	11.4
Multiyear average	5.5	5.5	5.5	5.5	**Multiyear average**	17.5	17.5	17.5	13.1	**Multiyear average**	20.0	20.0	20.0	20.0
Deviation (mm)	**-1.1**	**-3.4**	**-3.7**	**-5.5**	**Deviation (mm)**	**-14.0**	**+30.9**	**-3.3**	**-7.3**	**Deviation (mm)**	**-9.6**	**+3.0**	**+58.9**	**-8.6**

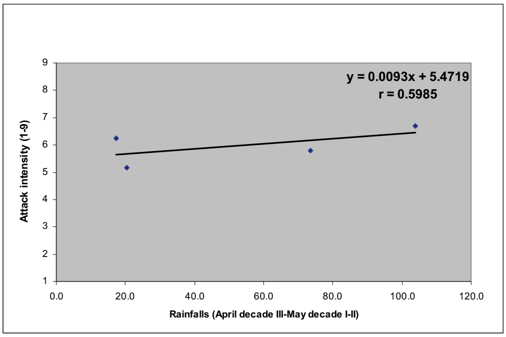

Figure 4. Relation between rainfalls level from spring and *T. dilaticollis* attack intensity at maize untreated plants at NARDI Fundulea (period 2010-2013)

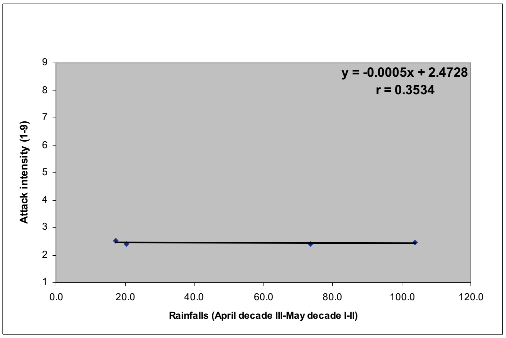

Figure 5. Relation between rainfalls level from spring and *T. dilaticollis* attack intensity at maize treated with Poncho 600 FS at NARDI Fundulea (period 2010-2013)

From Tables 1-6, it has ascertained that between 2010 and 2013, in different climatic conditions from spring period (April, decade III-May, decades I-II), at NARDI Fundulea, saved plants percent were equal or higher the 96.25%, and differences from one year to another have low values (Figures 4-6).

The results concerning influence of the seeds treatment concerning maize leaf weevil (*T. dilaticollis*) attack are similar with those obtained by Barbulescu et al. (2001), Vasilescu et al. (2005), Krusteva et al. (2006), Keszthelyi et al. (2008), Čamprag (2011).

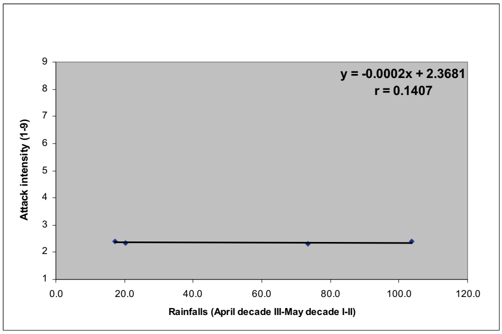

Figure 6. Relation between rainfalls level from spring and *T. dilaticollis* attack intensity at maize treated with Cruiser 350 FS at NARDI Fundulea (period 2010-2013)

CONCLUSIONS

Climatic conditions from spring period, April (decade III)-May (decades I-II) seems to favoured xerothermophilous pests such as *T. dilaticollis*. Even if total rainfall amount registered in this period can be higher then multiyear average, like in 2012, rainfall distribution and high values of the air temperature can favour this pest. In same month we can have periods with draught (more then 10 days without rain) and high air temperatures values followed by days with heavy rainfalls and moderate air temperatures.

In case of maize plants emerged from untreated seeds, more then 35% of plants can by destroyed by *T. dilaticollis* attack.

In a wide range of climatic conditions from spring period, seed treatment is one of the most effective method for controlling maize leaf weevil attack.

Further studies concerning the impact of the climatic changes on *T. dilaticollis* evolution are necessary.

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RESEARCH REGARDING THE TREATMENTS WITH BIO-STIMULATOR AT MAIZE CROP

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Abstract

The world`s population is constantly increasing, the areas intended for the production of bio-mass and bio-fuels are care continuously growing, while the food demand of mankind is an a continuous ascending trend. In this context, an increased efficiency in the use of agricultural areas and in obtaining large and steady productions, in compliance with the requirements of sustainable development of the agricultural eco-system, is a priority; this priority requires adequate technological measures, like a good protection of crops starting with the seed phase, application of effective treatments at the right moment, etc. Therefore, in the present paper we present the results of treatment with bio-stimulants applied as a seed treatment or in different stages of vegetation at maize. This treatment has as a result increase the quantity and quality production, to reduce phytotoxic environmental impact, a good management of resources and to reduce production costs in terms of environmental conservation. In experiment we test two bio-stimulator products for seed and different stages of vegetation with three graduations for each product (2 l/ha; 3 l/ha; 2 l+2 l/ha) Megafol and Cropmax. Both treatments has a result uniform flowering, growth rate, increased production and improved quality growth by increasing protein and starch compared to the control.

Key words: *bio-stimulant, maize, seed treatment, biometrical indicators.*

INTRODUCTION

World population is growing, so it requires continuous improvement of production technology in order to obtain high and stable yields.

In this case we present 2012, like an atypical year, the driest and hottest from last 50 years. It was drought in almost all the country, especially in south-east. The year 2012 can be characterized as a dry year due to the high frequency of days with temperatures > 30-35°C (48 days), moisture air relative < 30% (43 days) and lack of rain in May-August (13 May-16 August), when drought was accompanied by heat, suffering strong wheat plants stress water and temperature.

In this agricultural year there were high costs and losses consistently in different regions of Romania, especially in the South and East of the country, where without irrigation, generally yields are between 25 and 30% compared with those of previous years. Many corn plant shave been developed till drought installation, the during June-July, in the absence of rainfall corn plants began to suffer, dried pollen determined reducing of pollination followed by the premature plant drying.

Foliar application of specific organic matters have demonstrated to be a powerful tool for stimulating the plant to a more intense but balanced vegetative development; improving the effectiveness of usual soil and foliar mineral applications; curing or preventing nutritional disorders and/or physiopathy; making the plants overcome stress conditions affecting yields; increase efficiency of chemical treatments.

General characteristics of the Megafol: a bio-stimulant which contains L-Amino acids from vegetal extracts vitamins, proteins, growth factors and betains. Megafol is a growth activator and anti-stress. Foliar nutrition based on organic matter. Proteins are long and heavy molecules where peptide linkages bind single amino acids each other. Free amino acids are obtained through the chemical process called “hydrolysis” which breaks the linkage between each amino acid by inserting a molecule of water.

Cropmax is a certified organic bio-stimulant which is admitted in organic agriculture; increase production and improve quality growth; significantly improves resistance to diseases and pests; reduces metabolic plant deficiencies; also contribute to a better and faster development of the root system, therefore the resistance of plants to drought stress increase.

Completing basic fertilization is done by applying bio-fertilizer in vegetation that needs filling role, especially to promote the efficient use of mineral resources from the soil.

The objective of researches was to establish the impact of quantity and quality on maize production of Megafol and Cropmax treatments concerning accumulation of biomass and production costs.

MATERIALS AND METHODS

In order to achieve the objectives set in agricultural year 2012, it was held a mono-factorial experience with 9 variants (Table 1).

Investigations were conducted at S.C Tehnoplant S.A, Scinteia, district Ialomita (44°44′19″N and 27°28′11″E WGS 84), in cambic chernozem conditions with a pH of 5.5 and 3.4 humus.

Table 1. Experimental variants

Variant	Treatment	Dose	Period
V1	Control	-	
V2	Seed treatment 5-1809	200ml/100kg of seed	at sowing
V3	Megafol	2l/ha	BBCH 14-16
V4	Megafol	3l/ha	BBCH 14-16
V5	Megafol	2l + 2l /ha	BBCH 18-20
V6	Seed treatment Cropmax	200ml/100kg of seed	at sowing
V7	Cropmax	2l/ha	BBCH 14-16
V8	Cropmax	3l/ha	BBCH 14-16
V9	Cropmax	2l + 2l /ha	BBCH 18-20

The sowing data was 24 April 2012 after wheat (Mohammadi et al., 2012). Seeds are Limagrain 33.50, semi-early hybrid, group FAO 340-360, CRM 95) 50.000 plants/ha. The experience was placed in four repetitions by randomized block method, the surface of a plot was 100square meters (21.4 m/4.2 m).

Technology applied for weed control: Pre-emergent, Dual 960 Gold (S-metolaclor 960 g/l) applied at the same day as sowing. After two weeks from plant emergence, at the stage of the 4-6 leaves (BBCH 14-16), it was applied a basic fertilization (N60/P60); Post-emergent Principal Plus (Rimsulfuron 3.26%, Nicosulfuron 30 g/l), both with purpose to combat monocots and dicots species. Treatment was applied on 16 May (Radulov et al., 2010; Rehm, 2003).

RESULTS AND DISCUSSIONS

At 16 May 2012 we made the biometrical determinations in the stage of 4-6 leaves, when the first treatment was applied, to measure the influence of treatment at seed (Table 2).

We also observed and increase weight of plants from 15.5 g at untreated version to 17.2 g on the treated seed (Brad et al., 2010).

Analyzing data on the main bio-metrical characteristic of maize plant at two weeks after emerge, when the first foliar treatment was applied, we established that: Cropmax and 5-1809 have very significant increase of plant green mass from 15.5 g at over 17.2 g. In term of fresh mass of plant, there was a very significant increase for both seed treatments. The treatments influence on dry mass, has increased for both treatments from 2.3 g to 2.5 g. At dry plant roots, increases are statistically (Brown, 1993).

As far as plants height in the moment of treatment we is observed an increase with 2.3 cm at Cropmax treated seeds and 2.4 cm at the treatment with 5-1809, statistically uninsured increases.

Regarding root weight at green plants we saw that is an increase from 4.1 g at untreated seed to 5.2 g when seed treatment is applied. The control seed has a dry roots weight 2.3 g and the treated seed has an average of 2.5 g. On height was found a growth from 44 cm at control seed to 46.5 cm at seeds with treatment.

We also observed and increase weight of plants from 15.5 g at untreated version to 17.2 g on the treated seed.

Analyzing the data from Table 3, is found that the seed treatment has as a result an increase of biomass fresh and dry accumulated quantity and also height on the plant (Antonio, 2013; Yuncai et al., 2008).

Table 2. Biometrics application first treatment BBCH 14-16 (16 May 2012)

Variant Treatment		Fresh plant (g)				Dry plant (g)				Height (cm)	
		Plant weight (g)	dif	Root weight	dif	Plant weight	dif	Root weight	dif	cm	dif
V1	Control	15.5	Mt	4.1	Mt	2.3	Mt	0.66	Mt	44	Mt
V2	Seed treatment 5-1809	17.2***	1.7	5.2***	1.1	2.5*	0.2	0.78	0.04	46.4	2.4
V6	Seed treatment Cropmax	17.3***	1.8	5***	0.9	2.5*	0.2	0.69	0.03	46.3	2.3
	LSD 5 %		0.82		0.24		0.12		0.04		2.43
	LSD 1%		1.31		0.39		0.21		0.06		3.64
	LSD 0.1%		1.64		0.53		0.29		0.08		5.27

Table 3. Biometrical determination at maize on BBCH 14-16 at 14 days after first vegetation treatment

Variant Treatment		Dose	Fresh plant (g)				Dry plant (g)				Height (cm)	
			Plant weight	Dif	Root weight	Dif	Plant weight	Dif	Root weight	Dif		Dif
V1	Control	-	32.1	Mt	8	Mt	4.9	Mt	1.3	Mt	53	Mt
V2	Seed treatment5-1809	200ml/100kg seed	31.8	-0.3	8.3	0.3	5.1	0.2	1.4*	0.1	56	3
V3	Megafol	2l/ha	36.1***	4	9.6***	1.6	5.5**	0.6	1.6***	0.3	57*	4
V4	Megafol	3l/ha	41.2***	9.1	10.8***	2.8	5.9***	1	1.9***	0.6	60***	7
V5	Megafol	2l + 2l /ha	36.1***	4	9.7***	1.7	5.5*	0.6	1.6***	0.3	58**	5
V6	Seed treatment Cropmax	200ml/100kg seed	32	-0.1	8.4***	0.4	5.1	0.2	1.4*	0.1	55	2
V7	Cropmax	2l/ha	36.7***	4.6	8.8**	0.8	5.4**	0.5	1.5***	0.2	58**	5
V8	Cropmax	3l/ha	41.6***	9.5	10.4***	2.4	5.8***	0.9	1.8***	0.5	60***	7
V9	Cropmax	2l + 2l /ha	36.9***	4.8	8.9***	0.9	5.5**	0.6	1.5***	0.2	57*	4
		LSD 5 %		1.86		0.47		0.28		0.08		3.10
		LSD 1%		3.04		0.75		0.43		0.13		4.80
		LSD 0.1%		3.90		1.04		0.62		0.18		6.25

Analyzing the influence of vegetation treatment over maize plant green mass is observed a very significant increase from 32.1 g to 36 g for all variants were applied bio-stimulator products. At the seed treated variant, at this moment differences were not statistically identified. Analyzing the influence of treatment on green table roots after applying the first treatment is found that when applying the two bio-stimulants Megafol and Cropmax in dose of 2 l/ha and 3 l/ha we observed a very significant increase from 8 g in at control seed at over 1.6 g at seeds treated with 2 l/ha of Megafol, and where we use 3 l/ha bio-mass increase was of 2.4 g at Cropmax and 2.8 g at Megafol. Under the influence of treatment, at dry mass plant, it is a distinctive significant increase statistically provided at 2 l/ha doses, while using 3 l/ha doses is determinate a distinctive significantly increase of dry roots bio-mass. Application of treatments determined a significant increase in dry biomass of roots for all variants studied. In terms of plant heights under the influence of bio-stimulator treatments at seed, although at this point had determinate heights increases, which are statistically assured (Yuncai, 2008).

3 June represents the time when the second treatment was applied, at 8-10 leaves (BBCH 18-20) and we wanted to observe the same. Another measurement was made at 18 June for overall assessments of the effects on the main biometrical indicators. At harvest we checked the quantity and quality indicators (MMB, U%, MH, Starch, Protein).

Data in Table 4 make reference to main bio-metrical indicators determined at 14 days after the second treatment on vegetation. After we analyzed the effects of bio-stimulant on green mass plant of maize, it was observed that in lack of treatment mass was about 36.5 g, and when the treatment was applied we detect a statistically uninsured increase. In case when both treatments were applied, at both tested products and in both doses it was obtained very significant green mass increases.

Table 4. Biometrical determination at maize on BBCH 14-16 at 14 days after second foliar treatment

Variant Treatment		Fresh plant (g)				Dry plant (g)					
		Plant weight	Dif	Root weight	Dif	Plant weight	Dif	Root weight	Dif	Height (cm)	Dif
V1	Control	36.5	Mt	9.2	Mt	5.6	Mt	1.5	Mt	64.2	Mt
V2	Seed treatment5-1809	37.1	0.6	9.5	0.3	5.9	0.3	1.6*	0.1	67.8	3.6
V3	Megafol	41.0**	4.5	11.0***	1.8	6.3**	0.7	1.8***	0.3	69.0*	4.8
V4	Megafol	47.4***	10.9	14.7***	5.5	6.8***	1.2	2.2***	0.7	72.7***	8.5
V5	Megafol	50.1***	13.6	15.9***	6.7	7.1***	1.5	2.5***	1.0	75.3***	11.1
V6	Seed treatment Cropmax	36.8	0.3	9.7	0.5	5.9	0.2	1.6*	0.1	66.6	2.4
V7	Cropmax	42.2***	5.7	10.1*	0.9	6.2**	0.6	1.7**	0.2	67.8	3.6
V8	Cropmax	47.8***	11.3	13.5***	4.3	6.7***	1.0	2.1***	0.6	72.7***	8.5
V9	Cropmax	49.2***	12.7	14.8***	5.6	7.2***	1.6	2.2***	0.7	74.2***	10.0
	LSD 5 %		2.23		0.59		0.33		0.10		3.82
	LSD 1%		3.64		0.95		0.51		0.16		5.92
	LSD 0.1%		4.67		1.31		0.73		0.22		7.71

Analyzing the influence of bio-stimulator treatments on roots green mass we established that in case of control seed, roots accumulate 9.2 g, and when the treatment was applied we have increases of 0.3 g at 5-1809 bio-stimulant and 0.5 g with Cropmax treatment. In case of treatments on vegetation it was observed increases at green biomass of roots. Analyzing the influence of treatment at dry roots mass it was establish that the treatment applied determined increases of accumulated bio-mass statistically assured. When we refer at dry mass we record statistically assured increases for all the experimental variants compared with the control. At control we have a height of 64.2 cm but treatments on seeds determined insignificantly increases of plants and when treatment vegetation was applied were followed by significantly increases of plants height. When Megafol 2 l + 2 l/ha was applied we obtain the biggest increases. Application of bio-stimulator treatments resulted in improvement of all biometric indicators maize plants.

In Table 5 are represented recorded productions at maize. At control variant it was a production value of 2153 kg/ha and treatments applied to the seed determined a significantly distinctive increase of 228 kg/ha for seeds treated with 5-1809 and an increase of 242 kg/ha at Cropmax treatment. The other treatments applied on vegetation had as a result very significant increases between 408 kg/ha and 741 kg/ha. Maximum production in case of Megafol treatment was of 2895 kg/ha with a very significant increase of 741 kg/ha when we have a dose of 2 l + 2 l/ha. At 2 l + 2 l/ha with Cropmax maximum production was of 2813 kg/ha, it was obtained a very significant increase of 659 kg/ha. Analyzing the effect of two bio-stimulator products, differences were not statistically assured. The seed and vegetation treatment determinate statistically assured increases.

Table 5. Yields obtained in experimental variants

Var	Treatment	Dose	Kg/ha	Dif
V1	Control	-	2153.7	Mt
V2	Seed treatment 5-1809	200ml/100kg seed	2382.0**	228
V3	Megafol	2l/ha	2581.0***	427
V4	Megafol	3l/ha	2790.0***	636
V5	Megafol	2l + 2l /ha	2895.0***	741
V6	Seed treatment Cropmax	200ml/100kg seed	2396.0**	242
V7	Cropmax	2l/ha	2562.0***	408
V8	Cropmax	3l/ha	2760.0***	606
V9	Cropmax	2l + 2l /ha	2813.0***	659
		LSD 5 %		132.83
		LSD 1%		211.58
		LSD 0,1%		305.92

The two tested products at the same dose had similar effects on production (Yuncai, 2008).

Referring to the growing rhythm of maize plant from the data above it was remarked that treatments during maize vegetation period have a good influence on the growing rhythm, at the beginning of growing and seed treatment seems to have a slight negative effect on growing, but we have to underline that till the end of vegetation period this favorable effect has disappeared, maintaining negative effect of variant 1 (seed treatment) and soft positive effect at the moment of silking (Alam, 1999).

Table 6. Production quality indices of experimental variants

Variant Treatment		MMB		MH		U % harvest		Starch		Protein	
		g	Dif	Kg/l	Dif	%	Dif	%	Dif	%	Dif
V1	Control	339.4	Mt	87.1	Mt	14.2	Mt	69.8	Mt	10.03	Mt
V2	Seed treatment 5-1809	340.0	0.6	86.6	-0.5	14.2	0.0	69.7	-0.1	9.96	-0.1
V3	Megafol	340.2	0.8	87.2	0.1	14.6	0.4	69.9	0.1	9.93	-0.1
V4	Megafol	340.5	1.1	87.2	0.1	14.6	0.4	70.2	0.4	9.88	-0.1
V5	Megafol	340.0	0.6	87.3	0.2	14.9	0.7	70.3	0.5	9.78	-0.3
V6	Seed treatment Cropmax	340.3	0.9	87.3	0.2	14.2	0.0	69.1	-0.7	10.01	0.0
V7	Cropmax	340.1	0.7	87.2	0.1	14.5	0.3	69.8	0.0	9.98	0.0
V8	Cropmax	340.4	1.0	87.3	0.2	14.7	0.5	70.1	0.3	9.92	-0.1
V9	Cropmax	340.4	1.0	87.3	0.2	14.7	0.5	70.1	0.3	9.91	-0.1
	LSD 5 %		16.78		4.45		0.74		3.50		0.51
	LSD 1%		26.68		7.05		1.19		5.65		0.80
	LSD 0.1%		33.45		9.66		1.72		8.28		1.15

In Table 6 were presented results of the bio-stimulant treatment influence on main quality indicators of maize.

Treatments applied determined increases of MMB, MH, starch, U% and protein but those were not statistically assured (Wittwer and Teubner, 1959).

CONCLUSIONS

- Seed treatment has as a result an increase of fresh biomass and dry accumulated quantity and also height on the plant.
- Application of treatments determined a significant increase in dry biomass of roots for all variants studied.
- In terms of plant heights under the influence of bio-stimulator treatments at seed, although at this point had determinate heights increases, which are statistically assured.
- Application of bio-stimulator treatments resulted in improvement of all biometric indicators maize plants.
- The two tested products at the same dose had similar effects on production.
- Treatments applied determined increases of MMB, MH, starch, U% and protein but those were not statistically assured.

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FUTURE OF MAGNETIC AGRICULTURE IN ARID AND SEMI ARID REGIONS (CASE STUDY)

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Abstract

A great challenge for the agricultural sector is to produce more food from less water, particularly in arid and semi-arid regions which suffer from water scarcity. Utilization of magnetic water technology is considered as a promising technique to improve water use efficiency and crop productivity. Two field trials using wheat (Var. sakha-93), faba bean (var., nubaria-1), chick-pea (var. giza-3) , lentil (var. Giza-9), canola (var. sero-6) and flax (var. sakha-1) were conducted at Research and Production Station, National Research Centre, Alemam Malek village, Al Nubaria district, Al Behaira Governorate, Egypt in 2009/10 and 2010/11 winter seasons to study and evaluate the effects of magnetizing irrigation water on growth, yield and yield components of mentioned winter crops. The results showed significant positive effect of magnetic treatment on all studied parameters. The percent of increase in economic yield (ton ha^{-1}) in response to magnetized water application reached to 13.71% at wheat, 8.25% at faba bean, 21.8% at chick pea, 29.53% at lentil, 36.02% at canola, 22.37% at flax and 19.05% at sugar beet crop as compared with normal water application. Similar trend was obtained for water use efficiency was. It appears that utilization of magnetized water can led to improve yield and water productivity of tested crops under newly reclaimed sand soil. So, using magnetic water treatment could be a promising technique for agricultural improvements but we need extensive research in this field.

Key words: *magnetic water, winter crops, pigments, yield, water use efficiency.*

INTRODUCTION

A great challenge for the agricultural sector is to produce more food from less water, particularly in arid and semi-arid regions which suffer from water scarcity.
Utilization of magnetic water technology is considered as a promising technique to improve water use efficiency and crop productivity.
Our previous and promising studies (Hozayn and Amira, 2010 a&b; Amira and Hozayn 2010 a&b; Hozayn et al., 2010) under greenhouse condition observed that, wheat, lentil, chickpeas, flax, sunflower, as well as on ground nut, faba bean and mung bean (data unpublished) irrigated with magnetized water gave more value of all recorded parameter.
The increase in yield per plant ranged between 11-47% depended on tested plants.
So, the main objective of this study to clarify the role of magnetic water on increasing yields of sugar beet yield and quality and water productivity under field conditions.
In aboard, many works have been reported to exert a positive effect of magnetic fields on the germination of seeds, plant growth and development, the ripening and yield of field crops (De Souza et al., 2006; Shabrangi and Majd 2009). Where, magnetic field was shown to induce germination traits in wheat, soybean, cotton (Phirke et al., 1996), barley (Martinez et al., 2000), rice (Carbonell et al., 2000), corn (Florez et al., 2007), and chickpea (Vashisth and Nagarajan, 2008).
When the seeds were exposed to magnetic field, the percentage of germination increased while the time required for germination decreased.
The positive effects of magnetic field were also shown on metabolic substance i.e., protein biosynthesis, cell reproduction, photochemical activity, respiration rate, enzyme activities,

nucleic acid content, and growth-development period (Stange et al., 2002).

Moreover, in macro trials, application of variable electro and static magnetic fields with different frequency showed a yield increase up to 144,8% in potato (Marinkovic et al., 2002), rice by 13-23% (Tian et al., 1991), pepper by 64,9% (Takac et. al. 2002), soybean from 5 to 25%, with a higher quantity of oil and protein and at sunflower from 13,2 to 17,3% (Crnobarac et al. 2002), cereal by 20% (Marinkovic et al. 2000), wheat by 6.3 – 10.6% (Kordas 2002), broad bean and pea by 10 and 15%, respectively (Podlesny et al., 2004 and 2005). In addition, Vasilevski (2003) shows a 94% increase of the root mass of sugar beet, leaf surface up to 52%, yield to 12,88 t/ha and the percentage of sugar was increased for 0.70%.

In similar trials performed with corn a higher root mass (55.0%), vegetative mass (57.0%) and yield (18.7%) was achieved.

Consequently, the magnetic field effect can be used as an alternative to the chemical methods of plant treatment for improving the production efficiency (Aladjadjiyan, 2002 and 2003).

So, in this study will look at an innovative water treatment to study the physical, chemical and biological changes occurring in soil and water after treatment with a no uniform magnetic field and its effects on productivity of some winter crops under newly reclaimed sand soil

MATERIALS AND METHODS

Six field trials using wheat (var. Sakha-93), faba bean (var. Nubaria-1), chick-pea (var. Giza-3), lentil (var. Giza-9), canola (var. Sero-6) and flax (var. Sakha-1) were conducted at Research and Production Station, National Research Centre, Alemam Malek Village, Al Nubaria district, Al Behaira Governorate, Egypt in 2009/2010 and 2010/11 winter seasons to study and evaluate the effects of irrigation with magnetic water on growth, chemical constituent, yield and yield components of mentioned winter crops.

The experimental area is located at the North of Cairo (30.8667 N latitude and 31.1667 E longitude) at an elevation of 21 m above the sea level. It has a semi-arid climate with cool winters and hot dry summers prevailing in the experimental area.

The experimental soil and water were analyzed according to the method described by Chapman and Pratt (1978) (Table 1).

Table 1. Soil and water analysis for site experiments

	Soil depth		Irrigation water	
Parameters	**0-15**	**15-30**	**Before magnetic**	**After magnetic**
Particle size distribution				
Coarse sand	48.20	54.75	..	…
Fine sand	49.11	41.43	..	…
Clay + Silt	2.69	3.82	..	…
Texture	Sandy	Sandy	..	…
PH (1:2.5)	8.22	7.94	7.25	7.13
EC(dSm^{-1})(1:5)	0.20	0.15	0.50	0.40
Organic matter (%)	0.67	0.43	…	
Soluble cations (mq/l)				
Ca^{++}	0.60	0.50	2.15	2.05
Mg^{++}	0.50	0.30	0.50	0.65
Na^{++}	0.90	0.80	3.00	3.00
K^{+}	0.20	0.10	0.31	0.31
Soluble anions (mq/l)				
CO^{-3}	-	-	0.01	0.01
HCO^{-3}	0.60	0.40	2.33	2.46
Cl^{-}	0.75	0.70	2.17	1.72
SO^{-4}	0.85	0.60	1.45	1.82

Grains and seeds of the respective crops were obtained from Field Crop Research Institute, Agriculture Research Centre, Giza, Egypt. Recommended rates of grains and seeds of each crop were planted in plots (10 length m x 10 width m) at the last week of November. Four replications were used in each treatment. Control treatment was irrigated with normal water, while the other treatment (magnetized water) was irrigated with water after magnetization through a two inch Magnetron [U.T. 3, Magnetic Technologies LLC PO Box 27559, Dubai, UAE].

The recommended NPK fertilizers for each crop were applied through the period of experiment. Sprinkler irrigation was applied as plants needed. The layout of experiment was shown in (Figure 1).

After 85 days from sowing plant height, fresh and oven dry weight of ten plants from each crop were determined. Photosynthetic pigment contents (chlorophyll a, chlorophyll b and carotenoids) of leaves were estimated spectrophotometrically as the method described by Moran (1982). At harvest yield and yield components of tested crops were determined.

Statistical analysis was carried out using SPSS program Version 16. An independent t-test was also carried out to find the significant differences between magnetic and nonmagnetic water treatments.

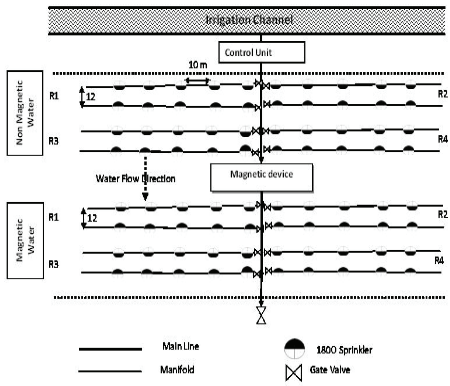

Figure 1. Layout of experiment design under solid set sprinkler system

RESULTS AND DISCUSSIONS

Dry weight

Results illustrated in Figure 2 showed the effect of using magnetized water on dry weight of plant. This parameter could use as effective indicator that reflect the increase in all growth parameters (shoot length, leaves number and area and fresh weight/plant). Dry weight/plant as a result of irrigation with normal and magnetic water ranged between 0.46-7.46 and 0.54-7.96, respectively according to the plant type. It's obvious that irrigation with magnetized water improved dry matter accumulation at all tested plants compared to control treatment. The maximum percent of increase was obtained at dry weight of flax by 23.01% followed by lentil by 15.88% and chick pea by 13.59%. The lowest percent of increase was recorded at wheat by 7.45 followed with faba bean by 7.99% and canola by 8.33%. The increase in dry weight/plant as a result of plant irrigation with magnetized water may be attributed to the increase all growth parameters (data not seen) which accompanied with increase in total pigment contents (Figure 3), increase in photosynthetic pigments, endogenous promoters (IAA) and increase protein biosynthesis (Hozayn and Amira, 2010 a&b and Amira and Hozayn 2010 a&b). These results are in good harmony with those obtained by Hozayn et al., (2011) and Ijaz et al. (2012). In this connection Also, Alikamanoğlu et al. (2007) suggested that, magnetic water treatment improved seed inhibition, vigor and germination rate, and seedling treatment promoted NPK absorption and increased root number, stem thickness, dry weight/100 plants and tillers number. Moreover, Celik et al. (2008) and Nasher (2008) concluded that, magnetized water increased growth and consider an important factor for inducing plant growth. Moreover, the influence of the magnetic field on plants, sensible to it increases its energy. Later this energy is distributed among the atoms and causes the accelerated metabolism and, consequently, to better germination. Magnetic treatment of water has been reported to change some of the physical and chemical properties of water, mainly hydrogen bonding, polarity, surface tension, conductivity, pH and solubility of salts (Amiri and Dadkhah, 2006; Otsuka and Ozeki, 2006). These changes in water properties may be capable of affecting the growth of plants.

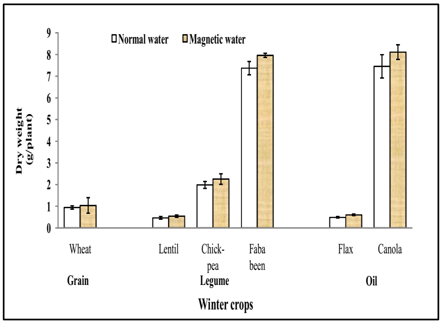

Figure 2. Dry weight (g/plant) at 85 days after sowing for winter crops irrigated with normal and magnetized water. Mean values of 2 seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

Pigment contents

Pigment content is an indicator of plant health and productivity. Results in figure 3 reflect the response of tested crops when irrigated with magnetized water to total pigment contents. The pigment contents ranged between 17.7-27.85 mg/100g fresh weight for irrigation with normal according to tested crops. Irrigation with magnetized water caused an increase in pigment content (22.14-35.83 mg/100 g fresh weight) according to tested crops.

Chick pea 9.14% < lentil 11.18% < canola 13.50% < flax 17.58% < wheat 36.77% and faba bean 50.68%.The increase in pigment content under irrigation with magnetized water was accompanied with the increase in growth (Figure 2).
These increments must supported by the increase in growth promoters (auxins and cytokinins) which responsible on increasing growth.
The stimulatory effect of magnetic water on photosynthetic pigment contents may be due to the effect of magnetic treatment on alteration the key of cellular processes such as gene transcription which play an important role in altering cellular processes.
The same result was obtained by Atak et al. (2003 and 2007) who found an increase in chlorophyll content specifically appeared after exposure to a magnetic field for a short time. They also suggested that, increase all photosynthetic pigment through the increase in cytokinin synthesis which accompanied by the increase in auxin synthesis that induced by magnetic field treatment of soybean plants. Recently Hozayn and Abdul Qados (2010 a and b), Abdul Qados and Hozayn (2010 a and b) and Hozayn et al., (2011) reported that, magnetic treatment increased photosynthetic pigment contents via increasing growth promoters (IAA). Helal, (2011) reported that, irrigation with magnetic water exhibited marked significant increase in the photosynthetic pigments (chlorophyll a, chlorophyll b, and carotenoids), photosynthetic activity, and translocation efficiency of the photo assimilates of common bean over the control.
These results for increasing photosynthetic activity are confirmed with that of (Mihaela et al., 2007; Mihaela et al., 2009). They showed an increase in chlorophyll and carotenoids content specifically appeared after treatment with magnetic water. Al-Khazan et al. (2011) reported that the magnetically treated water treatment has an enhancing effect on the photosynthetic pigments compared to the control treatment.

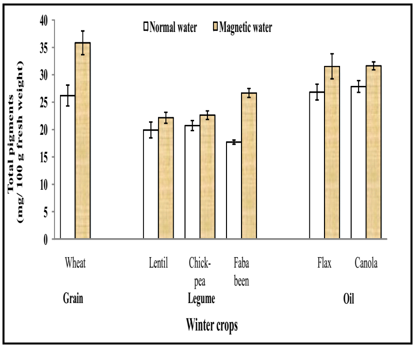

Figure 3. Total pigment contents in the leaves of winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation.

Plant height at harvest

Figure 4 cleared the result of using magnetized water on plant height at harvest of tested crops. Plant height at harvest as a result of irrigation with normal water ranged between 38.63 – 131.63 cm according to the plant type. Magnetized water increased this range to 45.00 – 147.88 cm according to the plant type. Legume crops (chick-pea and lentil) came in the first order in response of irrigation with magnetic water where gave the maximum increase percentage (18.99% and 16.50%, respectively).

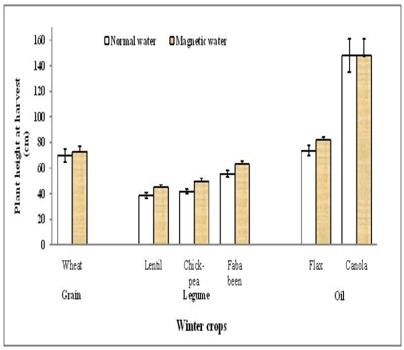

Figure 4. Plant height at harvest for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

While wheat as grain crop came in the last order by 4.11% increases.
The increments in plant height for the other crops ranged between 11.56 – 13.54%.

These increments may be attributed to the role of magnetized water in increasing growth (Figure 1), photosynthetic pigment (Figure 2).
The same trend was observed by Hozayn & Abd AlQodos (2010a and b) on wheat and chick-pea and Abd Alqodos and Hozayn (2010a and b) on lentil and flax under greenhouse condition

100-seed weight

100 seeds or grains weight in gram is a measure of seed size.
Data illustrated in Table 2 showed the effect of using magnetized water on 100-seed weight of tested winter crops.
The weight of 100-seed ranged between 0.42-87.62 g according to the plant type. Irrigation of plants with magnetized water increased 100-seed weight at all crops under study except canola.
The percent of increase reached to 5.19% at wheat, 10.10 at lentil, 9.34% at chick-pea, 10.72% at faba bean and 37.88% at flax. On the other hand the reduction percent reached to 5.36% at canola.
The same trend was observed by several investigators (Abd Alqodos and Hozayn 2011a &b; Hozayn and AbdAlqodos 2011a&b and Hozayn et al. (2011) who found an increase in the yield of various agronomic crops (chick–pea, lentil, flax and wheat) in response to magnetic water treatments.

Economic yield (ton/fed)

The response of some winter crops to irrigation with magnetized water was reflected of crop yield (ton/fed) (Figure 5).
The results showed that, the yield of plant irrigated with normal water ranged between 0.5 – 1.55 ton/fed according to the plant type.
The irrigation plants with magnetized water increased these yield to range between 0.7 – 1.72 ton/fed according to the plant type. Tested winter crops differed in response for irrigation with magnetized water.
Oil crops (canola and flax) came in the first order in response of irrigation with magnetic water where gave the maximum increase percentage over control (38.72% and 42.23%, respectively), followed by legume crops (chick-pea and lentil) by increasing value (27.01% and 29.53%, respectively).

Table 2. 100-seeds or grains weight for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, SD standard deviation

Treatment	**Mean ± SD**		**Increase (+) or decrease (-) (%) over control**
Crop	**Normal water (control)**	**Magnetic water**	
Wheat	3.764±0.13	3.96±0.11	5.19
Lentil	2.525±0.11	2.78±0.12	10.10
Chick-pea	17.10±0.67	18.70±0.45	9.34
Faba bean	87.62±1.73	97.01±0.98	10.72
Flax	0.61±0.03	0.84±0.03	37.88
Canola	0.42±0.04	0.40±0.02	-5.36

While, wheat as grain and faba bean as legume crops came in the last order by 10.65% and 8.04% increases, respectively.
These results are logical to improvement growth parameters (Figure 1), photosynthetic pigments (Figure 2) and increases in photosynthetic pigments, endogenous promoters (IAA) and increase protein biosynthesis (Hozayn and Amira, 2010 a&b and Amira and Hozayn 2010 a&b). The remarkable improvement induced by the magnetic treatment was consistent with the results of other studies on several crops like cereal, sunflower, flax, pea, soybean, broad bean, wheat, rice, pepper, tomato, potato and sugar beet.

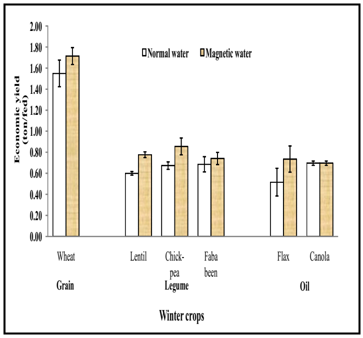

Figure 5. Economic yield (ton/fed) for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

In these studies the crop yield were increased (e.g., Tian et al., 1991, Marinkovic et al. 2000, Marinkovic et al., 2002, Aladjadjiyan, 2002 and 2003, Vasilevski 2003, Podlesny et al., 2004 and 2005, Souza et al. 2006, Selim 2008, Hozayn et al. 2013).

Moreover, Maheshwari and Grewal (2009) suggest that the effects of magnetic treatment varied with plant type, and there were statistically significant increases in plant yield of snow pea, celery and pea plants.

Water use efficiency (WUE)

Similar to economic yield per feddan, there was differential impact of magnetic treatment on water productivity (kg of yield produced per L of water used) (Figure 6). Normal water use efficiency in this study ranged between 0.17 – 0.62 according to the plant type. Magnetized water use efficiency ranged between 0.23 - 0.69 according to the plant type. The percent of increase in water use efficiency ranged between 8.04% at faba bean to 42.23% at flax. Mulook Al-Khazan et al. (2011) recorded that irrigation of jojoba plants with magnetized water led to increase water use efficiency under normal and drought water stress as compared to the recommended irrigation. Magnetic treatment of irrigation water is an acknowledged technique for achieving high water use efficiencies due to its effect on some physical and chemical properties of water and soil (Noran, et al. 1996; Basant et al., 2007; Basant and Harsharn 2009). These changes result in an increased ability of soil to get rid of salts and consequently better assimilation of nutrients and fertilizers in plants during the vegetative period.

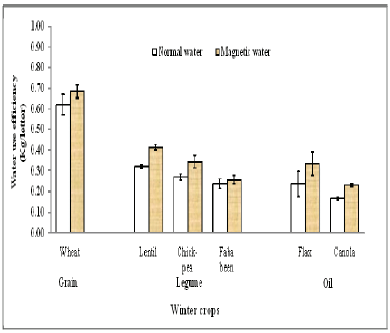

Fig. 6. Water use efficiency (kg/litter water) for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

CONCLUSIONS

The present studies confirmed the promising and previous studies under greenhouse condition. Generally, the present findings have shown that irrigation with magnetized water can be considered as one of the most valuable modern technologies that can assist in saving irrigation water and improving yield and quality of sugar beet under newly reclaimed sandy soil. The usage of magnetic water in the agricultural production will enable intense and more quantities and qualitative production.

ACKNOWLEDGEMENT

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RESULTS REGARDING BIOMASS YIELD AT SUNFLOWER UNDER DIFFERENT PLANTING PATTERNS AND GROWING CONDITIONS

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Abstract

There are several annual crops suitable to supply important biomass yields to be used as raw material for producing different kinds of energy, including the possibility to be used as substrate for biogas production. Sunflower is counted among these crops of great importance. Producing biomass in an efficient way become possible by using the most appropriate cultivation techniques and sunflower hybrids according to specific growing conditions.
The aim of this study was to identify how the row spacing and plant population, associated with different soil and climatic conditions and cultivated sunflower hybrids are influencing the above-ground biomass yield at sunflower.
Researches were performed in field experiments in 2013, in two locations from South Romania, respectively Fundulea (44°28' N latitude and 26°27' E longitude) from Călăraşi County, and Moara Domnească (44°29' N latitude and 26°15' E longitude) from Ilfov County. The studied sunflower hybrids were the followings: Pro 111, LG56.62, P64LE19, Pro 953. Each hybrid in the two locations was studied under three row spacing (75 cm, 50 cm, and twin-rows of 75/45 cm) and three plant populations (50,000, 60,000, and 70,000 plants ha^{-1}). Determinations were performed in the early dough - dough plant growth stage taking into account that the biomass yield in this growth stage of the sunflower plants is of importance as raw material for biogas production.

***Key words**: sunflower, biomass yield, row spacing, plant population, growing conditions.*

INTRODUCTION

Growing biomass is among the cheapest options for CO_2 emissions reduction, particularly if that biomass is used for energy production (Roman et al., 1998). Biomass is a unique fuel and has the potential to play a significant role in the future energy; unlike other renewables, biomass can provide continuous electricity generation, and is the only widespread source of renewable heat (Komlajeva et al., 2012). There are several annual crops suitable to supply important biomass yields to be used as raw material for producing different kinds of energy, including the possibility to be used as substrate for biogas production. Sunflower is counted among these crops of great importance.
Sunflower (*Helianthus annuus* L.) is one of the most important oil crops in the world, because it offers advantages in crop rotation systems, such as high adoption capability, suitability to mechanization and low labour needs (Kazemeini et al., 2009).
Romania has favourable conditions for growing sunflower (*Helianthus annuus* L.), this being the most important oil crop (Ion et al., 2013).
The above-ground dry biomass yield which a sunflower crop could supply is usually of 10-15 tons ha^{-1}, but it can reach 20 tons ha^{-1} (Stefan et al., 2008).
Cultivated sunflower could be used as a source of lignocelluloses biomass. Research is needed to determine the best agricultural practices, which are targeted at maximizing yield in the field (biomass/hectare) (Ziebell et al., 2013).
The most important yield limiting factors are heavy weed infestation and improper production technology particularly row spacing producing proper nutritional area to exploit available resources judiciously (Nawaz et al., 2001). Apart the row spacing, of great importance is also the plant population, as well as the cultivated hybrid.

Widely spaced sowing dates provide differences in soil water, temperature and radiation regimes, and these factors are further compounded by differences in vapour pressure deficits in the different seasons of planting (Agele, 2003).

Diepenbrock et al. (2001) found in 1996 and 1998 that the aboveground biomass increased significantly with increasing row spacing, but in 1997, however, the differences between the row spacings were small. These data prove the importance of performing this kind of studies and the necessity to be continued these studies concerning the relation between row spacing and aboveground biomass.

Plant population based on row and plant spacing is a major part of agronomic practices (Beg et al., 2007).

Producing biomass in an efficient way become possible by using the most appropriate cultivation techniques and sunflower hybrids according to specific growing conditions.

The aim of this study was to identify how the row spacing and plant population, associated with different soil and climatic conditions and cultivated sunflower hybrids are influencing the above-ground biomass yield at sunflower.

MATERIALS AND METHODS

Researches were performed in field experiments in 2013, in two locations from South Romania, respectively Fundulea (44°28' N latitude and 26°27' E longitude) from Călăraşi County, and Moara Domnească (44°29' N latitude and 26°15' E longitude) from Ilfov County.

In the period September 2012 – August 2013, from a climatic point of view Fundulea area was characterised by the average temperature of 12.0°C and the sum of rainfall of 700.6 mm, while Moara Domnească was characterised by the average temperature of 12.6°C and the sum of rainfall of 288.0 mm.

The specific soil from Fundulea area is chernozem (cambic chernozem soil), while the specific soil from Moara Domnească area is reddish preluvosoil.

The studied sunflower hybrids were the followings: Pro 111, LG56.62, P64LE19, and Pro 953. Each hybrid in the two locations was studied under three row spacing (75 cm, 50 cm, and twin-rows of 75/45 cm) and three plant populations (50,000, 60,000, and 70,000 plants ha^{-1}).

The field experiments were performed in four replications, with a number of variants of 36. Each variant consisted in four lines with a length of 10 m.

The sowing was performed on 17th of April at Fundulea and on 25th of April at Moara Domnească. The preceding crop was maize. The fertilization was performed with 106 kg ha^{-1} of nitrogen and 40 kg ha^{-1} of phosphorus. The weed control was performed by the help of herbicides and through one manual hoeing.

In each location and from each variant the sunflower plants from one square meter were cut at soil level and were weighed immediately for determining the fresh biomass yield (above-ground biomass). One sunflower plant for each variant was taken into the laboratory for determining the dry biomass by oven drying at 80°C for 24 hours.

Determinations were performed in the early dough - dough plant growth stage, respectively on 2nd of August at Fundulea (chernozem soil), and on 1st of August at Moara Domnească (reddish preluvosoil). Determinations were performed in the early dough - dough plant growth stage taking into account that the biomass yield in this growth stage of the sunflower plants is of importance as raw material for biogas production. Analysis of variance (ANOVA) was performed for the obtained data.

RESULTS AND DISCUSSIONS

Biomass yield at sunflower at different row spacing (Figure 1)

On chernozem soil, the narrow rows decreased the fresh and dry biomass yields compared to row spacing of 75 cm, the differences being negative distinct significant.

The highest biomass yield was obtained at row spacing of 75 cm, respectively 91.60 tons ha^{-1} of fresh biomass and 18.07 tons ha^{-1} of dry biomass. The smallest biomass yield was obtained at row spacing of 50 cm, respectively 74.91 tons ha^{-1} of fresh biomass and 15.25 tons ha^{-1} of dry biomass.

Narrow rows decreased the moisture content compared to the row spacing of 75 cm, but without significant differences. The plants were the driest at row spacing of 50 cm (79.6%).

On reddish preluvosoil, the narrow rows increased the fresh and dry biomass yields compared to row spacing of 75 cm, the differences being statistically significant.

The highest biomass yields were obtained at twin-rows of 75/45 cm, respectively 80.19 tons ha^{-1} of fresh biomass and 15.61 tons ha^{-1} of dry biomass. The smallest biomass yields were obtained at row spacing of 75 cm, respectively 63.48 tons ha^{-1} of fresh biomass and 13.00 tons ha^{-1} of dry biomass.

Narrow rows also determined the increasing of the moisture content compared to the row spacing of 75 cm. The plants were the driest at row spacing of 75 cm (79.5%), but without significant differences. The moisture content was the highest at twin-rows of 75/45 cm (80.5%).

Under favourable growing conditions, the row spacing of 75 cm seems to be more suitable for sunflower plants. Under less favourable growing conditions, the twin-rows of 75/45 cm seems to be more suitable for sunflower plants. In fact, the narrow rows provided better growing conditions for sunflower plants than row spacing of 75 cm.

Biomass yield at sunflower at different plant population (Figure 2)

On chernozem soil, the highest biomass yields were obtained at 70,000 plants ha^{-1}, which was followed by the biomass yields obtained at 50,000 plants ha^{-1}, and the smallest biomass yields were obtained at 60,000 plants ha^{-1}.

Compared to biomass yield obtained at 50,000 plants ha^{-1}, only the dry biomass yield obtained at 70,000 plants ha^{-1} registered a difference statistically significant.

The increasing of plant population decreased the moisture content of the sunflower plants, the differences being negative distinct significant.

On reddish preluvosoil, the increasing of plant population increased the dry biomass yield, but without significant differences. The highest dry biomass yield, as well as the highest fresh biomass yield was obtained at 70,000 plants ha^{-1}.

The increasing of plant population decreased the moisture content of sunflower plants, but without significant differences. It has to be underlined the fact that the driest biomass yield was obtained at 60,000 plants ha^{-1}.

Biomass yield at different sunflower hybrids (Figure 3)

The biomass yield, both fresh and dry biomass, was different according to hybrid and growing conditions.

On chernozem soil, the highest fresh and dry biomass yield was obtained by Pro 111 hybrid (90.25 tons ha^{-1} of fresh biomass and 17.46 tons ha^{-1} of dry biomass), which had also the highest moisture content (80.7%). The smallest fresh and dry biomass yield was obtained by LG 56.62 hybrid (74.97 tons ha^{-1} of fresh biomass and 16.04 tons ha^{-1} of dry biomass), which had also the smallest moisture content (78.6%).

On reddish preluvosoil, the highest fresh biomass yield was obtained by Pro 111 hybrid (77.51 tons ha^{-1}), but the highest dry biomass yield was obtained by P64LE19 hybrid (15.25 tons ha^{-1}).

As in the case of chernozem soil, the smallest fresh and dry biomass yield was obtained by LG 56.62 hybrid (63.54 tons ha^{-1} of fresh biomass and 13.84 tons ha^{-1} of dry biomass), which had also the smallest moisture content (78.2%).

The highest moisture content of the biomass yield was obtained at Pro 953 hybrid (81.5%), with a difference statistically significant compared to the average moisture content of the four studied sunflower hybrids.

Average biomass yield at different growing conditions (Figure 4)

In our study, chernozem soil was associated with favourable growing conditions for sunflower plants, while reddish preluvosoil was associated with less favourable growing conditions for sunflower plants with much less rainfall.

The fresh biomass yield obtained on chernozem soil was of 81.36 tons ha^{-1}, while that on reddish preluvosoil was of 72.52 tons ha^{-1} representing 89.1% of the fresh biomass obtained on chernozem soil.

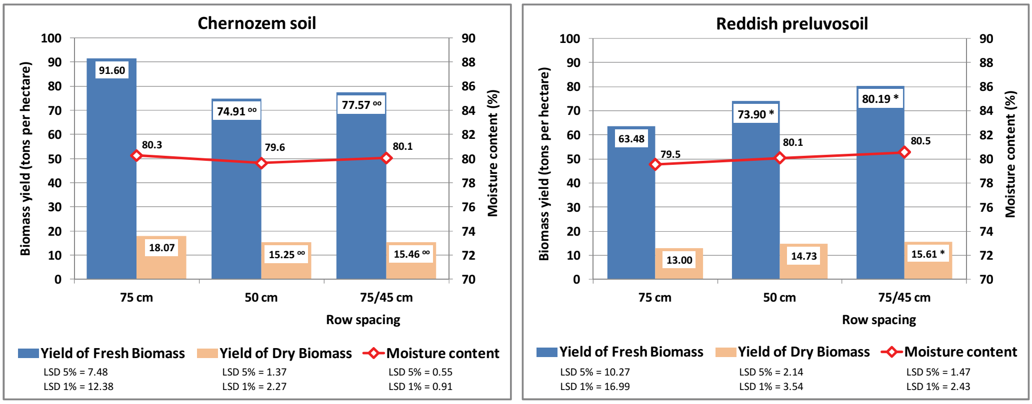

Figure 1. Biomass yield at sunflower at different row spacing and on different growing conditions from South Romania, in the early dough-dough plant growth stage of sunflower plants

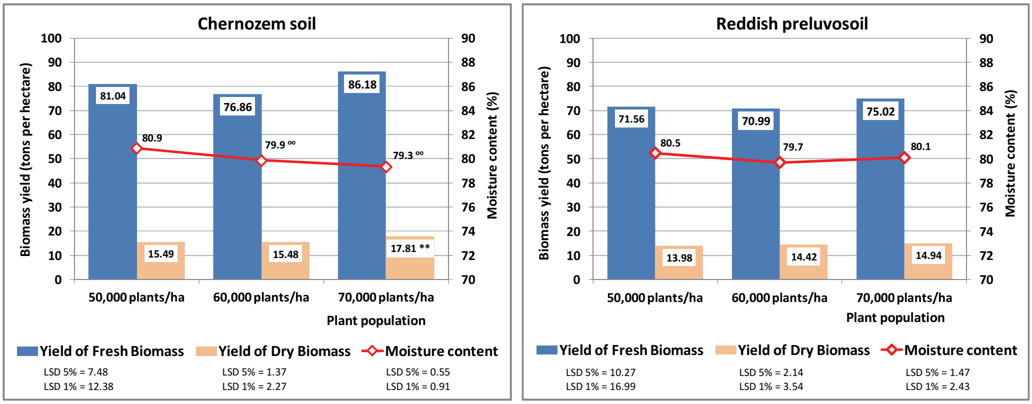

Figure 2. Biomass yield at sunflower at different plant population and on different growing conditions from South Romania, in the early dough-dough plant growth stage of sunflower plants

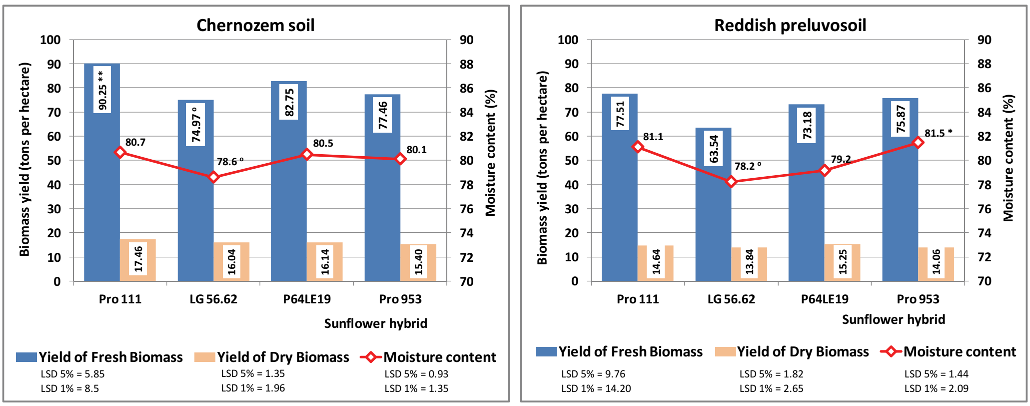

Figure 3. Biomass yield at different sunflower hybrids and on different growing conditions from South Romania, in the early dough-dough plant growth stage of sunflower plants

The dry biomass yield obtained on chernozem soil was of 16.26 tons ha^{-1}, while that on reddish preluvosoil was of 14.45 tons ha^{-1} representing 88.9% of the fresh biomass obtained on chernozem soil.

Under less favourable growing conditions on reddish preluvosoil, with much less rainfall than on chernozem soil in 2013 in South Romania, the fresh and dry biomass yield was of about 89% of those on chernozem soil. The moisture content of the biomass yield was very slightly different on the two growing conditions, being of about 80%.

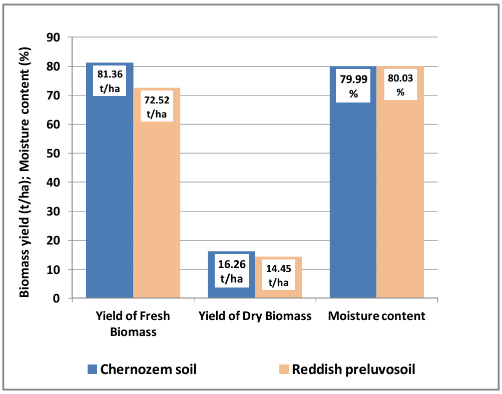

Figure 4. Average biomass yield at different growing conditions from South Romania, in the early dough-dough plant growth stage of sunflower plants

CONCLUSIONS

The fresh and dry biomass was different according to sunflower hybrid and growing condition.

Compared to row spacing of 75 cm in our study, narrow rows decreased the fresh and dry biomass yield under favourable growing conditions and increased the fresh and dry biomass yield under less favourable growing conditions. Thus, the highest fresh and dry biomass yield was obtained at row spacing of 75 cm under favourable growing conditions and at twin-rows of 75/45 cm under less favourable growing conditions.

The highest fresh and dry biomass yield was obtained at the plant population of 70,000 plants ha^{-1} whatever the growing conditions.

The increasing of plant population decreased the moisture content of sunflower plants.

The less favourable growing conditions in 2013 in South Romania, respectively less rainfall, led to fresh and dry biomass yields of about 89% of those on favourable growing conditions, with much more rainfall.

The moisture content of the biomass yield was about 80% in the early dough - dough plant growth stage.

ACKNOWLEDGEMENTS

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THE WEEDS CONTROL BY MECHANICAL AND MANUAL MANAGEMENT PRACTICES

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Abstract

New crop conditions considering today the promotion of important measures, including: agricultural sustainability and environmental protection. Control weeds in agricultural ecosystems with soil and plant belongs in each ecological zone. Ecosystems (crops) specific luvic soil are real situations of weed encroachment every year with different species and in large quantities. Among methods of weed control, making new demands hoeing enroll in Europe. Practice these methods proved favorable not only by stopping different degrees of weeding, but also by creating improved physical fitness necessary for the development of plant root systems. The intervention of the weeds, or only mechanical, or only manually, or with, have induced different levels of control in specific crops. Based on these methods, grain yields followed appropriate developments. This study was done in the three directions, with the demonstration plant hoe grown responses under these conditions in farm fields. Each of the four crops is presented: i)the structure of weeds on the four categories (AM,AD,PD,PM), ii)formation of grain production under natural weed encroachment, iii)development to production by hoeing complex in comparison with an-hoed, iv)comparing types of hoeing to control weeds and on this basis, the production of grains formed. Under natural conditions weeds formed averages of total biomass: 14.9 t.ha^{-1} in maize, 12.3 t.ha^{-1} sunflower, soybean 11.8 t.ha^{-1} and 18.1 t.ha^{-1} beans. Formed grain production under natural weeds encroachment were 2.0-3.0 t.ha^{-1} in maize, 1.0-1.5 t.ha^{-1} sunflower, 0.2-1.0 t.ha^{-1} soybean and 0.2-0.6 t.ha^{-1} at beans. Weeding complex (mechanical and manual) has improved the average grain yields from an average of: 6.8 t.ha^{-1} maize, 3.0 t.ha^{-1} sunflower, soybean 1.9 t.ha^{-1} and 1.9 t.ha^{-1} beans. This maximum levels of plants yields expressed also the white luvicsoil agri-potential.

Key words: *mechanical hoed, manual hoed, complex mechanical & manual hoed, field crops.*

INTRODUCTION

Practice of hoeing, using mechanical and manual weed control is applied in all over the world (Derksen et al., 1993; Froud-Williams, 1995; Van Der Weide et al., 1995), just like us (Ionescu et al., 1996). Positive effects have been shown to be important in any culture system. The problem that arises is that if the practice of high density can control weeds, to avoid competition between them, the species and the number per unit area so that this does not incur losses of production (Anghel et al., 1972; Berca and Ciorlăuş, 1994; Cousens & Mortimer, 1993). Today such outcomes are required to guide combat (Wyse, 1994) and farming in environmental protection conditions, or in response to opportunities in small households control of us, which often appeal to hoeing, or mechanical type (often with animal traction) or by hand- digging often. In such cultural conditions, mechanical weed control by hoeing may have some success and i.e. between 37-95 % regardless of the number of passes through the chain. Mechanically is, however, only effective when taking into account other factors involved in weed populations (Rasmussen, 1992). Thus, in addition to mechanical practices can promote other methods that reduce weed control. Some of them have begun to be applied, and namely: low rates of herbicides, biological control methods, physical methods, so manual methods (Lazauskas, 1995).

Given the fact that the mechanical weeding is not done yet acceptable levels of control of all weeds in weeding, currently us practical and manual weeding (Scurtu, 1996; Stefaniç & Knezeviç, 1995). Complexity between the two methods is produced by alternating relatively simple: it performs a mechanical shift then immediately hand she is leaving her. After a

period of about 15/12/10 days depending on rainfall, which promotes a new wave of weeding, mechanical longer make a move swiftly followed by hand hoeing. In some years "waves" of hoeing may comprise 1-2, sometimes 3 passes.
On the other hand, the moment or the time of making weed control by mechanical and manual weeding is important because, theoretically, they would be required to be completed as early as possible (Townson et al, 1995). Why this? In practice for control of weed plants by hoed, on finding that the spring weeds found that some time before the crop plants. The reason is that adaptability significantly better weed species have in the culture medium in comparison with the plants in the culture (Aldrich, 1984). This gap between rising grain crop and weed seeds, weed latter ensures their rapid and specific. Against this state, considered particularly dangerous to the success of the crop, it is necessary to take any kind or method of combat, including hoeing (Ammon, 1997). At the same time have known that the weed seedlings or bean- sprung all the species: annual and perennial stems or shoots emerged from underground, where perennial species have a certain vulnerability. The vulnerability of the weed seedlings is affected, and in case of using the compound of hoeing, as with all the measures chemical or non-chemical control of weeds in a crop. Weeds are in a young stage, as noted before the first hoeing (Berca, 2004; Courtney, 1996; Cousens, 1987) and hoeing after each wave of mechanical and manual, not yet producing damage. Biomass and grain damage occurring after some delay.
From research on when to perform multi hoeing, mechanical and manual showed that production losses were steep, very large and not recommended under any circumstances. It is also good to know the fact that the first two weeks (sometimes after a few days), weeds noncombatants from a hoe culture, contributes very strong plants and passes through any mechanical and manual saves culture. It is particularly strong stresses falling crop plants stress which may not be able to exit that culture- appropriate compromise (Auld, 1996). From research results will be presented both separately and in combination mechanical and manual weeding applied four crops: maize, sunflower, soybean and beans. In such research might find a recommended control response farmers practicing organic farming system with obvious trends, or the enhanced protection of agricultural environment, without any residual.

MATERIALS AND METHODS

Multiannual researches followed on the influence of mechanical and manual, separately and in combination of these, for the main hoed-plant in the area: maize, sunflower, soybean and beans, in several directions. The first study involved quantitative analysis of specific weed species from witness plots (with natural weed), grouped by dominant classes and namely annual monocots (AM), annual dicots (AD), perennial dicots (PD) and perennial monocots (PM). Data demonstrate the importance of each of the four groups of weeds that outcompete the plant. Weed that occurs every year in weeding plants here and highlights the specific nature of existing ecosystems white luvicsoil the resort.
Over the years of culture, natural weed had varying degrees, depending on the nature of each crop year and considered here as fluctuating. In spring weeds compete both at different times of sowing place in April and May, with favorable influence that early and late species of weeds and climatic conditions by rains falling throughout the growing season. Given the annual competition of weeds and plant production occurred hoes formed under these conditions were found different situations and characteristics of each species in culture. This study expresses levels and degrees of competition between crop plants and weed species existing. Expressions average production by the total biomass of weeds was done by correlation and regression.
A separate study was conducted to compare the average production of variants, the total hoeing weeding degree very low, with and an-hoed variants by any method, specifically the degree of weed. Differences obtained by hoeing complex: mechanical and manual led to obtaining increases very obvious, even spectacular in some years. By hoeing we realize that to remove both competition with weeds and creating conditions expressing an optimum physical condition of the soil of culture.

The results with separate influence of hoes performed separately and in combination, and compared to normal manual weeding could provide genuine opportunities in weed control status of the four cultures hoes. In the fourth study of the level of grain production in the following; i) no-hoed and no-herbicides, ii) mechanical weeding, iii) manual hoeing, and iv) complex mechanical and manual weeding. Graphs highlight possible levels of weed control by any of the four possibilities, the plants grown under white luvicsoil.

The experimental variants were located near various herbicide treatments for testing, made under programs established by the special laboratory of herbicides from INCDA Fundulea. Their surface was 25 m^2 each in four repetitions by the Latin rectangle method. Data processing was done by way analysis of variance (Anova test).

RESULTS AND DISCUSSIONS

A. The natural encroachment of the hoed crops

Over the years it was noticed that there is a substantial natural weeding of hoe plants (Backer, 1988). The causes of this situation is that they have large spread weed species, some of which are downright invasive, and massive storage of their year, the soil seed bank, and great susceptibility (the relatively weak the competition) of the four crops. Within several years weeding took place differently in each culture (or ecosystem). The data obtained over a long period of years have shown that there are some years, the plants produced more grain yield compared to previous years, due to climatic conditions that favor the existence of the earlier emergence of the crop plants against weeds. In other years, due to fierce competition with weeds, plants formed less useful production (seeds) or nothing (Ionescu, 2001; Morin et al., 1993). The phenomenon is often observed in maize, but this is true for other hoes plants. Nothing natural weed, i.e. that which occurs each year as a result of acclimatization weed species in agricultural ecosystems found that the annual oscillations with minimum and maximum limits which together provide an overview of the natural phenomenon of weed culture weeding plants.

B.The hoed systems efficacy in maize crop

In maize, weed every year demonstrated specific situations considered important (Benoit et al., 1996; Beraru, 1997). In terms of weed species composition, dominance resulted annual monocots type: *Echinochloa crus-galli, Setaria glauca, Digitaria sanguinalis.* They attended the annual dicots of which were present as *Amaranthus retroflexus*, *Galinsoga parviflora, Chenopodium album*. Perennial dicots were *Cirsium arvense, Convolvulus arvensis, Sonchus arvensis* and perennial monocots they were represented on *Agropyron repens* and *Cynodon dactylon*. Growth out very clearly the dominant species- AM, intermediate species- AD and the raced- PD and PM. The total biomass of these four categories of weeds amounted on average to 14.9 $t.ha^{-1}$ (Figure 1).

The study demonstrated the influence of natural weed vegetation (Mortensen et al, 2000) in the production of maize grain without hoeing or other methods of control (maize no-hoed). From the graph it appears that in one year is not formed maize, and the other year more than 2 $t.ha^{-1}$ grains. Developments of maize by performing mechanical and manual hoeing (complex hoeing)- bold line, with yields obtained by no-hoed- thin line, demonstrating the variety of maize culture conditions in this area. In the hoed variant there is an upward trend in yields over time constitutes a promotion hybrids increasingly improved genetic characters. In some years and the differences of hoed and no-hoed were placed in the addition of about 5 $t.ha^{-1}$. Average study period shows increases of 3.84 $t.ha^{-1}$ maize.

Grain yield showed growth by mechanical hoeing, by hand hoeing and in complex mechanical with the manual. Over several years, only mechanical hoeing weeds contained in the sensitive unsatisfactory even no-complete and in these conditions the addition of maize production was only 0.92 $t.ha^{-1}$ grains. Breeding only manually proved to be more effective even in addition the production obtained was 2.89 $t.ha^{-1}$ up no-hoed. The combination of the two hoeing: the mechanical with manual leading to the production of maize term average of 6.79 $t.ha^{-1}$. Under these conditions the maximum effectiveness of mechanical and manual hoed resulted in maize an increase of 3.84 $t.ha^{-1}$ grains.

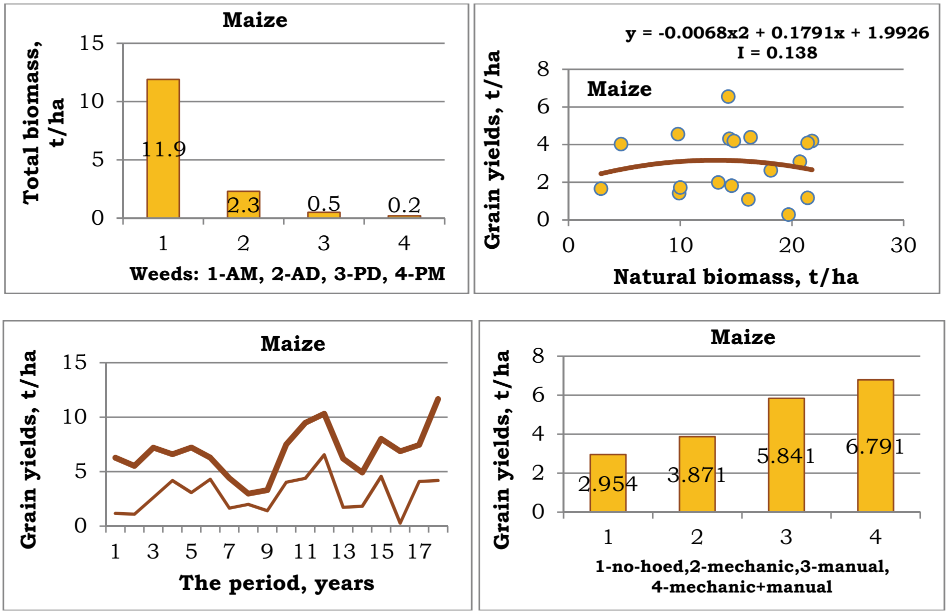

Figure 1. The weed encroachment state and the hoed systems efficacy in maize crop

C. The hoed systems efficacy in sunflower crop

The sunflower generally multi degree of weed was slightly reduced compared to maize. The explanation lies in the fact that this plant growing battle (concurring) something better with weeds. Thus, annual monocots weighted on average 8.6 t.ha^{-1}. Annual dicots close of maize were 2.6 t.ha^{-1}. Perennial dicots plants have competed sunflower more, so that under these conditions were made 1.0 t.ha^{-1} on average. Their value amounted on average to 12.3 t:ha^{-1} biomass of weeds. The dominant species are broadly the same as for maize (Figure 2).

Grain yield of sunflower was formed by natural weed and relatively better, i.e. between 1.5 and 1.0 t.ha^{-1}, so the downward trend. In the few years a more favorable culture of sunflower plants have won most of the battle with weeds. In other years, however, sunflower produced between 1.1 and 0.7 t.ha^{-1} grains. In a single year was an exception, when sunflower plants produced 1.9 t.ha^{-1} seeds, no control of weeds given by any means including hoeing. Performing manual and mechanical hoeds influence on the plant was more important in the control of weeds, in comparison with no-hoed. Complex formed by hoeing productions ranged from an average of 3.04 t.ha^{-1} grains. By no-hoed were lost in the same period about 1.68 t.ha^{-1} sunflower seeds. In withness no-hoed sunflower produced an average of 1.37 t.ha^{-1} grains, while the mechanical hoeing average stood at 2.07 t.ha^{-1}. The difference is 0.70 t.ha^{-1} grains. Weeding manually only contribute to relatively hardware control of the weed species, such as sunflower medium reached 2.92 t.ha^{-1}. Weeding provide training in complex environments sunflower production of 3.04 t.ha^{-1}.

D. The hoed systems efficacy in soybean crop

Soybean showed high degrees of weed when no action is taken to control the type hoed. Given the relatively small port of the plant and the slow pace of grown in the first month of vegetation, weeds that occur each year are in significant quantities, regardless of the suitability of the year. Out of weeds produced natural weed encroachment witness, annual monocots totaled 7.1 t.ha^{-1}. Annual dicots were 3.6 t.ha^{-1} and less than 1.0 t.ha^{-1} perennial species. The weed species were observed due to soybean, maize and sunflower were approximately similar. The total biomass of weeds in soybean ranged on average from 11.8 t.ha^{-1} (Figure 3).

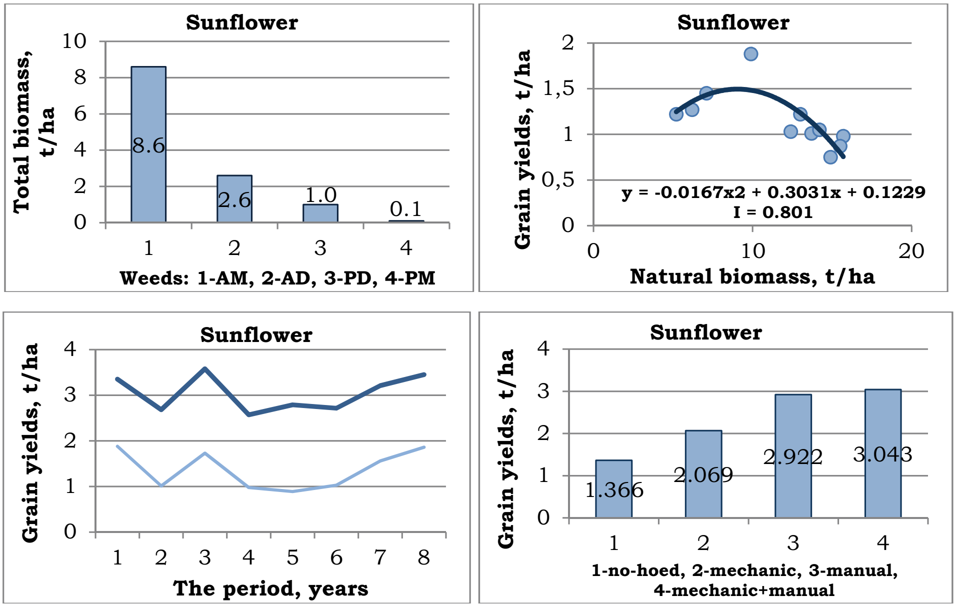

Figure 2. The weed encroachment state and the hoed systems efficacy in sunflower crop

In soybeans, the impact they have had and they have naturally grown weeds is particularly strong. The witness obtained with weeds shows decreasing trend of grain production of up to 0.3 $t.ha^{-1}$ amid weeds quantities and formats i.e. between 3-4 $t.ha^{-1}$ in the least favorable to them and 18-20 $t.ha^{-1}$ in the year's wet. The large differences between the outputs of soybean hoed obtained by carrying out the mechanical and manual are considered high compared with no-hoed, important. Thus, if the hoeing complex formed 1.94 $t.ha^{-1}$ average grain to no-hoed were obtained only 0.51 $t.ha^{-1}$. The average difference over several years was 1.43 $t.ha^{-1}$ grains. The intervention on the particular weed and demonstrate a gradual evolution in culture soybean. Thus, the formed blank no-hoed 0.51 $t.ha^{-1}$ beans. By performing only breeding mechanical grain yield increased from 0.87 $t.ha^{-1}$, so win a gain of only 0.36 $t.ha^{-1}$. Manual weeding contributed to the average level of 1.43 $t.ha^{-1}$ grains. By combining mechanical with manual hoed were obtained 1.94 $t.ha^{-1}$ soybeans production across media considered for many years as good.

E. The hoed systems efficacy in beans crop

Beans bean (crop field) approaches the port in the first growing phenophases but bean plants through the growing season in a shorter time and therefore control as early and completely provide conditions for yields grain far superior.

During the period studied weeds formed from the four specific groups. Were dominant annual monocots, who had a level of 11.3 $t.ha^{-1}$, followed by annual dicots with 5.1 $t.ha^{-1}$. Perennial dicots produced 1.4 $t.ha^{-1}$ and perennial monocots 0.3 $t.ha^{-1}$. This amount was set to 18.1 $t.ha^{-1}$ (Figure 4).

Bean production in natural weeds witnesses over the years ranged between 0.2 and 0.6 $t.ha^{-1}$. Given the high production potential of varieties of beans used considered by annual weeds without control by hoeing, is particularly harmful. It proved so bean plants rapidly and almost completely lost the competition for growth factors. Between hoed culture and the no-hoed beans were found large differences in production. By cultivating these varieties produced an average of 1.87 $t.ha^{-1}$. No-hoed produced an average only 0.40 $t.ha^{-1}$. This difference further by hoeing complex was of 1.46 $t.ha^{-1}$. The differences between the four states of weed control were clear. In the check plot has been formed only 0.404 $t.ha^{-1}$ grain. The yield obtained by carrying out the mechanical hoed was at 0.726 $t.ha^{-1}$ seeds, with the help of hand hoed the yield was 1.737 $t.ha^{-1}$ grains and by hoeing combination of mechanical and hand, 1.868 $t.ha^{-1}$.

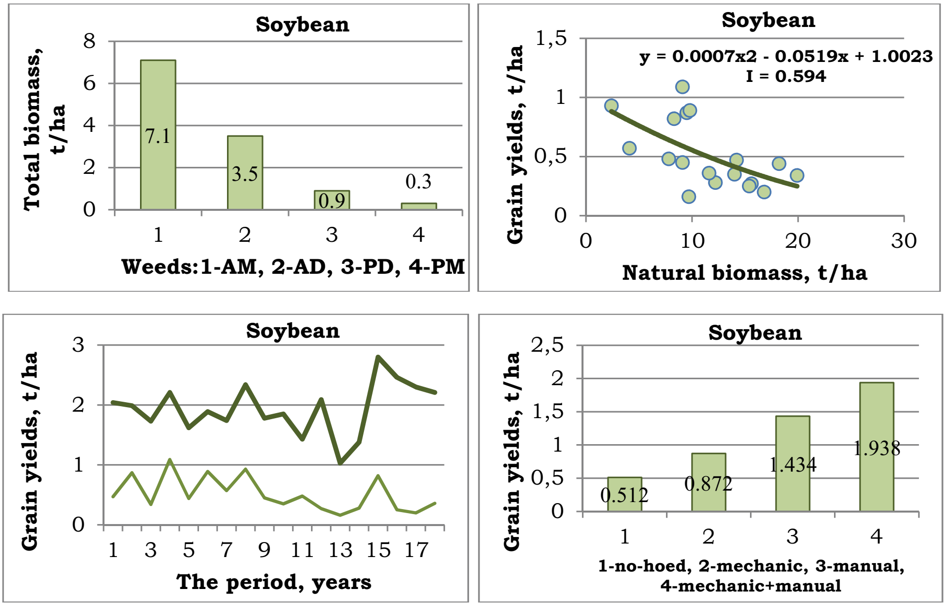

Figure 3. The weed encroachment state and the hoed systems efficacy in soybean crop

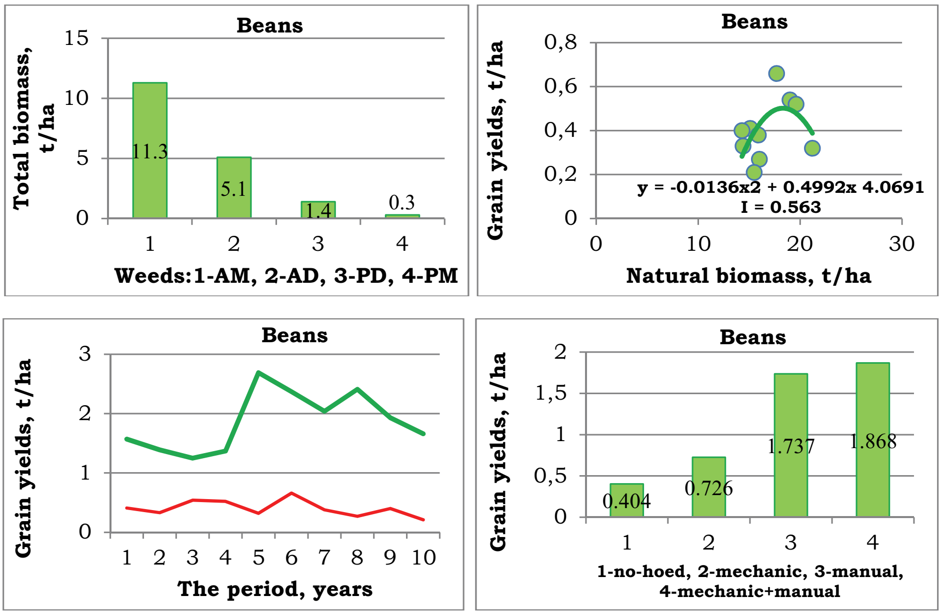

Figure 4. The weed encroachment state and the hoed systems efficacy in beans crop

CONCLUSIONS

Control of weeds by hoeing is part of new European rules for the protection of agricultural environment. Although it is known for a long time, it is not known multi influence both the mechanical hoed, of the hand and the combination of them. Research of this kind in the southern white luvic-soils novelty dress.

The weeds occurring in spring crops: maize, sunflower, soybean and beans are the dominant annual monocots (AM, 80% maize, 70% sunflower, soybean 60% to 63% of the beans) and is followed by annual dicots (15% maize, 21% sunflower, 30% soybean and 28% beans).

The other two groups, PD and PM were much lower proportion (5% maize, 9% sunflower, 10% soybean and 9% beans).

Plant vegetation with weed hoe culture showed high inter-specific competition. And in these circumstances, production of grain size, but at low levels: 2.9 $t.ha^{-1}$ maize, 1.0-1.5 $t.ha^{-1}$ sunflower, 1.0-1.3 $t.ha^{-1}$ in soybean and 0.2-0.5 $t.ha^{-1}$ beans.

Control weeds by hoeing perform both mechanical and manual kept the clean cultures. Production increases obtained were very evident in all periods studied. Maximum yields obtained throughout the period studied were 6.79 $t.ha^{-1}$ maize with an increase of 3.84 $t.ha^{-1}$ grain in comparison with no-hoed. Sunflower yield was 3.04 $t.ha^{-1}$, increase with 1.68 $t.ha^{-1}$. Soybean produced 1.94 $t.ha^{-1}$ with increase of 1.43 $t.ha^{-1}$, and the maximum yield of grain beans was 1.87 $t.ha^{-1}$ an increase of 1.46 $t.ha^{-1}$. Hoed whether manual or mechanical showed intermediate situations.

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EFFECT OF SOME ORGANIC FERTILIZERS TREATMENTS ON DRY SEED YIELD OF BROAD BEAN (*Vicia faba* L.)

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Abstract

A simple experiment was conducted at 2012-2013 growth season to study the addition effect of chicken and cattle manure, granular humus alone or with foliar application of humic acid or seaweed extraction as well as control and chemical treatments on yield of broad bean. The results were summarized as follow: Most of treatments caused a significant increase on all parameters studied. Chicken manure + humic acid was superior to most of other transactions in pods number.plant^{-1}, seeds number.pod^{-1} and seed yield, and it gave an increase percentage of 62.3%, 49.5% and 150% respectively, compared to control. Cattle manure + seaweed extraction caused higher proportion of protein in the seeds and it gave an increase percentage of 92.2% compared to control treatment.

***Key words**: chicken and cattle manure, granular humus, humic acid, seaweed, broad bean.*

INTRODUCTION

Broad bean (*Vicia faba* L.) is a famous winter leguminous crops in Iraq. It is considered as a good source of vegetarian protein for human consumption, and it is cultivated in crop rotations to improve soil properties (Jasim, 2007). Chemical and organic fertilizers are an essential process in plant management. Adequate fertilizers led to increase the crop yields, improves the nutrient element concentration in plant tissue and soil macro and micro nutrient status. Chemical fertilizers are expensive and harmful effects on the environment (Adediran et al., 2004), therefore recommended the addition of organic matter (animals manure, humic acid and seaweed extract) as an alternative to chemical fertilizers (Oad et al., 2004). The addition of organic fertilizers efficiently ensures high production and continuous crops by improving soil properties and increase roots development and soil micro organisms activity (Abou EL-Magd et al., 2006; Ayoola and Maknide, 2009). Some researchers reported that spraying with humic acid improve plant growth and yield (Akinci et al., 2009). Adding humic acid caused a significant increase in dry matter production by broad bean (El-Ghozoli, 2003) and bean (El-Bassiony et al., 2010). Seaweed extract was used to encourage growth and delay aging (Khan et al., 2009). Because of the importance effect of fertilizer types, especially organic fertilizers in influencing the quantity and quality of yield as well as external and physiological aspects of plant growth, this study was carried to compare the effect of a some organic fertilizers (chicken and cattle manure, granular humus, humic acid and seaweed extract spray, alone or in combination) on broad bean yield compared with control or chemical fertilization (NP)and as an alternative.

MATERIALS AND METHODS

A farm experiment was conducted at the farm of Agriculture College, Babylon University during 2012-2013 growth season to study the response of broad bean plants to chicken or cattle manure alone or with foliar organic fertilizers compared with recommended chemical fertilizer. The experiment was conducted according to the randomized complete block design (RCBD) with three replications; each replicates contained 13 experimental unit (each of it contained four ridges (3m length and 75 cm width).

Degradable chicken or cattle manure at a level of 20m^3.h^{-1} before seeding was used. The experiment included 13 treatments:

1- control;

2- chemical fertilizer (di-ammonium-phosphate);
3- degradable chicken manure (20 $m^3.h^{-1}$) adding before seeding;
4- degradable cattle manure (20 $m^3.h^{-1}$) adding before seeding;
5- granular humus;
6- humic acid;
7- seaweed extract;
8- degradable chicken manure + humic acid;
9- degradable cattle manure + humic acid;
10- granular humus + humic acid;
11- degradable chicken manure + seaweed extract;
12- degradable cattle manure + seaweed extract;
13- granular humus + seaweed extract.

Broad bean seeds (Spanish var.) were soaked in water for 24 hours and planted after calibration on one side of the ridges at 25 cm apart on 15 October 2012.After 45 days of germination, foliar fertilizers were done and after one month later the second spray was done. Plant and soil service process were done as the same as it was recommended. At harvest, dry pods of plants from the two internal ridges were harvested, and from it, number of pods per plant, dry seeds per plant and unit area were calculated. Statistical analysis was performed according to the program Gen. Stat (Edition 3), the averages were compared according to Least (LSD $_{0.05}$).

RESULTS AND DISCUSSIONS

Table 1 showed that all fertilizer treatments were superior in pods no. plants $^{-1}$ (except granular humus treatment) significantly compared to control. The table showed also that there were a significant differences between the superior treatments in which chicken manure + humic acid was superior upon chemical fertilizer, granular humus, humic acid, cattle manure + humic acid and granular humus + humic acid treatments, and caused a percentage increase of 62.3% compared to control.

The increase is attributable to the role of organic matter in the release of nutrients, notably nitrogen which is necessary for the elongation and cell division and growth and development of plant, and the role of organic matter in improving the properties vital to the soil by increasing number and quality of microbes that increase the readiness of the absorption of most nutrients, which is reflected positively the general activity of the plant (Sarkar et al., 2004). This is consistent with that found by Arjumand et al., 2013 on broad bean plants. The reason for the increase is also due to the role of organic matter in the processing and supply of good nutrient for plants, which appears in the growth characteristics of the crop, and these results are consistent with the findings of the researchers that the addition of organic matter had achieved significant increases in the yield of leguminous crops (Shaaban and Okasha, 2007; El-Desuki et al., 2010).

Table 1. Effect of treatments on pod number per plant

Treatments		Treatments	
control	5.70	chicken manure + humic acid	9.27
chemical fertilizer	8.00	cattle manure + humic acid	7.97
chicken manure	9.17	granular humus + humic acid	8.00
cattle manure	8.27	chicken manure + seaweed	9.13
granular humus	6.67	cattle manure + seaweed	8.93
humic acid	7.27	granular humus + seaweed	8.27
seaweed extract	8.97		
L.SD$_{0.05}$	1.233		

Table 2 showed the superiority of fertilization: chemical fertilizer, chicken manure, chicken manure + humic acid, cattle manure + humic acid, chicken manure + seaweed extract, cattle manure + seaweed extract significantly compared to control in the number seeds per pod. The treatment of chicken manure + humic acid was superior upon all treatments except for the treatment of chicken manure + seaweed extract, with a percentage increase of 49.5% compared to control treatment. And also shows that spray humic acid or seaweed extract for plants fertilized with chicken or cattle manure led to the strengthening of the increase in the number of seeds per pod significantly compared to control.

The increase was attributed to the role of organic matter in supplied the plants with nutrient-sufficient, which increases the vegetative parts and thus increase in the photosynthesis process, which utilized in the composition of plant parts and thus decrease of competition and abortion, which led to the increase in the number of seeds per pod, this is consistent with Anju and Vijayalakshmi (2013) on common bean and Maheshbabu et al. (2008) on soya bean.

The increase in the seed number per pod by chemical fertilizer (NP) was attributable to the role of phosphorus in increasing the activity and growth of plant roots as well as increasing plant vegetative growth, and to the phosphorus entry in most vehicles energy-rich which is necessary in plant biosynthesis (Silva et al., 2011). This was consistent with Ahmed and EL-Bagy (2007) in broad bean. And sprayed humic acid or seaweed extract led to increased permeability of cell membranes, which leads to easier transmission of nutrients to sites that require their presence and reduce abortion and thus increase seeds no. per pod (Buyukkeskin and Akinci, 2011).

Table 2. Effect of treatments on seed number per pod

Treatments		Treatments	
control	3.300	chicken manure + humic acid	4.933
chemical fertilizer	4.233	cattle manure + humic acid	4.333
chicken manure	3.933	granular humus + humic acid	3.833
cattle manure	3.667	chicken manure + seaweed	4.567
granular humus	3.400	cattle manure + seaweed	3.900
humic acid	3.567	granular humus + seaweed	3.833
seaweed extract	3.633		
L.SD$_{0.05}$	0.5756		

Table (3 and 4) showed that all fertilizer treatments were superior significantly (except the treatment of granular humus) in dry seeds yield per plant and per unit area, compared to control. Chicken manure + humic acid was superior on all treatments (except chemical fertilizer, chicken manure, cattle manure + seaweed extract, chicken manure + seaweed extract), with an increase percentage of 150% compared to control. The increase by adding chicken or cattle manure attributed to the amount of nutrients released from degrading the organic matter which increase cells activity and size, and increase the components of yield such as pod number per plant and seeds number per pod (Table1and2) and thus seed yield. This is consistent with Kovacs et al(2008) on broad bean. The increase by chemical fertilizer (NP) is attributable to the role of the two components N and P in the plant (El-Gizawy and Mehasen, 2009). This is consistent with Daur et al. (2008), Ahmed and EL-Bagy (2007) on broad bean. The increase in seed yield by spray seaweed extract was attributed to plant hormones containing in the extract that led to the increase in the number of origins of flowering and fruit and be transformed materials formed in the process of photosynthesis to the fruit as well as it`s containing of amino acids, vitamins and mineral elements (Stirk et al., 2004). This result is consistent with Sabh and Shallan (2008).

Table 3. Effect of treatments on dry seed yield (gm).plant^{-1}

Treatments		Treatments	
control	24.6	chicken manure + humic acid	62.6
chemical fertilizer	56.3	cattle manure + humic acid	46.6
chicken manure	51.7	granular humus + humic acid	41.9
cattle manure	42.3	chicken manure + seaweed	59.4
granular humus	32.1	cattle manure + seaweed	51.0
humic acid	37.7	granular humus + seaweed	46.9
seaweed extract	44.4		
L.SD$_{0.05}$	11.54		

Table 4. Effect of treatments on dry seed yield (Ton.hectare^{-1})

Treatments		Treatments	
control	1.333	chicken manure + humic acid	3.333
chemical fertilizer	3.033	cattle manure + humic acid	2.500
chicken manure	2.800	granular humus + humic acid	2.233
cattle manure	2.300	chicken manure + seaweed	3.233
granular humus	1.717	cattle manure + seaweed	2.767
humic acid	2.050	granular humus + seaweed	2.533
seaweed extract	2.400		
L.SD$_{0.05}$	0.597		

Table (5) shows that all fertilizer treatments were superior on control in 100 seeds weight (except for the treatment of spray seaweed extract, cattle manure + spray humic acid, granular humus + spray humic acid). The table also shows that chemical fertilizer treatment was superior on all treatments significantly, with a percentage increase of (22.7%) compared to control.

The increase is due to the role of humic in increasing permeability of cell membranes which increases the speed of entry of nutrients into the cell because of the presence of effective hydroxyl and carboxyl (Chen and Aviad, 1990). Organic matter that contains most of the nutrients leads to increase the amount of protein and carbohydrates accumulated in the seed which leads to increase the weight of the seed (Arjumand et al., 2013). The increase in the weight of 100 seeds by chemical fertilizer (NP) attributed to the providing of these elements to be ready for absorption by the plant, and to the role of each of nitrogen and phosphorus to encourage vegetative and roots growth and the performance of activities vital (Hauggard and Jensen, 2001). This was consistent with Ahmed and EL-Bagy (2007) and Daur et al. (2008).

Table 5. Effect of treatments on 100 seeds weight(gm)

Treatments		Treatments	
control	128.00	chicken manure + humic acid	141.00
chemical fertilizer	157.00	cattle manure + humic acid	137.33
chicken manure	142.00	granular humus + humic acid	136.33
cattle manure	139.67	chicken manure + seaweed	142.33
granular humus	141.67	cattle manure + seaweed	145.67
humic acid	145.67	granular humus + seaweed	144.33
seaweed extract	134.00		
$L.SD_{0.05}$			9.916

Table 6 shows that all fertilizer treatments caused a significant increase in protein percentage (except for the treatment of granular humus, humic acid, granular humus + seaweeds) compared to control. The table shows also that the superior treatments did not differ with each other, and the highest value obtained from cattle manure + spray seaweeds extract, which achieved a percentage increase (92.2%) compared to control.

The reason for increasing protein concentration when adding organic fertilizers is due to the high concentration of nutrient elements which is easy to absorb by the plant, and the property of humic acids in increasing the activity of most enzymes, including proteinase which converts the nitrogen to protein in the plant, which accumulates in the seeds during maturation. This is consistent with Mahmoud et al. (2012).

The increase is due to the role of humic acids which are produced during the decomposition of organic matter, and works to increase the permeability of cell membranes, and speeds up the absorption of nutrients (Esmaeilian et al., 2012). The increase in protein by chemical fertilization (NP) is attributed to the role of N and P in the plant (Kovacs et al., 2008; Kandil et al., 2013). The increase of protein by spraying seaweed extract with chicken or cattle manureis attributed to its contain of amino acids and vitamins and many of the elements (Stirk et al., 2004). This was consistent with Sabh and Shallan (2008).

Table 6. Effect of treatments on seed protein percentage

Treatments		Treatments	
control	13.80	chicken manure + humic acid	25.33
chemical fertilizer	22.10	cattle manure + humic acid	24.53
chicken manure	24.83	granular humus + humic acid	20.80
cattle manure	20.77	chicken manure + seaweed	24.57
granular humus	14.73	cattle manure + seaweed	26.53
humic acid	19.33	granular humus + seaweed	19.20
seaweed extract	24.47		
$L.SD_{0.05}$			5.97

CONCLUSIONS

It will be concluded that chicken or cattle manure with humic acid or seaweed fertilizers were more effective in enhancing growth and yield of broad bean than chemical fertilizer.

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STUDY OF THE EFFECTIVE PARAMETERS ON THE ADSORPTION OF MALONIC ACID FROM AQUEOUS SOLUTIONS BY RICE (*Oryza sativa* L.) BRAN

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Abstract

The adsorption of malonic acid on the rice (Oryza sativa L.) bran was studied under various conditions such as temperature, contact time, adsorbent dose and concentration of adsorbate. In this case Rice bran is one of the important agricultural wastes which in this study is used from it as adsorbent. The rice bran is a beneficial source of lots of lignin, cellulose and silica with adequate adsorptive capacity that can be uses as a sorbent. In this research Batch adsorption experiments were conducted and the results showed that the adsorption was dependent on all these parameters. The adsorption capacity was found to be 1.24 mg/g. The Sorption of malonic acid on the rice bran was rapid during the first 20 minutes and the equilibrium was found to be attained within 50 mines.

Keywords*: rice bran, adsorption isotherms, malonic acid, various conditions.*

INTRODUCTION

Through the physical and chemical processes of sorption, it is possible to remove a significant portion of the total metal concentration, thus lowering the effluent concentration to a level that will be less detrimental to public health and environmental quality (Kumar, 2010). Several workers have reported on the potential use of agricultural by–products as good substrates for the removal of metal ions from aqueous solutions and wastewaters. This process attempts to put into use the principle of using waste to treat waste and become even more efficient because these agricultural by–products are readily available and often pose waste disposal problems. Hence, they are available at little or no cost, since they are waste products. This makes the process of treating wastewaters with agricultural by–product adsorbents more cost effective than the use of conventional adsorbents like activated carbon. In addition, there is no need for complicated regeneration process when using agricultural by–products for wastewater treatment (Dabrowski, 2000; Kocaba, 2007; Al-Anber, 2008; Oei, 2009; Hsieh, 2000; Ho, 2002; Demirba, 2004; Tarley, 2004). Rice bran is one of the important agricultural wastes. In this study is used from it as adsorbent. The outer coating of a rice grain is the rice bran. It is the brown layer between the hull and the white rice. The hull and bran layer is the discarded byproduct during the milling process to make white rice. The rice bran is a beneficial source of lots of lignin, cellulose and silica with adequate adsorptive capacity that can be use as a sorbent (Tarley, 2004). Dicarboxylic acids are important compounds in biochemistry, nature and industry. Malonic acid is one of the derivatives of dicarboxylic acids by m.p of 136°C and density of 1.619 $g.cm^{-3}$. It is used as a chelating agent (Thongtem, 2005) and potential ragent in decontamination processes for Ni-rich alloy surface (Thongtem, 2005). Malonic acid accumulates in the pigments of some flowers (Saito, 2008) and fruits (Muchuweti, 2005) and can be regarded as a reliable indicator of orange fruit senses (Sasson, 1976). Removal methods of organic componds in industrial discharges may be traditionally divided into three main categories: physical, chemical, and biological processes. Among them, physical adsorption is generally considered to be the most efficient method for quickly lowering the concentration of dissolved organic componds in the solution.

Thus, the main objectives of this work were to characterize the physical properties of rice bran to examine its adsorption behaviors of removing malonic acid from aqueous solution. Batch experiments were conducted to investigate the effects of adsorbent dosage, absorbate concentration, contact time and temperature on the adsorption of malonic acid on the rice bran.

MATERIALS AND METHODS

All the chemicals were purchased from Merck. Before the process of adsorption characterization the rice bran must be prepared. Thus, the amounts which are needed were mixed with distilled water by stirrer-magnet for 1 hr. Then it was washed with distilled water until a pH of 7.0 was attained, derived in an oven at 50°C for 24 hr and stored in the desiccators. It was furthuer crushed grined and sieved to average size <0.5 mm in accordance with the American Society for Testing and Materials (ASTM). All experiments were carried out by samples containing 50 cc of different initial concentration (0.01- 0.05 M) of Malonic acid in the range of 28-60°C temperature. Four 4 g of the adsorbent was transferred into various 250 ml Erlenmeyer flask and malonic acid solution by fixed concentration was added and mixed using a stirrer- magnet for 1 hr. Then the solution was filtered and its concentration was determined by titration with 0.04 M solution of NaOH. The amount of equilibrium adsorption, q_e (mg/g), was calculated by:

$$q_e = \frac{(C_0 - C_e)V}{W}$$

where C_0 and C_e (mg/l) are the liquid-phase concentrations of malonic acid at initial and equilibrium, respectively. V (l) is the volume of the solution and W (g) is the the mass of dry adsorbent used (Brown, 2000).

RESULTS AND DISCUSSIONS

The mentioned process was controlled by several operational parameters. In order to enhance the process performances, the in fluencies of these parameters were studied as follows:

Effect of Adsorbate Concentration

Several stock solutions (0.01-0.05 M) were prepared. Each solution was added to 4.0 g of the adsorbent in different 250 ml flasks and agitated using a mechanical agitator for 1 hr each. At the end of the time, the contents of the flasks were filtered and analyzed. The results are shown in Figure 1.

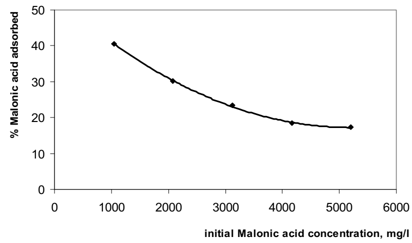

Figure 1. Influence of initial malonic acid concentration on adsorption of malonic acid on rice bran

It was found that the percentage of malonic acid removal decreased with increase in initial malonic acid concentration. This can be explained by the fact that more adsorption sites were being covered as the malonic acid concentration increases. For all these runs, initial malonic acid concentration was fixed as 100 mg/l.

Effect of Adsorbent dose

Fifty ml each of the malonic acid solutions were added to various amount of the adsorbent (0.2-7.0 g) in different 250 ml flasks, flasks were agitated for 1hr on a mechanical stirrer. The content of the flask was filtered and analyzed. The results are presented in Figure 2. The maximum removal of malonic acid was obtained in the adsorbent dose of 90 g/l. It is expected that an increase in the dosage of adsorbent should yield a corresponding increase in the amount of malonic acid adsorbed on the surface of the adsorbent since there will be more sites for the adsorbate to be adsorbed. Therefore competition for bonding sites between molecules of the adsorbate should decrease with increase in dose of the adsorbent (Wan Ngah, 2008; Bulut and Aydin, 2006). From Figure 2 this trend was inconsistent and therefore suggests that the use of rice bran as adsorbent partly depend on its dose in aqueous solution. Further increase of adsorbent dose did not cause any significant change because equilibrium was achieved between solution and solid phase.

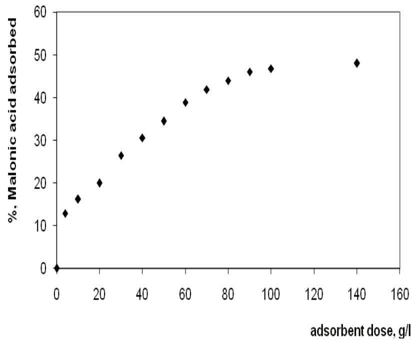

Figure 2. Influence of adsorbent dose on adsorption of malonic acid on rice bran

Effect of Contact Time

Fifty ml each of stock solution of malonic acid was transferred into different 250 cm^3 Erlenmeyer flask, corked and labeled. Four g each of the adsorbent was weighed into the different labeled flasks and agitated in a shaker for different contact times (3, 5, 10, 20 and 60 minutes). After each agitated time, the content of each flask was filtered. The equilibrium concentration of the metal in each of the filtrate was determined. The results obtained are shown in Figure 3.

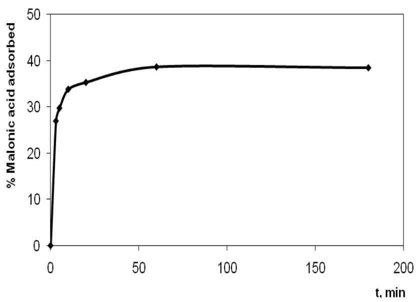

Figure 3. Influence of contact time on adsorption of malonic acid on rice bran

As the contact time was increased, the amount of malonic acid removed also increased. The data showed malonic acid removal from aqueous solution increases initially until equilibrium was attained and then was constant. In according to Figure 3, the observable time for maximum adsorption is between 50-60 minutes.

Effect of Temperature

Fifty ml each of stock solution was transferred into various 250 cm^3 flask containing 4.0g each of the adsorbent, corked and labeled for different temperatures 28, 45, 50, 60°C respectively. The mixture was heated and shaken to the appropriate temperature in a water bath. At the right temperature, the content of the each of the flask was removed, filtered and analyzed. The results obtained are shown in Figure 4.

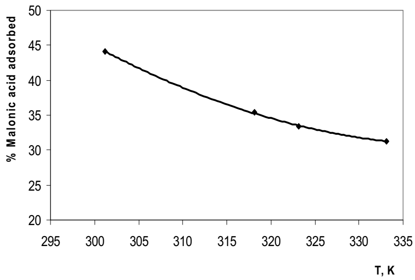

Figure 4. Influence of temperature on adsorption of malonic acid on rice bran

The effect of temperature on the removal of malonic acid from aqueous solution was investigated by varying the temperature of adsorption between 28°C and 60°C (Figure 4). The data showed that with increasing temperature the amount of malonic acid adsorbed on the surface of the adsorbent decreases. The attractive forces between the adsorbent and the adsorbate ion may have been weakened making the adsorption to decrease. At high temperature, the thickness of the boundary layer is expected to decrease due to the increased tendency of the ions to escape from the surface of the adsorbent to the solution phase hence there is bound to be weak adsorption interactions between the adsorbent and the adsorbate.

CONCLUSIONS

The results showed that the adsorption was dependent on all related parameters. The adsorption capacity was found to be 1.24 mg/g. The sorption of malonic acid on the rice **(***Oryza* *sativa* L.) bran was rapid during the first 20 minutes and the equilibrium was found to be attained within 50 mines.

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THE EFFECT OF SOWING DATE ON YIELD AND YIELD COMPONENTS AND SEED QUALITY OF CORN (*Zea mays* L.)

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Abstract

The seed yield of corn (Zea mays L.) consists of different proportional contributions of the effective factor in all growth stages from emergence to maturity. The aim of this study was to investigate the effects of two sowing dates on agronomic and seed quality traits such as oil, protein and starch content of three commercial corn cultivars (31G98, NK-Arma and Aveline). Experiments were carried out at two different sowing dates (30 of April and 26 of May) one month between sowing dates in the Aegean region of Turkey during 2012 and 2013 summer growth periods. The experiment was a randomized block design with three replications. The results of this study showed that sowing date had statistically effected on thousand seed weight, the seed number in corncob, corncob length, seed yield, ash, oil, protein, starch contents of corn seed. In particular, it was revealed that thousand seed weight, the seed number in corncob, corncob length, seed yield, protein, ash and oil contents of seed were decreased with the delaying sowing date due to decreasing the time of growth period and seed filling. On the other hand, starch content of seed was increased by delaying sowing date in both years. The highest seed yield was obtained from Aveline corn cultivar in late sowing date in both years because of having high thousand seed weight. The percentage of decreased in terms of protein was to highest in Aveline cultivar with the delaying sowing date. It was suggested that eventough the Aegean climate has a long growing period and is a suitable environment for second crop corn growth, the selection of cultivar is very important to grown in terms of seed yield in late sowing date because of the fact that plant can be exposed to inappropriate excessive temperature during the vegetative period in late sowing date in Aegean region.

Key words: *corn, sowing date, seed yield, protein, NIRS.*

INTRODUCTION

The seed yield of corn (*Zea mays* L.) consists of different proportional contributions of the effective factor in all growth stages from emergence to maturity. For a better understanding of climatic and cultural effects on corn yield and grain quality, intensive research that evaluates different geographic locations, sowing dates and genotype selection are needed. In order to minimized negative effect of some abiotic and biotic stress on plant, sowing date can play a major role in determining the seed yield, quality, seed germination and understanding whole phenological stages in many regions. Some researchers pointed out that especially, the effect on sowing date and plant density on corn expressed that delay in sowing reduces the number of kernels in corn (Cantarero et al., 2000). Shunway et al. (1992) explained that delay in sowing reduces quality performance and performance components of maize. Early and intermediate sowings tend to best utilize solar radiation for grain production (Otegui et al., 1995). The most widely used information about how corn hybrids respond to sowing date and plant population have been generated from research done about for a long time, in which the first sowing dates were late April or early May in Turkey.

This experiment was conducted to the effect of different two sowing dates on agronomic and seed quality traits such as oil, protein and starch content of three commercial corn cultivars.

MATERIALS AND METHODS

The experiment was conducted in the Research and Experimental Farm at the Adnan Menderes University in Aydın, located in the Western Turkey at 37º 44’ N 27º 44’ E at 65 m above sea level in the 2012 and 2013 years the city of Aydın on western Turkey. The results of some analysis on soil samples from the experiment field are given in Table 1. The soil analysis results are observed that the experiment field has loamy sand content, its reaction had alkaline characteristics and it has low levels of organic matter. The average monthly temperature and precipitation values during the time of the experiment (2012 and 2013) are presented in Table 2. It can be seen that the monthly temperature values for the corn season (April – August) in the first year is higher than that of the second year (Table 2).

The field experiment was carried out by split plot design for 4 repeats in two years. 31G98, NK-Arma and Aveline, which are hybrid corn varieties, were used as a experiment material. The main block was sowing date, sub-block was varieties. The harvest area for each variety was 11.2 m^2. The experiment's sowing dates were 30/April/2012-2013 (normal sowing date) and 26/May/2012-2013 (late sowing date) and the emerging dates were observed in 27 of May 2011 and 07 of May 2012.

1000 Seed Weight (g) was obtained by the average weight of 4 x 100. The seed number in corncob (number $plant^{-1}$) was obtained by counting the number of seed of 20 randomly selected cob at each parcel. Data was collected on seed yield per unit area (t/ha) according to the follow equation: Seed yield (t ha^{-1}) = seed weight (kg/plot) × 10.000 m^2 /plot area (m^2) × 100. Per cob yield was calculated by taking their average of 20 cobs from parcel. Per corncob length was obtained by the average corncob lenght of 20 plants in each plot.

Protein, starch and oil content of corn grain were analyzed by using NIRS-FT (Bruker MPA). Ash determination steps: 5 g of ground samples were weighed by tarring the crucible. After the samples were dried for 15 min at 550°C, 5 h, the heater and furnace were kept waiting. Then all were kept in a desiccator to cool. The results were analyzed using the TARİST package software (Açıkgöz et al., 1994) to determine the effect of nitrogen and water dosages on the corn varieties.

Table 1. Soil texture and chemical analysis of soil

Soil texture (%)			pH	Organic matter	P	K	Ca	Na	Fe	Mn
Sand	Silt	Clay		(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
72.0	16.7	11.3	8.4	1.2	2978	101	19	5.6	594	21

Table 2. Monthly mean temperature and total rainfall and long-term mean (1975–2011) during the growing seasons of 2011 and 2012 at the study site in Aydin Province, Turkey

Months	Temperature (°C)			Precipitation (mm)		
	2011	2012	Long term	2011	2012	Long term
January	8.1	5.6	8.2	147.2	160.0	121.0
February	9.6	6.8	8.9	68.6	154.0	95.5
March	11.4	10.6	11.7	26.1	38.6	71.1
April	14.6	16.3	15.7	51.5	83.8	45.5
May	19.6	20.1	20.9	44.7	43.6	33.5
June	25.1	27.0	25.9	14.6	2.4	14.0
July	31.0	29.6	28.4	0.0	3.2	3.5
August	28.8	27.9	27.2	0.2	0.0	2.2
September	26.2	22.7	23.2	32.2	0.0	14.4
October	16.3	19.9	18.4	69.8	60.4	43.8
November	11.3	14.5	13.0	-	45.6	87.5
December	9.6	9.7	9.4	87.8	202.0	110.2

RESULTS AND DISCUSSIONS

The results of the analysis of variance showed (Table 3) that sowing date significantly affected on thousand seed weight, the seed number in corncob, corncob length, seed yield, ash, oil, protein, starch contents of corn seed. There were also statistically significant differences in terms of corncob length, thousand seed weight and protein content among the years (Table 3).

It was revealed that corn cultivars different response to sowing date in terms of corncob length, seed yield, starch and thousand seed weight. In respect to yield attributes such as cob length, weight of cobs per plant were found significantly higher in 26 May sowing date in both years (Table 4).

It could be due to the better growth and development of crop as Kolawole et al. (2009) reported that due to the fact that good photosynthates accumulated in leaves and its transfer to economic part like grains, cobs etc.

This research showed that early sowing produced greater yields compared to late sowing in both years, and also the lowest pod yield was obtained for the latest sowing date in both years (Table 4), since seed filling and harvest time were affected by cold weather, rain, and frost after the late sowing date (Naab et al., 2004). In addition, the late sowing date has a higher probability of experiencing water stress during the critical seed-filling phase, resulting in lower yields (Nigam et al., 1998).

It might be suggested in this study that the late planted crop had a shorter period for the production of seed and a slightly lower rate of seed production due to reduced growth, and exposure of plants to warmer and longer photoperiod (long day) after the late sowing date. These differences were also largely related to the number of developing seed on cob. Percent of protein content in grain significantly affected by dates of sowing in both the years, the highest protein value was recorded in 2012 year.

Table 3. The result of variance analyses for all components measured of three corn genotypes in different sowing in 2012 and 2013 years

Variance Source	d.f	Calculated of Mean Square							
		CL	GN	1000SW	Yield	Protein	Oil	Ash	Starch
Y	1	30.932**	ns	9842.293**	ns	ns	ns	ns	ns
G	2	25.977**	ns	ns	4.938*	ns	ns	ns	3.484*
S.D	1	81.571**	473389.868**	7609.364**	111.769**	ns	3.731**	0.016**	9.151**
YxG	2	49.414**	18902.626**	ns	ns	ns	ns	ns	ns
YxS.D	1	ns	ns	6605.087**	ns	1.460**	ns	ns	ns
GxS.D	2	24.707**	ns	4422.008**	ns	1.342**	ns	0.009*	ns
YxS.DxG	2	37.656**	ns	3003.563*	ns	1.465**	ns	ns	ns
$LSD_{0.05\ Y}$		1.182	ns	19.078	ns	ns	ns	ns	ns
$LSD_{0.05\ G}$		1.447	55.031	ns	114.328	ns	ns	ns	0.809
$LSD_{0.05\ S.D}$		1.182	ns	19.078	93.349	ns	0.121	0.029	0.661
$LSD_{0.05\ YxG}$		2.047	77.826	ns	ns	ns	ns	ns	ns
$LSD_{0.05\ YxS.D}$		ns	ns	26.980	ns	0.478	ns	ns	ns
$LSD_{0.05\ GxS.D}$		2.047	ns	33.043	ns	0.585	ns	0.049	ns
$LSD_{0.05\ YxS.DxG}$		2.894	ns	46.730	ns	0.827	ns	ns	ns

*** P<0.001; ** P<0.05, ns: non-significant, Y: Years, G: Genotype, S.D: Sowing Date, CL: Cob Length, GN: Grain Number per cob, 1000SW: Thousand Seed Weight, d.f: degree of freedom.

Table 4. Growth characters of three hybrid corn as influenced by dates of sowing and years

Treatments	Cob lenght (cm)		Number grain per cob (number)		1000 seed weight (g)		Seed yield (kg ha)	
	2012	2013	2012	2013	2012	2013	2012	2013
Sowing date								
30. April	21.75	24.11	703.51	752.48	317.22	357.97	1493.03	1576.53
26. May	19.24	20.60	485.16	512.15	353.98	379.37	1040.29	1078.20
Cultivars								
31G98	20.78	25.40	571.73	700.42	316.78	386.00	1111.50	1301.42
NK-Arma	19.26	21.31	608.30	612.38	316.55	366.50	1272.06	1339.20
Aveline	21.46	20.36	602,96	584.16	374.47	353.51	1416.39	1341.48

Table 5. Grain quality parameters of three hybrid corn as influenced by dates of sowing and years

Treatments	Oil content (%)		Protein (%)		Ash (%)		Starch content (%)	
	2012	2013	2012	2013	2012	2013	2012	2013
Sowing date								
30. April	3.76	3.79	8.40	7.89	1.40	1.34	72.48	72.25
26. May	3.14	3.12	7.76	7.97	1.34	1.38	73.44	73.31
Cultivars								
31G98	3.44	3.44	8.07	8.11	1.41	1.40	72.85	71.66
NK-Arma	3.36	3.41	8.20	7.61	1.38	1.36	72.76	73.27
Aveline	3.55	3.51	8.10	8.06	1.39	1.38	73.05	73.41

The changing of protein content affected by sowing was very different in terms of years and cultivars. Protein content was decreased by late sowing date in 2012, while it was insignificantly increased by sowing date in 2013 (Table 5).

Differences in oil content among sowing date are usually associated with differences in the proportion of the kernel constituted by the embryo in different stage. In both years oil content of cultivars were decreased by sowing date.

The highest oil content from grain was obtained from Aveline corn hybrid in both years (Table 5). There are conflict opinion in literature that Gyenes-Hegyi et al. (2001) also reported no significant effect of growing season on the oil content of the 12 single-cross maize hybrids studied in their two-year research, whereas other authors (Zhang et al., 1993) reported significant variations in protein and/or oil contents in different years.

And also according to Fabijanac et al. (2006) point outed that the negative association between oil concentration and kernel weight can be partially explained by differences in the structural components of the kernel (i.e., the weight of the endosperm and the embryo).

Hybrids with small kernels would have a higher proportion of their kernels as embryo and endosperm aleurone layer, which contain almost all of the total grain oil (Kereliuk and Sosulski, 1995). Therefore, the oil content obtained from early sowing, which has small grain was higher than that of late sowing. Hence, our results finding was agree with those results.

The highest yielding hybrid, which was Aveline cultivars, had the highest grain starch content (Table 4 and 5).

CONCLUSIONS

In this study, corn hybrids commercially available at delayed sowing date cannot be successfully grown (4 weeks later than optimum) in Turkey because of having season shorter than full season maturity characteristics.

All recently released hybrids, studied in our investigation, there were significantly differences among the cultivars in both sowing date.

But in both years Aveline corn hybrid cultivar produced higher grain yields than the others corn hybrid.

And also to achieve high oil, starch in corn grain, the cultivars, which have highest seed yield, can be selected in the future breeding program.

Generally, late sowing date can easily disrupt the quality of grain in all corn cultivars. Therefore, it was suggested that eventough the Aegean climate has a long growing period and is a suitable environment for second crop corn growth, the selection of cultivar is very important to grown in terms of seed yield in late sowing date because of the fact that plant can be exposed to inappropriate excessive temperature during the vegetative period in late sowing date in Aegean region.

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GRAIN YIELD AND PROTEIN OF BARLEY IN DEPENDENCE OF PHOSPHORUS AND POTASSIUM NUTRITION

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Abstract

The different levels of phosphorus and potassium nutrition on the productivity of two-rowed winter barley (Hordeum vulgare L.) cv. Kamenitza were studied under conditions of pot experiments. Two greenhouse pot experiments with increased nitrogen, phosphorus, and potassium fertilizing levels were conducted. The effect of potassium fertilization and different levels of nitrogen fertilizing was studied at the first experiment. The investigated nitrogen levels were 0, 200, 400 and 600 mg N/kg soil and the levels of potassium fertilizing were 0, 200, 400 mg K_2O/kg soil. The aim of the second pot experiment was to establish the effect of increasing levels of phosphorus fertilizing at a background of 400 mg N and 200 mg K_2O per kg soil on the barley grain and protein yields. The plants were grown in plastic pots (5L volume). Each pot was contained 5 kg soil (Molic fluvisol) with pH $_{(H2O)}$ - 7.3, humus content 3.2%, Nmin - 39.8 mg N/kg, available phosphorus (method of Egner - Riehm) - 102 mg P_2O_5/kg, and available potassium (2 N HCL) - 460 mg K_2O/kg. The different levels of mineral nutrition at two pot experiments were created by applying of NH_4NO_3, $Ca(H_2PO_4)_2.H_2O$, and K_2SO_4 in the form of water solutions. Thirty seeds were sown in each pot ant the plants were reduced to equal number in each pot (15) at tillering. Phosphorus and potassium fertilizing were a proved positive effect on the nutrient regime of barley plants, productivity and grain quality. Moderate phosphorus fertilizing 200 mg $P_2O_5.kg^{-1}$ soil combined with levels $N_{400}K_{200}$ showed the highest grain and protein yields and grain protein concentrations. Grain protein concentration increased from 12.5 to 13.5% and protein yield increased by 28.6%, compared to variant without phosphorus $N_{400}P_0K_{200}$. The K levels of 200 and 400 mg $K_2O.kg^{-1}$ soil increased the grain yield when were combined with nitrogen levels of 200 - 400 N mg/kg soil. The changes of potassium nutrient regime by fertilizing alone in a range K_0 - K_{400} on the background of N_0P_{200}, slightly affect the grain protein concentrations and yields of barley. The potassium fertilization demonstrated a positive effect on the concentrations of plant nitrogen at tillering. The concentrations of N and P of barley plants at tillering stage slightly depended on fertilizing levels P_0-P_{400}.

Key words: *barley, phosphorus, potassium, productivity, protein.*

INTRODUCTION

The winter barley in Bulgaria occupies at about 190 000 hectares and many factors negatively affect on barley production, but decisive of them are land property reform and fertilization. The mineral fertilizer application in Bulgaria was sharply decreased and the application of phosphorus and potassium, especially (Agrarian Report, 2012). The potassium balance in Bulgarian agriculture has always been a negative (Gorbanov et al., 1998). The phosphorus balance from a positive (+90 $kg.ha^{-1}$) has become a negative (Gorbanov and Gorbanova, 1998). Phosphorus and potassium nutrition in barley is influenced by levels of supplying of these nutrients, cultivation practices, crop species and environmental conditions (Dessougi et al., 2002; MacLead, 1999). The natural potassium reserves in Bulgarian soils are relatively high, but the need of potassium fertilizing is increased under intensive nitrogen and phosphorus applications (Rachovski et al., 2010). Compared to N, application of phosphorus and potassium has been neglected from many farmers and this has resulted in the continual depletion of soil P and K (Tomov et al., 2006). Inadequate P and K applications leads to imbalance in agricultural ecosystems and stagnation of yields will become more pronounced with time (Regmi et al., 2002). Long term experiments have shown that high yields and good grain quality can be achieved from balanced NPK supply (Belay et al., 2002). To ensure sustained crop production under intensive cropping, application of recommended doses of NPK is required (Rupa et al., 2003). A nitrogen-potassium interaction generally exists in agricultural ecosystems (Johnston and Milford, 2009). The effect of phosphorus and potassium fertilizing on the productivity and grain quality of barley grown on soils with different available phosphorus and potassium in Bulgaria was studied on a small scale. The objective of the present study was to established the effect of increased levels of phosphorus and potassium on the yield and grain quality of barley plants under pot experiments.

MATERIALS AND METHODS

Two pot experiments with increased nitrogen, phosphorus, and potassium fertilizing levels were conducted under greenhouse conditions with barley variety Kamenitza. The effect of potassium fertilization and different levels of nitrogen fertilizing was studied at the first experiment. The investigated nitrogen levels were 0, 200, 400 and 600 mg N/kg soil and the levels of potassium fertilizing were 0, 200, 400 mg K_2O/kg soil. The aim of the second pot experiment was to establish the effect of increasing levels of phosphorus fertilizing at a background of 400 mg N and 200 mg K_2O per kg soil on the barley grain yield and protein. The plants were grown in plastic pots (5L volume). Each pot contained 5 kg Molic fluvy soil with $pH_{(H2O)}$ - 7.3, humus content 3.2%, Nmin - 9.8 mg $N.kg^{-1}$, available phosphorus (method of Egner - Riehm) - 109 mg $P_2O_5.kg^{-1}$, and available potassium (2 N HCL) - 460 mg $K_2O.kg^{-1}$. The different levels of mineral nutrition at two pot experiments were created by applying of NH_4NO_3, $Ca(H_2PO_4)_2.H_2O$, and K_2SO_4 in the form of water solutions.
Thirty seeds were sown in each pot at the beginning of December. The barley plants were reduced to equal number in each pot (15) at the tillering stage. The removed plants were used for analyses. The analyses of plant vegetative mass and grain were done after wet combustion using concentrated H_2SO_4 and H_2O_2 as a catalyst by using common methods (Tomov et al., 2009). The grain protein concentrations were calculated by multiplying total nitrogen concentrations of grain by factor 5.7 (% N total x 5.7). An overall analysis of variance (ANOVA) was performed to evaluate the effect of the experimental treatments on the referred variables, and Duncan's multiple range test (α = 0.95) was used in order to establish the difference among the means.

RESULTS AND DISCUSSIONS

The nitrogen supplying was the main factor affecting barley grain yields (Figure 1). The result showed yield decreasing when N level was higher then N_{600}. The potassium levels of 200 and 400 mg $K_2O.kg^{-1}$ soil increased the grain yield when were combined with nitrogen levels of 200-400 N mg/kg soil. A similar effect was observed in biomass productivity of barley at maturity (data not shown).
The highest grain yield was obtained at phosphorus fertilizing level of 200 mg $P_2O_5.kg^{-1}$ soil (Figure 2). The high level of P_{400} showed a negative effect on the productivity of barley grain and aboveground biomass, but the differences were no significant with level P_{400}. The similar results were obtained for barley biomass productivity.

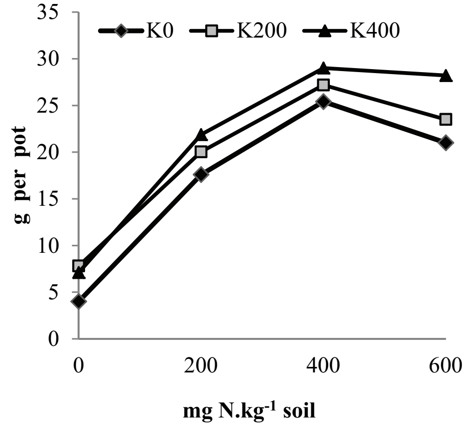

Figure 1. Barley grain yields in dependence of nitrogen and potassium levels of fertilizing.

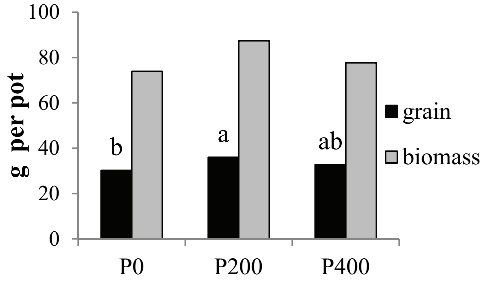

Figure 2. Barley productivity in dependence of phosphorus levels.

At tillering barley plants grown without nitrogen fertilizing had very low nitrogen concentration below 2.5% N (Table. 1). The potassium fertilization demonstrated a positive effect on the concentrations of plant nitrogen. All combinations of high potassium level K_{400} with nitrogen fertilizing 200 – 600 mg N.kg^{-1} soil showed nitrogen concentrations higher then 4.5% N, or very good nitrogen supply of plants. The plants received a high amount of potassium (K_{400}) reacheded the optimal range values of a winter barley still at nitrogen level N_{200}. It proves the favorable role of the potassium on the nitrogen nutrition of this crop. The plants grown at levels $N_{400}K_{200}$ and $N_{600}K_0$ were demonstrated similar nitrogen concentrations.

Table 1. Effect of nitrogen and potassium levels on the nitrogen concentrations of barley plants at tillering

Variants	K_0	K_{200}	K_{400}
1. N_0P_{200}	2.08 c	2.15 c	2.21 c
2. $N_{200}P_{200}$	4.15 b	4.35 a	4.62 b
3. $N_{400}P_{200}$	4.38 a	4.40 a	4.75 a
4. $N_{600}P_{200}$	4.39 a	4.42 a	4.61 b

Values in each column followed by the same letters are not significantly different at p<0.05 according to Duncan's multiple range test.

The obtained results showed no significant effect of the phosphorus levels (ranged from 0 to 400 mg P_2O_5.kg^{-1} soil) on the concentrations of plant nitrogen and potassium at tillering stage (Table 2). Applying of phosphorus 200 and 400 mg P_2O_5.kg^{-1} soil was increased the concentration of this nutrient from 0.32% to 0.86% P_2O_5. The values of total phosphorus at tillering were higher than the sufficiency range levels for this stage of winter barley proposed by Bergmann (1992). The phosphorus fertilizing did not affect significantly potassium concentration of barley plants at tillering.

The changes of potassium nutrient regime by fertilizing alone in a range K_0 - K_{400} on the background of N_0P_{200}, slightly changed the grain protein concentrations and yields of barley (Table 3). The best results with regard to the grain protein concentration and yield were observed when a high potassium fertilizing K_{400} was combined with higher nitrogen supply $N_{400}P_{200}$ and $N_{600}P_{200}$. Simultaneously used a high level of nitrogen N_{600} and potassium levels K_{200} or K_{400} did not show the positive effect on the grain protein yield of barley.

Table 2. Effect of phosphorus fertilizing levels on the concentrations of nitrogen, phosphorus, and potassium of barley plants at tillering

Variants	N %	P_2O_5 %	K_2O %
1. $N_0P_0K_0$	2.21 b	0.30 c	3.20 b
2. $N_{400}P_0K_{200}$	4.53 a	0.32 c	4.23 a
3. $N_{400}P_{200}K_{200}$	4.39 a	0.72 b	4.19 a
4. $N_{400}P_{400}K_{200}$	4.44 a	0.86 a	4.25 a

*Mean values followed by the same letters are not significantly different at p<0.05 according to Duncan's multiple range test.

Table 3. Effect of nitrogen and potassium levels on the grain protein concentrations and yields of barley

Variants	K_0	K_{200}	K_{400}
Protein concentration, %			
N_0P_{200}	8.76 d	8.83 c	8.95 c
$N_{200}P_{200}$	10.70 c	11.80 b	13.50 b
$N_{400}P_{200}$	12.30 b	13.50 a	14.06 a
$N_{600}P_{200}$	13.10 a	13.80 a	14.30 a
Grain protein, g/pot			
N_0P_{200}	0.35 c	0.69 c	0.64 c
$N_{200}P_{200}$	1.88 b	2.36 b	2.95 b
$N_{400}P_{200}$	3.13 a	3.67 a	4.08 a
$N_{600}P_{200}$	2.75 a	3.24 a	4.03 a

Values in each column followed by the same letters are not significantly different at p<0.05 according to Duncan's multiple range test.

The highest values of grain protein concentrations and protein yields were established at moderate phosphorus fertilizing (200 mg P_2O_5.kg^{-1} soil) combined with $N_{400}K_{200}$ (Table 4). As a result of phosphorus fertilizing P_{200} grain protein concentration increased from 12.5 to 13.5%. The obtained protein yield was by 28.6% higher in variant $N_{400}P_{200}K_{200}$ compared to variant without phosphorus $N_{400}P_0K_{200}$. The increasing of phosphorus level to P_{400} (N/P ratio one) at variant $N_{400}P_{400}K_{200}$ significantly decreased grain protein concentrations and yields of barley.

Table 4. Effect of phosphorus fertilizing levels on the grain protein concentrations and yields of barley

variants	Grain protein, %	Protein yield, g/pot
1. $N_0P_0K_0$	10.7 c	2.36 c
2. $N_{400}P_0K_{200}$	12.5 b	3.78 b
3. $N_{400}P_{200}K_{200}$	13.5 a	4.86 a
4. $N_{400}P_{400}K_{200}$	11.9 b	3.90 b

CONCLUSIONS

Under pot experiments phosphorus and potassium fertilizing had a proved positive effect on the nutrient regime of barley plants, productivity and grain quality. Moderate phosphorus fertilizing 200 mg $P_2O_5.kg^{-1}$ soil combined with levels $N_{400}K_{200}$ showed the highest grain and protein yields and grain protein concentrations. Grain protein concentration increased from 12.5 to 13.5% and protein yield increased by 28.6%, compared to variant without phosphorus $N_{400}P_0K_{200}$. The potassium levels of 200 and 400 mg $K_2O.kg^{-1}$ soil increased the grain yield when were combined with nitrogen levels of 200 - 400 N mg/kg soil. The changes of potassium nutrient regime by fertilizing alone in a range K_0 - K_{400} on the background of N_0P_{200}, slightly affect the grain protein concentrations and yields of barley. The potassium fertilization demonstrated a positive effect on the concentrations of plant nitrogen at tillering. The concentrations of nitrogen and potassium of barley plants at tillering stage slightly depended on phosphorus fertilizing levels P_0-P_{400}.

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EXPERIMENTAL RESULTS ON NON-GMO SOYBEAN VARIETIES PRODUCTIVITY IN TULCEA COUNTY CONDITIONS

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Abstract

25 years ago Soybean was an important component of crop rotations in South Romania and Romania was the most important Soybean grower with more than 500 thou ha total sown area. Nowadays, Soybean is minor crop with only 45-72 thou ha. In order to promote Soybean crop the authors elaborated a research program included in Danube Soya European initiative, based on experiments in the field and laboratory, organized in Tulcea County, Macin area. The research program included an experiment with Soybean varieties of different origin: Romanian (Triumf, Columna, Daciana, Victoria, Oana F, from National Agricultural R&D Institute of Fundulea; Eugen, Perla, Felix, Onix, Daciana TD from Agricultural R&D Station of Turda; PS1012, PS1020, of Procera Agrochemicals Company; Sigalia, from Probsdorfer Saatzucht Romania) and Serbian (Neoplanta, Galina, NS Rubin, NS Trijumf, Venerra).
The research carried out in 2010-2011 in Dobrudja region, Macin area showed that the soil and climatic conditions are very suitable for Soybean crop, which produced between 3027 and 5788 kg/ha in 2010 and between 2785 and 4393 kg/ha in 2011. In this context the research illustrated the high productivity potential of semi-early and semi-late varieties, characterized by high number of pods (57 pods) and grains (149 grains) per plant, grain production per plant (22.6 g) and TGW (151.7 g).
Based on these results, the authors recommended the extension of Soybean crop in the area, first of all in the irrigated areas, as an important component for better crop rotations and very suitable previous crop for winter wheat and a valuable source of fodder for animal production units and source of profit for Tulcea County farmers.

Key words: *soybean crop, Tulcea County, soybean varieties, productivity.*

INTRODUCTION

Covering a larger percentage of protein needs by own production is a priority of the European agricultural-food policy, stated as such in the Horizon 2020 strategy. Among the plant sources of protein for Romania (and Europe too), together with sunflower (about 800 thou ha) and rape (400-500 thou ha), Soybean can contribute to the production of increased amounts of proteins, of high quality, for food and feed purpose. In this regard, currently Europe secures only 3-5% of the soybean needs from its own production, the rest being covered by imports of seeds and cakes from the USA, Brazil and Argentina.
Prerequisites for increasing soybean acreage in Romania are very favorable: natural conditions (climate, soil) meet the requirements of soybean; there is an assortment of valuable varieties adapted to our conditions, including Romanian creation; Romanian farmers have experience in soybean cultivation, if given the expansion of the agricultural crop in the past, up to 500 thou ha.
As a result, research on soybean crop in doctoral thesis initiated in 2009-2010 fits well in European and national priorities, and present paper, which includes some of the results of this research, is part of the requirements of current times.

MATERIALS AND METHODS

The research was organized in Dobrogea region, Tulcea County, the polder near Macin City, an area with groundwater supply, in SC Lombardi Agro Ltd farm, within soybean crop occupies large areas each year (Figure 1). Conditions in this area are favorable for soybean crop: 10.5^{o}C average annual temperature; 489 mm annual rainfall; 2195 hours of sunshine duration; an aluvosoil with 2.6 Nitrogen Index, 62 ppm of Phosphorus and 140 ppm of Potassium contents and pH 7.7.

Figure 1. Tulcea County location in southeast of Romanian territory (www.rovt.ro/romania_map_ro)

Experimental years were different in terms of weather (Table 1): agricultural year 2009-2010 was characterized by 11.0°C average temperature, 445.7 mm annual rainfall and favorabile evolution of meteorological parameters during soybean growing season.

Table 1. Climatic features of the experimental area (multiannual values - Galati Meteo Station, National Institute of Meteorology and Hydrology)

Months	Sunshine duration (hours)	Air temperatures (°C)			Rainfall (mm)
		maximum values	mean values	minimum values	
I	76.0	13.3	-2.9	-23.4	31
II	35.7	17.6	-0.4	-19.4	34
III	138.2	24.6	4.0	-15.2	27
IV	192.1	29.2	11.0	-3.6	37
V	259.9	33.4	16.5	2.9	58
VI	293.6	34.6	20.3	3.7	50
VII	307.6	36.7	22.0	7.3	51
VIII	291.7	35.3	21.4	7.4	49
IX	230.3	35.7	17.1	-6.8	46
X	185.2	28.3	11.0	-6.8	29
XI	85.1	25.1	6.0	-10.2	36
XII	62.6	17.6	0.2	-14.5	31
Yearly values	2195.1	36.7	10.5	-23.4	489

By comparison, the 2010-2011 year was less favorable in terms of ensuring water, with only 365.5 mm annual rainfall and only 4.7 mm rainfall in August and September (compared with 107.6 mm annual average) in the growing stages of Soybean grains setting up and maturation, which was reflected in the yields level.

In the field was located an experiment with 20 varieties of Soybean, of Romanian and Serbian creation (Table 2), provided by breeders from NS Seme Novi Sad, NARDI Fundulea, ARDS Turda, Probsdorfer Saatzucht Romania. In the experimental field has applied the growing technology recommended for Soybean in the area. In the research has developed a program of phenological observations (dates of emergency, flowering, and physiological maturity) and biometric measurements (plant height, basal pods insertion height, number of pods/plant, number of grains/plant, grain weight/plant, TGW). The results were averaged and processed by analysis of variance.

RESULTS AND DISCUSSIONS

Weather suitability of the agricultural year 2009-2010 is reflected by the yields obtained in soybean (Table 2). In the experiment were harvested 3021.1-5788.3 kg grains/ha, on average 4550.2 kg/ha, which illustrates the high productivity of the tested biological material. Differences between varieties productivity were significant - from simple to double -, which is due to the diversity of biological material and its adaptability to natural conditions of the research.

Figure 2. View on Soybean crop in Macin Experimental Field (June 2010)

The semi-late and semi-early varieties posted the higher productions (over 5200 kg/ha): Zora (5788.3 kg/ha), PS2012 (5633.3 kg/ha), Galeb (5551.7 kg/ha), PR92B63 (5489.3 kg/ha), Sponsor (5417.5 kg/ha), Sigalia (5293.6 kg/ha). These varieties were characterized by the following morphological characteristics: 101.7 cm plant height; 10.9 cm basal pods insertion height; 57.1 pods/plant; 135.2 grains/plant; 2.3 grains/pod; grain yield 22.0 g/plant; TGW=166.1 g.

Table 2. Soybean varieties productivity in 2010 experimental year (kg/ha) (Macin Experimental Field)

Nr. crt.	Varieties	Grain yields (kg/ha)	(%)	Differ-ences (kg/ha)	Significance
1.	Zora	5788.3	127.2	1238.1	*
2.	PS1012	5633.3	123.8	1083.1	*
3.	Galeb	5551.7	122.0	1001.5	*
4.	PR92B63	5489.3	120.6	939.1	*
5.	Sponsor	5417.5	119.1	867.3	*
6.	Sigalia	5293.6	116.3	743.4	*
7.	PS1020	5195.2	114.2	645.0	*
8.	NS Rubin	5137.5	112.9	587.3	*
9.	Tea	4906.6	107.8	356.4	*
10.	NS Trijumf	4900.0	107.7	349.8	*
11.	Forteza	4896.6	107.6	346.4	*
12.	Triumf F	4820.8	105.9	270.6	
13.	Galina	4782.5	105.1	232.3	
14.	Condor	4717.5	103.7	167.0	
15.	Venerra	4624.1	101.6	73.9	
16.	Columna	4600.8	101.1	50.6	
Mean		**4550.2**	**100.0**	**Mt.**	**-**
17.	Julija	4324.3	95.0	-225.9	
18.	Neoplanta	4261.6	93.6	-288.6	o
19.	NS Mercury	4231.4	93.0	-318.8	o
20.	Dukat	4172.5	91.7	-377.7	o
21.	Eugen TD	4005.0	88.0	-545.2	o
22.	Perla	3860.8	84.8	-689.4	o
23.	Felix	3820.8	84.0	-729.4	o
24.	Onix	3710.0	81.5	-840.2	o
25.	Victoria	3706.6	81.4	-843.6	o
26.	Daciana TD	3453.1	75.9	-1097.1	o
27.	Diamant	3078.3	67.6	-1471.9	o
28.	Oana F	3027.1	66.5	-1523.1	o

LSD 5% 242.75 kg/ha

By comparison, early varieties produced less than 4000 kg/ha, and 689.1-1523.1 kg/ha less in comparison with average yield of the experiment. The majority of these varieties belong maturity groups early and very early (Pearl, Felix, Oana F, Onyx, Diamond), who developed and matured early and were unable to efficiently use the full heat potential of the area. These varieties were characterized by the following traits: 103.4 cm plant height; 11.0 cm basal pods insertion height; 46.1 pods/plant; 110.3 grains/plant; 2.2 grains/pod; grain yield 17.3 g/plant; TGW=151.5 g.

In the second experimental year, atmospheric drought and insufficient rainfall especially in the latter part of the growing season, limited the productive potential of the tested varieties, so yields ranged from 2785.0 to 4393.3 kg/ha, in average 3564.6 kg/ha.

Varieties highlighted in the previous year were again Sponsor, Zora, Galeb, PR93B63 with over 3700 kg/ha, plus Galina Dacian TD and Tea. Varieties with lower production, remain early varieties Oana F, Pearl, Onyx, Diamond, with under 3400 kg/ha.

This year, obviously Soybean plants growth was affected by the evolution of meteorological parameters, the plants of best varieties developed following characteristics: 85.0 cm plant height; 18.6 cm basal pods insertion height; 32.5 pods/plant; 76.7 grains/plant; 2.3 grains/pod; grain yield 10.5 g/plant; TGW=137.1 g.

Table 3. Soybean varieties productivity in 2011 experimental year (kg/ha) (Macin Experimental Field)

Nr. crt.	Varieties	Grain yields (kg/ha)	(%)	Differ-ences (kg/ha)	Signific-ances
1.	Sponsor	4393.3	123.2	828.7	*
2.	Triumf F	4031.6	113.1	467.0	*
3.	Zora	3969.3	111.3	404.7	*
4.	Galina	3920.8	109.9	356.2	*
5.	Daciana TD	3898.3	109.4	333.7	*
6.	Galeb	3880.0	108.8	315.4	*
7.	Tea	3845.8	107.9	281.2	*
8.	PR92B63	3700.0	103.8	135.4	
9.	Sigalia	3694.2	103.6	129.6	
10.	Neoplanta	3690.8	103.5	126.2	
11.	NS Rubin	3680.8	103.3	116.2	
12.	PS1020	3651.0	102.4	102.4	
13.	PS1012	3650.0	102.4	85.4	
14.	NS Mercury	3573.3	100.2	8.7	
Media		**3564.6**	**100.0**	**Mt.**	**-**
15.	Forteza	3555.8	99.7	-8.8	
16.	NS Trijumf	3541.0	99.3	-23.6	
17.	Columna	3538.3	99.3	-26.3	
18.	Eugen	3535.0	99.2	-29.6	
19.	Julija	3511.6	98.5	-53.0	
20.	Condor	3465.0	97.2	-99.6	
21.	Felix	3400.8	95.4	-163.8	
22.	Venerra	3400.0	95.4	-164.6	
23.	Dekat	3338.3	93.6	-226.3	o
24.	Oana F	3319.2	93.1	-245.4	o
25.	Perla	3120.0	87.5	-444.6	o
26.	Diamant	2870.8	80.5	-693.8	o
27.	Onix	2850.8	80.0	-713.8	o
28.	Victoria	2785.0	78.1	-779.6	o

LSD 5% 184.20 kg/ha

Figure 3. View on Soybean crop in Macin Experimental Field (September 2011)

CONCLUSIONS

Experimental area offers very favorable conditions for Soybean growing: fertile soil characteristics and climatic parameters, supplemented by groundwater and water from irrigation intake.

As a result, the area can achieve very cost-efficient high Soybean yields, near biological potential of Soybean varieties available to growers (about 6000 kg/ha).

In a year with normal meteorological parameters evolution Soybean varieties of semi-late and semi-early maturity groups can produce over 5000 kg/ha. In the research in Macin Experimental Field were detached varieties Zora, Sponsor, PR92B63, Galeb. By these varieties, in a low-rainfall year, but with the right growing technology, the grains productions may exceed 3500 kg/ha, just 4000 kg/ha.

Growing varieties with shorter vegetation season is recommended in the area in cases of late sowing or successive crop.

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EFFECTS OF ZINC AND PHOSPHOROS FERTILIZERS ON SUGAR BEET (*Beta vulgaris* cv. SBSI005 Crouse) YIELD IN IRANIAN HIGH ZINC ALKALINE SOIL CONDITION

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Abstract

In order to evaluate the effects of zinc and phosphate fertilizers on sugar beet yield and agronomical characteristics, an experiment was carried out as factorial based on RCBD with four replications in farm of Navaze village, Arak, Iran in 2010. Experimental factors were including of two levels of zinc utilization (Based on soil test 25 kg/ha) and non zinc utilization and also four level of phosphate fertilizer based on soil test, ammonium super phosphate 125 kg/ha, 250 kg/ha, 375 kg/ha and non P application as control. The indexes assessment were including of number of green leaves, number of yellow leaves, number of dry leaves, Percent of leaf water content, leaf area index, root water content, root length, Percent of purity sugar and sugar yield. Result showed the most purity sugar was 625 g/m^2 by apply of 375 kg/ha ammonium super phosphate plus zinc application.

Key words: *ammonium super phosphate, Iran, sugar beet, zinc.*

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) crop is one of the Chenopodiaceae family famous plants (Watson and Dallwitz, 1992). A cash crop or economically important species of this family is sugar beet. It is normally biennial species, however under certain conditions it can act as annual (Smith, 1987). The sugar beet plant develops a large succulent taproot in the first year and a seed stalk the second year (Smith, 1987). During the first growing season, the vegetative stage, need to enough macro and micronutrients (Duke, 1983). During the second growing season, the reproductive stage, a flowering stalk elongates from the root (Forster et al., 1997).
Recently, Sugar beet is one of the main crops in Iran as one of the most important sources of sugar with large annual consumption. Sugar is as an important resource for energy supply. Sugar beet crop has an important position in crop rotation systems as summer crop not only in the fertile soils, but also in poor, saline alkaline and calcareous soils (Draycoot, 1999).
Zinc is an essential micronutrient and has particular physiological functions in all living systems, such as the maintenance of structural and functional integrity of biological membranes and facilitation of protein synthesis and gene expression (Cakmak et al., 1999). Zinc is a catalyst in many of the enzyme systems used for protein synthesis and carbohydrate metabolism (Alloway, 2004). It is involved in the chloroplast activity and cell metabolism and plant growth processes. Thus, zinc micronutrient can increase yield quantity and quality in sugar beet. Previous research reports showed sugar beet can remove about 350 g/ha zinc per 50 ton sugar beet. The normal level of zinc in the fresh root is 0.05–2.30 mg/kg in normal soil nutrient condition (Stevens and Mesbah, 2004). Zinc availability is limited by high pH, high free calcium carbonate, sandy texture, low organic matter, and where subsoil has been exposed by land leveling (Draycott, 1996). In high zinc concentrations in soils, Zn can be toxic and plants affected may show symptoms similar to those found in other heavy metal toxicities, such as those of Cd or Pb (Foy et al., 1978). Zinc toxicity also induces chlorosis in young leaves, and this has been suggested to result from a Zn induced Fe or Mg deficiency, based on the fact that the three metals have similar ion radii other common Zn toxicity effects include decreases in tissue water content and

changes in the P and Mg concentrations in plant tissues (Marschner, 1995).
Moreover, high zinc concentration decreased N, Mg, K and Mn accumulation in all plants, while phosphorus and Ca concentrations increased in shoot (Cakmak, 2000). Leaves of plants treated with 50 and 100 micromole Zn developed symptoms of Fe deficiency, including decreases in Fe, chlorophyll and carotenoids concentrations. Plants grown with 300 micromole zinc had decreased photosystem efficiency and further growth decreases but did not have leaf Fe deficiency symptoms (Sagardoy et al., 2009).
Phosphorus is a major element in plant nutrition that is most important component of nucleic acids and lipids and is important in the production and transport of sugars in sugar beet plant. Phosphorus is effectiveness in sugar beet early root development (Kharchenko, 1983). It is a critical macro nutrient required for numerous functions in plant, including energy generation, nucleic acid synthesis, photosynthesis, glycolysis, respiration, carbohydrate metabolism and nitrogen fixation (Abel et al., 2002; Vance et al., 2003).
Meanwhile, P deficiency is considered as one of the greatest limitations in agricultural production (Schachtman et al., 1998; Lynch and Brown, 2008). It has been estimated that 5·7 billion hectares of land worldwide are deficient in P. Concentrations of phosphate in soil solutions are generally lower than10 ppm, which are well below the critical level that is needed for the optimal performance of crops (Batjes, 1997).
This problem of P deficiency might be mitigated by the application of concentrated fertilizers that provide soluble Pi or balance nutrition elements for plants. One of the main mechanisms is the ability of the root to absorb P from the soil under zinc soil balance. Sufficient phosphorus and zinc balance ensures rapid root growth and good uptake of other nutrients. Phosphorus is very immobile in the soil and is only taken up within 1-2 mm from the root. Placement of phosphorus will often give higher uptake efficiency and result in a higher availability of phosphorus. Phosphorus deficiency inhibits growth of the sugar beet plants by change the leaf color from dark green to dull blue-green (Ellis et al., 1964). Research indicates that yield increases are expected from phosphorus applications when soil test levels are below 15 ppm (Batjes, 1997).
The objective of our research was to emphasize the effect of different levels of zinc and phosphorus recourses on sugar beet yield and sugar percentage ratio.

MATERIALS AND METHODS

To study the effect of different levels of zinc and phosphorus fertilizer amounts on sugar beet yield and sugar percentage an experiment was conducted at Navazen (49° 46´N, 34°06´E and elevation 1710 m above sea level), Arak, Iran in 2010.
The soil was clay loam (clay: 42%, silt: 39% and sand: 19%), with EC of 0.6 ds/m, Zn absorbability of 2.3 ppm and organic matter of 1.1% at the 0-60 cm soil depth. The experiment was a factorial arrangement in a completely randomized block design with three replications. Treatments were included two levels of zinc (Z) utilization (Based on soil test), Z1 and Z2 were as no zinc consumption and 25 kg/ha $ZnSO_4$ as soil application before planting, respectively. Four level of phosphate (P) fertilizer (P1 to P4) was based on soil test, utilization of ammonium super phosphate chemical fertilizer (ASP) 125, 250, 375 kg/ha and non phosphorus utilize as control.

Table 1. Soil properties in the experimental site at the start of the study (2009)

Soil depth (cm)	0-60
Total N (%)	12.0
pH	7.00
P2O5 (ppm)	5.70
K20 (ppm)	123.0
Organic matter (%)	1.10
Zn (ppm)	2.3

In this experiment the sugar beet variety was SBSI005 Crouse. The field was plowed in autumn 2009 and then was used of two cross over disk in spring 2010. Seeds were hand sown on June 10^{th} and harvesting time was 10^{th} October 2010 in 2.5×6 m plots with a inter row space of 0.5 m.

Nitrogen and potassium fertilizers were added before sowing at a rate of 300 and 200 Kg/ha as a form of urea (46% N) in three equal portions and potassium sulfate (50% K_2O) respectively. Thinning operation was done twice to leave one plant/hill till harvest.

The indexes assessments were measured carefully. Sugar beet characteristics were including number of green, yellow and dry leaves, Percent of leaf and root water content by using the methods of Weatherly (1949), leaf area index (LAI), and root length (cm) at pre harvest time (100 days after sowing date). In addition, percentage of white sugar and sugar yield (kg/m^2) were determined from the three middle rows for each plot and then the sugar yield was also calculated by multiplying root yield x Sucrose % at harvesting time (10th October 2010). The data were treated by analysis of variance using the software SAS and mean were compared by DMRT.

RESULTS AND DISCUSSIONS

Number of green, yellow and dry leaf

Regarding to analysis of variance data results, Phosphorus and Phosphorus zinc interaction treatment had significant effect on number of green leaves 100 days after sowing date. Consequently, yellow leaf number was affected by zinc, phosphorus and both treatments interaction. Number of dried leaves at 100 days after planting (abnormally early dried leaves) also was affected at interaction of treatments and P and Z treatment separate (Table 2).

Sugar beet cell contaminations by zinc have harmful effects on the growth and metabolism of plant leaves. Increase in zinc application (Z2) could amplify the number of yellow (from 3.5 to 4.5) and dried (from 1.25 to 2.6) leaves in sugar beet specially when use of phosphorus fertilizer for 250 kg/ha was accrued in field. As a very imperative note, any incensement in P from 250 to 375 kg/ha can reduce the harmful effects of high zinc availability regarding the P and Zn negative relations in soil.

Leaf Area index

The results showed that the aapplication of zinc had no significant effect on LAI in 100 days after sowing date. Phosphorus treatments and P and Zn interaction had not significant effects on LAI. Data in table 3 showed LAI in case of P2 (250 kg/ha ASP application) and P3 (375 kg/ha ASP application) was highest (11.34 to 12.34) without significant difference. It seems, low level of available P in soil (2.3 ppm) is the most important cause for reduce the LAI in sugar beet (Table 3).

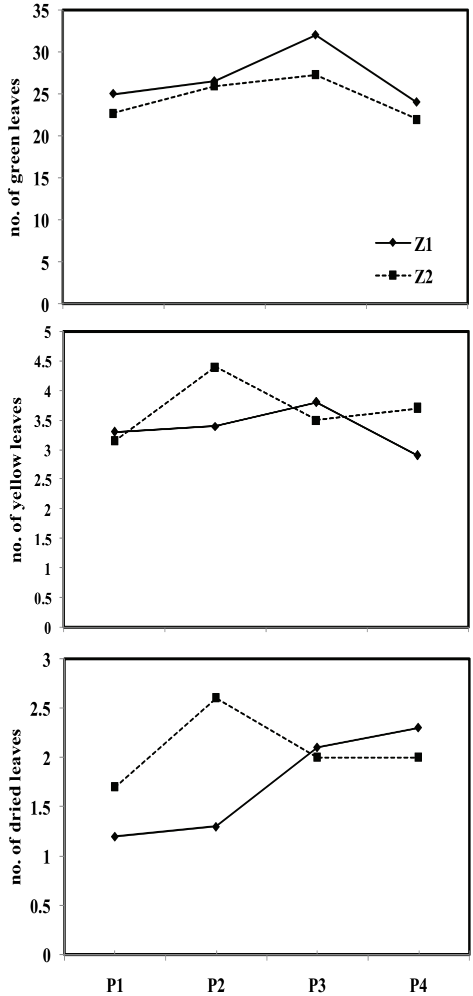

Figure1. Effect of P levels on number of green, yellow and dried leaves under different zinc application. Z1= control and Z2= 25 kg/ha $ZnSO_4$ in soil application. P1=125, P2=250, P3=375 kg/ha ASP and P4= Control

Leaf and root water content

In this field experiment the interaction effects between zinc and phosphorus treatments and also sole treatment effects had not significant differences in leaf and root water content

(Table 2). RWC of mature leaves and roots on 100 days old were unaffected by nutrient imbalance independently by zinc and phosphorus treatments simultaneously.

Table 2. Analysis of variance for effect of zinc and phosphorus on sugar beet

S.O.V	D.F	Mean square								
		No.green leaves	No.yellow leaves	No. dry leaves	LAI	leaf water content	root water content	root length	Sugar %	Sugar yield
Replication	3	16.35 ns	0.34 ns	0.08 ns	3.39 ns	1.72 ns	4.43 ns	0.56 ns	4.38ns	0.08ns
Zinc	1	47.04 ns	0.10 *	0.75 **	2.14 ns	8.40 ns	8.00 ns	11.64 ns	1.11ns	0.02ns
Phosphorus	3	70.15 **	0.77 **	0.99 **	9.72 *	6.31 ns	2.86 ns	9.50 ns	2.52ns	0.09*
Z.P. int.	3	6.18 *	0.85 **	0.72 **	2.31 ns	2.19 ns	2.68 ns	2.35 ns	1.44ns	0.03*
Error	21	31.19	0.13	0.03	2.57	5.07	6.04	5.48	2.38	0.03
Cv%		21.74	10.14	9.55	14.62	3.66	3.11	9.05	18.37	3.11

**: significant differences at P 0.01 level, *: significant differences at P 0.05 level and ns: Non-significant.

Table 3. Mean comparisons for sugar beet characteristics

Treatment	No.green leaves	No.yellow leaves	No. dry leaves	LAI	Leaf water Content %	root water content %	Root Length cm	Sugar %	Sugar yield Kg/m2
Z1(Control)	26.90 a	3.34 b	1.78 b	11.22 a	84.92 a	79.58 a	26.45 a	17.19 a	0.87 a
Z2(25 kg/ha)	24.75 a	3.70 a	2.09 a	10.70 a	85.94 a	78.58 a	25.24 a	17.57 a	0.92 a
P1(125kg/ha)	23.86 b	3.21 b	1.41 b	10.02 b	86.24 a	78.36 a	25.95 a	16.81 a	0.94 a
P2 (250 kg/ha)	29.05 a	3.89 a	2.06 ab	11.34 ab	84.16 a	79.31 a	27.35 a	18.03 a	0.92 a
P3 (375 kg/ha)	29.62 a	3.66 a	2.09 ab	12.34 a	85.69 a	79.76 a	25.07 a	17.50 a	0.98 a
P4 (Control)	23.01 b	3.32 a	2.17 a	10.12 b	85.64 a	78.89 a	25.01 a	17.02 a	0.74 b
Z1P1	25.07 ab	3.27 bcd	1.17 d	10.84 a	85.72 a	78.25 a	26.87 a	16.21 a	0.96 a
Z1P2	26.50 ab	3.37 bcd	1.25 c	11.96 a	84.32 a	79.55 a	27.77 a	18.06 a	0.94 a
Z1P3	32.00 a	3.80 b	2.12 b	12.58 a	85.10 a	80.40 a	25.00 a	17.18 a	0.88 ab
Z1P4 (Control)	24.02 ab	2.92 d	2.30 b	9.49 a	84.52 a	80.12 a	26.15 a	17.32 a	0.71 b
Z2P1	22.65 c	3.15 cd	1.65 c	9.20 a	86.75 a	78.47 a	25.02 a	17.41 a	0.92 a
Z2P2	26.00 ab	4.40 a	2.60 a	10.72 a	84.00 a	79.07 a	26.92 a	18.00 a	0.90 a
Z2P3	27.25 ab	3.52 bc	2.05 b	12.11 a	86.27 a	79.12 a	25 15 a	18.13 a	1.09 a
Z2P4	22.00 c	3.72 bc	2.05 b	10.76 a	86.75 a	77.65 a	23.87 a	16.72 a	0.77 b

Data by different letters indicate statistically significant differences using Duncan Multiple range at P 0.01. Z1 = control and Z2= 25 kg/ha $ZnSO_4$ in soil application. P1=125, P2=250,P3=375 kg/ha ASP and P4= Control

Root length

Sugar beet root length had not significant affected by phosphorus and zinc treatment and their interaction (Table 2). In general, P2 (250 kg/ha ASP application) treatment had more root length than P1 (125 kg/ha ASP application), P3 (375 kg/ha ASP application) and control. However, the lowest were recorded with Z2P4 interaction treatments. The differences between root length in P2 (250 kg/ha ASP application) and other phosphorus treatment levels were not significant in these traits (Table 2 and 3).

Sugar percentage and sugar yield

The nutrient treatments and their interaction (P. Z and PZ int.) had not significant effect on sugar percentage in sugar beet root extract under recent field assy. Sugar yield in this field study was affected ($P<0.05$) by P treatment and P.Z interaction significantly (Table 2). Thus, means comparisons for sugar yield showed the application of P increased sugar yield from 0.74 to 0.98 kg/m^2. Application $ZnSO_4$ had not significant effect on the percentage of sugar in recent field condition (Figure 2).

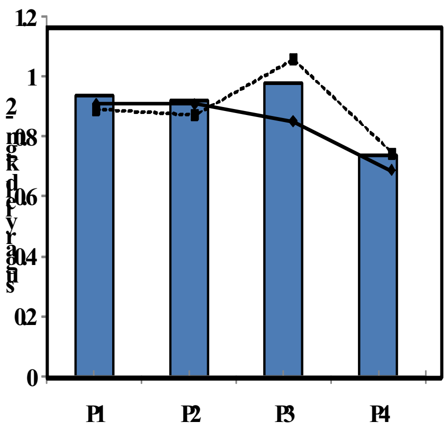

Figure 2. Effect of P levels under different zinc application (histograms) and interaction effects (lines) of P.Z on sugar yield. Z1= control and Z2= 25 kg/ha $ZnSO_4$ in soil application. P1=125, P2=250, P3=375 kg/ha ASP and P4= Control

CONCLUSIONS

The sugar beet is an important crop that extremely affected by zinc over dosage in alkaline soils with high Zn level (2.3 times more than threshold level) has sharply negative interaction effects with phosphorus amounts. Maximum sugar yields in high zinc soils was achieved by utilization of more Phosphorus fertilizer by 375 kg/ha about 1.09 kg/m^2 and lowest sugar yield was achieved by 25 kg/ha zinc application about 0.77 kg/m^2 under no more put in phosphorus fertilizer according to soil test results 5.7 ppm for P and zinc 2.3 ppm.

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ALFALFA (*Medicago sativa* L.) FORAGE YIELD RESPONSES TO TRIPLE SUPER PHOSPHATE, PHOSPHATE SOLUBLIZING BACTERIA AND GIBBERLLIC ACID FOLIAR APPLICATION

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Abstract

Phosphorus (P) is an essential element as plant macronutrition. Approximately all the most important biochemical and assimilation processes relate to phosphorus availability. In the old alfalfa stands the phosphorus availability becomes lower and lower and, consequently, alfalfa forage yield decreases extensively. Thus, in order to study the effect of P on alfalfa recovering rate we compared the combined effect of P and plant growth regulator - gibberllic acid (GA) application in a 3-years-old alfalfa stand, cut three times in year. Sources of P were phosphorus solubilizing bacteria (PSB) biofertilizer and triple super phosphate (TSP) fertilizer. Effects on alfalfa were studied after each of the three cuts in a field experiment set up as a split-plot randomized complete block design in four replications in 2011 year in the region of Shazand, Arak, Iran. Phosphorus treatments at 3 levels were applied to the main plots and included P0: control, P1: PSB and P2: TSP. GA levels, applied to the sub-plots, were also in 3 levels; G0: control, G1: 35 ppm of GA and G2: 75 ppm of GA. The results showed that in the third cut, application of TSP had a significant effect on the increase of fresh and dry weight of alfalfa's stem and leaf. GA applied with biological and chemical fertilizers effectively increased forage yield of alfalfa as well. Application of GA in the G2 concentration significantly increased stem yield up to 5.37 t/ha.

Key words: *alfalfa, gibberllic acid, phosphorus solublizing bacteria, triples super phosphate.*

INTRODUCTION

Alfalfa has been grown as a forage crop since the beginning of recorded history and can now be found almost anywhere in the world. It is generally agreed that alfalfa originated in the vicinity of Iran and was first brought to North America by the European colonists in the early 1700s. The ideal alfalfa soil is deep and well drained. Alfalfa has a vigorous root system which enables it to obtain water and nutrients from a large volume of soil. This characteristic helps alfalfa produce high yields and survives through dry periods. Poor soil drainage restricts oxygen supply to the roots, increases winter heaving problems, causes more disease problems, and damages alfalfa's nitrogen-fixing bacteria. All these effects lead to low productivity or loss of the stand. Alfalfa removes large amounts of nutrients from the soil. A ton of alfalfa hay can remove 5.5 kg of phosphate from soil. Phosphate is the fertilizer needed in the greatest amounts to establish and grow alfalfa and should be applied before sowing. Fertilizer can be applied at any time of the year and in one application rate (Lacefield et al., 1997). Phosphorus is used in various plant processes, particularly in energy acquisition, storage and utilization (Epstein and Bloom, 2005). The deficiency of phosphorous supply and availability remains a severe limitation on nitrogen fixation and symbiotic interactions (Beck and Munns, 1985, Pereira and Bliss, 1989). Thus, phosphorus (P) fertilization is essential for alfalfa production and is one of the most common nutrient inputs for this crop. This nutrient is involved in many essential metabolic roles within the plant, and deficiencies result in slow growth, suppressed yields, and lost of income.

A brief review by Mikkelsen (2004) covers some of the recent work regarding P fertilizer management for achieving high alfalfa yields. Many sources of P fertilizer are successfully used for alfalfa production including both, solid and liquid forms. A number of comparisons have shown that most of P fertilizer sources are equivalent, when used properly (Cihacek, 1993; Reid et al., 2004). The phosphorus content per unit dry weight is usually considerably higher in the nodules than in the roots and shoots, particularly at low external phosphorus supply (Azcon et al., 1988; Adu-Gyamfi et al., 1989).

Nitrogen fixing plants have an increased requirement for P over that receiving direct nitrogen fertilization, probability due to need for nodule development and signal transduction, and to P-lipids in the large number of bacteria (Graham and Vance 2000). Also, capability of developing nodules to compete with other vegetative sinks (root and shoot meristems) for P at limited external supply may be different between legume species (Jakobsen 1985, Robson and Bottomley 1991). Gull et al. (2004) proved an increased growth of chickpea plants, when co-inoculated with phosphorus solublizing bacteria and rhizobial cultures.

The very old research showed, that the foliage of alfalfa treated with gibberellins solution before and after forage harvesting, had no visible effect on the elongation of leaves and stems of alfalfa. Treatments with 200 ppm of gibberellins had no distinguishable effect on weight of alfalfa (Corns, 1958). But it seems that the effect of gibberelline on alfalfa plants needs to be revised. In this work the effects of phosphorus (P) and gibberllic acid (GA) application on alfalfa forage yields in three-years-old alfalfa (*Medicago sativa*) stand were studied.

MATERIALS AND METHODS

In order to study the effects of phosphorus (P) and gibberllic acid (GA) on alfalfa forage yields in three-years-old alfalfa (*Medicago sativa* cv. Hamedani) stand in the low phosphorus soil conditions (6 ppm) a field experiment was set up in 2011 at Shazand, Arak, Iran, as a split-plot with randomized complete block design in four replications.

A comparison of the P solublizing bacteria (PSB) biofertilizer (PSB is a combination of *Pantoea agglomerans* strains P5 and *Pseudomonas putida strain* P13 registered as Barvar2®) and triple super phosphate (TSP) fertilizer and also the effects of gibberllic acid (GA) on alfalfa were studied. P was applied to the leaves (PSB) or to the soil (TSP) in the main plots, whereas the GA was foliar applied to the sub-plots. Plant growth regulator GA was applied promptly after each cut by a sprayer. The experiment included three cuts of alfalfa, from early spring to late summer of 2011 period. P treatments included 3 levels – P0: control, P1: PSB biofertilizer – 100g of PSB in 200 L of water per each hectare, P2: 250 kg ha^{-1} TSP fertilizer, as a broadcast method. GA solutions were applied also in 3 levels – G0: control, G1: 35.0 ppm of GA and G2: 75.0 ppm of GA. The measured plant characteristics were: plant height, leaf and stem dry and fresh weight.

Before each cuts the randomized quadrates were chosen in each of the plots of 25 X 25 cm area, where all alfalfa stem number was counted within quadrate. Plant height and forage fresh weight were weighed on farm and later all the samples were transfer to laboratory for drying in oven in 75°C over 48 h. Statistical analysis of data was performed for all the three cuts by MSTAT-C software and the means were compared based on Duncan multiple test at 5% level.

RESULTS AND DISCUSSIONS

For plant height, P and GA and interactions were significant (Table 1). It is shown that the soil was poor in available P content and alfalfa responded significantly to the P application. Moreover, the application of P had also a meaningful interaction with GA as for the stem height. The TSP fertilization was more effective in comparison with PSB biofertilizer, resulting in 6% increase in the alfalfa height. Table 1 shows that G2 application increased plant height by about 11 cm, as compared with control. Analysis of variance for P: GA interaction for plant high showed significant effects (Table 2). Survey of the interaction between P and GA showed the highest plant high was in P3G1 combination - 92.7 cm.

Table1. Summary of analysis of variance

S.O.V	D.F	Mean square				
		Plant height	Fresh weight		Dry weight	
			Stem	Leaf	Stem	Leaf
R	3	4.3$^{n.s}$	0.02$^{n.s}$	0.01$^{n.s}$	0.02$^{n.s}$	0.02$^{n.s}$
P	2	350.5**	3.66**	3.06**	2.15**	2.21**
E1	6	1.36	0.03	0.01	0.02	0.01
GA	2	368.3**	2.25**	2.09**	0.84**	0.86**
P:GA	4	18.2**	0.15**	0.1**	0.04*	0.04**
E	18	1.19	0.03	0.02	0.01	0.007
CV%		1.34	3.18	3.91	6.23	6.24

** Significant at P< 0.01 level;

* Significant at P< 0.05 level; ns: non-significant. R: replication, P: Phosphorus, GA: Gibberlic acid and E: error.

Table 2. Mean comparisons for alfalfa characteristics

Treatments	Means				
	Plant high cm	fresh weight(g/stem)		dry weight(g/stem)	
		Stem	Leaf	Stem	Leaf
Control (P1)	76.01c	4.43c	3.03c	1.18c	0.93 c
PSB (P2)	81.29b	5.01b	3.53b	1.60b	1.33b
TSP (P3)	86.81a	5.53a	4.04a	2.03a	1.79a
Control (G0)	75.29c	4.51c	3.12c	1.32c	1.07c
GA 35 ppm (G1)	86.13a	5.37a	3.95a	1.85a	1.60a
GA 75 ppm (G1)	82.69b	5.08b	3.54b	1.65b	1.38b
P1G0	72.62g	4.14f	2.63f	0.96e	0.77g
P1G1	79.40e	4.69de	3.40cd	1.36d	1.10e
P1G2	76.00f	4.45e	3.06e	1.24d	0.92f
P2G0	74.62f	4.59de	3.19de	1.35d	1.02ef
P2G1	86.25c	5.41b	4.07b	1.92b	1.61c
P2G2	83.00d	5.02c	3.35cd	1.55c	1.38d
P3G0	78.62e	4.81cd	3.53c	1.66c	1.41d
P3G1	92.75a	6.01a	4.38a	2.27a	2.10a
P3G2	89.07b	5.78a	4.21ab	2.17a	1.85b

Within a column, values followed by the same letter are not significantly different at 0.05 level of Duncan multiple test at P<0.05.

Unfertilized and without GA application alfalfa had significantly lower fresh and dry weight. It was showed that alfalfa is a plant of high sensitivity to P and GA treatments. Stem and leaf fresh and dry weight, as compared to those that did not received TSP and 35 ppm GA, were significantly lower as compared to the other combinations (Table 2). A maximum increase in dry leaf and stem weight was for P3G1 treatments, by about 2.1 and 2.27 g per plant unite, respectively. We observed significant differences between PSB and TSP treatments for leaf and stem fresh weight too (Table 2). Our findings confirm the results by other studies, that reported positive influence of P and GA on alfalfa yield (Cihacek, 1993; Reid et al, 2004, Graham and Vance 2000), but our findings don't support Corns (1958) research report about none effect of GA on alfalfa yield.

CONCLUSIONS

Phosphorus nutrient performs several functions and is responsible for various metabolic processes in the plant, such as maintenance of osmotic concentration of cells, electron transport systems and enzymatic activity. Biological P is one of the most important fertilizers that can improve and optimize the insufficiency of soil mineral P significantly. Regarding to current report the deficiency of phosphorous in soil could be effectively replaced by PSB plus GA application in alfalfa stands after each cutting.

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INFLUENCE OF ORGANIC AND MINERAL FERTILIZATION ON GRASSLAND OF *Dichanthium ischaemum* L. ROBERTY IN THE MOLDAVIAN STEPPE

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Abstract

Given that in Moldavia and on meadows in Tutova Depression have been little research on grasslands of Dichanthium ischaemum L. Roberty (old world bluestem), we started at the RDCSEC Perieni, Vaslui, an experience on the effect of organic and mineral fertilization on yield and quality of forage obtained. It was administered organic fertilizer (well fermented sheep manure) in the fall of 2012, at 10 t ha^{-1} *yr*$^{-1}$ *and 30t ha*$^{-1}$ *yr*$^{-1}$*, and at the beginning of the growing season (April, 2013) were administered* $N_{50}P_{25}$ *kg ha*$^{-1}$ *yr*$^{-1}$*, respectively* $N_{75}P_{25}$ *kg ha*$^{-1}$ *yr*$^{-1}$*. In this paper we show preliminary values in 2013 as part of a medium-term experience (2013-2015). Harvesting took place in earing dominant species. The results showed various possibilities of increasing production grasslands of old world bluestem. In the variants fertilized with sheep manure yields ranged from 1.7 to 2.5 t ha*$^{-1}$ *DM and 180-215 kg ha*$^{-1}$ *CP, while the variants ranged from mineral fertilizers production 1.2-1.9 ha*$^{-1}$ *DM and 160-190 kg ha*$^{-1}$ *CP, and in embodiments with fertilizer production ranged from 0.6 t ha*$^{-1}$ *DM to 1.05 t ha*$^{-1}$ *DM. The results of the harvesting period bring valuable information on the optimal harvest time. Thus, the variants where harvesting was performed at earing of old world bluestem, yields were close in value of options where harvesting took place at the beginning of flowering. Results not recommend harvesting at full flowering or seed maturity, yields are significantly lower. Crude protein (CP) content decreases with vegetation. The highest content of crude protein was recorded in variants fertilized with sheep manure (30 t ha*$^{-1}$ *yr*$^{-1}$*) and harvested at early flowering earing dominant species. Regarding the content of Ca and P, and the ratio of these preliminary results strengthen the hypothesis that lead to optimal harvest must occur at earing species Dichanthium ischaemum L. Roberty to get the highest yield and better quality.*

***Key words**: old world bluestem, organic and mineral fertilisation, yield and quality.*

INTRODUCTION

In the past, the study of *Dichanthium ischaemum* L. Roberty grasslands in Romania and elsewhere, there has been a special concern of researchers, so in the literature are few and those of ecological data.

Grasslands of old world bluestem (OWB) is the most common type derived meadows, grazing resulted as a result of abuse, unreasonable and soil erosion (Vintu et al., 2004 Teague et al., 1996). In Asia it is considered an alternative to species *Eragrostis curvula* and *Cynodon dactylon* (Coleman et al., 1998).

In the agro-technical complex measures, mineral and organic fertilization is an important lever to increase production grasslands OWB (Koukouros Z. et al., 2004). Rodica Marinescu, 1969, mention that the amounted effect of the means of increasing agricultural production, fertilizer intake is about 40%.

Nutritive value of forage is influenced by many factors including soil fertility, growth stage and photosynthetic pathway (Dabo et al., 1987). Investigations by Niemann et al. (2001) and Phillip et al. (2005) suggested that nutritive value of OWB was influenced by species, environmental conditions, management and physiographic location.

Morphological characteristics of forage influence and can help in predicting value (Mitchell at al., 2001). Sanderson et al., 1999, recalling that while *Dichanthium* species have been widely adopted, little information is available regarding their nutritive value and morphological responses to a variety of fertilisation regimes when growth in droughty climatic conditions.

Thus, this study aims to suggest optimal dose of mineral and organic fertilization on the production and quality of grasslands for OWB. Inquiries followed production per unit area, the quality of the obtained feed (CP, Ca, P) as a function of the age of collection and dosage of fertilizing.

MATERIALS AND METHODS

The research was conducted in 2013 at the RDCSEC Perieni, Vaslui county, situated between 46° 18' North latitude and 27° 37' East longitude, with altitudes between 114 and 140m, western exhibition.

The experiment, established in 2012, was bifactorial, arranged in randomized plots in three replicates. The experimental factor had five graduations, represented by the fertilization: V_1 - unfertilized (control), V_2 - 10 t ha^{-1} annually, well fermented sheep manure, V_3 - 30 t ha^{-1} annually, well fermented sheep manure, V_4 - $N_{50}P_{25}$ kg ha^{-1} annually, V_5 – $N_{75}P_{25}$ kg ha^{-1} annually. Fertilization was done with two types of fertilizer: organic represented by well fermented sheep manure (older than two years) and mineral represented by comlex fertilizer with nitrogen and phosphorus.

The manure with a content of 0.42% total N, 0.19% P_2O_5 and 0.27% K_2O was manually applied late fall and the mineral fertilizer was administrated very early on spring after local practice.

Yield was determined by weighing the biomass harvested from an area of 12 m^2. Dry matter (DM) was determined by drying samples at 105°C for 5 hours.

Crude protein content (CP) was determined by the Kjeldahl method using a device Inkjel P and distillation Behrotest WD20, Labor Technik, Germany. The calcium content in the plant was measured by atomic absorption spectrometry (SR ISO 6869/2004) and the phosphorus content of the plant was determined by the spectrophotometric method.

RESULTS AND DISCUSSIONS

Flora and vegetation of the RDCSEC Perieni presents a considerable wealth due landforms, altitude, pedological substrate, and some climatic factors, which by their uniformity influences on the distribution of species in space and time, bringing together elements of different origin in floristic a frame so small (Dionița et al., 2005; Turenschi E., 1966).

From a climate perspective Perieni RDCSEC territory and its surroundings within the continental climate type with shades of excessively, characterized by very cold winters and hot-dry summers (Figure 1). The essential characteristic of the climate is the small amount of rainfall around 450 mm, below the national average, and the mean annual temperature levels of 11.8^{o}C în 2013.

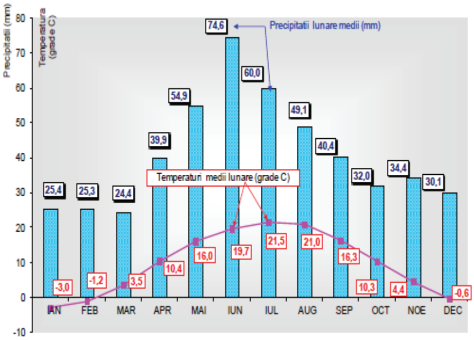


Figure 1. Average monthly precipitation and temperature in 2013 at RDCSEC Perieni

The RDCSEC Perienni are soils with the potential for fertility. These are the preluvisols and alluvisols in class Luvisols, Protisols respectively.

In the territory we investigated a relatively small area found a number of 115 species, of which the structure of phytocoenoses was dominated usually *Dichanthium ischaemum* L. Roberty species. The floristic structure of grasslands is dominated by *Poaceae* species (85%), in which OWB (64%); also present leguminous (4%), and other plants of the botanical families (11%).

Unfertilized pasture production was 1.05 t ha^{-1} DM (dry matter). Proposed variants of fertilization, the most advantageous variant was 30 t ha^{-1} sheep manure, where the production was 2.5 t ha^{-1} very significant compared to the control.

Also, the variants fertilized with 10 t ha^{-1} sheep manure and $N_{75}P_{25}$ kg ha^{-1} annually were very significant relative to controls.

No significant diference production records between the version control and fertilized with $N_{50}P_{25}$ kg ha[1] (Figure 2).
Regarding the values of CP (crude protein) content it is very significant in all fertilized variants (Figure 2). Values of CP content fertilized variants are included in range 160 - 214 kg ha^{-1} and the control variant this indicator was 117 kg ha^{-1}. The differences obtained between and organic and mineral fertilized variants, are very significant in terms of content of the feed in CP, Ca and P (Table 1).

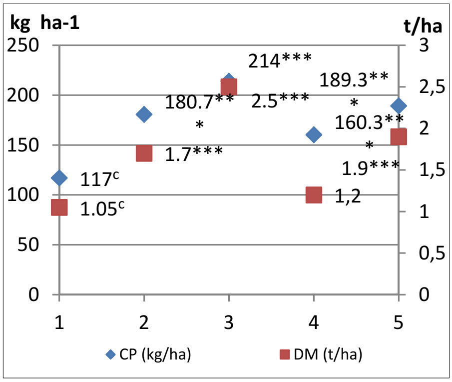
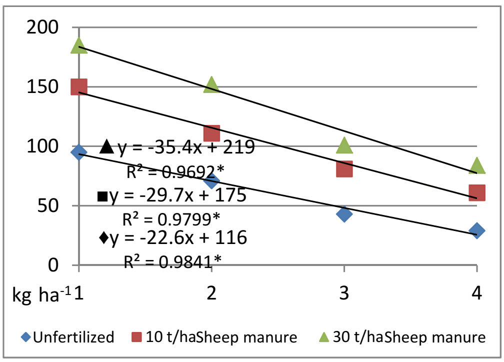


Figure 2. Influence of fertilization on the DM and CP yield

Table 1. Influence of organic and mineral fertilization on some indicators of quality

Experimental variant		Quality indicators					
		Organic fertilisation			Mineral fertilisation		
		CP (kg ha^{-1} from DM)	Ca (kg ha^{-1} from DM)	P (kg ha^{-1} from DM)	CP (kg ha^{-1} from DM)	Ca (kg ha^{-1} from DM)	P (kg ha^{-1} from DM)
V_1 (control)		117.0^C	4.51^C	3.60^C	117.0^C	4.51^C	3.60^C
V_2		180.7***	9.20***	6.12***			
V_3		214.0***	15.25***	10.52***			
V_4					160.3***	6.12***	4.52***
V_5					189.3***	11.02***	7.68***
LSD	*5%*	*1.51*	*0.11*	*0.129*	*7.28*	*0.23*	*0.42*
	1%	*2.54*	*0.19*	*0.31*	*12.04*	*0.47*	*0.74*
	0.1%	*4.78*	*0.27*	*0.54*	*22.41*	*0.76*	*1.31*

Studies were undertaken in order to recommend the optimal harvest time, resulting in a high yield with superior quality.
Data analysis on the content of CP shows that organic and mineral fertilizer doses correlate with harvest age, the differences being significant (figure 3). The proposed variants of fertilization is observed that the yields of CP were obtained when the meadow was harvested from earing dominant species.



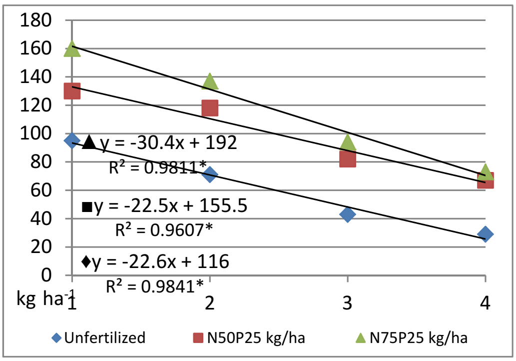


Figure 3. Correlation between applied organic (left) and mineral (right) fertilisation and harvest age regarding the crude protein (CP) content

The same trend is observed in the content of Ca and P. The feed obtained has the highest content in Ca and P when the harvesting has been the dominant species in earing, the trend is to decrease the content of these delay elements with harvest, even if the doses of fertilizer are increasing, the differences being statistically significant except for the variant fertilized with 10 t ha^{-1} sheep (Figure 4).

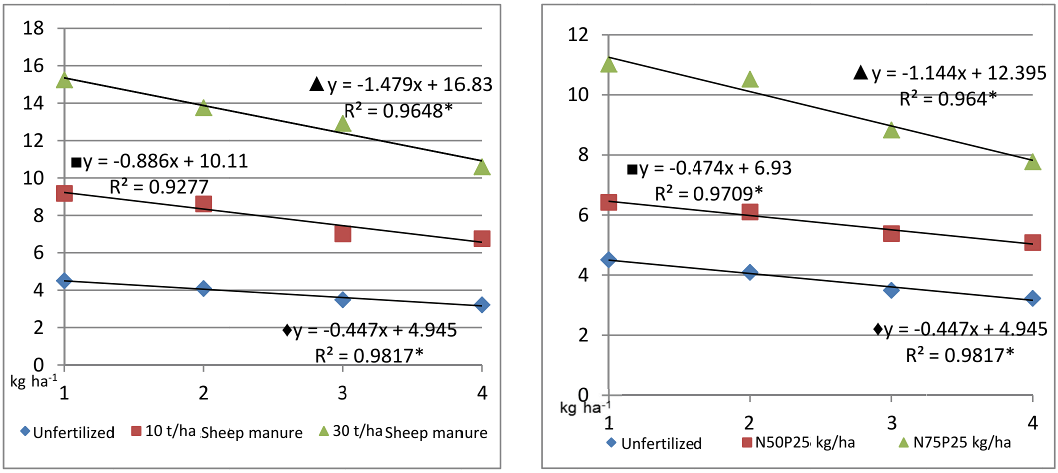


Figure 4. Correlation between applied organic (left) and mineral (right) fertilisation and harvest age regarding the calcium (Ca) content

Distinct differences significant at P content recorded variants fertilized with 30 t ha^{-1} sheep and fertilization $N_{50}P_{25}$ kg ha^{-1} (Figure 5). P content in plants is the largest when the plants are harvested grasses earing. The evolution towards maturity there of having a distinct significant trend with significant delay harvest.

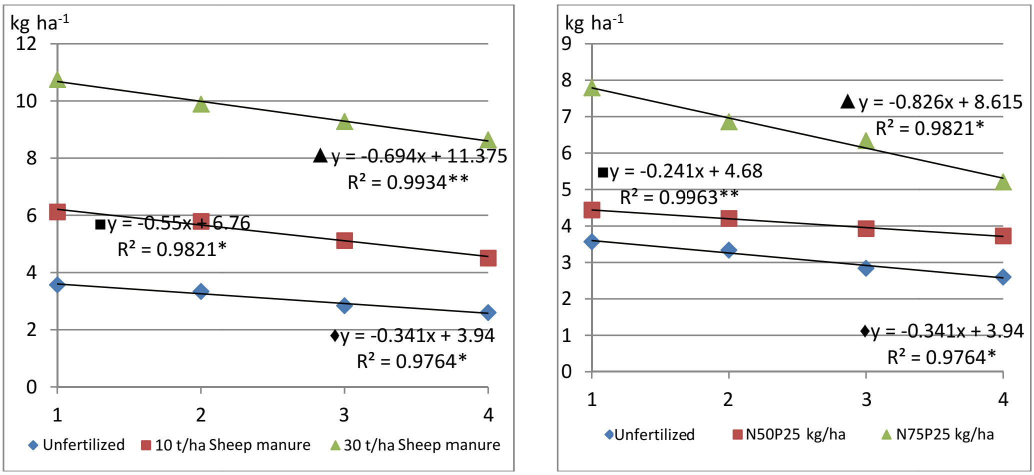


Figure 5. Correlation between applied organic (left) and mineral (right) fertilisation and harvest age regarding the phosphorus (P) content

CONCLUSIONS

The results showed that organic fertilization improved very significantly the production capacity of *Dichanthium ischaemum* L. Roberty meadow from the Moldavian steppe.

Regardless of the applied dose, using organic fertilizers on grasslands determines a high-quality forage with a crude protein content and forage value significantly higher compared to unfertilized variant or mineral fertilizers.

Following the results obtained from this study we recommend to use sheep manure as a fertilizer in the grasslands of *Dichanthium ischaemum* L. Roberty to obtain high yields and superior forage quality.

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ESTIMATION OF CROP EVAPOTRANSPIRATION IN BULGARIAN CLIMATE CONDITIONS

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Abstract

Precisely managed irrigation scheduling provides for on-time meeting of crop water needs, for high yields and high economic effect. Most important in crop water needs estimation is the right choice of an evapotranspiration calculation method. Comparative analyses of some calculation methods which are suitable for Bulgarian climatic conditions give advantage to the temperature-based ones. Since last decades, FAO Penman-Monteith method has been globally recognized as most accurate in various climatic conditions as it is based on great number of meteorological and plant factors. In this paper, decadal values of K_c factor in the course of vegetation of 25 crops, grown in Bulgaria – cereals, forage, industrial, vegetables, and berries are presented. Their accuracy is statistically evaluated. The standard error of the mean is mainly around 10%. A narrow correlation between the crop factors of FAO method and the temperature-base method, which is currently used in Bulgaria, has been established. Simulation of the irrigation scheduling of three crops by both methods is performed. The results show that FAO Penman-Monteith method is suitable for Bulgarian climatic conditions. The temperature-based method is simpler and easily maintained with meteorological information, hence it is recommended for practical purposes.

Key words: *FAO Penman-Monteith, K_c factor, correlation, simulation, Bulgaria.*

INTRODUCTION

Precisely calculated irrigation scheduling provides for on-time water application to the field. Precise irrigation contributes for high yield accumulation and high economic effect. Most important in crop water needs estimation is the right choice of an evapotranspiration calculation method. Since last decades, FAO Penman-Monteith evapo-transpiration calculation method proved to be the most accurate one and can be used in various climatic conditions (Allen et al., 1998). It reads the impact of several meteorological factors on crop evapo-transpiration. The method determines the evapotranspiration of a hypothetical crop (reference evapotranspiration), similar to grass, and transfers it into the evapotranspiration of a particular crop by a crop K_c factor. FAO suggests standard K_c factors for the main crops per phenological stages under different climatic conditions.

FAO Penman-Monteith method is not considered a new one, but in our country it is still poorly studied. A serious reason for that is that the meteorological information is hardly collected. Another reason is the lack of calibrated and verified for our soil-climatic conditions K_c crop factors. For many years, and still in use in Bulgaria, is Delibaltov-Hristov-Tzonev evapotranspiration calcula-tion method, which is based on the decadal totals of air temperature (Delibaltov et al., 1962). These totals used to be multiplied by a specific for every crop and decadal biophysical Z factor and thus the decadal evapotranspiration totals were calculated. Z biophysical factors of different crops under different soil moisture conditions were obtained as a result of a long-term research work (Zahariev et al., 1986). Recently, FAO Penman-Monteith reference evapotranspiration has been determined for 42 sites in the arable land of the country (Kazandjiev et al., 2010). Thus it became possible to develop a study which proved that Delibaltov-Hristov-Tsonev method was of similar accuracy like FAO Penman-Monteith method in Bulgarian climate conditions (Davidov, Moteva, 2010).

The goal of this paper is to calculate K_c crop factors for FAO Penman-Monteith evapotranspiration calculation method of some crops in the humid climatic regions of Bulgaria (4th Agroclimatic Group (Zahariev et al., 1986)) on the basis of long-term crop evapotranspiration data obtained from field experiments in Sofia region. Another goal is to assess the expedience for applying FAO method to Bulgarian irrigation practice by using statistical analyses.

Table 1. Data available and sources

Types of crops	Nb.	Crop	Period	Rows	Source
Cereals	1	Winter wheat	1971-1973	9	Al Shaua, 1974
			1975-1976		Zahariev, 1976
			1985-1988		Zhivkov, 1990
	2	Maize (grain) moderately early variety	1984-1988		Zhivkov, 1990
	3	Maize (grain) moderate late variety	1984-1988	13	Zhivkov, 1990
			1987-1989,1996-1998		Moteva, 2006
			1999-2000		Matev, 2001
	4	Maize (grain) late variety	1980-1983	9	Lazarov, 1984
			1984-1988		Zhivkov, 1990
	5	Winter barley			Zhivkov, 1990
	6	Spring barley			Zhivkov, 1990
Industrial crops	7	Sugar beet	1971-1976	12	Delibaltov, Zahariev, 1977
			1978-1980		Daher, 1981
			1980-1982		Lazarov et al., 1982
	8	Soybean	1984-1988	9	Zhivkov, 1990
			1991		Zhivkov, 1991
			1996-2000		Zhivkov Mladenova, 1994
Forage crops	9	Alfalfa 1st year	1971-1972	3	Mehandzhieva, 1974
	10	Alfalfa old	1972-1974	5	Mehandzhieva, 1974
			1981-1982		Mehandzhieva, 1982
			1978-1982		Gaidarova, 1988
	11	Maize for green	1984-1988	5	Zhivkov, 1990
	12	Maize 2nd crop	1984-1988	5	Zhivkov, 1990
	13	Pea-oats mixture 2nd crop	1984-1988	5	Zhivkov, 1990
	14	Pea-oats-sunflower mixture 2nd crop	1984-1988	5	Zhivkov, 1990
	15	Rye for green	1984-1988	5	Zhivkov, 1990
	16	Rye-pea mixture	1984-1988	5	Zhivkov, 1990
	17	Triticale (*Triticum aestivum* x *Secale cereale*)	1984-1988	5	Zhivkov, 1990
	18	Rape (*Brassica ssp. Spantula*) autumn period	1984-1988	5	Zhivkov, 1990
	19	Rape (*Brassica ssp. Spantula*) spring period	1984-1988	5	Zhivkov, 1990
Vegetables	20	Tomatoes	1996	1	Kireva, 2003
	21	Cucumber	1997, 1998	2	Kireva, 2003
	22	Moderately early potatoes	1984-1988	5	Zhivkov, 1990
	23	Early potatoes	1984-1988	5	Zhivkov, 1990
	24	Late cabbage	1984-1988	5	Zhivkov, 1990
Berries	25	Raspberries	1999-2003	5	Kireva, 2003

MATERIALS AND METHODS

Data of crop evapotranspiration (ET_c) were taken from series of field experiments which were conducted in the Sofia region during the period 1970-2010. They were composed in the following groups, shown in Table 1. Due to the short term of the field experiments, the rows of data are diverse, intermittent and inhomogeneous. Taking into account the fact that the data processed have been within the contemporary climate, and that principally it is hard to conduct long-term field experiments, we adopted homogeneous ranks for the statistical processing. Longest ranks drew the maize moderately late hybrid - 13 years, sugar beet - 12 years, and maize late hybrid, wheat and soybeans - 9 years each. Maize for green, triticale, spring barley, winter barley, early potatoes, rape, maize II crop, green rye, rye-pea mixture, pea-oat mixture, pea-oat-sunflower mixture and raspberries drew 5-year rows of statistics. Cucumbers and tomatoes grown in the open air allowed obtaining only approximate values of the coefficients K_c.

According to the vegetation period the crops fell into four groups: summer crops with vegetation periods from April to September; early-spring crops with April-July vegetation period, spring pre-crops with April-May vegetation period; late and post harvesting (second) crops with vegetation periods from July to October.

Reference evapotranspiration ET_o was calculated by FAO Penman-Monteith method. Meteorological data were taken from the data base of the National Institute of Meteorology and Hydrology – Bulgarian Academy of Sciences.

The decadal K_c factor was calculated as ratio of the decadal crop evapotranspiration total to the decadal reference evapotranspiration total:

$$K_c^i = \frac{\sum ET_{crop}^i}{\sum ET_o^i},$$

where: K_c^i – crop factor for i-decade; $\sum ET_{crop}^i$ - experimental crop evapotranspiration total for i-decade, mm; $\sum ET_o^i$ reference evapotranspiration for i-decade, mm. The standard error of the mean ($s_{\bar{x}}$) of the calculated K_c decadal values was determined as:

$$s_{\bar{x}} = \frac{s}{\sqrt{n}},$$

where: s– standard deviation, mm; n – number of cases (years).

K_c factors were compared to the analogous Z factors. Z factor originates from the temperature evapotranspiration calculation method and has been calculated as:

$$Z^i = \frac{\sum ET_{crop}^i}{\sum T^i},$$

where: Z^i - crop coefficient for i-decade, $\sum T^i$ - air temperature total of i-decade. Temperature method, also called Delibaltov-Hristov-Tzonev method, is currently in use in Bulgaria.

Simulations of the soil-water balance under winter wheat, maize moderately late hybrid and soybean, using both K_c and Z, was carried out in an EXCELL environment. The simulation was done after the water-balance equation:

$$SW_k^i = SW_{k-1}^i + R_k^i + m_k^i - ET_{crop,k}^i,$$

where: SW_k, SW_{k-1} - the available water of the 1-m soil layer on k and k-1 day of i-decade, mm; R_k – rainfall total on k day, mm; $ET_{crop,k}$ - crop evapotranspiration on k day, mm; m_k^i - irrigation application rate, mm (if any). If SW_k=0 (SW_k reaches zero-value), an application rate of 60-mm was given.

The perennial rows of experimental data are allied to years of different meteorological conditions (Figure 1). Some of the years were very wet (1971, 1973, 1976, 1977), other – moderate wet (1972, 1974, 1980). There were also moderately-dry and very dry years (1979, 1982, 1984, 1985, 1986, 1987), as well as moderate years (1975, 1977, 1978, 1981, 1983, 1988, 1978). As far as air temperature was concerned, the cool and moderate-cool years prevailed, while as far as vapor pressure deficit (VPD) was concerned – the years were basically moderately-wet and moderate.

RESULTS AND DISCUSSIONS

The seasonal course of K_c factors of the summer crops are synchronic to the dynamics of the meteorological factors, especially to the air temperature. They have the greatest values in the hottest summer months July and August.

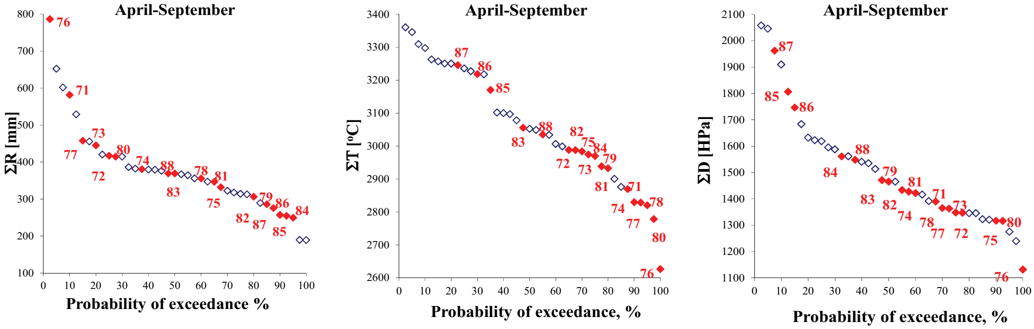

Figure 1. Probability of exceedance: Left to right: rainfall totals, air temperature totals and VPD totals

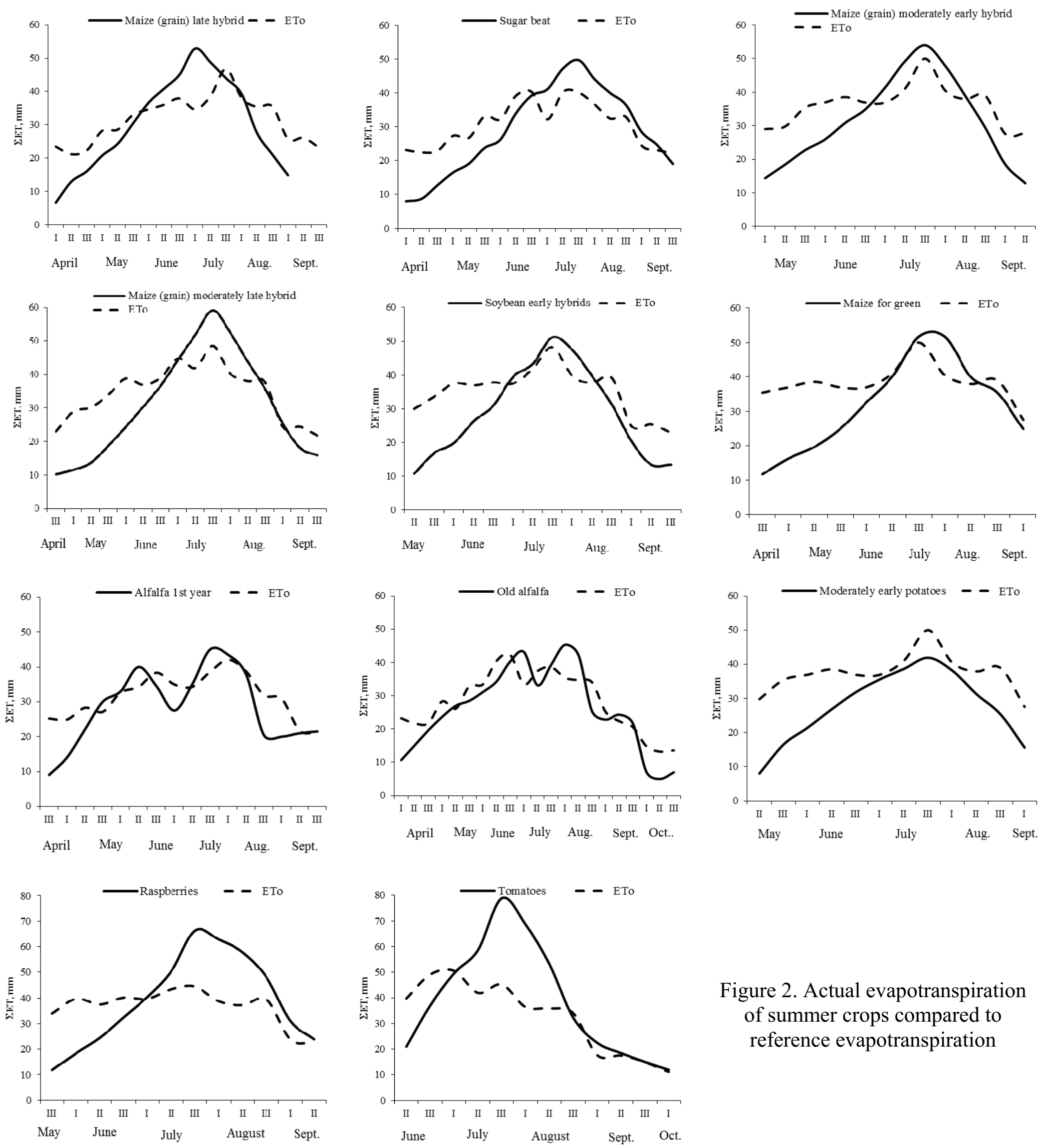

Figure 2. Actual evapotranspiration of summer crops compared to reference evapotranspiration

Table 2. K_c factors of late spring crops

Month	Decade	Maize (grain) moderately early	$S_{\bar{x}}$	Maize (grain) moderately late	$S_{\bar{x}}$	Maize (grain) late	$S_{\bar{x}}$	Maize for green	$S_{\bar{x}}$	Soybean	$S_{\bar{x}}$
April	I										
	II										
	III			0.45	0.05	0.32	0.03				
May	I	0.49	0.06	0.40	0.04	0.45	0.04				
	II	0.63	0.11	0.49	0.05	0.54	0.04			0.33	0.03
	III	0.63	0.08	0.57	0.06	0.64	0.07	0.32	0.10	0.47	0.05
June	I	0.72	0.14	0.65	0.06	0.70	0.05	0.46	0.15	0.53	0.06
	II	0.81	0.10	0.87	0.08	0.91	0.12	0.52	0.13	0.70	0.07
	III	0.95	0.06	0.97	0.07	1.00	0.08	0.68	0.14	0.83	0.07
July	I	1.13	0.06	1.01	0.05	1.19	0.06	0.90	0.20	1.00	0.07
	II	1.22	0.13	1.25	0.06	1.20	0.09	1.04	0.24	0.96	0.07
	III	1.10	0.09	1.24	0.05	1.14	0.05	1.06	0.13	1.22	0.09
Aug.	I	1.21	0.15	1.33	0.08	1.30	0.08	1.28	0.04	1.27	0.10
	II	1.14	0.32	1.18	0.08	1.27	0.06	1.11	0.20	1.09	0.09
	III	0.83	0.31	0.98	0.08	1.13	0.07	0.92	0.15	1.13	0.12
Sept.	I	0.68	0.16	1.00	0.12	1.09	0.10	0.89	0.22	0.75	0.07
	II	0.47	0.12	0.73	0.07	0.81	0.07			0.51	0.07
	III			0.75	0.06	0.65	0.07			0.33	0.07

Table 2. Continued….

Month	Decade.	Sugar beat	$S_{\bar{x}}$	Potatoes moderately early	$S_{\bar{x}}$	Alfalfa, Ist year	$\sigma_{\bar{x}}$	Alfalfa old	$S_{\bar{x}}$	Raspberries	$S_{\bar{x}}$	Tomatoes
April	I	0.30	0.03					0.46	0.09			
	II	0.43	0.08					0.70	0.11			
	III	0.59	0.09			0.17	0.09	0.93	0.10			
May	I	0.62	0.08			0.46	0.04	0.83	0.10			
	II	0.74	0.08	0.28	0.04	0.69	0.17	1.07	0.11			
	III	0.71	0.06	0.54	0.11	0.84	0.20	0.87	0.13	0.34	0.05	
June	I	0.81	0.07	0.61	0.15	0.94	0.10	0.95	0.08	0.45	0.09	
	II	0.91	0.10	0.75	0.17	1.16	0.10	0.87	0.08	0.64	0.11	0.53
	III	1.01	0.09	0.86	0.17	1.20	0.20	0.97	0.07	0.79	0.10	0.75
July	I	1.27	0.08	0.98	0.16	0.92	0.09	1.32	0.13	1.03	0.13	0.98
	II	1.19	0.08	1.07	0.13	0.81	0.09	0.90	0.09	1.16	0.10	1.40
	III	1.26	0.09	1.03	0.08	0.99	0.07	1.02	0.04	1.51	0.10	1.74
Aug.	I	1.24	0.10	0.77	0.08	1.26	0.12	1.33	0.13	1.64	0.08	1.88
	II	1.25	0.08	0.78	0.14	1.26	0.22	1.25	0.17	1.59	0.13	1.48
	III	1.11	0.07	0.67	0.10	0.67	0.11	0.77	0.11	1.25	0.10	0.95
Sept.	I	1.18	0.13	0.40	0.02	1.00	0.13	0.92	0.07	1.33	0.08	1.27
	II	1.06	0.09			1.07	0.11	1.14	0.14	1.06	0.08	1.06
	III	0.86	0.09			1.00	0.08	1.07	0.14			1.00
Oct.	I							0.49	0.00			1.08
	II							0.38	0.09			
	III							0.34	0.11			

During these months K_c is ≥1, i.e. the rate of crop evapotranspiration is greater than that of the reference evapotranspiration (Figure 2 and Table 2). The data available permitted K_c calculation with different accuracy. The long statistical rows gave more accurate results. The standard error of maize (grain) - late and moderate variety, sugar beet, 1st-year alfalfa and old alfalfa is less than 10%. Sorter rows, as those of green maize and moderate early potatoes demonstrated greater error – as much as 20% in some decades.

The spring crops of April-June vegetation were cultivated in years of dry to moderately dry conditions. Their maximal daily evapotranspiration occurred in the 3[rd] decade of May or in the 1[st] of June, mainly due to the development stage, while the course of ET_o was constantly increasing. This is evident from the illustrations on Figure 3 and the values of K_c factor (Table 3). The latter is >1 in May for all crops presented. Due to the great instability of the spring rainfalls, the accuracy of K_c of winter wheat is lower than that of the summer crops. The standard error of the decadal values of winter wheat is greatest in the 1[st] decade of June, of triticale and spring barley - in the 3[rd] of May. The values of K_c, obtained by us correspond to those suggested by FAO 56 (Allen et al., 1998): 1.15 in mid and 0.4 in late season for winter wheat; analogously 1.15 and 0.25 for barley; 1.15 and 0.75 for potatoes. $\sigma_{\bar{x}}$ of all crops in Table 2, except for spring barley, is >10%.

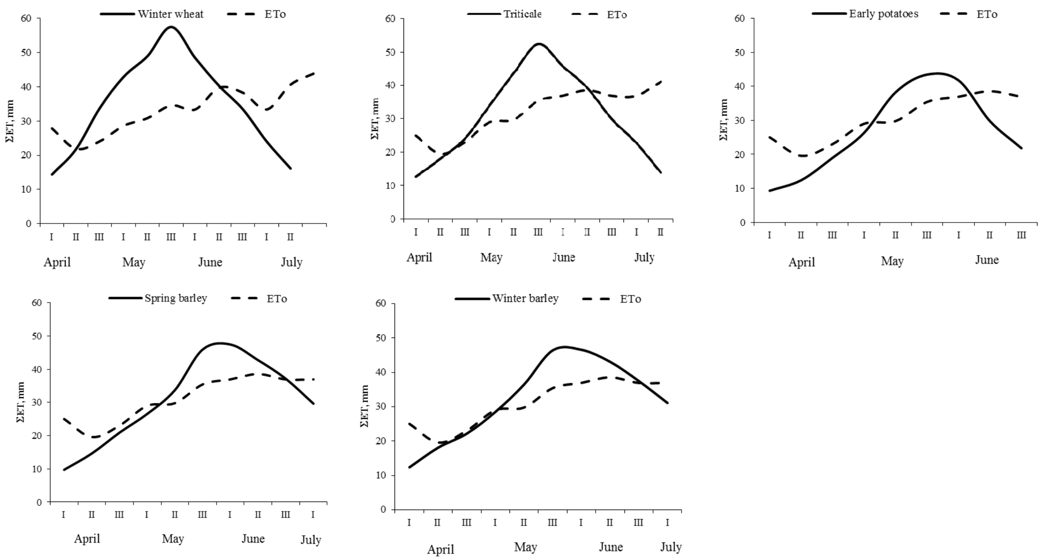

Figure 3. Actual evapotranspiration of early spring crops compared to reference evapotranspiration

Table 3. K_c factors of spring crops of April-July vegetation period

Month	Decade	Winter wheat	$s_{\bar{x}}$	Triti-cale	$s_{\bar{x}}$	Spring barley	$s_{\bar{x}}$	Winter barley	$s_{\bar{x}}$	Early potatoes	$s_{\bar{x}}$
April	I	0.52	0.12	0.53	0.16	0.40	0.04	0.53	0.11		
	II	1.01	0.17	0.91	0.15	0.76	0.09	0.95	0.14	0.47	0.12
	III	1.42	0.15	1.06	0.10	0.93	0.11	1.01	0.16	0.56	0.14
May	I	1.52	0.10	1.17	0.03	0.91	0.05	0.98	0.12	0.67	0.09
	II	1.60	0.09	1.50	0.14	1.17	0.15	1.25	0.12	0.90	0.10
	III	1.70	0.16	1.52	0.19	1.34	0.18	1.33	0.08	1.12	0.17
June	I	1.48	0.22	1.24	0.11	1.29	0.09	1.29	0.15	1.20	0.18
	II	1.04	0.11	1.03	0.16	1.12	0.08	1.14	0.15	1.09	0.17
	III	0.90	0.10	0.82	0.17	1.01	0.07	1.01	0.16	0.82	0.20
July	I	0.75	0.13	0.62	0.16	0.80	0.03	0.84	0.19	0.64	0.29
	II	0.40	0.09	0.36	0.12		0.04				

The spring pre-crops have a short vegetation period – from the beginning of April to the 2[nd] decade of May. The period April-May is predominantly dry to very dry. VPD is high. The course of ET_c is close to that of ET_o (Figure .4) hence K_c factors are around one (Table 4). The coefficients of spring rapeseed are with $s_{\bar{x}}$ >10%. The same is with the late crops and the second crops (Figure 5 and Table 5).

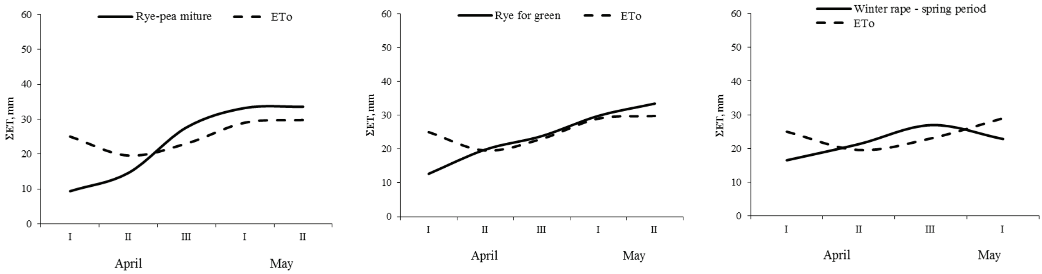

Figure 4. Actual evapotranspiration of spring pre-crops compared to reference evapotranspiration

Table 4. K_c factors of spring pre-crops of April-May vegetation period

Month	Decade	Rape spring period	$S_{\bar{x}}$	Rye for green	$S_{\bar{x}}$	Rye-oats mixture	$S_{\bar{x}}$
April	I	0.70	0.12	0.53	0.12	0.39	0.08
	II	1.11	0.23	1.03	0.17	0.74	0.12
	III	1.20	0.17	1.03	0.07	1.20	0.11
May	I	0.77	0.13	1.04	0.17	1.15	0.08
	II			1.11	0.15	1.13	0.06

The late crops and post-harvest second crops develop in the driest period of the year in nearly arid conditions. In most of the experimental years the period is moderately dry to very dry, and moderately warm to very warm. The daily crop evapotranspiration is highest during the 3rd decade of August and in September, while ET_o tends to lower values in autumn (Figure 5). This reflects on K_c which is >1 predominantly in September. The coefficients of rape and cabbage are similar to those suggested by FAO 56 (Allen et al., 1998): rapeseed - 1.5 for mid and 0.35 for late season; cabbage - 1.05 and 0.95 respectively.

A very narrow correlation between K_c and Z factors was established. The determination coefficients (Table 6) are in the range of 0.81-0.97 mainly. This is evidence for the like reading of the temperature factor in both calculation methods and for its main role in evapotranspiration formation.

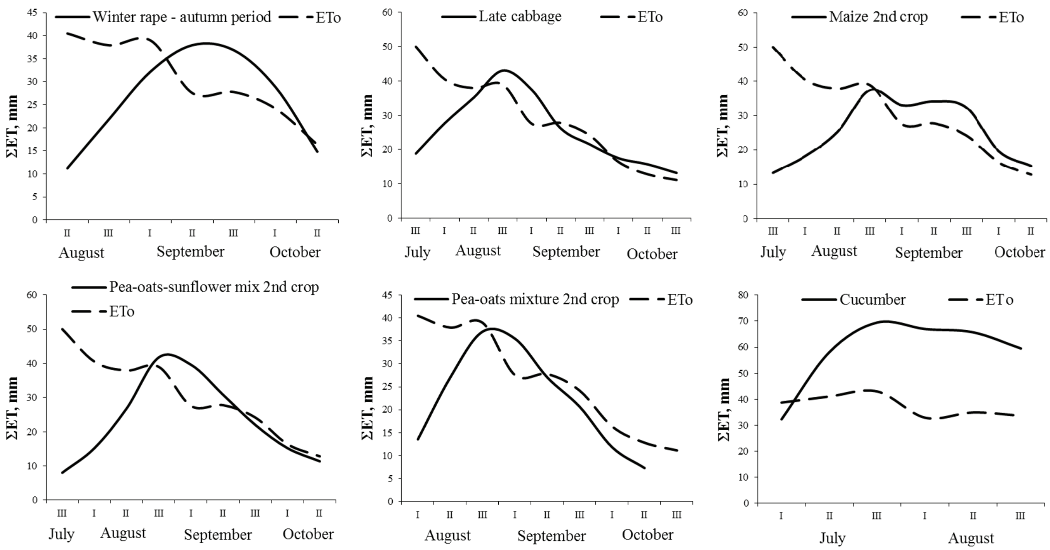

Figure 5. Actual evapotranspiration of second and other summer crops compared to reference evapotranspiration

Table 5. K_c factors of late crops and second crops of July-October vegetation period

Month	Dec	Maize 2nd crop	$s_{\bar{x}}$	Rape autumn period	$s_{\bar{x}}$	Late cabbage	$s_{\bar{x}}$	Pea-oats mixture 2nd crop	$s_{\bar{x}}$	Pea-oats-sunflower mixture 2nd crop	$s_{\bar{x}}$	Cucumber	$\sigma_{\bar{x}}$
July	III	0.28	0.06			0.40	0.10			0.17	0.04		
Aug.	I	0.46	0.11			0.69	0.07	0.33	0.12	0.38	0.06	0.83	0.02
	II	0.72	0.16	0.34	0.13	0.99	0.18	0.76	0.20	0.70	0.05	1.42	0.03
	III	0.99	0.20	0.58	0.12	1.13	0.18	0.99	0.13	1.06	0.11	1.62	0.10
Sept.	I	1.21	0.18	1.17	0.11	1.34	0.18	1.29	0.07	1.43	0.17	2.07	0.29
	II	1.24	0.18	1.37	0.13	0.94	0.19	0.97	0.10	1.10	0.16	1.89	0.11
	III	1.40	0.35	1.54	0.18	0.91	0.26	0.85	0.22	0.96	0.21	1.77	0.12
Oct.	I	1.22	0.17	1.75	0.31	1.15	0.31	0.76	0.31	0.94	0.21		
	II	1.23	0.17	1.11	0.25	1.25	0.36	0.56	0.28	0.89	0.22		
	III					1.18	0.35						

Table 6. Correlation between K_c and Z factors

Nb.	Crop	Regression equation	R^2
	Late spring crops		
1	Maize (grain) moderately early	$K_c = 4.9561\,Z + 0.0645$	0.9212
2	Maize (grain) moderately late	$K_c= 4.8986\,Z + 0.0830$	0.9134
3	Maize (grain) late	$K_c = 5.4223\,Z + 0.0171$	0.9192
4	Maize for green	$K_c = 5.4559\,Z - 0.0143$	0.9483
5	Soybean	$K_c= 4.7968\,Z+ 0.1191$	0.7814
6	Sugar beat	$K_c = 5.7113\,Z - 0.0687$	0.8767
7	Potatoes moderately early	$K_c = 5.4373\,Z - 0.0175$	0.9060
8	Alfalfa, Ist year	$K_c = 5.6327\,Z – 0.0594$	0.6734
9	Alfalfa old	$K_c = 4.6147\,Z + 0.1242$	0.5705
0	Raspberries	$K_c = 5.9481\,Z - 0.0412$	0.9224
11	Tomatoes	$K_c = 3.8531\,Z + 0.4111$	0.6938
	Spring crops of April-July vegetation period		
12	Winter Wheat	$K_c = 4.7205\,Z + 0.0440$	0.9705
13	Triticale	$K_c = 4.8249\,Z + 0.0037$	0.9404
14	Spring Barley	$K_c = 5.1318\,Z - 0.0628$	0.9335
15	Winter Barley	$K_c = 4.8432\,Z - 0.0058$	0.8566
16	Early potatoes	$K_c = 4.2867\,Z + 0.096$	0.5387
	Spring pre-crops of April-May vegetation period		
17	Rape spring period	$K_c = 3.312\,Z + 0.2308$	0.9739
18	Rye for green	$K_c = 3.8123\,Z + 0.168$	0.8167
19	Rye-pea mixture	$K_c = 4.5295\,Z + 0.0317$	0.9251
	Late crops and second crops of July-October vegetation period		
20	Maize 2nd crop	$K_c = 7.3462\,Z - 0.1032$	0.8437
21	Rape autumn period	$K_c = 7.9507\,Z - 0.157$	0.9106
22	Late cabbage	$K_c = 5.7556\,Z + 0.1051$	0.6621
23	Pea-oats mixture 2nd crop	$K_c = 5.4351\,Z + 0.1283$	0.8609
24	Pea-oats-sunflower mixture 2nd crop	$K_c = 6.0777\,Z + 0.0584$	0.8541
25	Cucumber	$K_c = 5.4232\,Z + 0.0615$	0.8293

The simulation of the soil water balance under maize (grain), soybean and winter wheat by using the evapotranspiration data, calculated by both methods – FAO Penman-Monteith and Delibaltov-Hristov-Tsonev, shows similar results. The course of depletion of the readilyavailable water by both methods is parallel and the dates for giving application mismatch 4 days at worst.

The results from figure 6 show firstly, that both methods are similarly accurate and the chief formative factor for crop evapotranspiration is air temperature and secondly, that there is no need for substituting of Delibaltov-Hristov-Tzonev calculation method with FAO Penman-Monteith method. The first one is simpler and with easy maintainance with meteorological information.

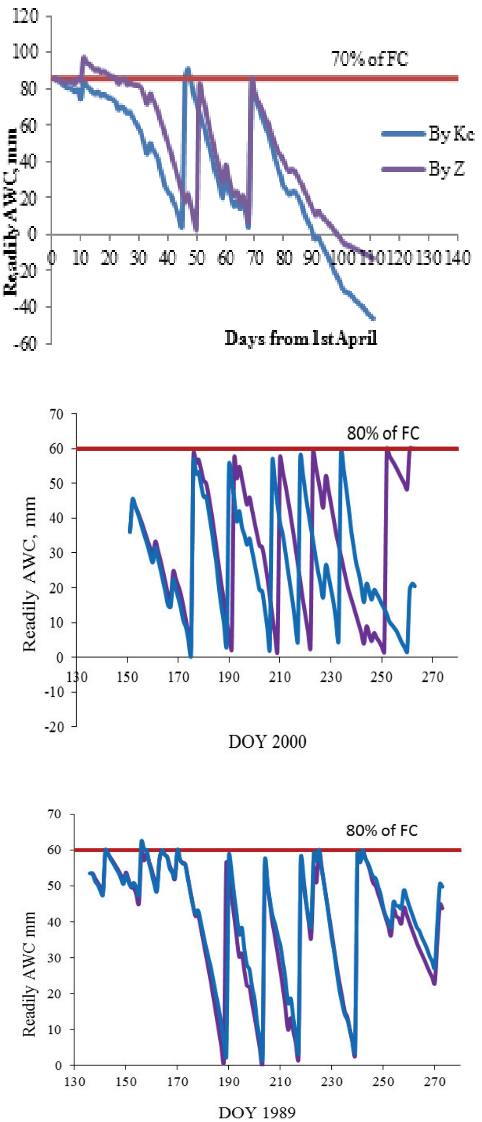

Figure 6. Soil water balance under winter wheat calculated with considering FAO 56 method and the method of air temperature totals. ET_o and ET_c of a) winter wheat; b) maize (grain) moderately late hybrid; c) soybean early hybrids

CONCLUSIONS

K_c values obtained correspond with those, suggested by FAO 56. They can be used for calculation of crop evapotranspiration in Bulgarian climate conditions. Their determination is a step for validation of FAO Penman-Monteith evapotranspi-ration calculation method to the regional climate peculiarities.

FAO Penman-Monteith method and Delibaltov-Hristov-Tzonev method for estimation of crop evapotranspiration have similar accuracy.

FAO Penman-Monteith method can successfully be used in Bulgarian climate conditions, but Delibaltov-Hristov-Tzonev one is considerably simpler and easy for maintenance with meteorological information. Hence there is no need for replacing it from practice.

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RESPONSE OF MAIZE (*Zea mays* L.) TO AQUEOUS EXTRACT OF MORINGA (*Moringa oleifera* LAM.) AND NITROGEN RATES. PART II

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Abstract

Maize (Zea mays L.), the major staple crop in Nigeria is recording low yield ha^{-1} in farmer's field. The low yield is attributed to inadequate application of fertilizers more especially the nitrogen type. Fertilizer is a scarcest and expensive commodity to small scale farmers who constitute major maize producers. Moringa (Moringa oleifera Lam.) a common plant in Nigeria were earlier reported to improve crop growth and yield. Thus, field experiments were conducted in 2009 and 2010 rainy seasons at the Teaching and Research Farm, Faculty of Agriculture, Bayero University, Kano, Nigeria to study the response of Maize to Aqueous Extract of Moringa and Nitrogen rates. Treatments consist of four concentrations of moringa shoots extract (0%, 3%, 4% and 5%) and three Nitrogen rates (0, 60, 120 kg N ha^{-1}). These treatments in a factorial combination were laid out in a Randomized Complete Block Design with three replications. Foliar spray of moringa extract on maize started at 2 weeks after sowing and continued fortnightly until 8 weeks after sowing. Nitrogen rates were applied in two doses at land preparation and at 5 weeks after sowing. Data were collected on Leaf area index, Crop growth rate, Net assimilation rate and Grain yield ha^{-1} and were subjected to Analysis of Variance. Results showed significant effects of moringa extract and Nitrogen rates with interactions on the parameters. Based on the results, it was concluded that moringa extract can compliment nitrogen fertilizer on the growth and yield of maize. Therefore, 120 kg N ha^{-1} with 5 % moringa extract which manifested highest effect on the parameters should be adopted to improve yield per unit area.

***Keywords**: Maize, Aqueous Extract of Moringa, Nitrogen rates, improve yield ha^{-1}.*

INTRODUCTION

Maize is the major staple crop in Nigeria. It is also a source of raw materials for industries. However, its average yield per hectare is very low (IITA, 2007), more especially under small scale farm farming families who constitute the major producers in the developing countries. Low yield per hectare under small scale farming is attributed to low input supply more especially inorganic fertilizers. Maize is known to be a heavy feeder of nitrogen (N) fertilizer. Hardly can a farmer apply half of the recommended rate because of its scarcity and where available it's high in cost. The application of 120 kg N ha^{-1} was reported to increase maize grain yield up to 213% (Adesoji et al., 2007). This report was in agreement with one earlier made by Ado et al., (2005) that maize yield increased with increased N application up to 150 kg ha^{-1}. Moringa (*Moringa oleifera* Lam.), a common plant in Nigeria was reported to improve soil fertility, crop growth and yield. The extract from the Moringa is use as plant growth hormone (PGH), which enhances crop growth and yield (Foidl et al., 2001). Moringa leaf extract at 2% concentration influenced leaf area index (LAI) of Kalmegh (*Andrographis paniculata*) (Prabhu et al., 2009). Leaf area index increased from 0.419 to 0.456 at 60 days after planting (DAP) and 0.978 to 1.034 at 90 DAP were recorded. Similar report on wheat, showed an increase in LAI from 3.62 to 4.66, and 5.41 with 0.28 kg ha^{-1} ethephon and 2.2 kg ha^{-1} chlormequat, respectively (Shekoofa and Emam, 2008). Contrastingly, garlic LAI of 0.82, 0.77 and 0.73 were obtained with gibberrelic acid (GA) at 0, 100, and 200 ppm, respectively (Rahman et al., 2004). These authors reported similar trend in crop growth rate (CGR) at 45 – 60 DAP, where CGR of 0.27, 0.22 and 0.18 g d^{-1} were obtained with GA at 0, 100, 200 ppm, respectively. Also, Net Assimilation Rate (NAR) at 30 – 45 and 60 – 75 DAP were 4.96, 4.41 and 4.11 g m^{-2}wk^{-1} and 10.19, 9.57 and 8.61 g m^{-2}wk^{-1} with 0, 100 and 200 ppm, respectively (Rahman et al., 2004). Interaction between N with PGH were also reported to influence plant growth. Leaf area index of rice (*Oryza sativa* L.) increased significantly with foliar application of NAA at 100 and 200 mg l^{-1} along with N rates at 0, 60, 90 and 120 kg N ha^{-1}

(Grewal and Gill, 1986). The results further indicated that rice grain yield was enhanced with foliar application of NAA under low level of N (0 and 60 kg ha^{-1}). There was interaction between N with PGH on grain yield of wheat (Shekoofa and Emam, 2008).

This research was therefore, carried out to determine if moringa extract can improve maize growth and yield as well as compliment N fertilizer to improve yield per unit area.

MATERIALS AND METHODS

Field experiments were conducted in 2009 and 2010 rainy seasons at the Teaching and Research Farm, Faculty of Agriculture, Bayero University, Kano, Nigeria (Latitude 11° 58' N and Longitude 8° 25' E at an altitude of 458 m), to study the response of maize to aqueous extract of moringa (AEM) and N rates. Moringa shoots of about 40 days were crushed with water (10 kg of fresh material in 1 litre of water) and filtered out. Liquid extract obtained were diluted with water in the following concentrations: 0%, 3%, 4% and 5%. These treatments with three N rates (0, 60, 120 kg N ha^{-1}) in a factorial combination were tested on maize in an experiment laid out in a randomized complete block design with three replications. Foliar spray started at 2 weeks after sowing (WAS) and continued fortnightly until 8 WAS. At land preparation half of the N in form of urea and 26.4 P – 49.8 K in form of single super phosphate and murate of potash, respectively were applied. At 5 WAS the remaining half of N in form of urea was side dressed. Samples of soils from the experimental sites were collected and their physico - chemical properties determined. Weeds were controlled by the application of pre – emergence herbicides (Primextra (290 g/liter S – metolachlor and 370 g/litre atrazine) at 4 L ha^{-1}) on the sowing dates. Application was done using CP 20 knapsack sprayer. Thereafter, supplementary weeding was done at 3 and 7 WAS. The following parameters were then measured and recorded: LAI at 5 and 7 WAS and at harvest. This was determined using the equation: LAI = LA/GA where LA = leaf area and GA = ground area covered by the plant. Crop growth rate, CGR (g wk^{-1}) was determined as follows: CGR = $(W_2 - W_1)/(T_2 - T_1)$; where W_1 and W_2 are shoot dry weights taken at two consecutive harvests over time intervals T_1 and T_2. Net assimilation rate (g cm^{-2} wk^{-1}) was determined by the relation: NAR = $(W_2 - W_1)(\text{Log}_e\ L_2 - \text{Log}_e\ L_1)/(t_2 - t_1)(L_2 - L_1)$; where W_2 and W_1 are shoot dry weights taken at two consecutive harvests over time t_1 and t_2 when the corresponding leaf area was L_2 and L_1, respectively. Grain yield ha^{-1}: Net plots were harvested and grain weights were converted to yield in kg ha^{-1}. Data collected were subjected to analysis of variance using SAS system for windows (SAS v8, 2000).

RESULTS AND DISCUSSIONS

The results of the composite soil samples for the two cropping seasons are presented in Table 1. Soils of the experimental sites were silty clay and slightly acidic; total N was moderately high. Organic carbon was also high. Table 2 shows the effects of N rates with AEM on LAI per plant of maize in 2009 and 2010 rainy seasons and the combined. There was a significant effect of N in 2009 rainy season at 5 WAS and highly significant effect in the seasons and combined at 5 and 7 WAS and at harvest; 60 kg N ha^{-1} had the highest effect, except in 2010 rainy season at harvest where 120 kg N ha^{-1} had the highest effect. In all seasons 0 kg N ha^{-1} gave the least LAI. The significant effect of N on LAI might be due to the role of N in promoting vegetative growth; this might have influenced number of leaves and leaf area, consequently, LAI. There was no significant effect of AEM on LAI in 2009 rainy season and combined at 5 WAS, and in the two seasons and combined at 7 WAS (Table 2). Highly significant effects in 2009 and combined as well as a significant effect in 2010 rainy season were recorded. In 2010 rainy season at 5 WAS and at harvest, 4% AEM produced the highest effect. Lowest effect was associated with 0% AEM. In 2009 rainy season and combined at harvest, 3% and 5% AEM had the highest and lowest effects, respectively. The significant effect of AEM on LAI might be due to the role of plant growth hormone in promoting rapid cell division, cell enlargement and the over all plant growth. The result of this study agreed with the earlier report of Prabhu et al. (2009) and Shekoofa and Emam (2008) who reported significant increased in LAI of crops with PGH. There were no interaction between N with AEM on LAI in 2009 rainy season at 5 and 7 WAS, and in 2010 rainy season at harvest (Table 2).

Table 1. Soil physical and chemical properties of the field experiments in 2009 and 2010 rainy seasons

Soil properties	**2009**		**2010**	
	0 – 15 cm	**15 – 30 cm**	**0 -15 cm**	**15 – 30 cm**
Soil pH (H_2O)	6.70	5.90	5.60	5.51
Organic carbon (g kg^{-1})	3.90	1.00	9.70	8.90
Organic matter (g kg^{-1})	6.72	1.72	16.72	15.34
Total N (g kg^{-1})	0.98	1.26	1.90	1.40
Available P (mg kg^{-1})	5.13	5.02	6.01	6.05
C.E.C (cmol kg^{-1})	9.67	5.94	6.92	4.30
Exchangeable K (cmol kg^{-1})	0.96	1.26	4.40	4.6
Exchangeable Na (cmol kg^{-1})	0.32	0.35	0.30	0.35
Exchangeable Ca (cmol kg^{-1})	0.04	0.05	0.28	0.73
Exchangeable Mg (cmol kg^{-1})	0.35	0.28	0.27	0. 27
Textural class	Silty clay	Silty clay	Silty clay	Silty clay

Table 2. Effect of aqueous extract of moringa and nitrogen rates on leaf area index of maize in 2009 and 2010 rainy seasons and combined

Treatments	**5 weeks after sowing**			**7 weeks after sowing**			**Harvest**		
	2009	**2010**	**CMBD**	**2009**	**2010**	**CMBD**	**2009**	**2010**	**CMBD**
Nitrogen (kg ha^{-1})									
0	0.88b	1.73b	1.31b	1.38b	2.14b	1.76b	1.05c	1.15b	1.10b
60	1.60a	3.75a	2.67a	2.36a	3.63a	2.99a	2.51a	2.67a	2.59a
120	1.51a	3.65a	2.58a	2.26a	3.63a	2.95a	2.25b	2.78a	2.51a
Level of probability	*	**	**	**	**	**	**	**	**
SE (±)	0.18	0.1	0.15	0.18	0.12	0.16	0.08	0.12	0.10
AE M (% conc.)									
0	1.57	2.70b	2.14	1.93	2.84	2.39	2.10b	1.84b	1.97b
3	1.43	3.09a	2.26	2.27	3.36	2.82	2.67a	2.25a	2.46a
4	1.18	3.32a	2.25	2.00	3.16	2.58	1.49c	2.38a	1.93a
5	1.13	3.08a	2.11	1.79	3.18	2.49	1.50c	2.31a	1.91b
Level of probability	NS	*	NS	NS	NS	NS	**	*	**
SE (±)	0.21	0.12	0.17	0.21	0.14	0.24	0.09	0.14	0.12
Interactions	NS	**	**	NS	**	**	**	NS	**

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability. NS = not significant at 5 % level of probability. * = significant at 5% level of probability using LSD ** = highly significant at 1% level of probability using LSD. AEM = aqueous extract of moringa. CMBD = combined.

Table 3. Interaction between aqueous extract of moringa and nitrogen rates on leaf area index of maize in 2009 and 2010 rainy seasons and combined

	Aqueous extract of moringa (%)							
	5 WAS 2010 rainy season				**Combined**			
Nitrogen(kg ha^{-1})	0	3	4	5	0	3	4	5
0	0.71c	2.68e	1.76f	1.78f	0.72c	1.94b	1.27c	1.30c
60	3.33cd	3.18de	4.61a	3.97abc	2.67a	2.43ab	3.06a	2.54ab
120	4.05ab	3.42bcd	3.58bcd	3.59bcd	3.02a	2.41ab	2.42ab	2.48ab
SE (±)	0.21				0.30			
	7 WAS 2010 rainy season				Combined			
0	1.62c	3.17b	1.83c	1.93c	0.99c	2.66ab	1.70bc	1.67bc
60	3.19b	3.41ab	3.87ab	4.04a	2.93ab	2.88ab	3.20a	2.96ab
120	3.71ab	3.50ab	3.77ab	3.57ab	3.23a	2.91ab	2.84ab	2.82ab
SE (±)	0.24				0.31			
	Harvest 2009 rainy season				Combined			
0	0.91g	5.19a	1.67der	1.84cd	0.34e	1.85c	1.07d	1.13d
60	1.97cd	2.82b	1.32efg	1.72cde	3.20a	2.38b	2.51b	2.27bc
120	1.16fg	2.20c	0.83g	1.30efg	2.38b	3.14a	2.22bc	2.32b
SE (±)	0.16				0.20			

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using LSD. WAS = weeks after sowing.

Highly significant interaction between N rates with` AEM on LAI were recorded in 2009 rainy season at harvest, 2010 rainy season at 5 and 7 WAS and the combined at 5 and 7 WAS and at harvest. In Table 3 the highest interactions in 2010 rainy season and combined at 5 WAS was with 60 kg N ha^{-1} and 4 % AEM. The least interaction was with 0 kg N ha^{-1} and 0 % AEM. At 7 WAS the interaction that had the highest LAI in 2010 rainy season was 60 kg N ha^{-1} coupled with 5 % AEM, while 120 kg N ha^{-1} with 0 % AEM had the highest LAI in the combined. Least interaction at 7 WAS were with 0 kg N ha^{-1} and 0 % AEM (Table 3). Also in Table 3, the highest LAI in 2009 rainy season at harvest was 0 kg N ha^{-1} with 3 % AEM and 60 kg N ha^{-1} with 0 % AEM in the combined. The least effect was with 0 kg N ha^{-1} and 0 % AEM.

There was a highly significant effect of N rates on CGR at 7 WAS and at harvest; 120 kg N ha^{-1} produced the highest effect in all seasons and combined except in 2009 rainy season at 7 WAS where 60 kg N ha^{-1} had the highest effect (Table 4). Nitrogen at 0 kg ha^{-1} had the least CGR in all seasons and combined. The significant effect of N on CGR might be related to the significant effect of N on LAI, which might have influenced the photosynthetic ability of the plant thereby, increasing dry matter production. AEM had no significant effect on CGR in 2009 rainy season and combined at 7 WAS (Table 4). Highly significant effects in 2010 rainy season at 7 WAS, and the seasons and combined at harvest were observed. In 2010 rainy season at 7 WAS, 3% AEM gave the highest effect and the least effect was with 4% AEM. At harvest, 5% AEM produced the highest CGR in the seasons and the combined while the least CGR where obtained with 4% AEM (Table 4). There was no significant interaction between N and AEM on CGR in 2009 rainy season and combined at 7 WAS (Table 4). The non – significant interaction might be due to the non – significant effect of AEM in the seasons. There was interaction in 2010 rainy season at 7 WAS and at harvest and highly significant interaction in 2009 rainy season and combined at harvest. In Table 5, the highest interaction in 2009 rainy season was obtained when 120 kg N ha^{-1} was combined with 0% AEM while the lowest interaction occurred with 0 kg N ha^{-1} and 0% AEM. 1n 2010 rainy season and at 7 WAS, the best interaction was with 120 kg N ha^{-1} and 3% AEM while the least was with 0 kg N ha^{-1} and 4% AEM. At harvest; 120 kg N ha^{-1} with5% AEM had the best effect in all seasons and combined. Least CGR was obtained when 0 kg N ha^{-1} and 0 % AEM (Table 5) were applied.

There was no significant effect of N rates on NAR of maize in the seasons and combined at 7 WAS and in 2010 rainy season at harvest (Table 4). Highly significant effect in 2009 rainy season and combined at harvest was observed. In 2009 rainy season, 60 kg N ha^{-1} and 120 kg N ha^{-1} had same effect with higher magnitudes while in the combined; 120 kg N ha^{-1} had the highest effect. Aqueous extract of moringa (Table 4) significantly affect NAR in 2009 rainy season at 7 WAS and at harvest, 4 and 5% AEM had the same effect in 2009 rainy season with highest NAR while 0 and 3% AEM had same effect and turned out to be the lowest. In 2009 rainy season at harvest, 5% AEM had the highest effect. There was a highly significant AEM effect in the combined. The 5% AEM had higher effect than all other concentrations that showed same effects. The significant effect of AEM on NAR might be due to the ability of the AEM to increase and maintain chlorophyll contents of plants which could help in photosynthesis partitioning and consequent increase in dry matter accumulation. There was no interaction between N rates with AEM in 2009 rainy season at 7 WAS and at harvest; in 2010 rainy season at harvest and combined at 7 WAS. There was interaction in 2010 rainy season at 7 WAS and combined at harvest (Table 4). The least interaction was found with 0 kg N ha^{-1} and 4% AEM and 60 kg N ha^{-1} with 5% AEM which were similar (Table 5).

Significant effects of N rates on grain yield of maize in 2009 rainy season and highly significant effect in 2010 rainy season and combined were observed. Nitrogen at 120 kg ha^{-1} had higher grain yield in the seasons while the lowest yield was obtained by 0 kg N ha^{-1} (Table 6). There was no significant effect of AEM on grain yield of maize in the seasons and combined. This might be due to the fact that AEM influenced the growth parameters more than grain yield. There was no interaction between N and AEM in 2009 rainy season and combined (Table 6). Significant interaction was recorded in 2010 rainy season, where 120 kg N ha^{-1} and 0 % AEM had the highest effect. Least interaction was obtained with 0 kg N ha^{-1} and 0 % AEM (Table 5).

Table 4. Effect of aqueous extract of moringa and nitrogen rates on crop growth rate (gwk^{-1}) and net assimilation rate ($gm^{-2}wk^{-1}$) of maize in 2009 and 2010 rainy seasons and combined

Treatments	Crop growth rate						Net Assimilation Rate						Grain yield		
	7 weeks after sowing			Harvest			7 weeks after sowing			Harvest					
	2009	2010	CMBD	2009	2010	CMBD	2009	2010	CMBD	2009	2010	CMBD	2009	2010	CMBD
Nitrogen (kg ha^{-1})															
0	50.71b	16.83b	33.77b	11.78b	72.49c	42.14c	0.03	0.01	0.02	0.01b	0.03	0.016c	719.7b	1369.3c	1044.5c
60	99.28a	34.35a	68.81a	81.59a	134.81b	108.20b	0.03	0.01	0.02	0.02a	0.02	0.021b	2065.6a	3277.2b	2671.4b
120	97.91a	43.15a	70.53a	93.08a	179.32a	136.20a	0.03	0.01	0.02	0.02a	003	0.026a	2137.0a	4649.5a	3393.3a
Level of probability	**	**	**	**	**	**	NS	NS	NS	**	NS	**	*	**	**
SE (±)	6.38	3.35	5.09	5.60	6.00	5.81	0.003	0.001	0.003	0.003	0.003	0.003	413.12	200.94	324.84
AE M (% Conc.)															
0	80.66	34.00b	57.33	65.71a	116.54bc	91.13b	0,02b	0.007	0.02	0.013b	0.03	0.02b	2391.0	2992.6	2691.8
3	79.54	45.80a	62.67	73.32a	135.33b	104.32ab	0.02b	0.008	0.02	0.014b	0.03	0.02b	1610.7	3085.4	2348.0
4	86.80	22.70b	54.75	35.43b	105.83c	70.63c	0.03a	0.003	0.02	0.011b	0.02	0.02b	1285.1	3290.7	2287.9
5	83.53	28.61b	56.07	74.16a	157.79a	115.97a	0.03a	0.004	0.02	0.022a	0.03	0.03a	1276.2	3026.1	2151.2
Level of probability	NS	**	NS	**	**	**	*	NS	NS	*	NS	**	NS	NS	NS
SE (±)	7.36	3.86	5.88	6.46	6.93	6.70	0.003	0.001	0.003	0.003	0.003	0.003	476.47	231.75	374.65
Interactions	NS	*	NS	**	*	**	NS	*	NS	NS	NS	*	NS	*	NS

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using LSD. NS = not significant at 5% level of probability.
* = significant at 5% level of probability using LSD. ** = highly significant at 1% level of probability using LSD. AEM = aqueous extract of moringa.

Table 5. Interactions between aqueous extract of moringa and nitrogen rates on crop growth rate (gwk^{-1}), net assimilation rate ($gm^{-2}wk^{-1}$) and grain yield ($kg\ ha^{-1}$) of maize in 2009 and 2010 rainy seasons and combined

	Aqueous extract of moringa (%)											
	Crop growth rate											
	7 WAS 2009 rainy season				**7 WAS 2010 rainy season**							
Nitrogen ($kg\ ha^{-1}$)	0	3	4	5	0	3	4	5	0	3	4	5
0	18.04d	60.12c	63.51c	61.19abc	26.22bcd	16.72de	3.72e	20.67cde				
60	94.06abc	97.83abc	116.57ab	88.66abc	40.50bc	46.89b	35.66bcd	30.34bcd				
120	129.89a	80.67bc	80.33bc	100.73abc	35.28bcd	73.78a	28.72bcd	34.83bcd				
SE (±)	12.76				6.70							
	Harvest 2009 rainy season				Harvest 2010 rainy season				Combined			
0	2.79f	15.41f	13.75f	15.17f	38.25e	89.08d	75.92d	86.72d	20.52e	52.25d	44.84d	50.95d
60	113.95ab	94.73abc	37.37ef	80.33bcd	143.80bc	134.69c	83.03d	177.70ab	128.88bc	114.71c	60.20d	129.01bc
120	60.40cde	109.81ab	55.15de	126.97a	167.56bc	182.22ab	158.56bc	208.94a	123.98bc	146.02ab	106.86c	167.96a
SE (±)	11.21				12.01				11.62			
	Relative growth rate								Grain yield			
	7 WAS 2009 rainy season				Combined				2010 rainy season			
0	0.010a	0.003bc	0.0001c	0.007ab	0.02bc	0.01c	0.02bc	0.02bc	685.71f	1318.52ef	1164.02ef	2308.99de
60	0.007ab	0.010a	0.007ab	0.0001c	0.02bc	0.03ab	0.01c	0.03ab	3061.37cd	3022.22cd	3835.98bc	3189.42cd
120	0.003bc	0.010a	0.003bc	0.007ab	0.02bc	0.03ab	0.02bc	0.04a	5230.69a	4915.34ab	4871.96ab	3579.90cd
SE (±)	0.002				0.01				401.88			

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using LSD. WAS = weeks after sowing.

The significant interaction between N and AEM in 2010 rainy season on maize grain yield might be due to the season, whose effect could not manifest clearly but with the application of N. The presence of interaction is an indication of differential response to the different rates of the factors employed (Hussaini et al., 2004).

CONCLUSION

From the results, it was obvious that AEM had significant effects on the growth and grain yield of maize and it can complement the crop's N fertilizer requirement. Conclusively, 120 kg N ha^{-1} with 5% AEM, which had the highest effects on the parameters studied, should be adopted to maximize production and economic benefits. Modern method of extraction of moringa should be explored to reduce drudgery.

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EFFECTS OF AQUEOUS EXTRACT OF MORINGA (*Moringa oleifera* LAM.) AND NITROGEN RATES ON THE CONTRIBUTION OF SOME PHYSIOLOGICAL AND YIELD ATTRIBUTES TO GRAIN YIELD OF SESAME (*Sesamum indicum* L.) II

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Abstract

Sesame is considered second best to cocoa in terms of export volume and value in Nigeria. However, there is a drawback in the land area under its cultivation recently due to the low yield per unit area. Yield is a quantitative character that is dependent on many related characters. For effective improvement in yield a simultaneous improvement of physiological and yield attributes alongside agronomic practices is pertinent. Moringa were reported to improve crops' yield because of its ability to improve soil fertility as well as play key roles as a plant growth hormone. Thus, field experiments were conducted in 2009 and 2010 rainy seasons at the Teaching and Research Farm, Faculty of Agriculture, Bayero University, Kano, Nigeria to study the roles of Aqueous Extract of Moringa and Nitrogen rates as they affect some Physiological and yield attributes in Sesame. Treatments consisted of four concentrations of moringa shoots extract (0%, 3%, 4% and 5%) and three Nitrogen rates (0, 45, 90 kg N ha^{-1}). These treatments were factorially combined and laid out in a Randomized Complete Block Design with three replications. Foliar spray of moringa extracts on sesame started at 2 weeks after sowing and continued fortnightly until 8 weeks after sowing. Nitrogen rates were applied in two doses at land preparation and at 5 weeks after sowing. Data were collected on Plant height, Leaf area index, Crop growth rate, Leaf area ratio, Number of capsules per plant and Grain yield ha^{-1}. Data obtained were subjected to correlation analysis between the measured characters and yield, thereafter, path analysis was carried out. Results showed significant association between the characters and grain yield. Plant height had the highest percentage direct contribution while Number of capsules per plant had the lowest contribution. Indirect/combined contribution of Crop growth rate with leaf area ratio was highest while leaf area ratio with number of capsules per plant was lowest and negative. Based on the results, it was concluded that moringa can compliment Nitrogen fertilizer in improving sesame growth and yield. Therefore, 90 kg N ha^{-1} with 3 % moringa extract are recommended for improved grain yield of sesame per unit area.

***Key words**: sesame, aqueous extract of moringa, nitrogen rates, physiological and yield attributes, grain yield.*

INTRODUCTION

The drawback in the land area under sesame (*Sesamum indicum* L.) cultivation in Nigeria had been attributed to low yield per hectare. This has become a major concern to the government, farmers and researchers. Sesame is considered second best to cocoa in terms of export volume and value in Nigeria (Anon., 2004). This concern made researchers to explore all possibilities to improve its production and productivity.

Yield is a quantitative character that is dependent on many related characters (Muhamman et al., 2012). For effective improvement in yield a simultaneous improvement of physiological and yield attributes alongside agronomic practices is important. Number of leaves per plant and plant height were earlier reported to significantly affect sesame grain yield (Muhamman et al., 2010).

Moringa (*Moringa oleifera* Lam.) a common plant in households in Nigeria were reported to enhance seed germination, growth and yield of crops (Foidl et al., 2001; Muhamman et al., 2009; Phiri and Mbewe, 2010).

On the other hand, fertilizer more especially nitrogenous types; the major input in crop production is very scarce and where available is beyond the reach of small holder farm families who constitute the major producers in Nigeria. The need to find synergy to nitrogen fertilizer becomes vital.

This research therefore, was conducted to determine the complimentary effect of aqueous extract of moringa with nitrogen rates and their effect on the contribution of some physiological and yield attributes to grain yield of sesame.

MATERIALS AND METHODS

Two years (2009 and 2010 rainy seasons) field studies were conducted at the Teaching and Research Farm, Faculty of Agriculture, Bayero University, Kano, Nigeria (Latitude 11^o 58' N and Longitude 8^o 25' E at an altitude of 458 m). Moringa shoots (about 40 days) were crushed with water (10 kg of fresh material in 1 litre of water) and filtered out.

Liquid extract obtained were diluted with water in the following concentrations: 0%, 3%, 4% and 5% to give 4 treatments. These treatments with three N rates (0, 45, 90 kg N ha^{-1}) in a factorial combination were tested on sesame in an experiment laid out in a Randomized Complete Block Design with 3 replications. Foliar spray started at 2 WAS and continued fortnightly until 8 WAS. Land for the experiments were prepared by harrowing and ridging at a spacing of 0.75 m between rows, thereafter were marked into plots with gross plot size of 13.5 m^2 and net plot size of 3.15 m^2.

Table 1. Soil physico - chemical properties of soils of experimental sites in 2009 and 2010 rainy seasons

Soil properties	2009		2010	
	0 – 15 cm	15 – 30 cm	0 -15 cm	15 – 30 cm
Soil pH (H_2O)	6.70	5.90	5.60	5.51
Organic carbon (g kg^{-1})	3.90	1.00	9.70	8.90
Organic matter (g kg^{-1})	6.72	1.72	16.72	15.34
Total N (g kg^{-1})	0.98	1.26	1.90	1.40
Available P (mg kg^{-1})	5.13	5.02	6.01	6.05
C.E.C. (cmolkg^{-1})	9.67	5.94	6.92	4.30
Exchangeable K (cmol kg^{-1})	0.96	1.26	4.40	4.6
Exchangeable Na (cmol kg^{-1})	0.32	0.35	0.30	0.35
Exchangeable Ca (cmol kg^{-1})	0.04	0.05	0.28	0.73
Exchangeable Mg (cmol kg^{-1})	0.35	0.28	0.27	0. 27
Textural class	Silty clay	Silty clay	Silty clay	Silty clay

Soil samples were collected in the two seasons randomly at a depth of 0 - 15 cm and 15 – 30 cm using soil auger and the soil's physical and chemical properties determined in the laboratory (Table 1).

Few seeds of sesame were dibbled and later thinned to one plant per stand at 3WAS at a spacing of 0.75 m x 0.15 m. Half of N with 60 kg ha^{-1} P_2O_5 – 60 kg ha^{-1} K_2O were applied at sowing, and at 5 WAS the remaining half of N was applied as side dressing. Weeds were controlled manually using hand hoes at 3, 5 and 7 WAS.

Data were collected on: Plant height (PH) at 5 and 7 WAS, and at harvest: heights of five plants selected randomly and tagged were determined from each plot, mean calculated and recorded.

Leaf area index (LAI) at 5 and 7 WAS and at harvest: LAI were determined using the equation: LAI = LA/GA where LA = leaf area and GA = ground area covered by the plant. Crop growth rate (CGR) (g wk^{-1}): CGR was determined as follows: $CGR = (W_2 – W_1)/ (T_2 – T_1)$; where W_1 and W_2 are shoot dry weights taken at two consecutive harvests over time intervals T_1 and T_2. Leaf area ratio (LAR) (g cm^{-2}): this was determined as follows: $LAR = A_2 – A_1 (Log_e W_2 – Log_e W_1)/W_1 – W_2 (Log_e A_2 – Log_e A_1)$; where W_1 and W_2 are shoot dry weights taken at two consecutive harvests over time t_1 and t_2 and A_1 and A_2 were leaf area at these periods.

Number of capsules per plant (NCPP): capsules of the five tagged plants in each plot were counted and their mean recorded. Grain yield ha^{-1}: Net plots were harvested and grain weights were converted to yield in kg per hectare.

Data collected were subjected correlation analyses between the measured parameters and yield using SAS system for windows (SAS v 8, 2000). Thereafter, path analysis was carried out as described by Dewey and Lu (1959).

RESULTS AND DISCUSSIONS

The results of the composite soil samples for the two cropping seasons are presented in Table 1. Soils of the experimental sites were silty clay and slightly acidic; total N was moderately high. Organic carbon was also high. The variation in the physico – chemical properties in the seasons, with that of 2010 being slightly higher, likely be due to the residual soil nutrients and post harvest left over of the previous cropping season. Table 2 shows matrix of correlation describing the mean relationship between some physiological and yield attributes to grain yield of sesame in 2009 and 2010 rainy seasons. Leaf Area Ratio had a highly significant positive correlation (r=0.42) with grain yield, and plant height had a positive significant correlation with grain yield of 0.26. Leaf area index, CGR, NCPP had no significant correlation with grain yield.

Path diagram and coefficient of factors of some physiological and yield attributes affecting total grain yield of sesame (Figure 1) showed that PH, LAI, CGR, LAR and NCPP contributed directly to grain yield with magnitudes of 0.5907, -0.3808, 0.3898, 0.4562 and 0.1540, respectively. Indirect/combined contribution of CGR with LAR was highest (0.63) followed by LAI with CGR (0.62) and lowest in LAR with NCPP (-0.13), while 0.13 was residual. When the contribution was quantified into percentage (Table 3), PH contributed highest (34.89%) followed by LAR (20.82%) and least contribution (2.37%) was from NCPP.

The highest contribution of PH may be due to the fact that the higher the plant, the more branches may be formed, since dormant buds close to apical meristems becomes viable, as the shoot apex grows away from the auxiliary bud.

This may result to more leaves and leaf area thereby increasing the photosynthetic ability of the plant.

This will result into more dry matter accumulation, which may be partitioned to the sink (the grain). Plant height was earlier reported to significantly contribute to grain yield of sesame (Muhamman et al., 2010)

This may also explain the contribution of LAR. Since LAR is an important factor in estimating canopy photosynthesis (Amanullah et al., 2007). Also the percentage indirect/combined contribution of CGR with LAR was highest (22.41%), followed by PH with LAR (13.48%). This also followed the earlier explanation that as the plant increases in height more leaves may be formed.

This increases the photosynthetic ability of the plant and thus, the accumulation of more dry matter.

The least percentage of indirect/combined contribution was in LAR with NCPP and it was negative (- 1.83%).

Sesame capsules remain green until when the plant attained physiological maturity, and could take part in photosynthetic activities; hence it is regarded more of a source than a sink.

This may explain the reason why direct and indirect contribution of NCPP was the lowest.

About 13.15% is residual; unaccounted form of error, which cannot be explained in this study. The residual might form part of the attributes which are not part of this study. Attributes such as number of branches per plant where earlier reported to significantly affect grain yield of sesame (Muhamman et al., 2010)

Table 2. Matrix of correlation showing the relationship between some physiological and yield attributes to grain yield of sesame (*Sesamum indicum* L.) in the combined of 2009 and 2010 rainy seasons

		1 **PH**	2 **LAI**	3 **CGR**	4 **LAR**	5 **NCPP**	6 **GY**
1	PH	1.00					
2	LAI	0.40**	1.00				
3	CGR	0.11ns	0.62**	1.00			
4	LAR	0.25*	0.34**	0.63**	1.00		
5	NCPP	0.42**	0.18ns	0.22ns	-0.13ns	1.00	
6	GY	0.26*	0.19ns	-0.05ns	0.42**	0.08ns	1.00

PH = plant height, LAI = leaf area index, CGR = Crop growth rate LAR = Leaf area ratio, NCPP = Number of capsules per plant, GY = Grain yield per hectare, *= significant at 5 % level. ** = highly significant at 1 % level. ns = not significant.

Table 3. Direct and combined contribution (%) of some physiological and yield attributes to grain yield of sesame (*Sesamum indicum* L.) and their residual effect in the combined of 2009 and 2010 rainy seasons

Characters	**% Contribution**
Individual/direct contribution	
Plant height (PH)	34.8931
Leaf Area Index (LAI)	14.5013
Crop Growth Rate (CGR)	15.1955
Leaf Area Ratio (LAR)	20.8151
Number of pods per plant (NPP)	2.3716
Indirect/combined contribution	
PH – LAI	-17.9955
PH – CGR	5.0658
PH – LAR	13.4750
PH – NPP	7.6414
LAI – CGR	-18.4070
LAI – LAR	-11.8141
LAI – NPP	-2.1112
CGR – LAR	22.4087
CGR – NPP	2.6414
LAR – NPP	-1.8268
Residual	13.1457
Total	100.0000

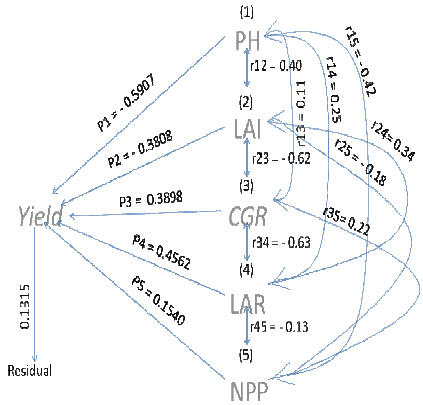

Figure 1. Path diagram and coefficient of factors of some physiological and yield attributes affecting total grain yield of sesame

CONCLUSIONS

From the results of this study, aqueous extract of moringa and nitrogen rates had significantly effects the physiological and yield attributes that contribute meaningfully to grain yield of sesame.

While it was obvious that the two factors complement each other, 90 kg N ha^{-1} with 3% aqueous extract of moringa should be adopted for improved grain yield.

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FRESH BIOMASS PRODUCTION OF DOUBLE CROP MAIZE (*Zea mays* L.) HYBRIDS CULTIVATED IN MOARA DOMNEASCA, ILFOV

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Abstract

Double crops system constitutes a means by which the vegetation factors can be more efficiently exploited (Tiru, 1973). In Romania the specie most used for double crops is maize, because it can be harvested as grain or as fresh biomass if the climatic conditions do not ensure the attainment of physiological maturity. To reach physiological maturity the double crop of maize needs between 900 and 1800^{o}C (Tiru, 1973) and a irrigation regime of 2000 m^3 water/ha (Hulpoi, 1966). Also the fertilization levels play an important role in the attainment of physiological maturity (Budoi, 1988). The research done has the purpose of establishing the optimal precocity of the hybrids used for double crops in the pedo-climatic conditions of Moara Domneasca, Ilfov and also to assess the importance of the fertilization levels and irrigation regime on double crops. In the conditions of 2013, the maize double crop was harvested as fresh biomass, yielding between 28 and 64 t/ha, considering the hybrid, fertilization level and irrigation regime.

Key words: *Zea mays L., double crops, fertilization levels, irrigation regime, sum of biological useful degree temperature.*

INTRODUCTION

The biological particularities and outstanding food quality led maize cultivation in various parts of the world, nowadays occupying the third place in surface cultivated after wheat and rice (Ion, 2012).
The importance of maize is given mainly by its nutritional qualities, both for human nutrition and for animal feed. Using maize silage is the most effective way of feeding animals during stabulation, having a very high degree of expendability (Ion, 2012).
Another important feature of maize is the possibility to be cultivated in double crops, after species that are harvested early (Ion, 2012).
Double crops system constitutes a means by which the vegetation factors can be more efficiently exploited (Tiru, 1973).
In areas with heavy rainfall and even in other areas, in the rainy years, without irrigation after straw cereals, the forage crops can be cultivated, which can increase the efficiency of agricultural land up to 30% or more (Taru, 1973, Zhu Zixi et al., 1994). Under irrigation condition, increased yields can be obtained for forage maize as well as for grain production.
Navarro et al. (2012) showed the double crops system profitability.
They calculated the prices obtained by farmers for main crop per acre and two crops in the double crops system.
Thus, they observed that a soybean main crop brings in a profit of $ 80 / acre, when double crops of sorghum fresh biomass grown after grain wheat, brings together a profit of $ 244 / acre.
This is because the farmer operates in two markets, grain and forage. Of course, this increase of profit is dependent of the obtained production, of the sales prices and of the relationship between these two.
Double crops system is an alternative for the future of agriculture in the context of the climatic changes. Meza (2012) suggest, after some simulations to see the impact of climate change on agriculture, that double crop of maize could become a common practice due to the extension of the vegetation as a result of global warming.
The only inconvenience is the necessity of irrigation, creation and use of hybrids that are drought and heat tolerant.
The maize, having a high capacity of production, a high tolerance to drought and heat, and

being a culture with minimal risk for the farmer, having uses such as grain or fresh biomass, represents an important crop for irrigated double crops system.

The most important quality of maize in the double crops system is that it can be harvested as fresh biomass if it does not have the necessary conditions to reach grain maturity. The losses in this case are determined only by the use of production, because its value in units nutrients may be even higher for fresh biomass compared to the same culture harvested for grain (Taru, 1973).

The maize is a heat-loving plant that needs about 900-1800°C for the whole vegetation period according to the hybrid maturity group. So, to reach grain maturity and to have a good production in double crops system, the maize hybrids should be from a early maturity group (Kratochvil et al., 2006).

Over time, it has been created highly productive hybrids from all the maturity groups and even hybrids especially for double crops system (Sarca et al., 1980).

Due to higher temperatures and faster growth of the stem and root, the double crop of maize requires about 2000 m^3 water/ha (Hulpoi et al., 1966; Taru, 1973) and also a higher demand in nutrients, especially nitrogen (Taru, 1973; Budoi et al., 1988).

MATERIALS AND METHODS

The research was conducted in 2013 at the Moara Domneasca Teaching Farm, Ilfov.

The experience was three-factorial type, the three factors were: the hybrid, the irrigation regime and the fertilization.

The arrangement of the experience was performed by the method of subdivided parcels.

The maize hybrids used were: a_1: LG 22.44 (FAO 240) – as control, a_2: LG 30.290 (FAO 290) and a_3: LG 30.489 (FAO 470).

Irrigation regimes studied were b_1: non-irrigated (control), b_2: irrigated with 450 m^3/ha and b_3: irrigated with 900 m^3/ha (a mildly irrigation regime).

The fertilization presented four graduations: c_1: no fertilization (control), c_2: nitrogen 80 kg/ha active substance, c_3: nitrogen 80 kg/ha active substance plus foliar fertilization and c_4: foliar fertilization. For the nitrogen fertilization it was used urea, and for the foliar fertilization it was used the product Hortifor with applications at a dose of 2.5 kg/ha.

The maize hybrids were used in double crop after winter wheat. The soil was prepared for sowing with disc harrow and combiner.

Sowing was on 18th of July, slightly delayed due to weather conditions that delayed the harvesting of the wheat.

Weed control was achieved by herbicide Dual Gold (pre-emergence) and Ceredin Super (post-emergence) and by an application of a mechanical weeding.

The irrigations were applied every 10-15 days depending on rainfall, in small quantities of about 200 and 250 m^3 water/ha.

Maize plants were harvested on 7th of October, this it was imposed by the low temperatures in early October.

RESULTS AND DISCUSSIONS

The climatic data, for the vegetation period of the double crop maize (July-September 2013), are presented in Figure 1.

From its analysis it can be seen that the temperatures were higher than the normal average temperatures of the area, the sum of useful degree temperature was 1180°C with 55°C more than the area normal.

Regarding rainfall, in July and August they were below normal, with 40 mm in July and 15 mm in August. In September 2013, the rainfall was higher than the normal by 16 mm.

FRESH BIOMASS PRODUCTION IN DOUBLE CROP MAIZE

In Table 1 are presented the productions of fresh biomass production (t/ha) recorded for the double crop maize, depending on the hybrid, irrigation regime and the fertilization level.

The highest values of fresh biomass production were recorded for the hybrid LG 22.44 (from 28.37 t/ha at b_1c_1 to 64.86 t/ha b_3c_3). The hybrid from the highest maturity group (LG 30 489) registered the lowest values.

The fertilization level plays an important role in the yields obtained for the double crop maize, therefore, as the level of the fertilization increases the fresh biomass production increases.

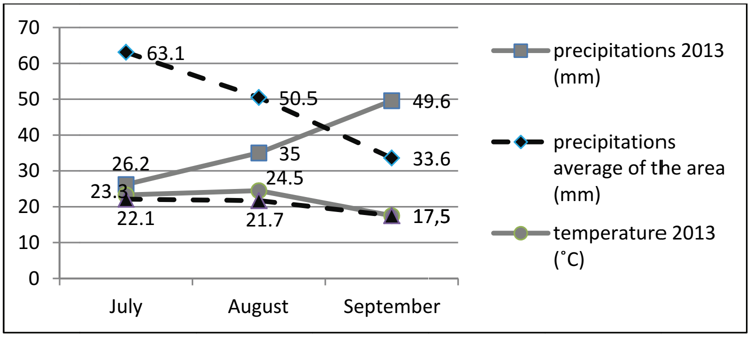

Figure 1. Climatic conditions of the period July – September 2013 (Ganeasa, Ilfov, Weather Station)

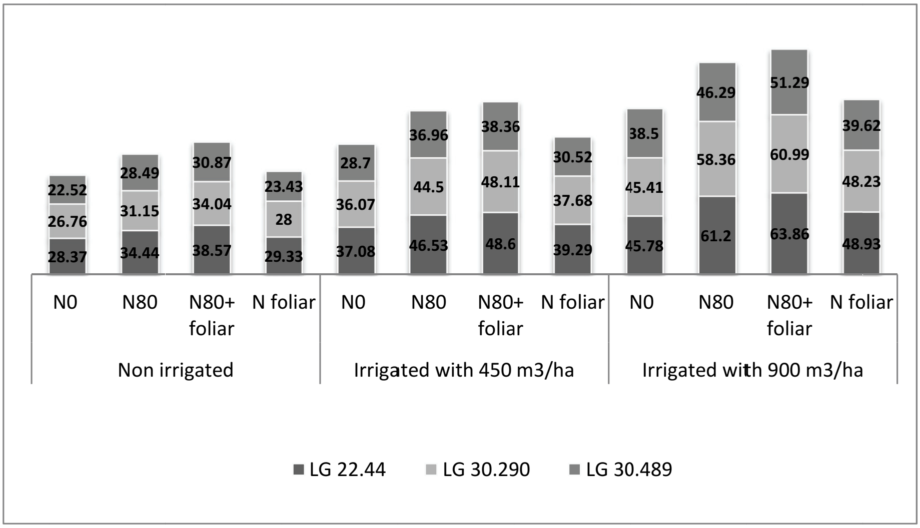

Figure 2. Double crop maize fresh biomass production (t/ha), Moara Domneasca-2013

The differences from the non-fertilized variants are ranging between 0.96 t/ha and 18.08 t/ha. In the same measure, the irrigation regime is important for a high yield of the double crop maize.

The highest values according to hybrid (63.86 t/ha, 60.99 t/ha and 51.29 t/ha) were recorded for the irrigation norm of 900 m^3/ha.

In table 2 and figure 2, are presented the differences of the fresh biomass production (t/ha) between the earliest hybrid (LG 22.44) and the other two hybrids (LG 30 290 and 30 489 LG).

Thus from Table 2 it can be observed the gradual decrease of productions in the same time with increasing the maturity group of the hybrids regardless of the fertilization levels or the irrigation regimes analyzed.

For non-irrigated regime, the maximum difference between the hybrid LG 22.44 and the hybrid LG 30.290 was 4.53 t/ha, and the hybrid LG 30.489 was 7.7 t/ha.

At the irrigation regime of 450 m^3/ha, the difference with LG 30.489 increased to 10.24 t/ha, reaching to 14.91 t/ha at the irrigation regime of 900 m^3/ha. These differences show that for the early hybrids the accumulation speed of the biomass is higher.

Table 1. The influence of the hybrid, fertilization and irrigation on biomass production of double crop maize

Variant		Hybrids								
		LG 22.44			LG 30.290			LG 30.489		
Irrigation regime	Fertilization	Biomass prod. t/ha	%	Dif. t/ha	Biomass prod. t/ha	%	Dif. t/ha	Biomass prod. t/ha	%	Dif. t/ha
Non irrigated	N0	28.37	100	Mt	26.76	100	Mt	22.52	100	Mt
	N80	34.44	121	6.07	31.15	116	4.39	28.49	126	5.97
	N80+ foliar fertilization	38.57	135	10.2	34.04	127	7.28	30.87	137	8.35
	Foliar fertilization	29.33	103	0.96	28	104	1.24	23.43	104	0.91
LSD 5% =1.3 t/ha LSD 1% =1.75 t/ha LSD 0.1% = 2.33 t/ha										
Irrigated with 450 m3/ha	N0	37.08	100	Mt	36.07	100	Mt	28.7	100	Mt
	N80	46.53	125	9.45	44.5	123	8.42	36.96	128	8.26
	N80+ foliar fertilization	48.6	131	11.53	48.11	133	12.04	38.36	133	9.66
	Foliar fertilization	39.29	105	2.22	37.68	104	1.61	30.52	106	1.82
LSD 5% = 0.68 t/ha LSD 1% = 0.92 t/ha LSD 0.1% = 1.22 t/ha										
Irrigated with 900 m3/ha	N0	45.78	100	Mt	45.41	100	Mt	38.5	100	Mt
	N80	61.2	133	15.42	58.36	128	12.95	46.29	120	7.79
	N80+ foliar fertilization	63.86	139	18.08	60.99	134	15.59	51.29	133	12.79
	Foliar fertilization	48.93	106	3.15	48.23	106	2.82	39.62	102	1.12
LSD 5% = 0.72 t/ha LSD 1% = 0.98 t/ha LSD 0.1% = 1.3 t/ha										

Table 2. The influence of the maturity group on the biomass production (t/ha)
in double crop maize – Moara Domneasca, Ilfov

Variant		Hybrids								
		(FAO 240) LG 22.44			(FAO 290) LG 30.290			(FAO 470) LG 30.489		
Irrigation regime	Fertilization	Biomass prod. t/ha	%	Control	Biomass prod. t/ha	%	Dif. t/ha	Biomass prod. t/ha	%	Dif. t/ha
Non irrigated	N0	28.37	100	Mt	26.76	94.33	-1.61	22.52	79.36	-5.86
	N80	34.44	100	Mt	31.15	90.45	-3.29	28.49	82.72	-5.95
	N80+ foliar fertilization	38.57	100	Mt	34.04	88.26	-4.53	30.87	80.04	-7.7
	Foliar fertilization	29.33	100	Mt	28	95.47	-1.33	23.43	79.87	-5.9
LSD 5% =1.3 t/ha LSD 1% =1.75 t/ha LSD 0.1% = 2.33 t/ha										
Irrigated with 450 m3/ha	N0	37.08	100	Mt	36.07	97.29	-1	28.7	77.41	-8.38
	N80	46.53	100	Mt	44.5	95.64	-2.03	36.96	79.44	-9.57
	N80+ foliar fertilization	48.6	100	Mt	48.11	98.99	-0.49	38.36	78.92	-10.24
	Foliar fertilization	39.29	100	Mt	37.68	95.89	-1.61	30.52	77.67	-8.77
LSD 5% = 0.68 t/ha LSD 1% = 0.92 t/ha LSD 0.1% = 1.22 t/ha										
Irrigated with 900 m3/ha	N0	45.78	100	Mt	45.41	99.18	-0.37	38.5	84.1	-7.28
	N80	61.2	100	Mt	58.36	95.35	-2.85	46.29	75.64	-14.91
	N80+ foliar fertilization	63.86	100	Mt	60.99	95.51	-2.87	51.29	80.31	-12.58
	Foliar fertilization	48.93	100	Mt	48.23	98.57	-0.7	39.62	80.97	-9.31
LSD 5% = 0.72 t/ha LSD 1% = 0.98 t/ha LSD 0.1% = 1.3 t/ha										

CONCLUSIONS

From experiments conducted in 2013 on the double crop maize, it results that the precocity of the hybrids used is very important to ensure a high production of fresh biomass in a short time.

The precocity group FAO 240 (LG 22.44) has recorded positive difference up to 14.91 t/ha compared to the semi-late hybrid, LG 30 489 (FAO 470).

In the same measure, both the irrigation regime and the fertilization level are significant for a high production of fresh biomass. The best results has occurred for irrigation regime of 900 m^3/ha water and at fertilization level of 80 kg N/ha plus foliar fertilization.

In terms of 2013 year, at Moara Domneasca, for the double crop maize, the best yields results were obtained by the hybrid LG 22.44.

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THE EFFECTS OF FOLIAR APPLICATION OF ABA AND CYTOKININE IN DIFFERENT REPRODUCTIVE GROWTH STAGES OF MATERNAL WHEAT PLANTS ON THE SEED TRAITS UNDER SALINE CONDITIONS

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Abstract

In order to study the effects of foliar sprays of Cytokinine (CK) and Abscisic Acid (ABA) in different reproductive growth stages of maternal plant on the seed characteristics under laboratory saline conditions a factorial experiment arranged in RCBD with three replications and two factors was conducted in Agricultural Faculty of Mahabad Azad University. Factor A included three salinity stress levels (0, 0.4 and 0.8 ds/m) and factor B included seven levels; b_1: no spray of hormones as control, b_2: CK foliar spray in pollination stage, b_3: CK and ABA foliar sprays in grain filling and pollination stages, b_4: CK foliar spray in grain filling and pollination stages, b_5: ABA foliar spray in pollination stage, b6: ABA foliar spray in grain filling and pollination stages, b_7: CK and ABA foliar sprays in pollination stages. Results showed that with increasing salinity rate all of the studied traits decreased significantly so that the least germination velocity, rootlet dry weight and rootlet length were obtained from the salinity stress of 0.8 ds/m and their greatest amounts were obtained from the control. The interaction of salinity and plant growth regulators with dry weight and stemlet length was significant. With increasing the salinity percentage at various levels of hormones the stemlet length and dry weight decreased so that the least values were obtained from ABA foliar spray at pollination and grain filling with salinity stress of 0.8 ds/m. The greatest values were obtained from the foliar spray of CK at pollination and grain filling with distilled water (control). The results showed that CK foliar spray at pollination and grain filling had the greatest positive effect on seed vigority under saline conditions.

Key words: *foliar application, cytokinins, abscisic acid, salinity.*

INTRODUCTION

Seed viability and vigor are two important factors affecting seedling establishment, plant growth and yield (Sawan and Copeland, 1997). Many factors such as genotype, seed size, seed weight, environmental stresses including water shortage, high temperatures, salinity, soil acidity, pathogens, nutrients shortage and abundance and anaerobic (no-O_2) conditions which directly affect the growth and nutrition of maternal plant can indirectly affect seed development, food supply and seed quality such as seed viability and vigor (Sawan et al., 1993).

The saline stress causes decrease in yield in field crops in dry and semi dry areas through negatively affecting grain production (Yokoi et al., 2002).

Also, saline stress causes decrease in germination percentage (Epstein et al., 1987) and rootlet length, stemlet length and shoot growth of seedlings (Chi Lin et al., 1995).

The study of effects of salinity on germination (velocity and % germination) and stemlet and rootlet growth in most field crops showed that saline stress at germination is a dependable test for evaluation of tolerance in many species because it decreases % germination and growth of rootlet and stemlet (Ghoulham and Fares, 2001).

Field crops are mostly exposed to restrictive environmental factors such as high salinity of soil or drought which affect plant processes through restricting available water (Grover et al., 2001).

There is a direct and inseparable relationship between salinity stress and water shortage. In saline-exposed plants besides the osmotic effect of saline stress that disrupts water relations in plants, there is also the specific effect of saline stress that shows up through the effect of ions on the cell metabolism and in some cases toxicity from ions accumulation (Hare et al., 1997).

Wide studies in terms of defensive responses to different abiotic and biotic stresses such as thermal stress, salinity, ultraviolet radiation, flooding, chilly stress and pathogen contamination indicate that there are probably several paths of message transmission which have interference with each other and regulate plant's response to the environmental stresses. Such a system of relative interference of response patterns to stress shows that plant's responses to the environmental stresses depend on a total change in the activities of several growth regulators among which abscisic acid and cytokinins are the most dominant ones. Although, other growth regulators such as salicylic acid and gasmonats play an important role in controlling plant's responses to unfavorable environmental conditions (Xiong et al., 2002).

Growth reduction in stress conditions is caused by prevention from cell division and growth or both of them which these preventive effects may come from change in plant growth regulators balance caused by stress (Stavir et al., 1998). It's been revealed that under unfavorable environmental conditions the inner levels of phytohormones make fundamental changes (Hare et al., 1997). Reduction in the amount of cytokinines and gyberelic acids and increase in abscisic acid content in variant species under drought and saline stress have been reported (Stavir et al., 1998). Although the mechanisms of hormone balance is weak in plants, but it's been revealed that absolute concentrations of cytokinins and other growth regulators reciprocally affect their synthesis and metabolism (Xiong et al., 2002). Thus, external treatment of growth regulators as reciprocal factor on stress-affected plants can be a possible method to improve the effects of abiotic environmental stresses (Stavir et al., 1998).

The present article is a report of the effects of two growth regulators, abscisic acid and cytokinines, on the seed germination and initial growth of the wheat seedlings under saline stress conditions. The aim of the present research was to study the effects of these two growth regulators foliar spray at pollination and grain filling on the seed vigor obtained from saline stress conditions.

MATERIALS AND METHODS

In order to study the effects of plant growth hormones, ABA and CK, at different plant growth stages of wheat on the seed vigor a factorial experiment arranged in CRBD with three replications was done on the farm of Mahabad Azad University. This experiment contained two factors: factor a, comprised of three levels of saline stress: 0 (distilled water), 0.4 and 0.8 ds/m. Factor b, hormone foliar sprays containing seven levels; b1: no-spray (check), b2: CK foliar spray at pollination, b3: ABA and CK foliar spray at pollination and grain filling, b4: CK foliar spray at pollination and grain filling, b5: ABA foliar spray at pollination, b6: ABA foliar spray at pollination and grain filling, b7: ABA and CK foliar spray at pollination.

Each experimental unit (plot) contained one sterile Petri dish with a filter paper medium. The seeds were sterilized with 50% ethanol for 30 seconds and then with 10% sodium hypochlorite (bleach) for 10 minutes.

After each sterilization the seeds were washed at least three times with distilled water. After sterilization ten seeds were put in each Petri dish. To generate the saline stress, NaCl was used in three tested concentrations 0, 0.4 and 0.8 ds/m and as much as 5 ml per each Petri dish. Then, their covers were tightly covered with Parafilm and transferred to germinator at 25°C.

The germinated seeds were counted daily. Seeds with a 2mm-long rootlet were considered as germinated. After 10 days the following traits were calculated:

germination velocity, average germination, % germination, seed vigor, rootlet dry weight, stemlet dry weight, rootlet length, stemlet length and the ratio of rootlet length/stemlet length under saline conditions in the laboratory of the Agricultural College.

Some traits were calculated as follows:

Function 1: Germination velocity, GR (germinated seeds per day) (Bajji et al., 2002)

$GR = \Sigma N_i / T_i$

in which,

N_i: number of germinated seeds in i^{th} day,

T_i: number of das to the i^{th} count.

Function 2: Mean Daily Germination (MDG) based on Magoyer's formula (Bajji *et al.*, 2002).
MDG= FGP/d
in which,
FDG: final % germination,
d: number of days to max final germination.

Function 3: Final % germination (FGP), (Abdul Baki and Anderson, 1973).
FGP=Σ (Ni × 100)/total seeds

Function 4: Seed vigor index (VI), (Abdul Baki and Anderson, 1973).
VI= [mean stemlet length (mm) × %germination]/100

Analysis of variance and statistical calculations
The data were analyzed using the program MSTAT-C and mean comparisons were done by means of LSD test at $p\leq5$ and the tables and figures were drawn by means of the program Excel.

RESULTS AND DISCUSSIONS

The effect of different salinity treatments on the germination velocity of wheat seeds was significant at $p\leq1$ (Table 1) so that with increasing salinity from 0 to 0.8 ds/m the germination velocity of the seeds decreased (Figure 1).
According to mean comparisons the greatest germination velocity belonged to the check and the least GV belonged to the saline stress of 0.8 ds/m. Of the mechanisms of salinity effect on germination velocity are the toxicity of ions like Na and Cl and disrupting the ion balance including K/Na ratio (Lianes et al., 2005). Decrease in germination velocity caused by salt concentration has been reported in different plants.
In this regard, Keshavarzi et al. (2008) studied the effects of salt on different varieties of sesame and achieved similar results. Demir-Kaya et al. (2006) studied the effects of saline stress on sunflower and reported that with increase in saline stress the germination velocity decreased.

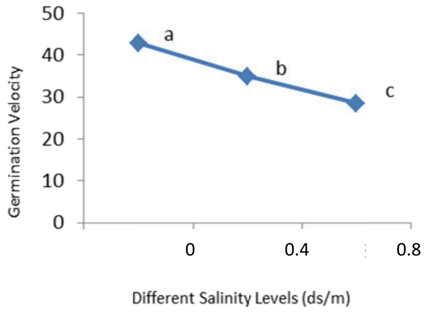

Figure 1. Effects of different salinity levels on germination velocity

The analysis of variance showed that the effect of foliar application of plant growth hormones at different growth stages of the maternal plant on germination velocity of the obtained seeds was significant at $p\leq1$ (Table 1).
According to mean comparison of data (Figure 2) the foliar spray of CK at pollination and grain filling had the greatest increase in germination velocity by 12% relative to the check. Foliar application of CK to seeds during the growth stage leads to increase of CK in these organs (Yang et al., 2003).
Acceleration of germination velocity is probably due to high concentration of CK in seeds during cell division period. The lowest germination velocity belonged to ABA spray at pollination and grain filling which decreased by 30.7% relative to the Check.
Mehrabi et al. (2008) reported that ABA had a severe preventive effect on germination and growth of wheat seedlings under saline stress so that all the studied traits from ABA spray decreased significantly relative to the check. The results of the ANOVA showed that the interaction of saline levels and growth regulator hormones aren't significantly different (Table 1).

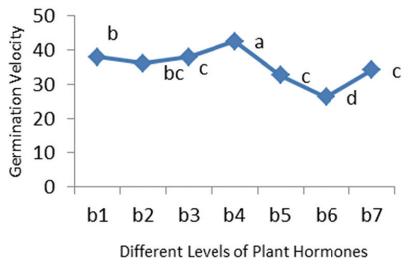

Figure 2. Effects of plant growth hormones on germination velocity

Table 1. Analysis of variance of studied salinity and plant hormones traits on seeds of wheat

S.O.V	df	Germination Velocity	Mean Germination Velocity	Seed Vigor	Root Length	Shoot Length	Shoot Dry Weight	Root Dry Weight
Salinity	2	1087.450**	582.159**	27.213**	26.894**	26.213**	0.001**	0.0001**
Plant Hormones	6	234.611**	315.692**	13.677**	16.810**	16.374**	0.001**	0.001**
Salinity* Plant Hormones	12	31.385^{ns}	166.434**	0.917*	0.426^{ns}	0.920*	0.0001**	0.0001^{ns}
Error	42	44.892	33.426	0.384	0.588	0.415	0.0001	0.0001
C.V.	62	8.92	5.99	4.48	5.61	4.54	7.12	5.99

ns, * and **: non-significant and significant at p≤5% and 1%, respectively.

Average Germination Velocity

The analysis of variance showed that the interaction effect of foliar application of plant growth hormones at different growth stages of the maternal plant on Average Germination Velocity of the obtained seeds was significant at p≤1 (Table 1). The results of means comparison showed that the no-stress treatments had more mean germination velocity than saline stress treatments (Figure 3). The foliar application of plant hormones at different growth stages and at different salinity levels in treatment compounds of a_1b_1, a_1b_2, a_1b_3 and a_1b_5 had the highest mean germination velocity without any significant difference. The CK foliar application had a positive significant effect on the mean germination velocity relative to ABA in most treatment compounds. The ABA spray at pollination and grain filling with 0.8 ds/m stress had the lowest mean germination velocity. Increase in mean germination velocity by kinetin under stress conditions can be due to increase in water uptake because of increasing membrane permeability or the inner concentration of active osmotic salts (Stavir et al., 1998).

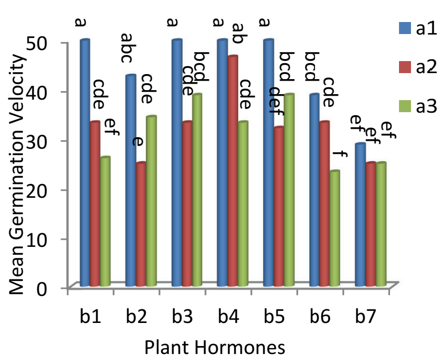

Figure 3. The interaction of salinity and plant hormones with average germination velocity

Seed Vigor

Regarding seed vigor there wasn't a significant difference among different saline stress levels and different levels of plant hormones at p≤1% and interaction between them at p≤5%. The results of means comparison showed that saline stress causes seed vigor to decrease so that the greatest seed vigor belonged to no-stress treatment (distilled water) and the least seed vigor belonged to 0.8 ds/m saline stress (Figure 4). The effects of ABA and CK sprays on the seed vigor at different plant growth stages and different salinity levels was significant. CK foliar application at pollination and grain filling together with the no-salinity stress (*a_1b_4*) had the greatest seed vigor among treatments. ABA foliar application at different growth stages caused decrease in seed vigor so that the seeds from ABA foliar application at pollination and grain filling with 0.8 ds/m saline stress had the least vigor (Figure 4).

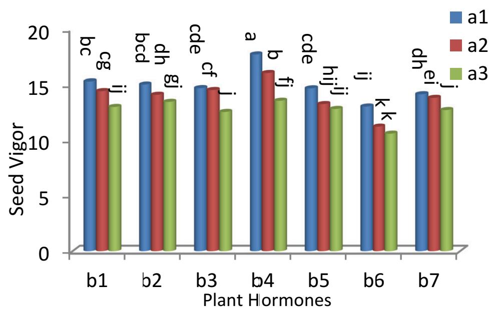

Figure 4. Effects of plant growth hormones and salinity on seed vigor

Rootlet Dry Weight

According to the analysis of variance (Table 1) the saline stress had a significant effect on the mean rootlet dry weight at p≤1% so that with increasing salinity from 0 to 0.8 ds/m the mean rootlet dry weight reduced.

The least mean rootlet dry weight was of the 0.8 ds/m saline stress. The greatest mean rootlet dry weight was obtained from no-salinity treatment (Check). The results of this study showed that the 0.4 ds/m saline stress and the check were in the same statistical group and in terms of rootlet dry weight they were not significantly different (Figure 5).

Keshavarzi et al. (2009) studied the effects of saline stress on seven sesame cultivars and achieved the same results as the present study so that with increasing the salinity level the root and shoot weights of all cultivars reduced significantly. In another study, Jamil et al. (2006) showed that with increasing salinity the root and shoot weights of the canola plant reduced. Hatami and Galeshi (1998) studied the impacts of different levels of NaCl on bareley and wheat and observed a significant reduction in all germination traits including root and shoot weights relative to the check with increasing salinity level.

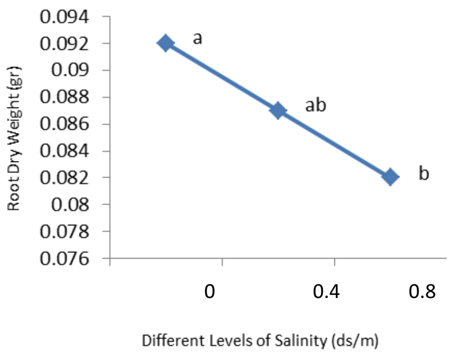

Figure 5. Effects of salinity on root dry weight

Results revealed that the impact of plant growth regulators spray at pollination and grain filling of maternal plant was significant on its seed's root dry weight at $p \leq 1\%$ (Table 1). According to means comparison the treatments of CK and ABA foliar application at pollination and grain filling (b3) and foliar application of CK at pollination and grain filling without any significant difference with 0.094 and 0.103 gr had the greatest root dry weight.

The least root dry weight with 0.076 gr was obtained from ABA foliar application at pollination and grain filling which was in the same statistical group as the treatments b2, b5 and b7 (Figure 6). Mehrabi et al. (2008) reported that significant interactions of salinity with ABA in relation with most growth traits show that growth responses of seedlings under simultaneous effects of salinity and ABA are different but with increasing ABA the growth of the seedlings and their wet weight reduced obviously.

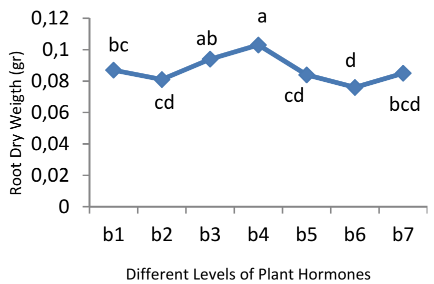

Figure 6. Effects of plant growth hormones on root dry weight

Shoot Dry Weight

Results of analysis of variance showed that among different levels of salinity, different levels of plant hormones and

their interactions with shoot dry weight there wasn't significant difference at $p \leq 1\%$ (Table 1). The results of mean comparison of interaction of salinity and plant hormones showed that with increasing %salinity at different levels of plant hormones the dry weight of shoot decreased so that the least shoot dry weights were obtained from ABA foliar applications at pollination and grain filling with 0.4 ds/m (a2b6) and 0.8 ds/m (a3b6) salinity as much as 0.076 gr and 0.064 gr, respectively which reduced by 24% and 36%, respectively relative to the check (no-salinity and no-spray).

Ekiz and Yilmaz (2003) studied the dry weight and height of barley seedlings under saline conditions and concluded that plant dry weight is a better index than plant height to show sensitivity to salinity. The studies of Keshavarzi et al. (2009) on the impacts of salinity on sesame cultivars showed that with increasing salinity the shoot weight decreased significantly. The greatest shoot dry weight was obtained from the treatment of no-salinity together with CK foliar application at pollination and grain filling that with 0.112 gr increased the shoot dry weight by 12% relative to the check (Figure 7).

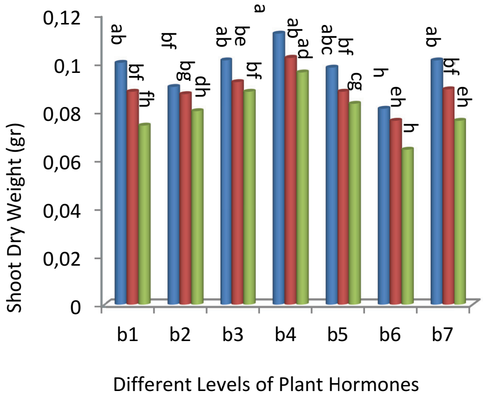

Figure 7. Interaction of salinity and plant hormones with shoot dry weight

Root Length

According to the ANOVA table different levels of salinity and plant hormones influenced the root length significantly at p≤1% (Table 1). With increasing salinity this trait decreased significantly so that the greatest root length and the least root length were obtained from the Check (distilled water) with 14.80 mm and 0.8 ds/m saline stress with 12.54 mm, respectively (Figure 8). Niu et al. (1995) believe that after or simultaneous with water uptake a series of hormones and certain important enzymes inside the seed including lipaz, proteaz, amylaz, etc. are secreted that decompose the stored food stuffs including starch and dissolve them in water. Thus, the energy necessary for the emergence and growth of root and shoot is supplied which in high levels of salinity the activity mechanisms inside the seed are changed and these processes get disrupted and with growth cessation and decrease due to lack of transfer of nutrients from cotyledon to root and shoot of seedling their dry weight reduces. The growth retardation by saline stress has been reported by other researchers. For instance, Soltani et al. (2001) reported that saline stress reduced the growth of root and shoot of pea and with increasing salinity level the growth reduced more.

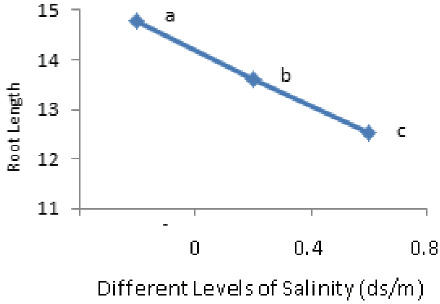

Figure 8. Effects of salinity on root length

According to means comparison of plant hormones the foliar application of CK at pollination and grain filling with an average of 16.14 mm had the greatest root length that increased by 13.18% relative to the check.
The ABA foliar application at pollination and grain filling decreased root length relative to the check through its preventive effect so that it had the least root length with 11.62 mm (Figure 9).

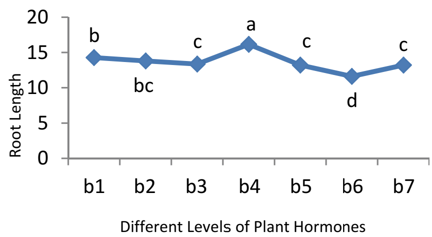

Figure 9. Effects of plant hormones on root length

Shoot Length

Results of analysis of variance showed that among different levels of salinity, different levels of plant hormones (p≤1%) and their interactions with shoot length (p≤5%) there wasn't significant difference (Table 1). Mean comparison of treatments interaction showed that with increasing salinity level the shoot length at different levels of ABA and CK sprays decreased during maternal plant growth stages. In the treatment of 0 ds/m salinity (distilled water) the foliar application of CK at pollination and grain filling with 17.47 cm had the greatest shoot length that increased by 13.44% relative to the check. The least shoot length belonged to the ABA foliar application at pollination and grain filling together with 0.8

ds/m salinity and a shoot length of 10.43 cm that reduced by 32.33% relative to the check (Figure 10).

Of factors causing shoot length to reduce under saline conditions, decrease in or lack of transfer of nutrients from cotyledons to the nucleus have been reported. Besides, decrease in water uptake by the seed in saline conditions leads to decrease in enzymes activity and secretion of plant hormones and eventually disruption in growth of root and shoot (Kafi et al., 2006).

Apparently, the shoot length is associated with seed vigor and sufficient nutrients supply. Jamil et al. (2006) reported that increase in salinity level results in decrease in % germination and % germination velocity, root and shoot length and root and shoot dry weights of canola.

According to the above-mentioned results it seems that increase in salinity decreased the wheat seedlings height significantly through disrupting the shoot function.

According to Stavir et al. (1998) findings it is reasoned that harmful effects of saline stress on plant growth and amylase activities can be reversed through adding synthetic kinetin and ABA to the growth medium of pea seeds. These compounds neutralize the saline effects and improve seedlings growth via strengthening or enhancing starch metabolism and amylase activity.

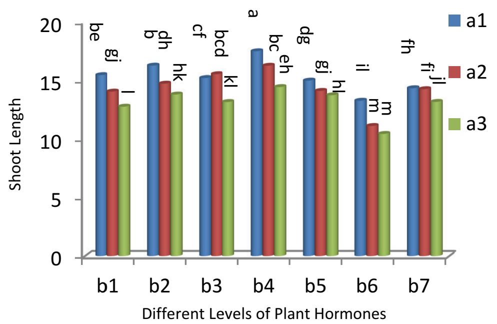

Figure 10. Interaction of plant hormones and salinity with shoot length

CONCLUSIONS

Utilization of with high vigor and establishment potential on the field is of great importance. In the present experiment maternal treatments foliarly sprayed with CK had greater seed quality which can be a new method of seed production on fields of maternal plants. In the present study the Zarrin cultivars of wheat were used which is susceptible to draught and saline stresses. The application of this technique promoted the germination quality of the CK-treated treatments in the above mentioned cultivar relative to different levels of salinity being promising in the future. Of course, fidelity of this method requires continuous studies which the author is pursuing it. Another strong point of this experiment is the significance of the interaction of CK and ABA which indicates that increase in CK concentration under water stress conditions regulates the effects of ABA which, in turn, increases plant establishment of the field.

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INTERRELATIONSHIPS BETWEEN GRAIN PROTEIN CONTENT AND INDICATORS OF NITROGEN STATUS OF WHEAT PLANT

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Abstract

Grain protein content is one of indicators of small grains quality. It is important trait, but negatively correlated with grain yield what represents obstacle in small grains breeding on quality and yield, simultaneously. The objective of investigation is to estimate interrelationships between grain protein content and some physiological indicators of nitrogen status in wheat. Tested indicators of nitrogen status in wheat plant are: nitrogen content in aboveground plant part at anthesis (Nanthesis), grain nitrogen content (Ngrain), nitrogen content at straw (Nstraw), nitrogen content at whole matured plant (Ntotal), nitrogen harvest index (NHI), nitrogen reutilization (NreU), nitrogen lost or gained (Npost anthesis) and physiological efficiency of nitrogen (PEN). According to obtained correlation coefficients, NHI and NreU expressed statistically high significant and positive influence on grain protein content. Influence of Npost anthesis was, in some investigation years, statistically high significant and positive, while influence of PEN on grain protein content was statistically high significant and strong, but negative. Influence of indicators of nitrogen accumulation efficiency, like: Nanthesis, Ngrain, Nstraw and Ntotal on grain protein content was insignificant during entire investigation. Such notice could mean higher importance of nitrogen utilization, as a part of process of nitrogen nutrition, in grain protein synthesis. Obtained results could achieve to better understanding of grain protein synthesis and overcoming some evident obstacles in wheat breeding programs.

Key words: *grain protein, nitrogen, wheat plant.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most widely grown crop in the word with its unique protein characteristics that serves as an important source of food and energy in human diet. Mature wheat grains contain 8–20% protein, while grain quality is a complex trait resulting from the interactions between numerous protein components (Daniel and Triboi, 2000). The protein content in the wheat grain is dependent on genotype but it is also clearly influenced by environmental variables such as nitrogen application, water access and temperature during growth especially through the grain filling period (Dupont and Altenbach 2003; Tea et al., 2004). The most effective environmental factor on wheat quality is N fertilization. At the same time, the degree of influence is affected by annual weather conditions and by residual soil N (López-Bellido et al., 2001). Therefore, proper management of N fertilizer is essential to ensure high quality wheat production. Nitrogen fertilization management (rate and timing) offers the opportunity for increasing wheat protein content and its quality besides high wheat production. However, excess applications of N are not economically efficient and can reduce protein content as well as create environmental problems (Tayebeh et al., 2011). The nitrogen fertilizers using and efficiency of wheat plant nitrogen nutrition is topical subject nowadays, especially because of world energetic crises and fertilizers market, as well as requests for agriculture to be more effective and ecosystem protection appeal at the same time (Malesevic et al., 2010). The wheat plant nitrogen nutrition is very complex process and its explanation need following and appreciation a lot of physiological traits and reactions. Basically, the entire process depends on root system activity, mass and absorption capacity, kinds of fertilizers and time of their application, seasonal trends, physiological and genetic factors (Lopez – Bellido et al., 2005; Vuckovic et al., 2005; Bozhkov et al., 2007). The direct evaluation of root system activity, as trait which works highly on plant absorption efficiency, is hardly deducible in the field conditions. So, there are some certain parameters, suitable to do it indirectly, like: nitrogen content in plant at anthesis or maturity as well as physiological efficiency of nitrogen and nitrogen harvest index as indicators of efficiency of plant nitrogen utilization. By wheat selection and breeding aspects, existance of dependence between these parameters and desirable traits is one of very important questions. Many authors (Anderson et al., 2004; Gallais and Coque 2005) defined that some of these parameters affect grain yield positively.

The aim of this study is to estimate correlation between parameters of nitrogen status and grain protein content in wheat, hoping obtained results could be helpful to overcome obstacles in wheat breeding on yield and quality simultaneously.

MATERIALS AND METHODS

The study was carried out on the property of the Small Grains Research Center in Kragujevac (186 m.a.s.l.), Serbia, during three consecutive seasons (2001/02, 2002/03 and 2003/04). The soil type was smonitza in degradation (Vertisol).

In all three years, the mean temperature was higher than the 30 yr average (Table 1).

There was considerable variability in rainfall amounts and distribution from year to year (Table 2).

The amount of rainfall was most suitable for plant growth in the third season. Rainfall (74.5 mm), received during the germination period (October - November) in the first season was less than in other two (97.00 mm and 111.8 mm) and long-term average (94.73 mm).

The experiment included 30 wheat cultivars and experimental lines, originating from the Serbia: Small Grains Research Center, Kragujevac and Institute of Field and Vegetable Crops, Novi Sad.

The basic processing and pre – sowing preparation of the soil was done using standard procedures.

The randomized complete block experimental design was used with five replicates in rows 1.5 m on, with spacing between rows of 0.20 m. Sowing (200 grains per row) was done by hand (one genotype per row), during the optimal planting period for central Serbian conditions, for winter wheat (29. 10. 2001, 15. 11. 2002 and 06.11. 2003).

Table 1. Average monthly temperatures during the three test growing season and long-term (30-yr) mean (LTM)

M	Average monthly temperatures (^oC)			
	2001/02	2002/03	2003/04	LTM
X	13.8	12.2	10.6	11.40
XI	4.6	9.7	8.9	5.90
XII	- 2.4	1.1	2.2	2.13
I	- 0.1	0.7	- 0.9	0.73
II	7.0	- 2.4	3.0	2.42
III	8.9	5.8	7.1	6.43
IV	10.8	10.8	12.8	11.22
V	18.4	19.9	14.5	16.24
VI	21.6	23.3	19.8	19.40
Season average				
	9.18	9.01	8.67	8.43

Table 2. Monthly amounts of rainfall during the three test growing season and long-term (30-yr) mean (LTM)

M	Monthly amounts of rainfall (l)			
	2001/02	2002/03	2003/04	LTM
X	10.4	65.5	83.2	47.53
XI	64.1	31.5	28.6	47.20
XII	27.6	39.4	37.2	44.33
I	17.2	59.0	86.4	36.70
II	20.1	19.7	59.5	35.77
III	26.0	2.8	21.3	41.57
IV	63.7	37.2	52.3	50.77
V	38.6	42.3	50.3	65.43
VI	57.2	47.7	61.4	81.27
Total				
	324.9	345.1	483.2	624.43

NPK fertilizer, formulated 8:24:16, was applied at the rate of 300 kg ha^{-1} before sowing each season. Eight grams row^{-1} of nitrogen (260 kg KAN ha^{-1}) was added at the tillering stage of development each season.

Plant samples of each genotype were taken at anthesis (10 plants per replication) and maturity (five plants).

The samples were air – dried and the above – ground weight of the plants at anthesis (DManthesis, g m^{-2}), grain yield (GY, g m^{-2}), weight of straw at maturity (DMstraw, g m^{-2}) and total above – ground biomass at maturity (BY, g m^{-2}) were measured.

All dry vegetative samples and grain were first ground and then plant N concentration was determined by the standard macro- Kjeldahl procedure. Nitrogen content (at anthesis, grain, straw and total at maturity) was calculated by multiplying the N concentration by dry weight (gN m^{-2}).

Moreover, the following parameters, related to dry matter and N accumulation and translocation within the wheat plant during grain filling, were calculated according to Arduini et al. (2006) and Masoni et al. (2007), as follows:

1. Nitrogen reutilization (NreU) = Nanthesis – Nstraw (g m^{-2})
2. Nitrogen lost (–) or gained (Npost - anthesis) = N content at maturity – N content at anthesis (g m^{-2})
3. Physiological efficiency of N (PEN) = GY/Ntotal (g_{grain}/gN) and
4. Grain protein content (GP) = %Ngrain x 5.7 (%)

The simple correlations coefficients between all pairs of variables were determined according to Chaudhary et al. (1999).

RESULTS AND DISCUSSIONS

Correlation coefficients between some traits pair are indicators of nature and significance of their relations and influences. So, correlation coefficients for GP and Npost anthesis (Npa) varied from negative and insignificant (genotypic and phenotypic - 0.08) to positive and high significant (genotypic 0.48** and phenotypic 0.53**) (Table 3).

Many authors (Egle et al., 2008) determined the term „nitrogen excess"conected with post – anthesis nitrogen accumulation. It can be suposed that nitrogen amount could be an important source of components for grain filling as well as for protein synthesis.

At the other side, many authors (Kade et al., 2005; Asseng and Milroy, 2006; Bahrani et al., 2011) found positive and strong correlation between grain protein content and reutilized nitrogen.

In contrast to these observation, relationship between GP and nitrogen reutilization efficiency was very unstabile in our investigation, varied from strong and negative (genotypic - 0.63** and phenotypic – 0.51**) to strong and positive (genotypic 0.29** and phenotypic 0.49**).

It could mean more important role of nitrogen accumulated after anthesis in provide plant with nitrogen substances for protein synthesis. It is obvious that the extreme variation of weather conditions during investigation, among years, influenced different relations between these traits.

Table 3. Correlation coefficients between grain protein content and investigated indicators of plant nitrogen status

Trait	Year	Correlation coefficients	
		genotypic	phenotypiuc
		Grain protein (GP)	
Nanthesis	1	- 0.07	-0.06
	2	- 0.60**	-0.43**
	3	0.02	0.17
Ngrain	1	0.06	0.07
	2	0.08	0.11
	3	0.13	0.17
Nstraw	1	-0.13	-0.11
	2	0.13	0.16
	3	-0.17	-0.14
Ntotal	1	-0.03	-0.02
	2	0.11	0.16
	3	0.05	0.07
NHI	1	0.14	0.1*
	2	0.25*	0.39**
	3	0.38**	0.47**
NreU	1	-0.04	-0.01
	2	-0.63**	-0.51**
	3	0.29**	0.48**
Npost Anthesis	1	0.13	0.12
	2	0.49**	0.53**
	3	-0.08	-0.08
PEN	1	-0.73**	-0.54**
	2	-0.87**	-0.73**
	3	-0.65**	-0.54**

In the context of these relationships, results about negative and strong, statistically high significant correlation coefficients between reutilized and post anthesis gained nitrogen (Nicolic, 2009) could be interested.

Although, some authors registered connection between nitrogen harvest index (NHI) and grain protein content as insignificant, their correlation coefficients were positive and high significant in this investigation, no matter if you look at the genotypic (0.14, 0.25* and 0.38**) and phenotypic coefficients (0.1*,0.39** and 0.47**).

Obtained results are in agreement with studies Bahrani et al. (2011) Physiological efficiency of nitrogen (PEN), as another indicator of nitrogen utilization efficiency, was in negative and statistically high significant relation with grain protein content (GP) in this study. It can be explained by claim this parameter expresses ability of plant to use nitrogen for grain filling and yield formatting more than for protein synthesis.

At the other side, parameters belonging to the group of indicators of nitrogen accumulation efficiency, like: Nanthesis, Ngrain, Nstraw and Ntotal, expressed statistically insignificant correlation with GP, mainly.

The exception is nitrogen accumulated up to anthesis at above ground part of plant (Nanthesis), only in second studied year (genotypic – 0.60** and phenotypic – 0.43**). Low correlations of N assimilation prior to anthesis and grain protein concentration or grain protein yield were reported by Charmet et al. (2005).

Such results may lead to the conclusion that nitrogen utilization of earlier accumulated nitrogen reserves in plant, as part of nitrogen nutrition process, has greater role in plant physiological cycles.

CONCLUSIONS

Grain protein content in wheat is complex trait, influenced by many factors, processes and other indicators of plant nitrogen status. The effects of indicators of nitrogen status on grain protein content varied through investigation in dependence on weather and other conditions. The strongest and positive effect on grain protein content was achieved by nitrogen accumulated after anthesis, during reproductive period.

The significant and positive relationship was noticed between grain protein content and nitrogen harvest index, too. Physiological efficiency of nitrogen influenced grain protein content statistically high significant and strong, but negatively.

Generally, indicators of nitrogen utilization efficiency made more significant influence on grain protein content than indicators of nitrogen accumulation efficiency.

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THE DOSAGE EFFECT OF THE OPAQUE-2 GENE ON THE AMINO ACID COMPOSITION OF PROTEIN FROM TETRAPLOID MAIZE GRAIN

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Abstract

In this paper we aimed at studying the influence of different doses of opaque-2 gene (number of recessive alleles) in endosperm on amino acid composition of grain protein from tetraploid maize in comparison to diploid forms. Biochemical analysis was performed on grains of a comercial hybrid Chișiniovschi 307 PL containing the mutant gene, tetraploid forms of this hybrid obtained by colchicine treatment, a commercial hybrid Porumbeni 331Mrf and tetraploid synthetic population B. Protein content was determined by the Kjeldahl method, amino acid composition was assayed by ion exchange chromatography on an automatic amino analyzer T339M. In diploid grains the o2 gene showed a clear dosage effect on the content of lysine. In tetraploid grains, two recessive alleles of o2 gene in the hexaploid endosperm determined an increase in the content of lysine in protein as compared to the dominant genotype, in the four dose endosperm, the lysine content was intermediate between the dominant and two dose genotypes and was significantly higher in six doses. The expression pattern of the o2 gene was similar in replicate experiments carried in different growing season. As a result, it was concluded that the o2 gene has a dosage effect in diploid maize and, partially, in tetraploid maize.

Key words: *diploid, lysine, maize, opaque-2, tetraploid.*

INTRODUCTION

Kernel mutants of maze have been extensively used as tools in maze breeding programs for quality traits. It is known that protein of maize grain has a low biological value due to deficiencies in such essential amino acids like lysine and tryptophan, so that, improving the amino acid composition of maize grain is an important objective in maize breeding (Palii, 1989; Vasal, 2001). The research on improving the quality of maize protein opened up new perspectives after the discovery of the biochemical effect of the recessive mutation gene *opaque-2* (o2), which determines a floury texture of the endosperm and a dramatic shift in protein metabolism resulting in considerable increase of lysine and tryptophan (Mertz et al., 1964).

Maize endosperm is an important biological tissue derived from double fertilization. In diploid maize the endosperm is made up of two maternal and one paternal genome (triploid) (Birchler, 1993; Pennington et al., 2008). By controlled pollination, different doses (1, 2 and 3) of a particular gene in endosperm can be obtained and their biochemical influence assessed. Many endosperm genes in maize show dosage effect, which means that each present allele determines a corresponding biochemical effect (Boyer, Hannah, 2001). The first notice of such an effect in maize was reported by Mangelsdorf and Fraps in 1931 (Egesel et al., 2003), who found a direct relationship between the number of alleles for Y_1 gene (yellow pigment) present in endosperm and the content of carotenoids in grains. A similar expression pattern was revealed for the *o2* gene by Bates (1966), who found that lysine content in grains increased proportionally with the number of recessive alleles in endosperm.

In tetraploid maize forms, grains have a hexaploid endosperm (40 maternal and 20 paternal), allowing greater variability of gene dosage (2, 4 and 6) (Pennington et al., 2008). Randolph and Hand (1938, 1940) noted that the Y_1 gene in tetraploid grains of maize doubles the content of carotenoids as compared to diploid grains. Nevertheless, no research has been made with other genes, including *o2*, so far. At the State Agrarian University of Moldova (Chisinau) are carried out experiments with the aim of using polyploidy and *o2* gene in improving the quality of maize grain. In this paper we present the results on studying the dosage effect of the *opaque-2* gene on the amino-acid content in diploid and tetraploid maize grains.

MATERIALS AND METHODS

Experiments were performed at the State Agrarian University of Moldova and the Moldavian Institute of Plant breeding "Porumbeni" in 2012-2013. The biological material included a diploid (2x = 20) maize hybrid Chişiniovschi 307 PL, that incorporates the *o2* mutation, a tetraploid form (4x = 40) of this hybrid (U3-2) obtained by treatment with colchicine in 2010 (Palii, Batiru, 2011). Also, taken into study were a diploid hybrid Porumbeni 331Mrf and the tetraploid synthetic population B, both with normal texture of the endosperm. All genotypes were reproduced by controlled pollination. Different doses of o2 gene were obtained by reciprocal crosses between genotypes with vitreous and o2 endosperms at both ploidy levels. Protein content was determined by the Kjeldahl method for the quantitative determination of nitrogen (N × 6.25), and amino acid composition was assayed by ion exchange chromatography on an automatic amino acid analyzer T339M. The percent lysine content was obtained by dividing the lysine content per unit dry matter to protein content.

RESULTS AND DISCUSSIONS

The recessive o2 gene prevents zein synthesis in grain protein of maize which causes an increase content of albumins, globulins and glutelins.

This redistribution of protein fractions conditions a higher content of lysine, histidine, arginine, aspartic acid, glycine, cysteine, tryptophan, reduces the content of glutamic acid, alanine, methionine, leucine, tyrosine, phenylalanine, as well as, increases the content of free amino acids (Mertz et al.1964; Bates, 1966; Vasal, 2001; Wang and Larkins, 2001; Plotnikov, 2005).

The results of our research show that protein content in diploid forms was at the same level with tetraploid grains, which can be explained by dry conditions of the 2012 season. The difference between the two diploid genotypes was 1% and negligible between the tetraploid genotypes. In the dosage series of diploid grains, protein content decreased with one and three recessive alleles and increased with two. In tetraploid grains, protein level was higher in two and six doses and lower in four as compared to the dominant genotype.

Lysine content in diploid grains increased with the number doses in endosperm, that confirm the research made by Bates (1966), but in the case of tetraploid grains, two recessive alleles of o2 gene in hexaploid endosperm determined an increase in the content of lysine in protein (4.07%) as compared to the dominant homozygote genotype (3.17%), while in grains with a four dose endosperm the content of lysine was lower (3.03%).

At the same time, in the case of maximum number of doses (six o2 recessive alleles), the content of lysine exceeded all other variants of gene dosage of diploid and tetraploid levels (5.18%). A similar pattern as lysine was found for arginine at both diploid and tetraploid levels, due to their biochemical interdependence, but leucine showed a negative trend.

Therefore, with the exception of the variant with four doses, the phenomenon of gene dosage effect of the o2 gene was confirmed, at both diploid and tetraploid levels. However, these data can easily be influenced by genotypes involved in crosses, especially the effects of reciprocal crosses (maternal influence).

In order to minimize the effect of maternal influence and confirm the expression pattern of the dosage effect of the o2 gene in tetraploid maize grains, in 2013 we performed such a cross: o2 grains obtained in 2012 from segregating ears of the U3-2×Syn.B combination (that we named Seg. 1) were grown and during the silking period, some ears were isolated and their silks split in two halves. One half was self pollinated and the other half cross-pollinated with synthetic population B.

Table 1. Dosage effect of o2 gene in endosperm on protein amino acids of diploid and tetraploid maize grains (2012), %

Amino acid	Number of recessive alleles in endosperm							
	2x				4x			
	++/+	++/o2	o2o2/+	o2o2/o2	++++/++	++++/ o2o2	o2o2o2o2/++	o2o2o2o2/o2o2
Essential amino acids								
Lys	3.02	3.63	3.76	4.78	3.17	4.07	3.03	5.18
His	2.71	3.49	3.60	3.53	3.37	3.28	3.39	3.63
Arg	4.39	5.68	5.53	6.32	4.85	4.22	5.53	7.31
Thr	2.66	2.60	2.54	2.76	2.23	3.14	2.99	3.06
Phe	4.22	3.58	3.46	3.60	3.98	4.12	3.90	3.44
Ile	3.03	2.79	2.77	2.87	2.51	2.25	2.42	2.43
Leu	12.78	12.91	11.81	9.66	13.54	10.27	14.45	10.18
Met	0.53	0.44	0.47	0.47	0.63	0.23	0.28	0.63
Val	4.42	3.66	4.77	5.03	4.14	3.65	3.70	4.32
Σ	37.75	38.78	39.17	39.04	38.41	35.24	39.69	40.19
Non-essential amino acids								
Glu	26.92	22.31	23.56	20.55	22.86	25.46	25.80	22.71
Pro	9.12	11.83	8.92	8.56	10.95	9.35	7.58	6.82
Ala	6.84	6.18	6.28	5.32	6.14	5.83	6.13	5.31
Asp	5.58	5.66	5.31	7.51	5.01	8.77	5.76	10.36
Tyr	2.69	3.05	3.13	2.69	3.35	1.98	3.50	3.10
Cys	0.89	1.24	1.53	1.18	1.02	1.10	0.93	1.10
Ser	4.60	4.74	4.93	4.34	4.54	5.46	5.38	5.11
Gly	3.30	3.94	4.19	4.69	3.60	4.15	2.69	3.60
Σ	59.95	58.96	57.85	54.82	57.47	62.10	57.76	58.11
Σ total	97.69	97.73	97.02	93.86	95.88	97.34	97.46	98.29
Protein. % dry matter	12.90	12.25	13.19	11.91	13.60	14.06	12.75	13.74

In this way we obtained grains with four and six doses of o2 gene on the same ears and minimized the difference from the two progenitors involved in cross. To obtain zero and two doses of o2 gene in tetraploid grains, we used plants of tetraploid synthetic population B that developed two ears, one of which was self pollinated and the other cross-pollinated with Seg.1. The developed kernels were analyzed by protein and lysine content (Table 2).

Table 2. Dosage effect of o2 gene on protein and lysine content in tetraploid maize (2013)

Denumirea mostrei	Number of recessive alleles in endosperm	protein, % d.m.	Lys, %
Syn. B	++++/++	10.59	3.40
Syn.B x Seg.1	++++/o2o2	12.01	3.99
Seg. 1 x Syn.B	o2o2o2o2/++	11.07	3.61
Seg.1	o2o2o2o2/o2o2	10.83	4.61

The growing season of 2013 was favorable for maize, so that, tetraploid plants and ears developed normally, kernel set was complete and grains well filled.

In such conditions the protein content was lower than previous year by 2-3%. In two dose grains, the content of lysine was higher than wild type grains, slightly reduced with four doses (intermediate between wild type and two dose), and increased again in six, which confirm the expression profile of the o2 gene in tetraploid grains. The results show the possibility to create tetraploid forms with floury and vitreous endosperm with a high content of lysine in protein.

CONCLUSIONS

As a result of the study it was established that in tetraploid grains, two recessive alleles of o2 gene in hexaploid endosperm determine an increase in the content of lysine in protein as compared to the dominant homozygote genotype, in the four dose endosperm, the lysine content is intermediate between the first two and is significantly higher in six doses.

The expression pattern of the o2 gene on lysine content in tetraploid grains was similar in replicate experiments carried out in different growing season. This fact allowed concluding that the o2 gene has a dosage effect in diploid maize and partially in tetraploid maize.

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WHEAT EFFICIENCY USE OF CLIMATE RESOURCES IN GĂVANU-BURDEA PLAIN

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Abstract

The maximum efficiency use of climate resources in plant culture technology is the principal aim of agriculture adapted to climate change. In this paper, there are presented the results of experimental research concerning the maximizing effect of climatic factors on the yield of wheat in the Găvanu-Burdea Plain.
The research was carried out within 2011-2012 and 2012-2013 in the SC Polirom Prod SRL experimental field, situated inside Găvanu-Burdea Plain, Scurtu-Mare locality, Teleorman County, on the ground of preluvosol reddish type. Within the trial, there have been used 3 wheat Romanian varieties and 10 foreign varieties, belonging to the precocious/half-precocious varieties, with increased resistance to drought, heat, and wintering. The applied technology was that specific to minimum system works.
In terms of climate, crop year 2011-2012 has been a dry year. From sowing to harvesting 370.0 mm precipitation fell, and during the growing season, after leaving winter there was a precipitation quantity of 248.0 mm. Instead, 2012-2013 crop year was characterized by high pluviometric regime: 478.6 mm from sowing to harvesting and 261.8 mm during the spring-summer growing season.
Specific consumption of climate resources in the vegetation period is averaging 79 mm/t of grains and 423^{o}C/t of grains. Varieties with water specific consumption below average are: Izvor (68 mm/t), Felix (69 mm/t), Renata (75 mm/t) Kalasz (76 mm/t), Csillag (77 mm/t), Glosa (78 mm/t), Akratos (78 mm/t). The highest specific water consumption from precipitation were registered in the varieties: Quebon (102 mm/t), Genius (93 mm/t), and Mulan (86 mm/t).
Precipitations and temperature recovery efficiency, expressed through the annual average unit yield, recorded the following values: 13 kg grains/mm precipitation during the growing season; 2.4 kg grains/^{o}C active temperature in the vegetation period. Varieties with specific minimum levels of water consumption had the highest recovery efficiency (15 kg grains/mm for Izvor, 14 kg grains/mm for Felix, 13 kg/mm for Renata, Kalasz, Csillag, Petur, Glosa varieties etc.).
Among all the experienced varieties, Izvor Romanian variety is to be remarked, this one achieving the highest recovery efficiency of climate resources. Almost similaris the Romanian Glosa variety as well as some foreign varieties: Felix and Renata (originating in Croatia), Kalasz, Csillag and Petur (from Hungary). Quebon, Mulan and Genius German varieties are not recommended.

Key words: *climate, consumption, efficiency, precipitations, temperature.*

INTRODUCTION

The genotypes used in technologies adapted to climate change is characterized by high resistance to drought and high temperatures. This characteristic implies achieving high yields with lower specific costs of climate resources (water, temperature) and with greater efficiency in achieving yields. There are also appreciated the varieties which ensure the stability of the production under contrastant environment conditions, namely as well under favourable as unfavourable water regime. (Mustăţea et al., 2008; Voica, 2009; Melucă et al., 2011; Marinciu, 2013; Voinea, 2013).

Within the research whose results are presented in this paper, there has been studied the effect of climate resources (precipitation and air temperature) for the production of a range of wheat varieties in the specific conditions of Găvanu-Burdea Plain during 2011-2013.

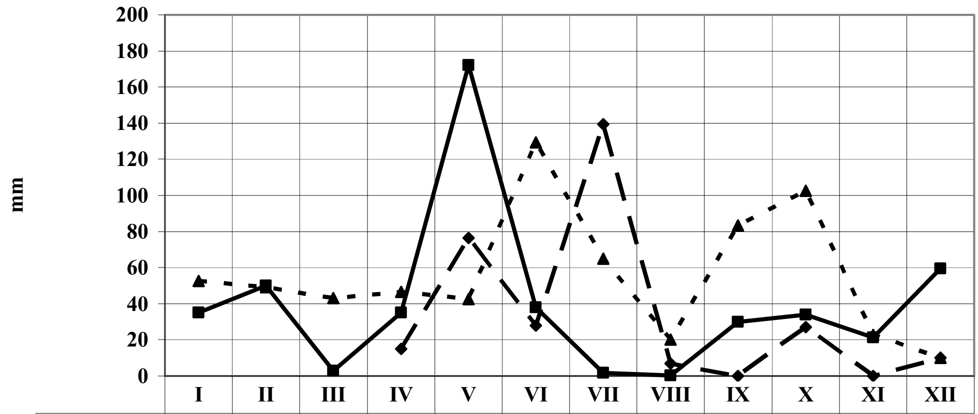
MATERIALS AND METHODS

Research was effected during 2011-2012 and 2012-2013 agricultural years in the experimental field from SC Polirom Prod SRL, located in Scurtu Mare locality, Teleorman county.

The soil where the research was effected is reddish preluvosoil, characteristic to the areas of Găvanu-Burdea Plain.

General climate. Related to climate, the yearly amount of precipitations is of 530-580 mm, and the year average temperature is of 10.0-10.5°C.

Experimental period climate. Crop year 2011-2012 has been a dry year (Figures 1 and 2).



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2011				15.0	76.5	28.0	139.5	7.0	0	27.0	0	10.0
2012	35.0	50.0	3.0	35.0	172.0	38.0	1.6	0.4	30.0	34.0	21.4	59.6
2013	52.6	49.2	43.2	46.6	42.6	129.4	65.0	20.0	83.2	102.6	22.6	10.0

Figure 1. Precipitations regime from the experimental field during 2011-2013

In the autumn of 2011 (October-November) fell only 27 mm precipitation. To these have been added 95 mm in the winter (December-February), 89.8 mm in the spring 2012 (March-April) and 210.0 mm for the rest of the months (May-June).

It appears that from sowing to harvesting it fell only 370.0 mm precipitation. Although the pluviometric regime was generally found to be ineffective (248.0 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), precipitations during May and June have ensured the average consumption of 3.5 mm/day in the last two months of the growing season.

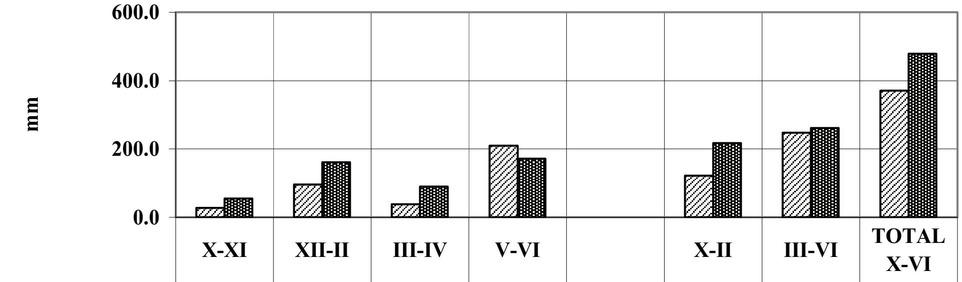
In exchange, 2012-2013 crop year was characterized by a higher pluviometric regime: 478.6 mm from sowing to harvesting (29% more than in the previous year) and 261.8 mm during the vegetation period in the spring-summer period (5% in addition to 2012). However, if we refer to the critical period for wheat (May-June) we note that in 2013 only 170 mm rainfall shall be recorded, which represents 38 mm less than 2012.

In this situation, the water intake in 2013 from rainfall during the period of grain filling and it was averaging only 2.8 mm/day, specific to a dry year. The average daily temperature during the growing season of wheat during the crop year 2012-2013 was of 8.6°C (X-VI) and 10°C (X-VII).

In the given circumstances, the majority of tested wheat varieties, characterized by superior precocity in comparison with the older varieties, valorized with efficiency the water from precipitations falling and they realized as it will be seen further on, under non-irrigated production performances, which make them competitive with the most intensive culture technologies.

For the calculation of climate resources indices there were used the rainfall amount and the sum of daily average temperatures exceeding 5^0C (active temperatures) along certain periods during the growing season (Figure 2 and 3): along the vegetation period in autumn-sowing (October-November), cripto-vegetation period (December-February), the period of vegetation from spring until the heading-flowering (March-April), the period of formation and filling of the grains (May-June).

The sum of daily average temperatures exceeding 5^oC (biologically active temperature for plant, vegetation wheat) throughout the growing season of the crop year 2012-2013 was 2379.3^oC, and that corresponding to the period of vegetation after the winter was 1749.2^oC.



	X-XI	XII-II	III-IV	V-VI		X-II	III-VI	TOTAL X-VI
2011-2012	27.0	95.0	38.0	210.0		122.0	248.0	370.0
2012-2013	55.4	161.4	89.8	172.0		216.8	261.8	478.6

Figure 2. Precipitations amount from wheat vegetation period (Scurtu Mare, Teleorman county, 2011-2013)

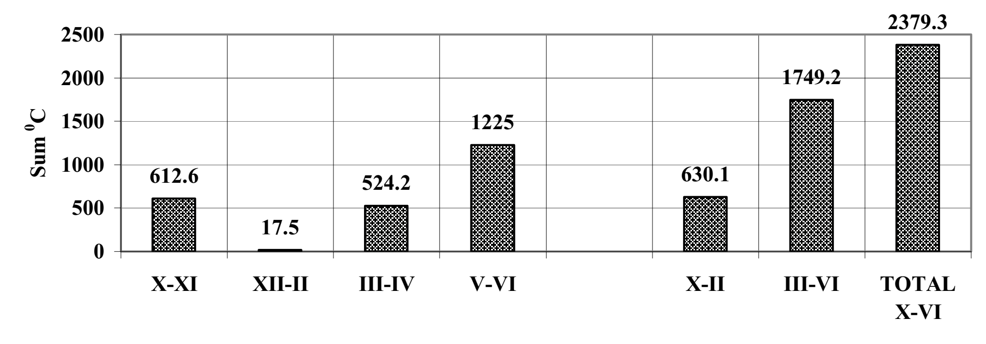


Figure 3. Active temperatures amount ($t>5^oC$) from wheat vegetation period (Scurtu Mare, Teleorman county, 2012-2013)

The efficiency of climate resources use for wheat culture was expressed by the following indices: the specific contribution (specific use) water from precipitation (mm/t), specific warmth air (^oC/t), the unit of production (kg/1mm precipitation and kg/1^oC active temperature).

Experimental variants. Within trials, there have been used 3 Romanian varieties and 10 foreign varieties of wheat, from very early varieties half-precocious category, with increased resistance to drought, heat and wintering. The technology applied was the one specific to minimum works.

Before sowing, there were made fertilizations with complex fertilizers (20-20-0) in the dose de N60 P_2O_5-60, and in the spring, at the beginning of vegetation, N100 has been applied in the form of urea.

Sowing was carried out between 1st and 20th of October, the optimal period for research area.

There have been also used chemical treatments to fight against weeds, diseases and pests.

RESULTS AND DISCUSSIONS

The genotype influence on the production. Table 1 shows that the higher level of precipitations in the crop year 2012-2013 has contributed to an average increase of production reaching 11% in 2013 (5620 kg/ha) compared to 2012 production (5081 kg/ha). Hence, it results that the relationship between the relative increase of precipitation and the relative increase of production has been averaging 3:1.

Generally, in 2013 all trial varieties achieved gains in production in comparison with 2012, excluding Renata and Akratos varieties. Individual varieties having extra allowances vacillated between 2% (Kalasz) and 33% (Quebon) and the corresponding ratio between relative precipitation increase and relative production increase has been between 2% and 33%.

As an average for two years, the highest yield was obtained from the Romanian variety Izvor (6204 kg/ha). This variety, together with Felix, Kalasz and Renata have achieved very significant production gains (255-853 kg/ha), statistically, in comparison with the average experienced varieties. Genius, Mulan and Quebon varieties were characterized by differences in less than the average, being very significant too (391-1185 kg/ha). Other varieties, among which the Romanian varieties Boema 1 and Glosa achieved average yields.

Varieties with the lowest yields had the weakest recovery efficiency of resources and the greatest climate variability of production from one year to another.

Table 1. Genotype influence on wheat production (2012-2013)

	Variety	2012	2013	2013/2012	Average 2012-2013			
		kg/ha		%	kg/ha	%	Difference (kg/ha)	Signification
1	**Boema 1**	4960	5635	114	5298	99	-54	-
2	**Ilinca**	4563	5887	129	5225	98	-126	-
3	**Glosa**	5151	5775	112	5463	102	112	-
4	**Izvor**	***5952***	***6456***	***108***	***6204***	***116***	***853***	***
5	**Genius**	4166	4935	118	4551	85	-801	ooo
6	**GK Petur**	5158	5454	106	5306	99	-45	-
7	**GK Csillag**	5357	5714	107	5536	103	185	*
8	**Felix**	5952	6320	106	6136	115	785	***
9	**GK Kalasz**	5555	5656	102	5606	105	255	***
10	**BC Renata**	5753	5541	96	5647	106	296	***
11	**Mulan**	4365	5555	127	4960	93	-391	ooo
12	**Akratos**	5555	5367	97	5461	102	110	-
13	**Quebon**	3571	4761	133	4166	78	-1185	ooo
AVERAGE		**5081**	**5620**	**111**	**5351**	**Control**	**-**	**Control**

LSD 5% =144 kg/ha; LSD 1% =192 kg/ha; LSD 0.1% = 250 kg/ha.

Specific contribution (specific use) of rainfall with production. On average throughout the wheat growing season (October-June) during the two years taken into study and as an average for each variety, one tonne of grain is obtained with 79 mm of rainfall (Figure 4).

The lowest specific water consumptions were recorded with Izvor, Felix, Renata, Kalasz, Csillag, Glosa and Akratos (68-78 mm/t), and the highest with Mulan, Genius and Quebon varieties (86-102 mm/t).

With few exceptions (Ilinca, Quebon), throughout the vegetation period, the specific consumption was higher in 2012-2013, as compared to 2011-2012. If we take into account only the period of vegetation after exiting winter (March-June), it appears that between those two years whether there are practical no differences in respect to the specific water consumption, whether it is higher than in the first year. As an average on years and varieties, during the spring-summer growing season the specific consumption of water from rainfall was of 48 mm/t (Figure 5). The minimum and maximum values of water intake are the same for the varieties specific to the period of October-June.

From these data it appears that 2013 production gains were obtained by increasing the specific water consumption in particular of the water water consumption in particular of the water accumulated from the autumn-winter rainfall.

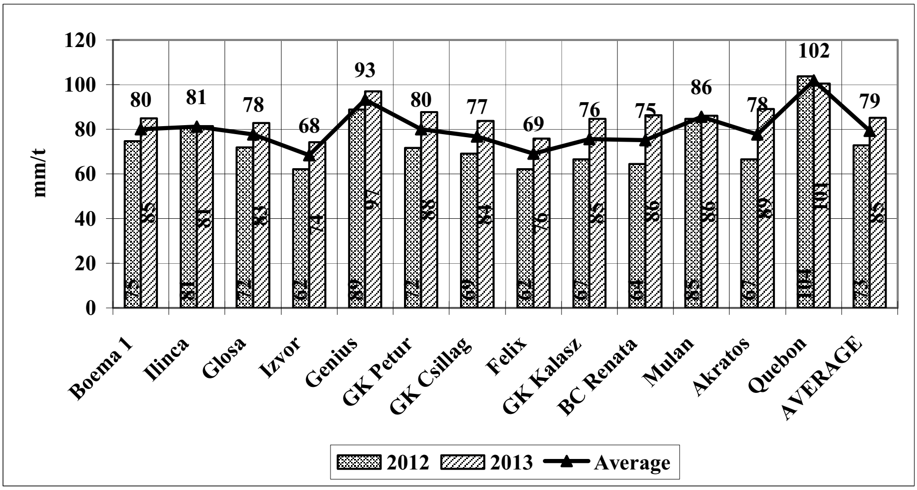


Figure 4. Precipitations specific contribution during the whole growing period (X-VI) when achieving production

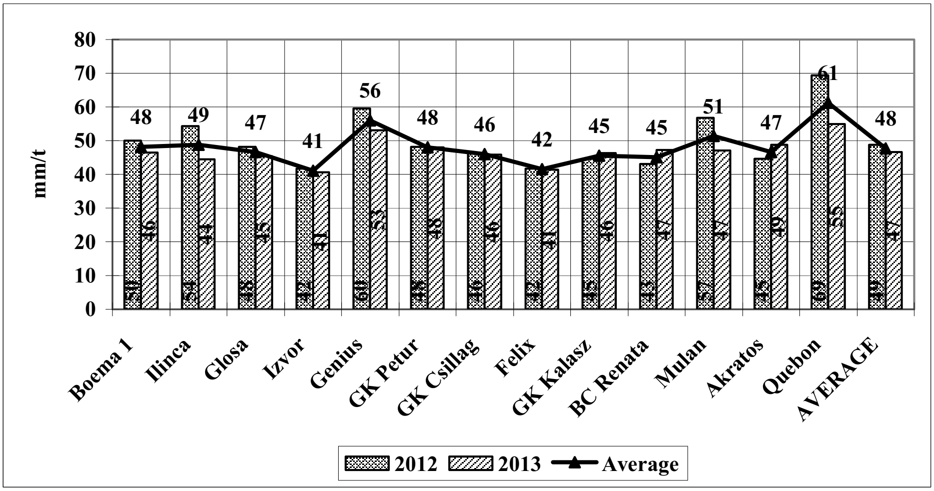


Figure 5. Precipitations specific contribution in the early spring (III-VI) when achieving production

The efficiency of precipitations recovery for the wheat production. The most reliable effectiveness indicator of the climate resources is represented the useful production compared to the assembly of resources (kg/mm, kg/^{o}C). In terms of valorizing the rainfall throughout the growing season, as shown in Figure 6, the average production per unit and varieties was of 13 kg/mm. Varieties which have had the use efficiency of the above-average precipitation have been Izvor (15 kg/mm) and Felix (14 kg/mm). Out of the varieties with the lowest use efficiency of precipitation, we can name: Quebon (10 kg/mm) and Genius (11 kg/mm).

In relation to the research year, the efficiency was higher in 2011-2012 than in 2012-2013. In the year 2012, with a pluviometric regime lower with about 30% in comparison with 2013, there were obtained, however, particularly large productions for an extremely dry year, productions which have oscillated around 5 t/ha. In these conditions, rainfalls in 2012 were capitalized for most varieties with a yield higher than the one of the year 2013 (an extra 1-4 kg/mm).

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Figure 6. Precipitations valorization efficiency during the whole growing period (X-VI) for wheat production

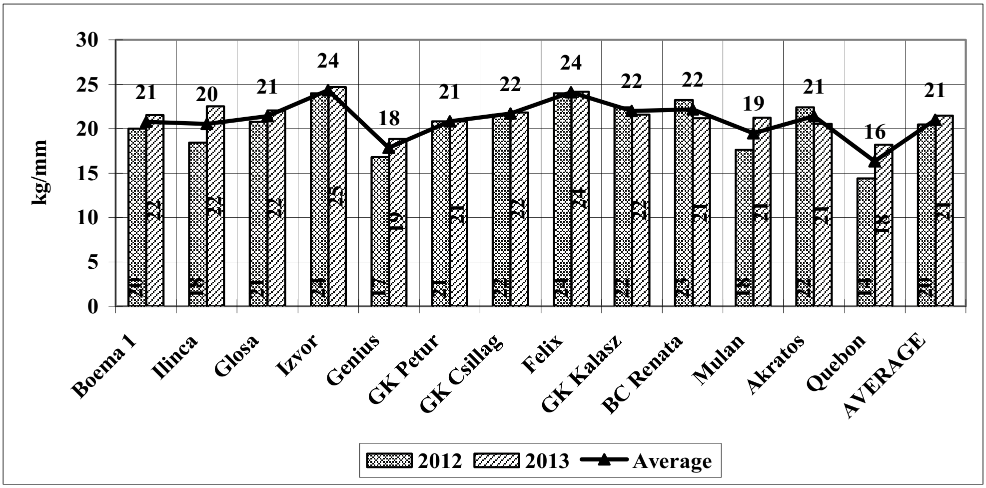

Figure 7. Precipitations valorization efficiency in the early spring (III-VI) for wheat production

If production is compared only to the period of vegetation in the spring-summer (III-VI), the average unit yield obtained reaches 21 kg/mm (Figure 7), with a variability, depending on the tried variety similar to the one recorded throughout the period of vegetation. The influence of the pluviometric regime of trial years during the vegetation period after winter plant output is almost identical. In Figure 7, however, there is observed a higher efficiency in 2013 from the varieties throughout the period of the growing season there were differences from one year to another, or they were insignificant: Ilinca, Genius, Mulan, Quebon.

Specific contribution (specific use) of temperature to achieve production.

The amount of biologically active temperatures (daily average temperatures exceeding $5^{o}C$) throughout the period of vegetation (X-VI), acquired for the production of grain in the year 2013, was $423^{o}C/t$, an average of all trial varieties (Figure 8). Similarly, the specific contribution of the precipitation minimum temperature recorded has been active in the most productive varieties (Izvor and Felix), and the maximum for the varieties with the lowest yields (Quebon and Genius).

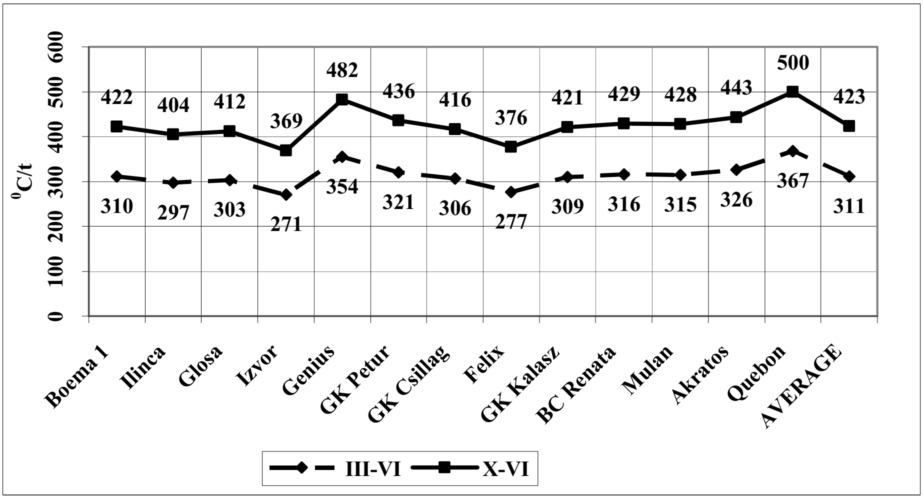

Figure 8. Temperature specific contribution when achieving production (2012-2013)

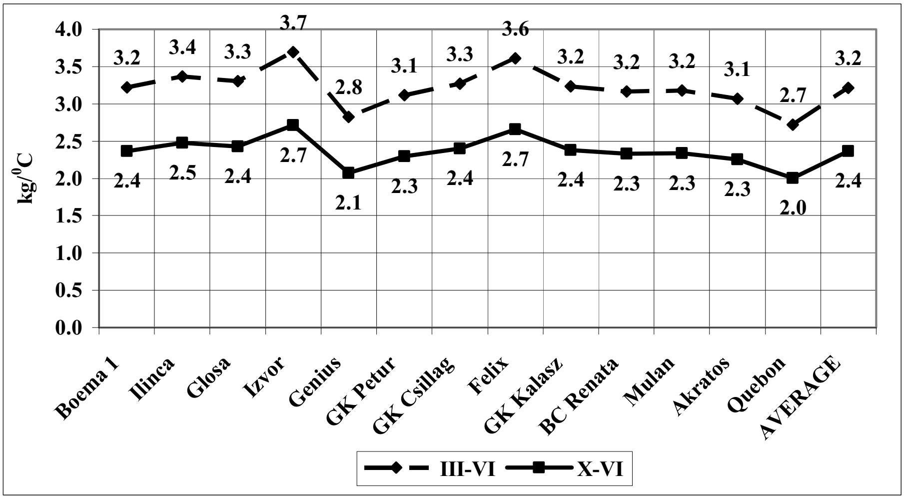

Figure 9. Temperatures valorization efficiency for wheat production (2012-2013)

During the spring-summer growing season (III-VI) the intake of air temperature reached the average amount of 311^{o}C/t, with the same variations before, depending on the grown variety.

The effectiveness of the recovery temperature for production. The production, which moved back to the active temperature 1^{o}C, reached an average of 2.4 kg for the whole period of vegetation and 3.2 kg for the period March-June (Figure 9). Maximum efficiency of temperature use is recorded with Izvor and Felix varieties (2.7-kg/^{o}C), and the smallest with Quebon and Genius varieties (2.0-2.1 kg/^{o}C).

CONCLUSIONS

In specific conditions of Găvanu-Burdea Plain, during two agricultural years, one dry (2011-2012) and another close to the normal period (2012-2013), the early and half-precocious varieties of wheat have valorized with higher efficiency the area climate resources.

On average per year, and all wheat growing season (October-June), 1 tonne of grain is obtained with 80 mm of precipitation, and with 423^{o}C.

The lowest specific rainfall consumptions (precipitation intake) were recorded with the following varieties :Izvor, Felix, Renata, Kalasz, Csillag, Glosa and Akratos (68-78 mm/t), and the highest for Mulan, Genius and Quebon varieties (86-102 mm/t).

The efficiency of basic climate resources, expressed by unitary benefit was 13 kg/mm precipitations and 2.4 kg/^{o}C.

Climate resources low consumption varieties achieved unity gains of 13-15 kg/mm and 2.4-2.7 kg/^{o}C, and the ones with high consumptions of 10-12 kg/mm and 2.0-2.3 kg/^{o}C.

Among the experimented varieties, the highest valorization of basic climate resources is found with: Izvor (RO), Felix (HR), Renata (HR), Kalasz (HU), Csillag (HU), Petur (HU), Glosa (RO) and Akratos (DE). These varieties are productive and they have the capacity to adjust the climate resources specific consumptions but also the development and growing process, so that it ensures the production stability under variable climate conditions.

Quebon (DE), Mulan (DE) and Genius (DE) varieties are characterized by low valorization efficiency sof climate resources and production important dependency on climate regime of the agricultural years.

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INFLUENCE OF IRON FOLIAR FERTILIZATION ON SOME GROWTH AND PHYSIOLOGICAL PARAMETERS OF WHEAT AT TWO GROWTH STAGES

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Abstract

A field experiment was carried out to evaluate the influence of foliar application of iron on growth and physiological parameters of wheat (Triticum aestivum L. Alex cultivar) at various growth stages, during the growing season 2012-2013 at Didactic Station, Timisoara, Romania. The experiment was laid out in a randomized complete block design with three replications. Wheat plants were exposed to four treatments: control (T1), Fe applied to plants at Feekes growth stage 2 (T2), Fe applied to plants at Feekes growth stage 9 (T3), Fe applied to plants at growth stage Feekes 2 and 9 (T4). The treatments were foliar application of Fe (1000 mg L^{-1}) using iron chelate [Fe-DTPA (6% Fe)]. Foliar solution of Fe was sprayed with a hand held pump sprayer at the rate of 1.2 L $plot^{-1}$ on plant foliage. Soil samples were collected before sowing of crop from 0-25 cm depth and analyzed for chemical and physical properties. Data analysis showed that there were significant differences among treatments on plant height, number of plants, flag leaf area and flag leaf chlorophyll content. The highest plant height (88 cm), number of plants m^{-2} (418), flag leaf area (30 cm^2) and chlorophyll (59.3 SPAD value) were obtained from the foliar application of Fe at Feekes GS 2 and Feekes GS 9 (T4), in comparison with the control. The data suggest that foliar application of Fe during vegetative growth stages can maximize plant growth and development of wheat.

***Key words**: iron, growth stages, morphological and physiological parameters, wheat.*

INTRODUCTION

Micronutrients consist of six essential elements: iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B) and molybdenum (Mo). These elements present in very small amounts in both soils and plants, but their role is regularly as important as the primary or secondary nutrients (Steven, 2000). They are playing an important function in growth and development of plant. Actually, their necessary function in plant nutrition and rising soil productivity makes their significance ever greater. In an intensive cropping with high yielding varieties and application of high analysis, primary and secondary nutrient fertilizers, micronutrient deficiency have been more marked (Dewal and Pareek, 2004). Fe plays major role in many plant functions. This function includes respiration, photosynthesis processes, chlorophyll development, energy transfer within the plant, a component of at enzymes and proteins, and involved in nitrogen fixation (Eskandari, 2011). Wheat plant needs Fe in small quantity but many research showed that foliar spray of Fe alone or share with other micronutrients had a positive effect on growth and yield parameters of wheat crop. (Ali, 2012; Abbas,et al., 2012; Bameri et al., 2012; Safyan et al., 2012). Very little deficiency of Fe is observed in common soils but many factors can cause deficiencies of Fe including imbalance of nutrient in soil, critical physico-chemical state of soil like high pH, poor aeration, and accumulation of phosphorus (P) (Lindsay and Schwab, 1982). In Romanian Banat Region, Fe chlorosis has been noticed on plum tree grown on a pre-luvisol soil. The deficiency of Fe happened due to the momentary storage of limestone near plum trees for purpose on nearby farmland. Rainfall leached enough limestone into the soil to cause Fe deficiency (Sala, 2012). Until now in Romania the affect of foliar application of micronutrient on growth parameters of wheat plant is not sufficient investigated and documented. The present study was undertaken to evaluate the impact of foliar application of Fe on some growth parameters of wheat plant at different growth stages.

MATERIALS AND METHODS

This research was conducted during the growing season of 2012-2013 at the Didactic Station, Banat University, Timisoara. The experimental site was located at 45°46′ N latitude, 21°25′ E longitude with an altitude of 85 m above sea level. Composite soil sample of surface soil (0-25cm depth) was taken after the site had been prepared, air dried, ground, passed through 2 mm sieve, analysed for chemical and physical properties by using standard methods at laboratory of Physical-Chemical analysis "OSPA – USAMVB" according to (SR-ISO, 1998). Available Fe was determined by ammonium oxalate 0.2 N extractions (Pouget and Juste, 1972). Soil texture was clay, pH 6.73, EC 0.41 dS m^{-1}, humus 3.22%, total N 2.21%, P 11.23, K 171.13 ppm, available Fe 25.30 ppm. The experiment was laid out in a randomized completely block design (RCBD) with three replications. Seeds were sown through drills at a 15 cm distance between rows. A seed rate 270 kg ha^{-1} of "Alex" wheat cultivar was used. The size of each plot was 10.0 m long and 3.0 m wide. A buffer zone of 2.0 m spacing was given between plots. Nitrogen was applied in two doses. First dose of nitrogen along with full dose of phosphorus and potassium were applied for all treatments at 4 weeks after sowing in the form of complex 150:100:100, respectively at the rate of 360 kg ha^{-1}. Second dose of the nitrogen in the form of urea was applied at the stem elongation stage at a rate 100 kg ha^{-1}. Weeds and insects associated with wheat were controlled by using a tractor-mounted boom sprayer. The experiment included four foliar spray treatments: control (only received distilled water) T1, 1000 mg L^{-1} Fe at Feekes GS 2 T2, 1000 mg L^{-1} Fe at Feekes GS 9 T3, T2+T3 T4. Source of iron Fe-DTPA (Fe 6%). Foliar solutions of Fe were sprayed at leaves with a hand pump sprayer at the rate of 1.2 L $plot^{-1}$ at two growth stages: beginning of tillering stage (Feekes GS 2); and early booting stage (Feekes GS 9) according to the Feeks scale as described by (Travis, 1999). At maturity stage, plants in one square meter area selected randomly, selected at three locations in each plot were harvested by manually and the following parameters were obtained:

Plant height. The height of plants from ground level to the tip of the plant excluding spike. The average height of these plants was calculated and expressed as mean plant height (cm).

Number of plants. The number of plants was counted and the average was calculated and then mean value was recorded and converted into number of plants per square meter.

Flag Leaf area. Flag leaf area was measured by taking the maximum length and width of the fully grown flag leaf of the main tiller in cm. Flag leaf area was calculated by using the formula of (Muller, 1994).

Flag leaf area (cm^2) = Maximum flag leaf length × Maximum flag leaf width × 0.74.

0.74 = Correction factor.

Measurement of Chlorophyll content (Unit SPAD). Fifty flag leaf of the main tiller samples were selected randomly from each plot one week after anthesis to determine leaf chlorophyll content by using a SPAD-502 (Model Konica-Minolta, Osaka, Japan). Data presented are total chlorophyll.

Data analysis. Data were analyzed statistically for analysis of variance following the method described by (Gomez and Gomaz, 1984). MSTAT-C computer software was used to carry out statistical analysis (Russel and Eisensmith, 1983). The mean differences among the treatments were compared by Duncan Multiple Comparison Test at 0.05 level of probability.

RESULTS AND DISCUSSIONS

Plant height. Plant height was significantly affected by foliar application of Fe (Figure. 1). The highest plant height (88 cm) was achieved by treatment T4 followed by T3 and T2 treatment. The lowest plant height (79 cm) was obtained by T1 treatment. Compared with control, plant height increased 12%, 11% and 9%, by treatments of T4, T2 and T3 respectively. Fe plays a role in energy transfer within the plant, component of enzymes and proteins, and involved in nitrogen fixation and enters in root cells these reasons may be leads to an increase in plant height. (Abbas et al., 2009; Ali, 2012; Bameri et al., 2013). Reported that soil application and foliar spray of Fe alone or in combination with other micronutrients increase plant height of wheat.

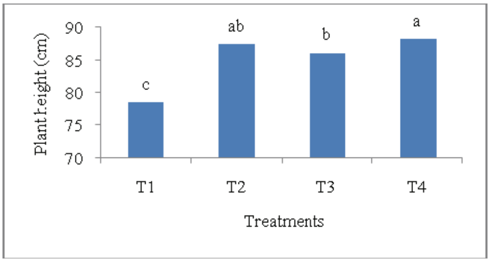

Figure 1. Effect of foliar fertilizer of iron at different growth stages on wheat plant height
(The columns sharing the same letter are not significantly different at P=0.05)

Number of plant m^{-2}. Number of plants was significantly increased by foliar spray of Fe as compared with the control (Figure 2). The highest number of plant was recorded with the application of Fe at two growth stages (T4). Number of plants was increased by 12.51% with T4 followed by 8.21% with T3 and 6.59% with T2 as compared with the control. There was no significantly difference between T2 and T3 for number of plant m^{-2}. Nadim et al. (2012), Abbas et al. (2009), they reported that application of Fe alone or in combination with other micronutrients significantly increased the number of tillers compared with the control.

Flag Leaf area (cm^{-2}). Flag leaf area was significantly increased by foliar application of Fe at different growth stages (Figure 3). The highest flag leaf area 30 cm^{-2} was obtained by foliar application with Fe at two growth stages (T4). The lowest flag leaf area was obtained from control (T1). Compared with control, flag leaf area was increased 37%, 28% and 19% by treatments application of T4, T2 and T3 respectively. Fe is an important element in crops, because it is necessary for synthesize chlorophyll, keeps up the structure of chloroplasts, involved in nitrogen fixation which lead to higher crop production and leaf area increase (Zayed et al., 2011).

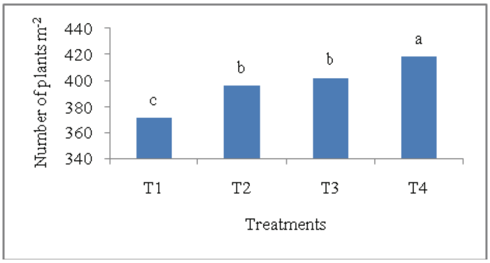

Figure 2. Effect of foliar fertilizer of iron at different growth stages on number of plant m^{-2} of wheat plant
(The columns sharing the same letter are not significantly different at P=0.05)

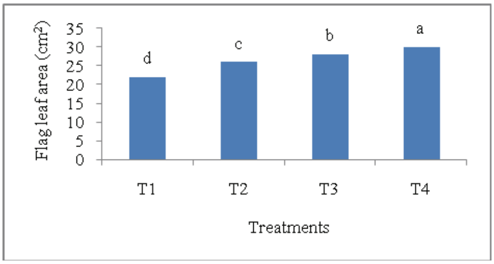

Figure 3. Effect of foliar fertilizer of iron at different growth stages on flag leaf area of wheat plant
(The columns sharing the same letter are not significantly different at P=0.05)

Flag leaf chlorophyll content. The effect of foliar spray with Fe on chlorophyll content (SPAD value) in the flag leaves of wheat plants at Feekes GS 2 and Feekes GS 9 are shown in (Figure. 4). Flag leaf chlorophyll content was significantly increased by foliar application of Fe at Feekes GS 2 and Feekes GS 9. The maximum value of leaf chlorophyll content (59.30) was recorded from the treated plants with T4, and followed by T3 and T2. The minimum values of chlorophyll content (51.46) was recorded when wheat plant received only distilled water (T1). Fe is important in chlorophyll formation, photosynthesis, enzyme systems, chloroplast development and respiration of plants (Miller et al., 1995; Halvin et al., 1999). This result was agreement with

(Ai - Qing et al., 2011; Mohsen, 2013 and Kobraee et al., 2011) who demonstrated that adding Fe alone or in combination with other micronutrients increased chlorophyll content of plants.

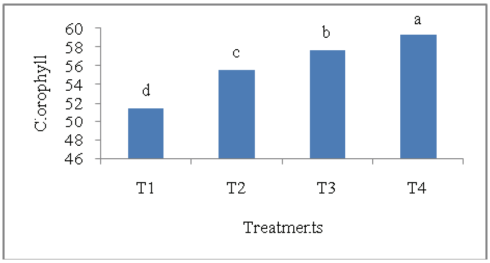

Figure 4. Effect of foliar fertilizer of iron at different growth stages on flag leaf chlorophyll content of wheat plant
(The columns sharing the same letter are not significantly different at *P*=0.05)

CONCLUSIONS

The current study showed that foliar spray of Fe (1000 mg L^{-1}) at different Feekes growth stage (GS 2 and GS 9) significantly increased wheat plant height, number of plants, flag leaf area and flag leaf chlorophyll content. The best result of all studied parameters was obtained from Fe sprayed at two growth stages (T4). The control (T1) gave the lowest values of all studied parameters.

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ASSESSMENT OF MUNG BEAN YIELD POTENTIAL PRODUCTION IN THE NORTH EASTERN REGION OF ROMANIA

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Abstract

The significant climate changes observed and registered throughout the entire world over the past few years demonstrate the vital importance of finding workable solutions allowing us to preserve our natural resources (especially vegetal genetic resources, land, and water) and ensure a steady and nutritious food supply to all people. The use of genotypes with drought and salinity tolerance, which are resistant to pathogens and have minimum inputs, might represent an alternative solution to the current challenges. The aim of this study was to test a species – the mung bean -- that has all the above characteristics, and to recommend its use to farmers. The mung bean is distinguished by its high protein content, and it is appropriate for human consumption. The study was accomplished using a number of 96 genotypes. The paper presents data for 22 representative genotypes of (Vigna radiata (L.) Wilczek). The vegetation period for the genotypes involved in the study varied from 85 to 110 days. Our study revealed the fact that variety influenced: germination, emergence duration, interval to appearance of first true leaves, flowers and pods, plant height, number of fertile shoots, number of pods per plant, pod length, number of seeds in pods, and weight of 100 seeds production of grain. The mean value per hectare in relation to the mung bean's productive potential was 1.88 t ha^{-1}. The sprouting capacity highlighted a full germination process in 2-3 days, and a necessary minimum of 4-5 days to develop sprouts 5 cm in length. During our investigation, we discovered that the genotypes with the highest seed weight value had a faster rate of sprouting. Our TLC investigation concluded that the mung bean can be considered a food-drug due to its chemical composition. Correlation and path coefficient analyses indicated that high yielding mung bean genotypes could be obtained by selecting plants with a high number of pods per plant. The cultivation of Vigna radiata (L.) Wilczek species can contribute to the development and diversification of agricultural production through diversification of food in general and the development of sustainable agriculture in the context of European and world agriculture.

Key words*: Vigna radiata, cultivation, germination, pods.*

INTRODUCTION

In recent years, society as a whole has begun paying increasing attention to the health of the environment. This shift demonstrates a growing interest in finding sustainable solutions that would reduce the negative effects of human activity upon the environment, particularly those caused by agriculture.
Intensive agriculture, established after the World War II, completely ignored the need for biodiversity and for preserving the environment. Over the course of the last few years, the use and development of adapted genotypes with minimum impact (genotypes requiring only low doses of fertilizers and pesticides) that are also resistant to drought, salinity, and pathogens has become increasingly important. In our research, we sought to introduce a relatively new and little-known species to our area, one which is distinguished by its unique quantitative and qualitative potential. Towards this purpose, the evaluation and characterization of the germplasm are necessary to identify qualitative and quantitative characters useful for the cultivation program.
The main international objective of mung bean cultivation is to develop new varieties of the species, some with short vegetation periods (55 and 65 days), with mass maturation phases (for a single harvest) MMB high value (> 5 g per 100 seeds) with high and stable yield (2.5 t ha^{-1}), with reduced sensitivity to photoperiod and temperature, and with resistance / tolerance to biotic and abiotic stress. This species is

particularly valuable due to its ability to improve soil quality through its cultivation by using symbiotic nitrogen fixation – a factor particularly important for farmers with limited resources. Input requirements for mung bean cultivation are low, making the species extremely valuable in the current economic crisis. The mung bean can be easily grown in newly reclaimed sandy soil and can be irrigated with saltwater, because it can tolerate drought and soil salinity (Mohamed, 2005). The species is one of the best to use for winter grains (Pierce and Rice, 1988; Sharma, 1996). Mung bean can be grown in a variety of cropping systems; wheat-mungbean-wheat was the dominant cropping rotation in Pakistan. The mung bean is widely cultivated for human consumption (consumed as fresh pods, fresh and dry beans, sprouts, and flour). Is it regarded as a quality nutrient for its rich protein content and excellent digestibility, especially when combined with other grains (Rachie and Roberts, 1974; Thirumaran and Seralathan, 1988). Rich in easily digestible protein (24%), the mung bean adds much-needed diversity to the grain-based diet of the poor (Thirumaran and Seralathan, 1988). Mung beans contain vitamin A (94 mg), iron (7.3 mg), calcium (124 mg), zinc (3 mg) and folate (549 mg) per 100 g dry seed. It is consumed as dhal in South Asia, and is used in food products such as fried snacks, desserts, and bean sprouts. Mung bean sprouts, which are a good source of vitamin C (8 mg per 100 g), can be produced year-round at home or commercially (Calloway et al., 1994; Gopalan et al., 1989). Each kilogram of mung bean seeds produces 6-10 kg of sprouts. The mung bean is the most important grain legume in Thailand and the Philippines, and it ranks second in importance in Sri Lanka, and third in India, Burma, Bangladesh, and Indonesia (Lawn and Ahn, 1985).

Considering the species' potential to perform in drought condition with minimum input, our study investigates some yield compounds, as well as the quality (antioxidant compounds) of seeds. The study's findings should be useful to the diversification of the assortment of cultivated species and to the establishment of selection criteria in the mung bean breeding program for high seed yield.

MATERIALS AND METHODS

Place and experimental conditions

The research was carried out over the course of two experimental years. The experiments were conducted at the Vegetable Research and Development Station in Bacau, Romania, at an elevation of 91 m, latitude 46.521946 N, longitude 26.910278 E.

Average annual temperatures during the experimental period averaged between 8 to 9 degrees Celsius. During the winter, temperatures dropped as low as -29º C, while during the summer, they reached as high as +39º C. Average annual rainfall exceed 500-550 mm per m^2. Precipitation ranged between 500 and 1100 mm per year. The predominant wind direction is north and northwest.

Given the strength of the species specified in the literature, the experimental culture was placed into a certified polygon of biological agriculture. No fertilizers or chemical treatments for diseases or pests were applied. The experiment used no inoculated seeds. No desiccation treatments were applied before harvesting.

Experimental variants were placed in a plot of land subdivided into four partitions.

The seeds were sowed into moisture at a depth of 2-4 cm, without the use of press wheels that exert heavy pressure directly over row, at a density of 40 plants per m^2.

Biological material

The study was carried out using 96 genotypes. The paper presents data for 22 representative genotypes of (*Vigna radiata* (L.) Wilczek).

Observations

Regarding growth, we made the following phenologycal observations*:* the number of days required for germinating, the appearance of the first true leaves, the number of days to flowering and to set pods.

Regarding yield potential, we took into account*:* plant height, number of fertile shoots, number of pods per plant, number of seeds in pods, MMB, production of grain per hectare.

Statistical analysis

Statistical calculations were performed to highlight differences between experimental variants.

RESULTS AND DISCUSSIONS

Even though this species has an important potential for cultivation, in many European countries, it is still little known and rarely cultivated. Our results, obtained during a post-doctoral research project and continued over other the two years, in the northeast of Romania, establish the suitability of mung bean cultivation, and also promote its use (*Vigna radiata* (L.) Wilczek) species.

According to our results, mung bean has a high potential for cultivation in the climatic conditions of northeast Romania (confirming the recommended area of cultivation longitude 26°55 and latitude 46°34', as stated in the literature).

We registered differences between genotypes, but generally, species of mung beans requires 90-120 days of no frost for development of production.

One of the challenges that cultivators of mung beans face is obtaining short vegetation period genotypes.

In our experimental conditions, we planted the seeds on May 2nd into moisture at a depth of 2-4 cm, at a density of 40 plants per m^2.

The lowest level of germination was registered at genotype PA17, with only 20% germinated seeds. The genotype PA5 registered 80% germinated seeds; seven genotypes accomplished 90% germinated seeds (PA1, PA2, PA, PA10, PA19, PA21, PA22). The rest of the 10 genotypes registered the optimum level of germination of 100%. Eight genotypes required 9 DAS for germination. Even when the time period was longer, this was not an impediment, as all these genotypes experienced a germination level of 100%. In our study, we analyzed the dynamic of germination and as a result, we observed the genotypes at 7, 9 and 10 days after sowing (DAS).

83% germinated seeds in 7 DAS was the fastest rhythm of germination, at PA 14. Six genotypes registered up to 50% germination in 7 DAS. Although 11 genotypes required a minimum of 9 DAS for germination, final germination percentage was not influenced, as nine of those genotypes registered 100% germination at 9 DAS, and two genotypes germinated 90%.

The appearance of the first true leaves requires a number of 17 to 21 DAS. The total number of DAS to flowering varied from 66 for genotypes PA11, PA12 and PA19 to 71 for genotypes PA14, PA18, PA 21 and PA 22, with a mean value of 68.27.

We observed that the process of setting pods started after a mean interval of 70.63 DAS. The process of set up pods occurs after a minimum of 68 DAS and a maximum of 74 DAS.

Our study revealed the fact that variety influenced: germination, emergence duration, interval to appearance of first true leaves, flowers, and pods.

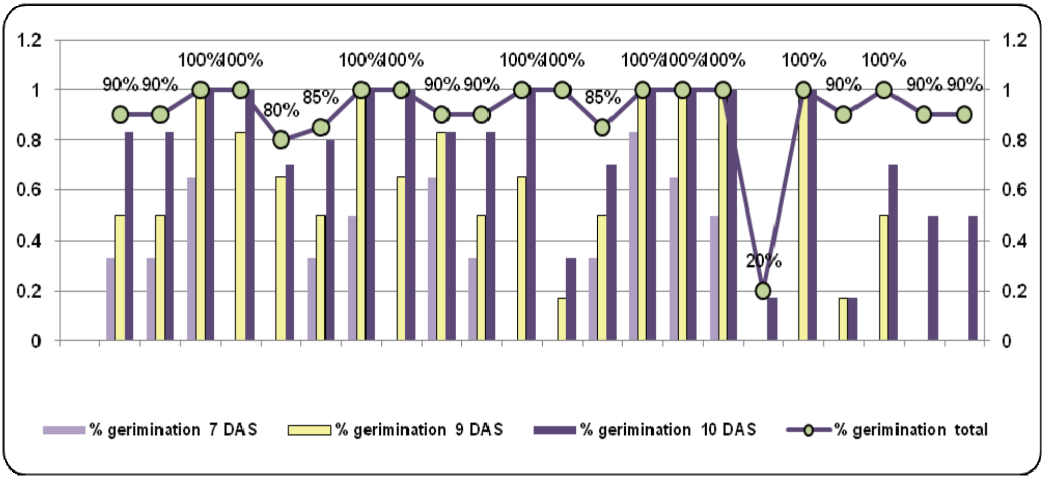

Figure 1. Influence of mung bean variety on germination capacity

Table 1 Phenological observation accomplished at genotypes

Genotype cod	Data of sowing	% germination				number of days to first true leaves appearance	number of days to flowering	number of days from sowing to set up pods
		7	9	10	total			
		Days After Sowing (DAS)						
PA1	2.05	33%	50%	83%	90%	20	68	70
PA2	02.05.	33%	50%	83%	90%	20	67	68
PA3	02.05.	65%	100%	100%	100%	19	67	69
PA4	02.05.	0%	83%	100%	100%	19	67	69
PA5	02.05.	0%	65%	70%	80%	21	69	71
PA6	02.05.	33%	50%	80%	85%	20	67	70
PA7	02.05.	50%	100%	100%	100%	19	67	69
PA8	02.05.	0%	65%	100%	100%	19	68	70
PA9	02.05.	65%	83%	83%	90%	20	68	70
PA10	02.05.	33%	50%	83%	90%	20	68	70
PA12	02.05.	0%	65%	100%	100%	20	66	70
PA11	02.05.	0%	17%	33%	100%	20	66	71
PA13	02.05.	33%	50%	70%	85%	20	67	70
PA14	02.05.	83%	100%	100%	100%	17	71	73
PA15	02.05.	65%	100%	100%	100%	19	69	71
PA16	02.05.	50%	100%	100%	100%	29	69	71
PA17	02.05.	0%	0%	17%	20%	22	70	73
PA18	02.05.	0%	100%	100%	100%	18	71	73
PA19	02.05.	0%	17%	17%	90%	19	66	69
PA20	02.05.	0%	50%	70%	100%	19	69	71
PA21	02.05.	0%	0%	50%	90%	19	71	74
PA22	02.05.	0%	0%	50%	90%	19	71	74
Mean		**25%**	**59%**	**77%**	**91%**	**19.91**	**68.27**	**70.73**

In determining the yield capacity of mung beans in our research, we investigated the next quantitative characters: plant height, number of fertile shoots, number of pods per plant, pod lenght, number of seeds in pods, weight of 100 seeds, and production of grain (t ha^{-1}). Phenotypic and genotypic correlations between seven quantitative characters studied showed that plant height has a positive correlation to the number of fertile branches and the number of pods per plant. These results are in agreement with previous results obtained in research conducted by Malhorta (1974) and Malik (1983). Variety influenced: emergence duration, plant height, number of branches per plant, plant port, and productivity. There were differences of: plant height, number of branches, number of pods per plant, number of viable seeds in pods.

All studied genotypes registered very significant differences in terms of plant height when compared to the control variant. The plants' height varied from 43.10 cm for genopype PA2 to 52.30 for genotype PA5. Significant diffrences were registred based on the number of fertile shoots and the number of pods per plant.

The yield is determined by the number of pods, which is a product of the number of flowers and pod-set-ratio. Since pod-set-ratio is strongly affected by pollen fertility under high temperature conditions, pod yield deterioration in the summer might be due to the decrease of pollen fertility.

Heat stress in particular affects the development of reproductive organs (Hall, 1992).

The pod yield of mung beans was severely depressed under high temperature conditions (especially in the second year of experimentation). High temperatures, combined with high solar radiation led to excessive transpiration. The decline in the water potential of the vegetative and reproductive organs in mung bean plants was considerably larger under high temperatures, compared to the results obtained under optimal temperature conditions (Tsukaguchi et al., 2003).

Table 2 Mean values and standard deviation for seven quantitative characters of 22 mung bean genotypes

Genotype	Plant height (cm)	Number of fertile shoots	Number of pods per plant	Pod lenght (cm)	Number of seeds in pods	Weight of 100 seeds	Production of grain (t ha^{-1})
VR 75 control	39.13	4.23	54.23	5.94	11.03	3.85	1.26
PA1	46.90 **	7.28 **	59.59 **	6.15	11.38 *	4.43 **	1.68 **
PA2	43.10 **	6.87 **	63.03 **	6.41	11.44 *	4.46 **	1.79 **
PA3	48.47 **	9.41 **	73.88 **	6.99 **	11.52 *	4.41 **	2.59 **
PA4	44.71 **	6.95 **	62.46 **	6.75 **	11.49 *	4.41 **	1.69 **
PA5	52.30 **	7.39 **	55.04 **	6.56 **	11.20	4.37 **	1.42
PA6	46.95 **	8.57 **	64.45 **	6.44 *	11.26	4.53 **	1.64 *
PA7	45.80 **	7.52 **	55.92 **	6.61 **	11.41 *	4.55 **	1.48 *
PA8	50.73 **	8.82 **	55.33 **	6.62 **	11.37 *	4.51 **	1.47 *
PA9	49.52 **	7.25 **	73.28 **	6.63 **	12.10 **	4.66 **	2.12 **
PA10	48.34 **	7.44 **	70.12 **	6.72 **	12.20 **	4.68 **	2.10 **
PA11	48.55 **	6.98 **	71.55 **	7.12 **	11.98 **	4.55 **	1.99 **
PA12	47.82 **	6.46 **	70.42 **	7.10 **	13.02 **	4.98 **	1.96 **
PA13	46.59 **	6.86 **	71.44 **	6.95 **	12.62 **	4.96 **	1.87 **
PA14	46.56 **	8.45 **	69.55 **	6.45 **	12.45 **	4.69 **	1.75 **
PA15	47.88 **	8.22 **	68.88 **	7.22 **	11.98 **	4.85 **	1.73 **
PA16	50.22 **	7.53 **	62.59 **	7.29 **	11.82 **	4.76 **	1.89 **
PA17	50.31 **	7.45 **	64.45 **	6.88 **	11.96 **	4.88 **	1.95 **
PA18	51.24 **	7.12 **	65.65 **	7.33 **	12.23 **	4.91 **	2.12 **
PA18	51.62 **	6.55 **	66.44 **	7.04 **	12.23 **	4.75 **	2.13 **
PA20	49.88 **	6.59 **	67.56 **	7.23 **	12.02 **	4.82 **	2.15 **
PA21	49.66 **	6.98 **	70.23 **	7.33 **	11.88 **	4.69 **	1.98 **
PA22	48.75 **	7.51 **	70.11 **	7.98 **	11.86 **	4.90 **	1.86 **

The mean of pods per plant was 70.11, with a variation from 55.04 at PA4 to 73.88 at PA3. As is the case with plant port, the total number of pods per plant is strongly influenced by variety. In our research, the genotypes with red seeds registered a higher number of pods per plant (up to 70 pods per plant) when compared to the genotypes with green seeds.

The total number of seeds in pod varies from 11.20 to 13.03.

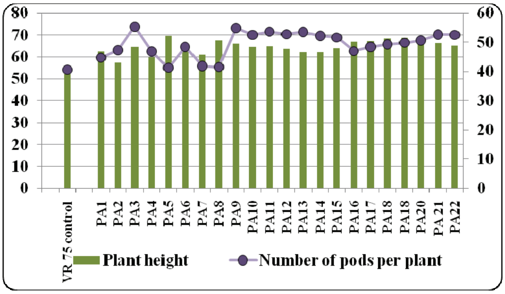

Figure 2. Variation of plant height and total number of pods per plant

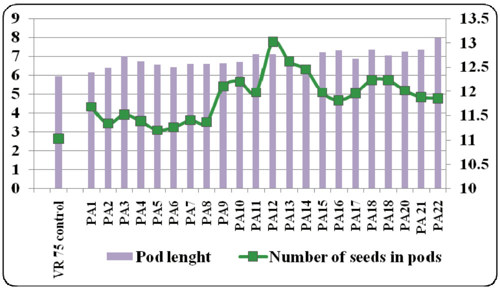

Figure 3. Variation of pod length and the number of seeds in pods

From a farmer's point of view, the most important factors are obviously the weight of the seeds and the total yield of each genotype. We obtained outstanding yield results during our study, especially considering the fact that the experimental culture was placed in a certified polygon of biological agriculture and received no fertilizer or chemical treatments for diseases or pests. The experiments used no inoculated seeds. No desiccation treatments were applied before harvesting. In order to avoid losses, the harvesting process was carried out early in the morning.

The data presented in table-2 noted that yield ranged from 1.42 t/ha for PA5 genotype to 2.59 at PA3.

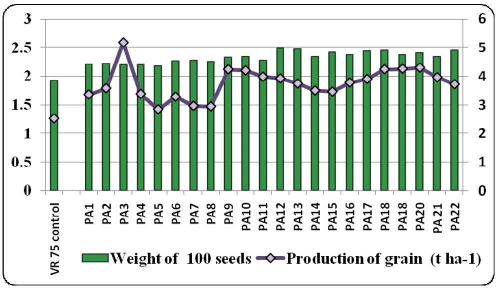

Figure 4. Variation of weight of 100 seeds and yield

CONCLUSIONS

The assessment of the 22 mung bean genotypes tested in the climatic conditions of Romania, in an ecological culture system, led us to some interesting conclusions.

Variety influenced: emergence duration, plant height, number of branches per plants, plant port, and productivity.

The appearance of the first true leaves requires a number of 17 to 21 DAS.

The total number of DAS to flowering varied from 66 to 71, with a mean value of 68.27. Upon collection, the process of setting pods started after a mean interval of 70.63 DAS. The process of set up pods occurs after a minimum of 68 DAS and a maximum of 74 DAS. These results can be extremely important to the selection of genotypes with the fastest rate of growth and development for cultivation programs, in order to obtain new genotypes with short vegetation periods.

The number of pods per plant represents an important yield component, and should be useful as selection criteria.

Correlation and path coefficient analyses indicated that high yielding mung bean genotypes could be obtained by selecting plants with high number of pods per plant.

ACKNOWLEDGEMENTS

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THE EFFECTS OF PHOSPHORUS DEFICIENCY AND RHIZOBACTERIA ON PHOSPHORUS CONTENTS OF TWO SOYBEAN (*Glycine max* L.) CULTIVARS GROWN AT LOW WATER SUPPLY

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Abstract

Phosphorus (P) deficiency and low water supply are major environmental constraints for *agricultural production in many regions. Compared to cereal crops, the soybean (Glycine max.L.) is more susceptible to phosphorus insufficiency and drought. A soil pot experiment was conducted in the greenhouse to investigate the effects of phosphorus deficiency and pseudomonas florescence and azotobacter chroococcum strains on phosphorus uptake by soybean grown under temporary drought conditions. Soybean cultivars Zodiac and Horboveanca were grown on soil-sand mixture with P deficiency at two water regimes - 70% water holding capacity of soil (WHC) and 35% WHC. Plants were harvested and analyzed for P contents in each organ after 12 days of water deficit at the setting pod stage. Phosphorus deficiency significantly decreased nutrient uptake by all plant parts especially in drought conditions. Leaves have shown a higher sensitivity to P deficiency than roots. Application of rhizobacteria induced P uptake in both cultivars but their effects were more pronounced in Horboveanca under both well watered and dry soil conditions. Phosphorus fertilization alone of plants significantly increased P accumulation irrespective of soil moisture regime and Horboveanca displayed a higher response than Zodiac cultivar. The P accumulation in the roots of both cultivars and in the pods of Zodiac enhanced after the application of bacteria or P fertilizer under temporary drought. Interactive effects of applied bacterial strains and water soil regime depend on the cultivar used. From the results of the present experiment it can be concluded that biofertilizers seem to be particularly beneficial to P uptake in normal as well as in water limiting environment.*

Key words: *drought, phosphorus*, *rhizobacteria, soybean.*

INTRODUCTION

Phosphorus (P) is an essential nutrient required for plant growth, development and productivity, but its low availability in soils makes it one of the least mobile mineral elements. Phosphorus deficiency is worldwide spread and it affects agriculture sustainability in many agricultural regions. In field conditions, low soil fertility frequently is accompanied by droughts. Drought and low P availability in soil presents a serious problem to agriculture production on global and national levels. Chemical P fertilizers are the main source of plant available phosphates alleviation in agroecosystems, but the majority (approximately 75-80%) of applied phosphates are fixed in soil and they became less available for crops (Vance et al., 2003). Nowadays, the use of P fertilizer is reduced substantially in many countries because of the higher costs of these fertilizers and many farmers don't have the capacity to buy them. In addition, the long-term sustainability of fertilizers application is questionable because according to some estimates the world reserves of rock phosphates are expected to be exhausted in the next 50 years at current rates of consumption (Gilbert, 2009).

Under low levels of soil moisture, not only water but also nutrient availability may be severely decreased when compared with well watered conditions (Gahoonia et al., 1994). There is need to identify suitable biological approach to improve plant nutrition under poor soil resources such as scarce availability of phosphates and water.

Plant growth promotion rhizobacteria (PGPR) due to their ability to increase nutrient uptake and thus to promote plant growth, have often been suggested as a means to improve crop production (Adesemoye et al., 2009). There are

evidences that the application of P-mobilizing microorganisms is regarded to be an alternative strategy to improve the supply of P to agricultural crops (Rodrigues and Fraga, 1999).
Whitelaw (2000) stated that the bacterial genera *Pseudomonas* are the most powerful P solubilizer. Simulative effects on plant P uptake under P deficient conditions were found after the application of *Pseudomonas* strains in a pot experiment with cotton and pea (Egamberdiyeva and Höflich, 2004).
Plant growth promoting bacteria could effectively colonize plant roots and provide plant growth through different mechanisms that include enhancing mobilization of less available nutrients and subsequent increase in nutrient uptake (Dey et al., 2004). There are many experimental results which demonstrated the beneficial effects of PGPR on nutrient acquisition and plant growth. Their analyses have shown that the application of PGPR is a suitable approach for reducing the doses of chemical fertilizers and their pollution hazards that could also support eco-friendly crop production (Dey et al., 2004).
Legumes are well known to be an essential component of various agroecosystems in order to develop organic agriculture. Legumes, particularly soybean, have a higher demand of P nutrition because nitrogen fixation required considerable sources of energy. This species is sensitive to low P supply and drought.
We hypothesized that particularly under unfavorable conditions P deficiency and low water supply the application of rhizosphere microorganisms would improve plant growth by increasing phosphorus absorption in plant parts.
Moreover, the analyses of available literature data revealed that the effects of PGPR on nutrient uptake were examined as a rule under normal water conditions and there is scarce information regarding their impact on P uptake by legumes under combined abiotic stresses the low P and water deficit. Suspension of nitrogen-fixing *(Azotobacter chroococcum*) and phosphate solubilizing (*Pseudomonas florescence*) bacteria (Rh - in Figures) was used as tested strains in the study and soybean plants which have a higher demand of P nutrition.
Thus, the main objective of the research was to investigate the influence of phosphorus deficiency and *pseudomonas florescence and azotobacter chroococcum* suspension application on P accumulation within soybean organs of two cultivars were either cultivated under normal or suboptimal soil water regime.

MATERIALS AND METHODS

To accomplish the objective of this study it was conducted out a pot experiment in a greenhouse under controlled humidity conditions. The research included two soybean (*Glycine max., L.*) cultivars: Zodiac and Horboveanca that differ by potential productivity and responsiveness to phosphorus fertilization. The soil was chernoziom carbonated with low level of available phosphates, basic pH (7,7), which was mixed with sand in a 3:1 ratio (by volume). Seed inoculation with bacterial preparation was carried out on the basis of *rhizobium japonicum*. Phosphorus as monocalcium phosphate dose of 100 mg kg^{-1} was administered to the soil (P100), being regarded as sufficiently supplied with phosphorus and control treatment (without chemical and biofertilizers, P0) - deficient in phosphorus. The bacterial suspension of *azotobacter chroococcum* and *pseudomonas fluorescens* strains (equivalent to 10^8 cells ml^{-1}) was applied to the soil before sowing. Soil moisture regime was achieved by watering to 70% of the water holding capacity of the soil (WHC) in the control as optimal value and 35% WHC treatment option, being considered as water stress for soybean. The pots were distributed in a complete randomized block design with 3 replications and three plants per pot. Temporary drought regime began in the full-flowering stage and lasted 12 days. The plants were harvested at the end of water stress and separated into roots, leaves, stems, nodules and pods and dried at 60ºC for 3 days. Dry weight of each fraction was measured. The concentration of P was measured in samples of ground tissues following wet digestion, using the phosphovanado-molybdate method of Murthy and Riley (1962). The phosphorus contents in plant parts were calculated by multiplying dry weight of each organ with P concentration.
Data in figures represent the average value of the results of chemical analysis of plants in

three replications. The experimental results were analyzed statistically, determining significant differences at the level of P = 0.05. In figures are presented means of 3 replicates with standard error.

RESULTS AND DISCUSSIONS

Plant growth usually benefits from application of rhizobacteria in nutrient-deficient soils. It is well known that PGPR can improve the nutrient status of their host plants (Rodrigues and Fraga, 1999).

One of the main objectives of our research was to explore the beneficial effects of potential bacterial inoculants (nitrogen fixer and phosphate solubilizer) that can enhance mineral nutrition of plants. In our study, phosphorus fertilization and PGPR application generally increased plant growth and P uptake of both soybean cultivars in soil with initial P deficiency. The data in Figures 1-4 show that the accumulation of phosphorus in plant parts varied among cultivars and were significantly altered by rhizobactria (Rh) application and soil water regime.

In P deficiency treatment the total plant uptake of P was generally higher for Horboveanca compared with Zodiac under optimal moisture level (70% WHC). However, there was no significant difference between cultivars when plants were subjected to limited water conditions (35% WHC). Consequently, the water suboptimal regime reduced substantially P accumulation in Horboveanca than in Zodiac. Phosphorus accumulation in leaves of the P deficiency and bacteria application treatments did not differ significantly while the P sufficiency (P100) treatment increased evidently the uptake of nutrient in Zodiac (Figure 1 and 2). The analysis of experimental results revealed that the administration of biofertilizers improved nutrient contents in the stems of Zodiac. Drought is considered one of the major environmental abiotic factors with a considerable adverse influence on the plant performance, in particular on the nutrient status of crops. In our study it was revealed that low water supply significantly reduced P contents in both cultivars irrespective of treatments. There is evidence that improving P nutrition of plants could attenuate the negative impact of droughts on plant growth and development. As we expected, the phosphorus sufficient treatment (P100) had positive impact on P uptake in all parts of soybean plants. The P concentrations of roots in the control treatment and with biofertilizers administration were similar in Zodiac cultivar under drought but rhizobacteria increased this trait by 14.5% in normal soil moisture level.

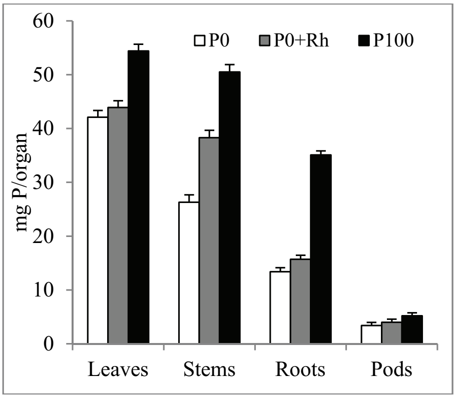

Figure 1. Effects of P deficiency and rhizobacteria (Rh) application on P content of cultivar Zodiac grown in normal water conditions (70% WHC)

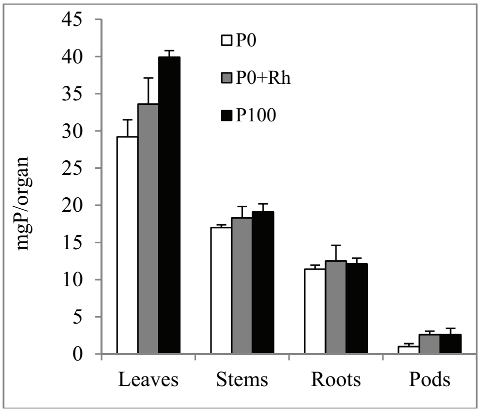

Figure 2. Effects of P deficiency and rhizobacteria (Rh) application on P content of cultivar Zodiac grown in suboptimal water conditions (35% WHC)

This was linked with more biomass accumulation by roots in no water stress conditions (data are not presented). Compared to the P-deficiency plants the P content of pods in the treatments with biofertilizers and chemical P fertilizer was approximately twice as high at low water supply (Figure 2). Wani and collaborators (2007) revealed a beneficial impact of PSB and N_2-fixing bacteria on chickpea plants with a significant increase in productivity and uptake of phosphorus and nitrogen.

Likewise, Li and coworkers (2013) demonstrated an increase of N_2 fixation in inoculated alfalfa with phosphate solubilizing rhizobium and nitrogen fixing bacteria when both nitrogen and phosphorus are limited. It may be concluded that the application of rhizobacteria increases significantly P uptake in the stems of Zodiac in normal water conditions but their influence was not registered in roots in water deficit treatment. Probably, these results could be explained by the decreased transport of nutrients from roots to above ground plant parts at low water supply. Our results are consistent with experimental data obtained in cowpea (Franzini et al., 2010; Neuman and George, 2009).

In normal water soil conditions the differences between treatments with P deficiency and the application of PGPR were not so pronounced in terms of P contents in leaves. In contrast, under dry soil conditions P deficiency and biofertilizers administration treatments were significantly different in biomass production (data not presented) and total plant P content. Thus, soil dryness limited P availability in the P deficiency-plants, compared with the biofertilizers treatment. The similar effects were registered in maize (Krey et al., 2011) and rice (Panhwar et al., 2011). Interesting data were obtained in Horboveanca cultivar which is considered more responsive to supplemental P nutrition than Zodiac. The results registered by this cultivar indicate that the suspension application of *pseudomonas florescence* and *azotobacter chroococum* contributed significantly to increase plant P uptake and plant biomass production (Figure 3 and 4).

At the optimal soil moisture level, as shown in Figure 3, there were significantly higher P contents in stems, roots and pods of treatments with P and biofertilizers application compared with those of the control plants. However, there was poor difference in terms of P accumulation in leaves between P deficiency and microorganism treatments. Experimental results demonstrated that the administration of bacterial suspension induced a significant increase of P uptake in stems and roots of 7.5% and 32.1% in comparison to control plants (without rhizobia supply), when plants were not subjected to low water regime. The highest increase in phosphorus accumulation was observed in the pods of plants grown with *pseudomonas florescence and azotobacter chroococcum* biofertilization under well watered conditions. However, the application of these strains had no significant effects on the accumulation of nutrient in the pods under water limited conditions (Figure 4).

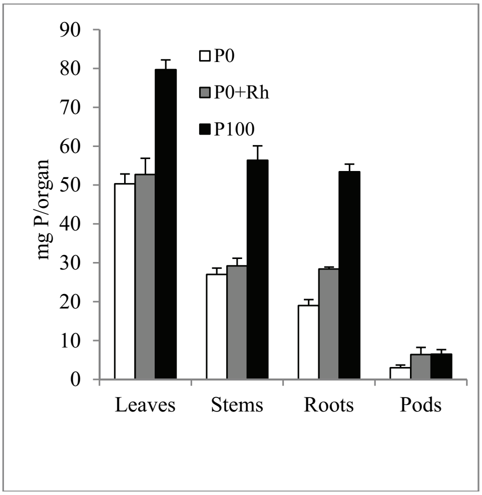

Figure 3. Effects of P deficiency and rhizobacteria (Rh) application on P content of cultivar Horboveanca grown in normal water conditions (70% WHC)

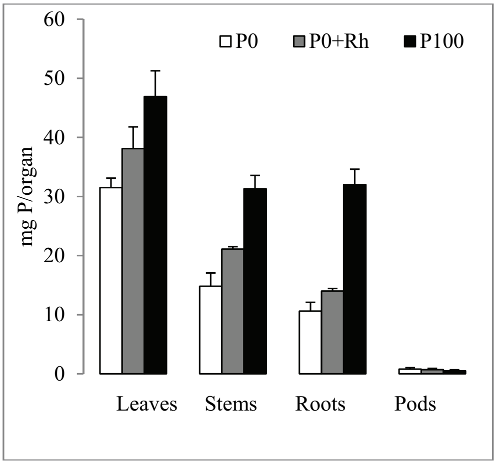

Figure 4. Effects of P deficiency and rhizobacteria (Rh) application on P content of cultivar Horboveanca grown in suboptimal water conditions (35% WHC)

In contrast, at the suboptimal soil moisture regime, significant differences between treatments were recorded, regarding phosphorus contents in leaves, stems and roots. Thus, the biofertilizers and mineral phosphorus applications contributed to an increase in total nutrient uptake of 19.4% and 47.9% in plants for Horboveanca under suboptimal water conditions, respectively. As related in literature the rhizobacteria application improved P availability in soil from hard compounds of organic form. In addition, they in association with plant roots could stimulate protons and low weight organic acids release that in turn improve the nutrient condition of plants (Rodrigues and Fraga, 1999). Thus, the lowest phosphorus accumulation in plant parts was obtained in control plants of both cultivars, particularly in water limiting environment.

The highest phosphorus accumulation in the present work was obtained in the plants fertilized with P for Zodiac and Horboveanca.

Hence, considering the influence of the PGPR application on this parameter, the effect was lower than those of the industrial fertilizer. There is a body of reports on plant growth promotion by bacteria (Kery et al., 2011) that have the ability to enhance P availability for plants. The use of PGPR can improve phosphorus uptake by the plant which in turn would result in more energy available for nitrogen fixation by rhizobium.

In addition, inoculation with PGPR improves plant growth parameters and nutrient uptake, but this effect was more pronounced in Horboveanca than in Zodiac, expressing that the colonization of rhizobacteria also significantly reduced the negative effect of P deficiency (Figures 1-4). The uptake of other essential micronutrients from the soil due to biofertilizers could play a role in general plant growth improvement as well as in more indirect effects upon the N_2-fixing system. The obtained results indicated that bacteria application increased the phosphorus content in roots and pods, compared with their controls which were not supplied with rhizobacteria. These findings are in agreement with that of Xiurong et al. (2011) and Li et al. (2013). Increased mineral nutrient status in roots would contribute to enhance the acquisition of scarce resources from dry soil in our case of water and mineral nutrients. Also, they could lead to increase photosynthesis, making a greater proportion of photosynthates available to plant - rhizobium symbiosis (Mortimer et al., 2008).

In summary, our results have evaluated the effects of rhizobacteria application and P fertilizer on low soil fertility on the soybean phosphorus uptake under suboptimal soil moisture regime. These investigations show a potential strategy of microorganisms used for agricultural development in marginal lands that are often deficient in P.

Likewise, these findings point to a higher dependency of Horboveanca, cultivar responsive to supplemental P nutrition, compared with Zodiac on the bacterial application for growth and nutrient uptake under conditions of drought and/or low nutrient availability. In this study we used non-sterile soil due to the fact that in many researches, plant growth promotion with PGPRs was observed usually under controlled conditions where these bacteria do not have to compete with a range of indigenous soil microbes. At present, unfortunately, the use of microorganisms in the biotechnology of legume production is very modest. Although the effects of rhizobacteria symbiosis are more difficult to reveal in the field there is a need to examine their functional properties in further studies.

CONCLUSIONS

Phosphorus deficiency decreased the phosphorus contents in soybean organs in particular under water-limited conditions.

In P-deficient soils, application of *P. fluorescens* and *A. chroococcum* strains can affect the P supply of soybean plants. However, the magnitude of this influence is affected by soil water regime.

The application of rhizobacteria biofertilizers led to a significant increase in total phosphorus uptake by Zodiac and Horboveanca soybean cultivars. Cultivar Horboveanca displayed a higher response to PGPR application than Zodiac. Subsequent field experiments should be consider the agronomic effects of microorganisms in combination with different doses of phosphorus fertilizer and organic manure on crop production.

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PRELIMINARY RESULTS ON CREATING NEW SUNFLOWER (*Helianthus annuus* L.) WITH RESISTANCE TO DROUGHT BASED ON INTERSPECIFIC HYBRIDATION WITH WILD SILVERLEAF SUNFLOWER (*Helianthus argophyllus* TORR. & A. GRAY)

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Abstract

In the period 2008-2013 at NARDI Fundulea research have been carried out in order to introduce drought-resistant gene/genes from wild to Helianthus annuus L. cultivated species. Interspecific hybridisation, backcross (six generations) and self-pollination (two generations), and a rigorous selection (after each generation, under the water stress conditions and minimum inputs) for productivity, MMB and oil content were performed. Drought resistance and yield quality improvement under organic farm conditions is a difficult goal due to polygenic determinism of these characters. Progress has been obtained for genetic characters studied (production, oil content and MMB) for all inbreeded lines presented. One of these lines presented improved values for all characters as compared with maternal lines. Four from seven inbreeded lines were improved achenes production and the other 3 improved lines have better capacity of oil production in drought conditions and in the organic farms technology. The results from 2013 confirmed the improvement trends reported from the previous selection years.

Key words: *backcross, Helianthus annuus L., Helianthus argophyllus Torr. & A. Gray, interspecific hybridization.*

INTRODUCTION

First interspecific hybridization was performed in 1916 in Russia by Satziperov. These and other later investigations showed that as a result of crossing of different Helianthus species with cultivated sunflower. New forms resistant to different diseases and the broomrape parasite could be obtained by Pustovoit (1960), Putt and Sackson (1957), Cristov, (1996).
Sunflower forms with higher seed oil content and drought tolerant were obtained by interspecific hybridization with *H. argophyllus* Torrey. & Grey (Iouraş and Voinescu, 1984; Saucă, 2010).
The wild species *Helianthus argophyllus* possess considerable variability for resistance to drought, diseases and parasitic plant which can be utilized for the improvement of cultivated sunflower (Jan et al., 2008).
This report presents the results of interspecific hybridization between cultivated sunflower (*Helianthus annuus* L) and wild species (*Helianthus argophyllus*) and their potential for developing lines with economically important characters suitable as parental lines for developing new sunflower hybrids.

MATERIALS AND METHODS

The results presented in this paper were obtained during the period 2012-2013 only, at the NARDI Fundulea - Călăraşi (a typical location for Bărăgan plain area) and Stupina-Constanţa (a very dry location). The weather conditions for these locations are presented in Figure 2. The investigation included 8 interspecific hybrids of sunflower (2n=34) in the 6 backcross generation. Methods of interspecific hybridization and selection, self-pollination, backcrossing with pollen from *Helianthus argophyllus* species and pollination with pollen cultivated sunflower were used (Figure 1).

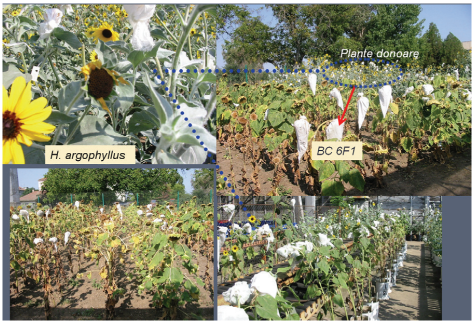

Figure1. Some aspects from breeding field of NARDI - Fundulea

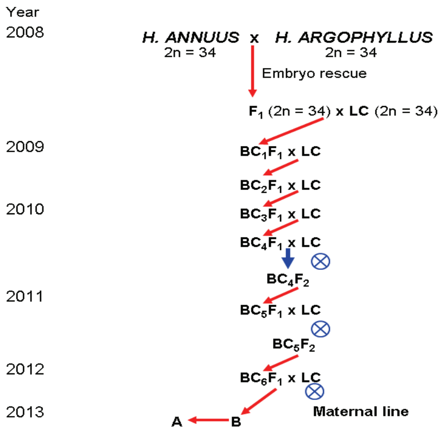

Figure 2. The breeding procedure

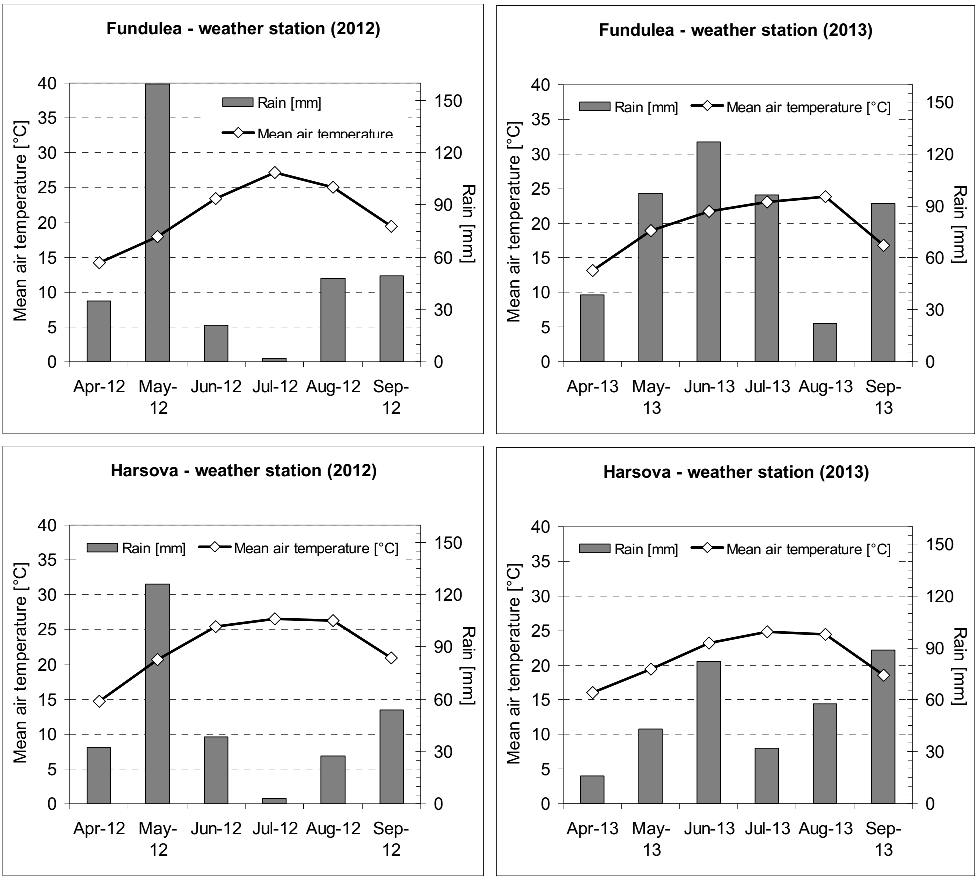

Figure 3. Weather conditions during sunflower vegetation at Fundulea and Stupina (Hârşova weather station) in 2012 and 2013

RESULTS AND DISCUSSIONS

As a result of interspecific hybridization between cultivated sunflower (*Helianthus annuus* L.) and wild species *Helianthus argophyllus*, hybrid plants from the different combinations produced a great diversity regarding the inflorescence dry weight, thousand kernels weight and oil content, both from the point of view of the line used as

mother and the location were has carried out the experiment (Table 1).
The values for the studied characteristics Inflorescence dry weight, one thousand kernel weight and oil content were much lower for the drier location (Stupina), but in the most cases the values for the improved lines were higher than values of the maternal lines. The ratios (in %) between improved lines and maternal lines are shown in Table 2. In the drier conditions of Stupina, in the year 2013, the improved lines exceeded the maternal lines with up to 147% for inflorescence dry weight, with about 67% for TKW and one improved line presented an oil content with 3.8% higher than initial line, meanwhile other two lines were at the levels of maternal lines. One improved line (Bio.3) had a lower performance in Stupina conditions, but it had better results than maternal line under Fundulea conditions.

Table 1. Main target parameters

Code	Inflorescence dry weight (netto) [g]		Thousand kernels weight [g]		Oil content [%]	
	Fundulea	Stupina	Fundulea	Stupina	Fundulea	Stupina
Bio.1	**61.4**	**19.1**	**59.6**	**41.2**	**42.9**	**39.2**
M.2	58.6	7.7	52.0	35.8	42.8	37.8
Bio.3	**100.3**	**44.1**	**89.4**	**75.1**	**43.3**	**39.5**
M.5	71.1	44.8	82.6	84.2	42.7	39.6
Bio.5	**82.8**	**45.4**	**49.1**	**40.8**	**43.3**	**39.8**
M.6	53.8		49.7		42.7	
Bio.7	**98.0**	**43.0**	**59.0**	**55.9**	**43.8**	**39.7**
M.7	50.4	38.4	50.2	48.2	44.3	40.0
Bio.9	**53.8**	**32.7**	**59.2**	**45.2**	**44.5**	**39.8**
M.10	51.0	19.1	59.1	33.4	42.7	39.7
Bio.11	**75.2**	**37.4**	**66.0**	**51.8**	**43.0**	**39.8**
M.12	72.0	27.0	71.1	46.3	43.6	39.8
Bio.13	**102.6**	**33.5**	**80.5**	**58.7**	**42.8**	**40.3**
M.12	52.7	14.4	68.3	35.2	43.2	40.5
Bio.17	**79.9**	**32.7**	**78.1**	**52.0**	**43.0**	**39.7**
M.11	72.0	27.0	71.1	46.3	43.6	39.8

Table 2. Percentage from value of initial line grown in the same conditions (%)

Code	Inflorescence dry weight (netto)		Thousand kernels weight		Oil content	
	Fundulea	Stupina	Fundulea	Stupina	Fundulea	Stupina
Bio.1	**104.8**	**247.2**	**114.5**	**115.2**	**100.2**	**103.8**
Bio.3	**141.1**	98.5	**108.2**	89.3	**101.5**	99.7
Bio.5	**153.8**		98.9		**101.3**	
Bio.7	**194.5**	**111.8**	**117.4**	**115.9**	99.0	99.3
Bio.9	**105.5**	**170.9**	**100.2**	**135.5**	**104.4**	**100.1**
Bio.11	**104.5**	**138.6**	92.9	**112.0**	98.6	**100.1**
Bio.13	**194.6**	**232.0**	**117.8**	**166.9**	99.0	99.5
Bio.17	**111.0**	**121.2**	**109.8**	**112.3**	98.5	99.8

CONCLUSIONS

The results of this investigation showed that successful interspecific hybridization between cultivated sunflower (*Helianthus annuus* L) and wild species *Helianthus argophyllus* and the transfer of new genetic material into cultivated sunflower was possible.
Improved lines with valuable characters were obtained.
Lines developed from these crosses can be used in developing high quality sunflower hybrids, increases the genetic diversity for drought resistance.

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BIOCHEMICAL CHANGES DURING ACCELERATED AGEING CONDITIONS OF MUNG BEAN SEEDS AND THEIR FIELD PERFORMANCE

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Abstract

Mung bean seeds has been exposed to accelerated ageing(A.A) conditions(45± 100% R.H.) for 2, 4, 8 and 14 days. Evaluation of biochemical changes were obtained by comparing accelerated aged seeds to un-aged seeds (control).The results were revealed many biochemical changes that have been occurred during accelerated ageing of seeds and leaves of field plants, such as: 1. A significant increase in malondialdehyde (MDA), as a result of membrane damage due to lipid peroxidation. 2. A significant increase in proline content of seeds exposed to A.A conditions compared to un-aged seeds. 3. A significant decrease in protein, catalase enzyme (CAT), glutathione (GSH) and ascorbate (AsA) in seed were exposed to A.A conditions. 4. No significant change of glutathione, ascorbate, proline, protein and chlorophyll content in leaves of filed plants of their seeds that already expposed to A.A conditions.

Key words: *aging, mungbean, catalase, glutathione, proline, ascorbate.*

INTRODUCTION

Seed deterioration is a serious problem in developing countries where seeds are stored in places usually without a proper control of humidity and temperature. Temperature and seed moisture content (and/or relative humidity) are the main factors influencing seed deterioration and viability loss during storage (James, 1967). Changes occurring in seed during accelerated ageing are very significant with regard to quality and longevity of seed. Seed longevity is one of the components of seed quality (Milošević and Malešević, 2004; Baiyeri and Mbah, 2006). The speed at which ageing processes takes place depends on the seed's ability to resist degradation changes as well as its protection mechanisms (Balešević-Tubić, 2001). Many hypotheses have been proposed regarding causes of seed ageing such as lipid peroxidation mediated by free radicals, inactivation of enzymes or decrease in proteins, disintegration of cell membranes and genetic damage (McDonald, 1999; Murthy et al., 2003; Priestley, 1986).

Biochemical and physiological deterioration during seed ageing has been studied mostly under accelerated aging conditions using high temperature and high seed water content (McDonald, 1999; Hsu et al., 2003). Accelerated aging is one of the vigor tests widely used to determine the quality of seed lots (Thant et al., 2010). Under such storage conditions, seeds typically lose their viability within a few days or weeks. Although these studies allowed important progress towards the understanding of seed ageing mechanisms. The aim of the present research was to investigate the possible effects of accelerated ageing upon biochemical changes of mungbean seeds and its reflections on field plants performance.

MATERIALS AND METHODS

Determination of proteins

Seeds were extracted in 0.1M phosphate buffer (pH 5.6) and estimated by Bishop's method (Bishop et al, 1985). Bovine serum albumine (BSA) was used as standard protein.

Determination of catalase activity

CAT was estimated by Aebi's method (Aebi, 1983). Seeds were extracted in 20 mM phosphate buffer (pH 7) then H_2O_2 added to the sample. Absorbance reading at 210 nm. Catalase activity determine by:

$$Catalase\ activity\ (unit) = \frac{reaction\ volume \times \Delta bs/min}{0.001}$$

Determination of ascorbic acid

Ascorbic acid was estimated in 2,4 dinitrophenyl hydrazine **(Shalata and Neumann, 2001)** One gram of seeds sample were ground with 10 ml of TCA solution and 2 ml of Metaphosphoric acid (m-HPO_3) was added and mixed well then 0.4 ml was added from DTCS reagent to the supernatant and incubated at 37°C for 3 hours. The tubes were cooled in ice for 10 minutes. Then 2 ml of cool H_2SO_4 (12 M) was added slowly to all tubes.Absorbance was read at 520 nm.

Estimation of Malondialdehyde (MDA)Content

MDA content was estimated by the method of Zacheo et al. (2000). One gram of seed sample was homogenized with 20 ml of Trichloroacetic acid. A volume of 1ml of 2-thiobarbituric acid (TBA) was added. Malondialdehyde was calculated according to the Beer-Lambert equation:

$$A = E*B*C$$

Estimation of Glutathione Content (GSH)

Glutathione was estimated by a modified method using Ellman's reagent (Ellman, 1959). A volume of 0.5 ml of seeds sample was ground with 5 ml of TCA 50%. A volume of 0.2 ml of TCA, 0.2 of a distal led water and 0.8 ml of Tris base buffer was added to test tube then 0.02 ml of DTNB reagent was added. The absorbance was read at 412 nm.

RESULTS

1- MDA content

The results of Figure 1 demonstrated that a significant increase of lipid peroxidation product (MDA) under accelerated aging treatment for (4, 8 and 14 day) compared to control. MDA content increased from 0.41µg\g (in control) to 0.53, 0.64 and 0.69 at 4, 8 and 14 day of aging respectively, although its increase at day 2 is not significant.

Accelerated ageing had significantly decreased the protein content in mungbean seeds, for 4,8,14 days compared to control (Figure 2-A), Whereas protein content was unchanged significantly in leaves of field plants (Figure 2-B) that already exposed their seeds to A.A conditions.

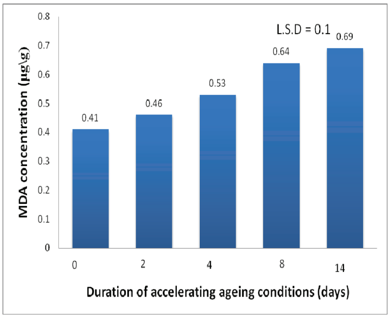
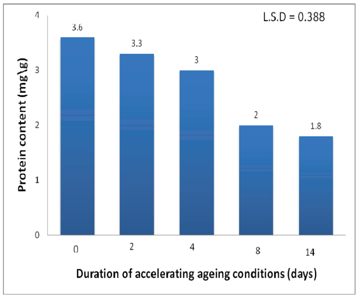


Figure 1. Effect of accelerated ageing conditions on MDA content (µg\g) of mung bean seeds.

2- protein content



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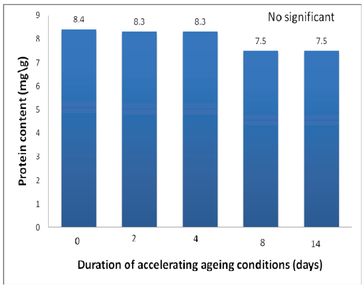
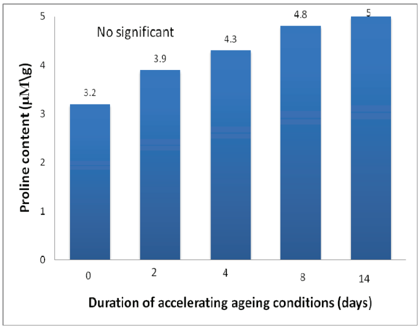


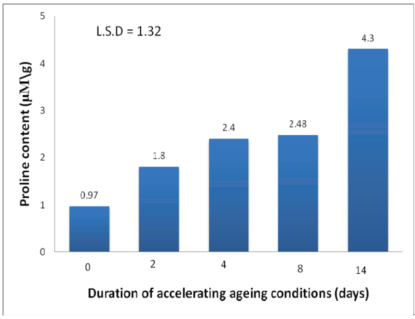
B

Figure 2. Effect of accelerated aging conditions on protein content (mg/g) of mung bean seed (2-A) and leaves (2-B), 3-proline content

Accelerating ageing conditions also exhibited significant effect on proline content compard to control.

Proline content increase with increasing accelerating ageing peroid as shows in figure 3-A. Whereas proline content was unchanged significantly in leaves of field plants (Figure 3-B), that already exposed their seeds to A.A conditions.





A

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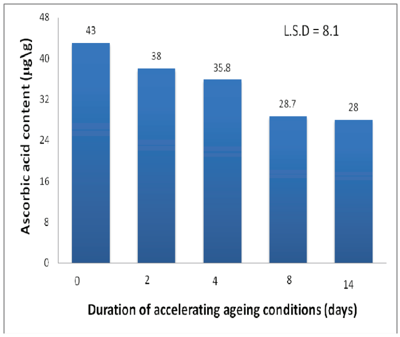
Figure 3. Effect of accelerated aging conditions on proline content (µM/g) of mung bean seed (3-A) and leaves (3-B)



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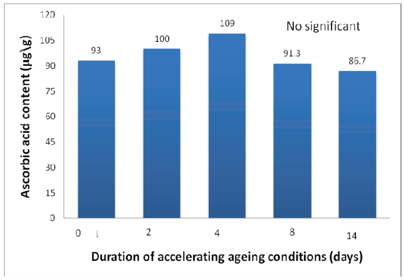


B

Figure 4. Effect of accelerated ageing conditions on ascorbic acid content (µg/g) of mung bean seed (4-A) and leaves (4-B)

2- Ascorbic acid

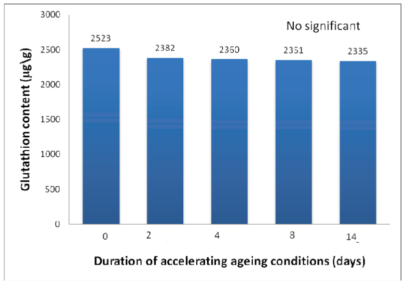
Figure (4-A) shows that accelerated ageing had significant decline in ascorbic acid of seeds after 8 and 14 days (28.7 and 28 µg/g) compared to control (43 µg/g). Whereas, ascorbate content was unchanged significantly in leaves of filed plants (Figure 4-B), that already exposed their seeds to A.A conditions.

3- Glutathione (GSH)

Accelerated ageing also decreased glutathione content of mungbean seeds. The significant reduction of GSH was started after 8 and 14 days of ageing treatment period (1543 and 1506 µg/g) repectively Figure 5.A. Whereas, GSH content was unchanged significantly in leaves of field plants (Figure 5.B) that already exposed their seeds to A.A conditions.

4- Catalase activity (CAT)

The reduction of CAT activity increased progressively with increasing ageing peroid. So, the least activity were recorded after 14 day (12.25 units) compared to control (73.7 units).



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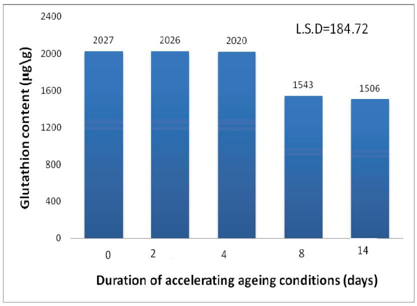

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Figure 5. Effect of accelerated ageing conditions on glutahtione conten (GSH) of mung bean seeds (5-A) and leaves (5-B)

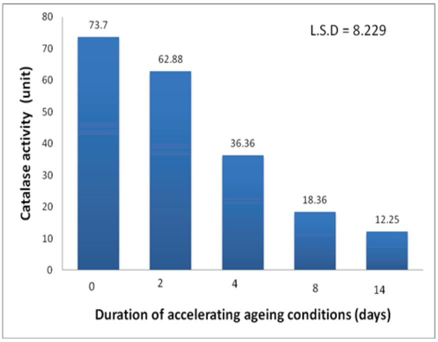

Figure 6. Effect of accelerated ageing conditions on catalase activity (unit) of mung bean seeds

5- Chlorophyll content

Figure 7 shows that accelerated ageing conditions of mung bean seeds has no significant changes on chlorophyll content of 5th true trifaliated leaves of field plants (after 56 day of sowing).

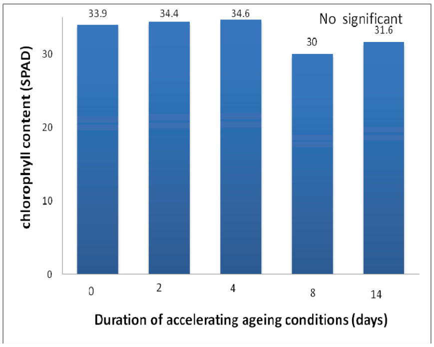

Figure 7. Effect of accelerated ageing conditions on chlorophyll content (spad)of mung bean leaves

DISCUSSIONS

The production of oxy-radicals or ROS by plant cells was induced by different factors such as: ageing, metabolic by-products, air-pollutants, herbisids, biotoxins and radiation (Scandalios, 1997). The latter was mentioned that, these radicals were causes damage for lipid and fatty acid, proteins, amino acids, pigments and nucleic acids. The above changes were reflects membrane damages and lossing of organelles functions in terms of permeability perturbation. Moreover, reducing the efficiency of cellular metabolism by reducing of carbon-fixation, as well as chromatid Mutations that collectively leads to the death of cell (Scandalios, 1997).

Four main points has been raised from the results of the current study.

First, accelerated ageing considered as oxidative stress (Scandalios, 1997; Blokhima et al., 2003) which induce the production of ROS that cause lipid peroxidation in terms of malon-dialdehyde (MDA) as a final product.

The results of the current study that deals with Mungbean seeds were confirmed this point (Figure 1) after 4 – days of A.A. conditions.

The decline in phospholipid content (or increase in MDA) content (Figure 1), is in agreement with increasing MDA content in many speices such as Soybean (Tubic et al; 2011), sunflower (Bailly et al.; 1998) and in sweet pepper (Kaewnaree et al., 2011).

The possible reason of this increment might be due to enhance lipid peroxidation products and subsequently resulted in membrane damage (Periestley et al., 1980). In addition, the increased seed leachates particularly in mung bean (Farah and Shaheed, 2012) confirms the above results, that associated with the loss of membrane phospholipid in deteriorated seeds (Copeland and McDonald, 1995), or due to increase of lipoxygenes activity during A.A conditions (Bhattacharjee et al., 2006; Shaheed et al., 2009). Similarly, a decrease in protein content was observed during A.A. conditions in pigenpea (Kelpana and Madhava Roa, 1997) and in rice (Kapoor et al., 2011).

The decrease was due to protein denaturation (Kaplana and Madhava Roa, 1995) and lack of ATP (Gidrol et al., 1998) or due to increase of protease activity (Bhattacharjee et al., 2006; Shaheed et al., 2009).

Second, the decline in enzymatic anti-oxydant defense system (e.g. Catalase activity, Figure 6) during the day-2- as well as non-enzymatic anti-oxydant defense system (e.g. Ascorbate, Figure 4) and Glutathione (Figure 5) during the day -4- and the day 8 respectively, denotes:

a) Precosious sensitivity of catalase during day -2- against high level of ROS as H_2O_2, which acts as substrate for the above enzyme (Fridovich, 1986). The loss of sunflower seed viability during accelerated ageing conditions was associated with a decrease in the activities of catalase enzyme (Hussein et al., 2012). However the decrease in CAT activity appered to be associated with an increase in the level of MDA (Figure 1). Similar results were reported in sunflower seeds (Balesevic et al., 2005) and maize seeds (Wattanakal Pakin et al., 2012). In addition, A.A. may either denaturates the enzymes to different degrees or affects their synthesis (Bailly et al., 1998).

b) The need for Ascorbate as non-enzematic anti-oxidant during the day -4- of A.A. conditions, that coincided with increased level of MDA (Figure 1) and reflects the damage of phospholipid by lipid peroidation, as well as the decline in protein (Figure 2).

c) The delayed need (requirement) for GSH until the day -8- of A.A conditions (Figure 5). It was confirming the progression of events after exposing seeds to A.A conditions that enhances the anti-oxidant defense mechanisms to acts according to its priority for each event. Accelerated ageing conditions for 14 day caused a sever diminishing of AsA&GsH contnt (92.5% and 97.5% respectively) in maize seeds (Hussein et al., 2012).

d) The latter found a positive correlation (r = 0.9966) between AsA & GSH in maize as well as (r = 0.9899) in sunflower seeds. Similar results were reported in sunflower seeds (De Paula et al; 1996) and in senescent leaves of pea (Jimenez et al; 1998). This reduction was probably due to the decrease in Glutathione reductane (GR) activity (Hussein et al., 2012) that took place under the A.A. conditions (De Puala etal, 1996; Jimenez et al., 1998) or due to the increase in ascorbic acid oxidase (Hussein et al., 2012).

Third, Proline level was raised at day -4- (Figure 3), that coincided with the diminishing of phospholipid (Figure 1) and protein (Figure 2) (Ain-Lhout et al., 2001).

Although, proline has many physiological roles in plants but, it was assumed that proline ats as electron acceptor to avoid the damage of photosynthesis (in terms of unchange chlorophyll content Figure 7) that inhibited by ROS (Hare et al., 1999). Alternatively, proline maintaining high level of GSH as well as the enzyme that deals with GSH metabolism (Hussein et al., 2012).

Fourth, the unchanged level of protein (Figure 2-b), Ascorbate (Figure 4-b), proline (Figure 3-b) and chlorophyll (Figure 7) in leaves (5 th true trifolated leaf) of field plants of mung bean suggested the strength (Seed Vigor) of some seeds within a seed lots having a high performance after 56- days, irrespective of A.A. conditions.

The standard germination test may fail to provide accurate information concerning a seed lots field performance potential for at least few reasons. Mostly, a test was designed to provide for a first and final count. The first count deals with strong seeds that already germinated, the final count is designed to provide a sufficiently long period that every opportunity to be considered terminable, particularly when provided environmental stresses associated with field emergence (AOSA, 2000).

CONCLUSIONS

It could be concluded that accelerated ageing caused a significant increase in MDA and proline, while it caused a decreases in protein CAT, GSH and AsA.

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NEW AMPHIDIPLOID WHEAT SPECIES (NOTHOSP. NOV.) AS A RESULT OF ARTIFICIAL HYBRIDISATION

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Abstract

The continuous growth of the demand of cereals and diversification of agricultural production is reason to seek new and high-yielding plant species. Remote hybridization and artificial polyploidisation are methods creating new species which combine the valuable properties of their parental forms and in some cases outmatch them. A large number of hybrids and amphidiploid forms in the genus Triticum are created and characterized with resistance to diseases, high yield potential and high adaptability under different growing conditions. Some of them are genetically stable in subsequent generations without sharp variation to the specific characteristics. Similar plant accessions exhibiting significant differences from their parental components as well as from other plant species in the same genus, furthermore in combination with their high genetic stability, should be separated as a new species within the genus Triticum. In studies on the morphology and physiology of three amphidiploid accessions (Triticum polonicum × Triticum boeoticum, Triticum durum × Triticum boeoticum, Triticum turanicum × Triticum timopheevii), for a period of three years (2011-2013) their stability, lack of sharp variations, high adaptability to growing conditions, high yield performance, resistance to diseases and tolerance to pests are established. As a result of their complex evaluation, the accessions are differentiated and described as a new species in the genus Triticum as follows: Triticum ×savovii H.P. Stoyanov nothosp. nov. (Triticum polonicum × Triticum boeoticum); Triticum ×spetsovii H.P. Stoyanov nothosp. nov. (Triticum durum × Triticum boeoticum); Triticum ×toschevii H.P. Stoyanov nothosp. nov. (Triticum turanicum × Triticum timopheevii). The described new species could be successfully introduced as grain cereals and used as initial material in winter wheat breeding programs.

Key words: *new species, polyploidisation, Triticum sp., wide hybrids.*

INTRODUCTION

Modern agricultural production is based on high yields of crops as well as the ever increasing demand for quality agricultural production. This requires more high-yield varieties of certain plant species to be created which could meet food needs of the population and the need for livestock feed. Diversification of production enables plant resources to be used in accordance with good agricultural and plant protection practices, but also to provide diversity as regards food production. Introduction of new crops into the grain production is done by introduction of plant species from other geographical regions, but also by artificially creating of cultural hybrid and amphidiploid species (Ayala and Kiger, 1987).

Amphidiploids are plant organisms created by the methods of wide hybridization and combining the genomes (or specified parts of them) of the parental species involved in the cross (Stoyanov, 2013a). Such organisms combine valuable breeding characteristics such as resistance to biotic and abiotic stress, which also determines the high yield potential. Despite these properties amphidiploids are characterized by a number of negative others caused by interspecies incompatibility of organisms participating into the cross (Stoyanov 2013b, Spetsov et al., 2008). The biotechnological methods accepted in modern breeding programs enable to overcome such difficulties, but the creation of cultural amphidiploids is associated with large-scale study of the applicability of the new plant organism as a potential food product.

A large number amphidiploids are created into the tribus *Triticae*. These plant organisms possess a number of valuable qualities and combine high variability because of the high degree of polymorphism and possibilities for recombination due to the integration of diverse genomes, which depends on the species participating into the initial crosses (Stoyanov et al., 2012; Kolev, 1984). The largest number of created amphidiploids are synthetic hexaploid wheats (2n=6x=42, AABBDD), because of the identity of their genomic constitution with that of bread wheat *Triticum aestivum* (2n=6x=42, AABBDD), allows for the introduction of various genes from wild species *Aegilops tauschii* (2n=2x=14, DD) (Spetsov et al., 2008; Spetsov et al., 2009; Stoyanov et al., 2010). Synthetic forms also could combine the genomes of various forms tetraploid wheats (*Triticum durum*, *Triticum polonicum*, *Triticum dicoccon*, etc.) and diploid wild species (*Aegilops* sp., *Hordeum* sp., *Secale* sp., *Dasypyrum* sp., *Triticum* sp.), allowing the transfer of valuable breeding characteristics, and also leads to the creation of high-yield plant forms. These are amphidiploid grain cereals triticale (×*Triticosecale*) and tritordeum (×*Tritordeum*) (Stoyanov, 2013a; Knuepffer, 2009; Martin et al., 2000; Kolev, 1978).

Amphidiploid species in the genus *Triticum*, which combine the genomes of various wheat forms, are distinguished by simple crossability of parental forms and a variety of properties inherited from wild species – high protein content, resistance to pathogens and insect pests, tolerance to drought. These include species such as *Triticum ×petropavlovskyi*, *Triticum ×timococcum*, *Triticum ×fungicicum* (Mico et al., 2013; Goncharov et al., 2007; Masum-Akond and Watanabe, 2005; Badaeva et al., 1990; Scharen and Eyal, 1980; Krupinsky et al., 1972). Research and collection of detailed information about the hybrid plants in the genus *Triticum* is essential for the development, description and release of new cultural amphidiploids. New wheat species that are genetically stable in their morphology, physiology are key factor to the diversification of grain cereals (Matsuoka et al., 2011).

The purpose of this research is to be studied and described high-yield amphidiploid wheat forms that could be differentiated as separate species in botanical terms, and to delineate as different crop or to take part in the breeding programs of wheat species.

MATERIALS AND METHODS

3 samples of amphidiploid wheat forms (*Triticum polonicum* × *Triticum boeoticum*, *Triticum durum* × *Triticum boeoticum*, *Triticum turanicum* × *Triticum timopheevii*) are used, which are derived from Dobrudja Agricultural Institute – General Toshevo. 15 seeds of each amphidiploid accession are sown in a scheme with a spacing 30 cm between rows and 5 cm inside rows. The sowing was carried out respectively on 06.11.2011 and on 08.11.2012, under field conditions in the area of Stozher, Dobrich region. Harvesting is done in phase full maturity in the period 12-20.07.2013. Field germination (FG) is recorded. 10 fully matured spikes, free of infestation by pests were randomly selected of each accession. In 2010, 2011 and 2012 under laboratory conditions, between 15 and 20 October amphidiploid seeds are placed for germination. After they germinated, laboratory germination (LG) is reported. In 2010 and 2011 plants were transferred into pots and acclimatized in an unheated plastic greenhouse where they are cultivated to maturity. Spikes are harvested at full maturity. In order to determine the morphological and genetic stability of the studied accessions, indices fertility (F) and weight of 1000 grains (M1000) were reported and averaged for three years period. It is also reported the variation into characteristics LG, FG, F and M1000.

The standard varieties are sown into the same scheme: for susceptibility to powdery mildew (*Erysiphe graminis*) - Sadovska ranozreyka; brown rust (*Puccinia recondita*) - Michigan Amber; septoria leaf blight (*Septoria tritici*) - Enola. A comparative analysis of susceptibility to phytopathogenic infection of amphidiploid accessions compared to those varieties of wheat is done.

The determination of the phytopathogens attack aiming determining of the physiological stability is carried out under field and greenhouse conditions with naturally presented pathogens races: for powdery mildew (EG) using the methodology of Stoilova and Spetsov (2006); for brown rust (PR) using methodology of Ivanova (2012) and Roelfs et al. (1992); for septoria leaf blight (ST) using methodology of Eyal et al. (1987). Reporting is done in a 10-point scale and resistant (0-2), medium resistant (3-6) and susceptible (7-9) accessions are established. It is reported the attack of cereal leaf beetle and adult insects found on plants before oviposition are counted. The number is averaged per plant.

To summarize the data and for the analysis of variance software Microsoft Excel 2007 is used.

For each year anatomical features of plants are described in order to trace some differences and similarities of consecutive generations.

Based on the analysis aiming establishing a morphological, physiological and genetic stability of the studied amphidiploids and their anatomical features, the accessions are separated as new hybrid botanical species and described in English and Latin in accordance with the International Code for Nomenclature for Algae, Fungi and Plants (2012) (ICNAFP) (Melbourne Code). When compiling crosses, the formulas were based on the classification of the genus *Triticum* by Goncharov et al. (2009). Latin description is based on Stearn (2004).

RESULTS AND DISCUSSIONS

The data of the morphological and physiological characteristics of the studied accessions (Tables 1-3) demonstrate the presence of certain genetic stability. Low variation in indices F and M1000 proved the lack of hybrid dissociation in consecutive generations. The values of the coefficient of variation within 1-3% are indicative of the modification and the recombinant variation that occurs in plant organisms, but also emphasizes the high level of homozygosity into the studied amphidiploids. Similar are the values reported for LG. The slight variation in this indicator and its high values suggest the lack of physiological disturbances due to the hybrid nature of the plants. However, in the FG significant variation of the indicator is observed, which is indicative of the changing conditions of the environment where the experiment was carried out. Such data reported Stoaynov (2012) in a similar conducted experiment on physiological characteristics of the studied amphidiploids.

As regards resistance to diseases, all studied amphidiploid accessions exhibit no symptoms of powdery mildew, brown rust and septoria leaf blight. In 2011, because of the intensity of precipitation and the presence of high infective background, on studied standard varieties, pathogenic expression is too high, while there are no symptoms on the amphidiploid accessions.

In 2012 the possibility of occurrence of phytopathogenic attack is very limited in the largest part of the vegetation of plants, due to relatively low temperatures and lack of moisture, which does not allowing initial inoculation. Therefore, before flowering, at all observed accessions, including standards for the susceptibility of the pathogens no signs of the disease are occurred. After flowering in May-June period 2012, due to the intense rainfall and high temperatures, on stadart wheat varieties was observed only slight attack by powdery mildew, brown rust and septoria leaf blight. Too high temperatures, however, inhibit the development of pathogens which caused the lack of significance in some accessions. In the majority of the accessions during the tillering phase and after flowering, they show full resistance to pathogens of powdery mildew, brown rust and septoria leaf blight.

The lack of an infectious process in 2013 emphasizes sustainability of the three amphidiploid accessions to pathogens of powdery mildew, brown rust and septoria leaf blight.

Studies on the reaction of amphidiploids to phytopathogens, indicate that they largely show resistance to powdery mildew and brown rust. Bred in DAI-GT, amfidiploids, in the period 1950-1990, possess a high degree of resistance to the listed pathogens (Spetsov and Savov, 1992). Similar results are reported by Sharma and Gill in studies of other amfidiploids in genus *Triticum*.

In relation to insect pests, during the vegetation, under field conditions in 2012 and 2013, adults and larvae of *Lema melanopa* and *Lema lichensis* (cereal leaf beetle) are found, with numbers below the economic threshold for bread wheat (Lecheva et al., 2003). In amphidiploid *Triticum turanicum* x *Triticum timopheevii* no damage of these insect pests was observed. The lack of attack could be attributed to a horizontal or vertical resistance (Shulembaeva, 2012; Gallun et al., 1966). On the remaining two accessions, attack of both adults and limited by larval forms of the two insects is reported.

Based on the reported genetic stability in relation to morphological and physiological charachteristics of accessions and also on the lack of sharp variation in the anatomy of plants of the three studied amphidiploids, for three years period, they are separated into independent amphidiploid species as follows: *Triticum ×savovii* HP Stoyanov nothosp. nov. (*Triticum polonicum* × *Triticum boeoticum*); *Triticum ×spetsovii* HP Stoyanov nothosp. nov. (*Triticum durum* × *Triticum boeoticum*); *Triticum ×toschevii* HP Stoyanov nothosp. nov. (*Triticum turanicum* × *Triticum timopheevii*). Spikes and seeds from the accessions are shown on Figures 1-6. The compilation of the names is based on the requirements and recommendations of ICNAFP. Descriptions of new species are formulated:

Figure 1. Spikes of *Triticum ×savovii*

Table 1. Characteristics of *Triticum ×savovii*

Species	***Triticum ×savovii***				
Year	**2011**	**2012**	**2013**	**AV**	**VC**
F	89.00	92.00	95.00	92.00	3.26%
LG	94.00	93.00	95.00	94.00	1.06%
FG	-	85.00	100.00	92.50	11.47%
M1000	53.12	54.68	56.02	54.61	2.66%
EG	0	0	0	0	-
PR	0	0	0	0	-
ST	0	0	0	0	-
LM	0	5	10	5	-

F – fertility; LG – laboratory germination; FG – field germination; M1000 – weight of 1000 grains; EG – powdery mildew; PR – leaf rust; ST – septoria leaf blotch; LM – cereal leaf beetle.

Vernacular description of *Triticum ×savovii* H.P. Stoyanov nothosp. nov. (*Triticum polonicum* × *Triticum boeoticum*).

Annual, tufted grass up to 100 cm tall, with 2-5(-10) tillers; stem (culm) cylindrical, smooth, hollow except at nodes. Leaves distichously alternate, simple and entire; leaf sheath rounded, auricled; ligule membranous; blade linear, 20-40 cm × 1-2 cm, parallel-veined, flat, glabrous. Inflorescence a terminal, distichous spike 7-12 cm long, with sessile spikelets borne solitary on zigzag rachis. Spikelet 15-20 mm long, laterally compressed, 3-6-flowered with bisexual florets, but 2-3 uppermost ones usually rudimentary, sometimes only 2 of the florets bisexual; glumes almost equal, oblong, exceeding spikelet apex, thinly leathery, acuminate, veined; lemma rounded on back but keeled towards the tip, leathery, with an awn 10-20 cm long; palea 2-keeled, not hairy on the keels; lodicules 2, ciliate; stamens 3; ovary superior, tipped by a small fleshy hairy appendage and with 2 plumose stigmas. Fruit an ellipsoid caryopsis (grain) at one side with a central groove, reddish brown to yellow brown.

Figure 2. Seeds of *Triticum ×savovii*

Latin description of *Triticum ×savovii* H.P. Stoyanov nothosp. nov. (*Triticum polonicum* × *Triticum boeoticum*).

Gramen annuum, caespitosum, usque 100 cm altum. Culmi (2-5(-10)) cylindrici, leaves, praeter nodis cavi. Folia distiche alterna, simplicia et integra; folii vagina rotunda, auriculata; ligula membranacea; lamina linearis, 20-40 cm × 1-2 cm, parallelinervia, plana, glabrata. Inflorescenia spica, terminalis, disticha 7-12 cm longa, sessilispiculae; Spicula solitare portata, rachidi valde flexuosae insidens, 15-20 mm longa, laterale compressa, 3-6-flora bisexualibus flosculis; Flosculi 2-3 summi plerumque rudimentalis; flosculi due interdum bisexuales; glumae paene aequialae, oblongae, apicem spiculae superantem, tenuiter coriaceae, acuminatae, nerviae; lemma postice rotundata sed apice carinata, coriacea, arista 10-20 cm longa; Palea 2-carinata, glabricarinata; Lodiculae duae, ciliatae; Stamina 3; Ovarium superum, ad apicem carnose ciliate apendiculatum, bistigmatibus plumosis. Fructus caryopsis ellipsoidea, a ventre sulco laterali, spadicea vel testacea.

Figure 3. Spikes of *Triticum ×spetsovii*

Table 2. Characteristics of *Triticum ×spetsovii*

Species	***Triticum ×spetsovii***				
Year	**2011**	**2012**	**2013**	**AV**	**VC**
F	84.00	91.00	94.00	89.67	5.72%
LG	99.00	93.00	95.00	95.67	3.19%
FG	-	65.00	40.00	52.50	33.67%
M1000	58.36	56.18	59.46	58.00	2.88%
EG	0	0	0	0	-
PR	0	0	0	0	-
ST	0	0	0	0	-
LM	0	6	8	4.67	-

F – fertility; LG – laboratory germination; FG – field germination; M1000 – weight of 1000 grains; EG – powdery mildew; PR – leaf rust; ST – septoria leaf blotch; LM – cereal leaf beetle.

Vernacular description of *Triticum ×spetsovii* H.P. Stoyanov nothosp. nov. (*Triticum durum* × *Triticum boeoticum*).

Annual often tufted grass up to 90-100 cm tall with 2-5(-8) tillers; stem (culm) cylindrical, smooth, hollow except at nodes. Leaves distichously alternate simple and entire; leaf sheath rounded, auricled: ligule membranous; blade linear, 25-35 cm x 1-2 cm parallel-veined, flat, glabrous. Inflorescence a terminal, dense distichous spike 6-8 cm long, with sessile spikelets borne solitary on zigzag, brittle rachis. Spikelet 10-15 mm long, laterally compressed, 3-5-flowered, with bisexual florets, but the 1-2 uppermost ones usually rudimentary; glumes almost equal, oblong, shorter than to almost as long as spikelet, thinly leathery, veined; lemma rounded on back but keeled towards the tip, leathery, with an awn 15-20 cm long; palea 2-keeled, not hairy on the keels; lodicules 2 ciliate; stamens 3; ovary superior tipped by a small fleshy hairy appendage and with 2 plumose stigmas. Fruit an ellipsoid caryopsis (grain) at one side with a central groove, gray to brown.

Figure 4. Seeds of *Triticum ×spetsovii*

Latin description of *Triticum ×spetsovii* H.P. Stoyanov nothosp. nov. (*Triticum durum* × *Triticum boeoticum*).

Gramen annuum, caespitosum, usque 90-100 cm altum. Culmi (2-5(-8)) cylindrici, leaves, praeter nodis cavi. Folia distiche alterna, simplicia et integra; folii vagina rotunda, auriculata; ligula membranacea; lamina linearis, 25-35 cm × 1-2 cm, parallelinervia, plana, glabrata. Inflorescenia spica, terminalis, disticha 7-12 cm longa, sessilispiculae; Spicula solitare portata, rachidi fragili valde flexuosae insidens, 10-15 mm longa, laterale compressa, 3-5-flora bisexualibus flosculis; Flosculi 1-2 summi plerumque rudimentalis; glumae paene aequialae, oblongae, apice spiculae breviores vel paene aequilongi, tenuiter coriaceae, nerviae; lemma postice rotundata sed apice carinata, coriacea, arista 15-20 cm longa; Palea 2-carinata, glabricarinata; Lodiculae duae, ciliatae; Stamina 3; Ovarium superum, ad apicem carnose ciliate apendiculatum, bistigmatibus plumosis. Fructus caryopsis ellipsoidea, a ventre sulco laterali, fulvia vel cinerea.

Figure 5. Spikes of *Triticum ×toschevii*

Table 3. Characteristics of *Triticum ×toschevii*

Species	*Triticum ×toschevii*				
Year	**2011**	**2012**	**2013**	**AV**	**VC**
F	-	59.00	65.00	62.00	6.84%
LG	-	96.00	95.00	95.50	0.74%
FG	-	100.00	67.00	83.50	27.95%
M1000	-	48.25	50.30	49.28	2.94%
EG	0	0	0	0	-
PR	0	0	0	0	-
ST	0	0	0	0	-
LM	0	0	0	0	-

F – fertility; LG – laboratory germination; FG – field germination; M1000 – weight of 1000 grains; EG – powdery mildew; PR – leaf rust; ST – septoria leaf blotch; LM – cereal leaf beetle.

Vernacular description of *Triticum ×toschevii* H.P. Stoyanov nothosp. nov. (*Triticum turanicum* × *Triticum timopheevii*).

Annual, tufted grass up to 150-160 cm tall, with 3-5(-12) tillers; stem (culm) cylindrical, smooth, hollow except at nodes. Leaves distichously alternate, simple and entire; leaf sheath rounded, auricled; ligule membranous; blade linear, 15-40 cm × 1-1.5 cm, parallel-veined, flat, glabrous or slightly pubescent. Inflorescence a terminal, distichous spike 7-12 cm long, with sessile spikelets borne solitary on zigzag rachis. Spikelet 10-15 mm long, laterally compressed, 3-6-flowered with bisexual florets, but 1-2 uppermost ones usually rudimentary; glumes almost equal, oblong, shorter than to almost as long as spikelet, thinly leathery; lemma rounded on back but keeled towards the tip, leathery, with an awn 10-15 cm long; palea 2-keeled, not hairy on the keels; lodicules 2, ciliate; stamens 3; ovary superior, tipped by a small fleshy hairy appendage and with 2 plumose stigmas. Fruit an ellipsoid caryopsis (grain) at one side with a central groove, moderate shriveled, reddish brown to yellow brown.

Figure 6. Seeds of *Triticum ×toschevii*

Latin description of *Triticum ×toschevii* H.P. Stoyanov nothosp. nov. (*Triticum turanicum* × *Triticum timopheevii*).

Gramen annuum, caespitosum, usque 150-160 cm altum. Culmi (3-5(-12)) cylindrici, leaves, praeter nodis cavi. Folia admodum alterna, simplicia et integra; folii vagina rotunda, auriculata; ligula membranacea; lamina linearis, 15-40 cm × 1-1.5 cm, parallelinervia, plana, puberule nervia. Inflorescenia spica, terminalis, disticha 7-12cm longa, sessilispiculae; Spicula solitare portata, rachidi valde flexuosae insidens, 15-15 mm longa, laterale compressa, 3-5-flora bisexualibus flosculis; Flosculi 1-2 summi plerumque rudimentalis; glumae paene aequialae, oblongae, apice spiculae breviores vel paene aequilongi, tenuiter coriaceae, acuminatae, nerviae; lemma postice rotundata sed apice carinata, coriacea, arista 10-15 cm longa; Palea 2-carinata, glabricarinata; Lodiculae duae, ciliatae; Stamina 3; Ovarium superum, ad apicem carnose ciliate apendiculatum, bistigmatibus plumosis. Fructus caryopsis ellipsoidea, a ventre sulco laterali, spadicea vel testacea.

Thus, described and characterized by a number of valuable properties including resistance to economically important diseases, the new species in the genus *Triticum*, could be introduced as a crop or could participate as a starting material in the breeding programs of wheat species.

CONCLUSIONS

Considering those results, the following conclusions could be drawn:

1. Studied amphidiploids features slight variations in the reported morphological and physiological indicators, which highlights their genetic stability and high level of homozygosity.
2. All studied accessions exhibit resistance to pathogens of powdery mildew, brown rust and septoria leaf blight under field and greenhouse conditions, during the three-year period of observation.
3. Based on its valuable properties and stable anatomy, studied amphidiploid wheat accessions are separated and described as a new species in the genus *Triticum* as *Triticum ×savovii*, *Triticum ×spetsovii* and *Triticum ×toschevii*.

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PRELIMINARY AGRONOMIC EVALUATION OF *Chenopodium quinoa* Willd. UNDER CLIMATIC CONDITIONS OF ROMANIA

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Abstract

During the 2013 growing season.the trial was carried out in the experimental field of University of Agronomic Sciences and Veterinary Medicine of Bucharest to explore the potential for quinoa growing in climatic conditions of South Eastern Romania. Four quinoa varieties provided by the University of Copenhagen were evaluated for seed yield and some morphological traits. Under irrigated conditions, with nitrogen fertilization, seed yield ranged from 1.70 to 2.96 t/ha Jason Red showing the lowest yield (1.70 t/ha).Highest seed yield was exhibited by Jacobsen 2 (2.96 t/ha), followed by Mixed Jacobsen (2.53 t/ha) and Jørgen 37 (1.84 t/ha). Out of four quinoa varieties, only two showed above average seed yield (2.25 t/ha). These two varieties Jacobsen 2 and Mixed Jacobsen also exhibited above average performance for all morphological traits: plant height, maturity, dry weight and harvest index. All morphological traits showed significant positive association with seed yield. The agronomic performances recorded by these varieties suggest that can be extended commercial cultivation of quinoa in the Romania.

Key words: *Chenopodium quinoa, seed yield, harvest index, maturity, correlation.*

INTRODUCTION

Quinoa (*Chenopodium quinoa* Willd.) is native to Andean mountains of Peru, Bolivia, Ecuador and Colombia where it was domesticated some 3.000 to 5.000 years ago. Quinoa is in fact not technically a cereal grain at all, but is instead what it calls a "pseudo-cereal" – the name for foods that are cooked and eaten like grains and have a similar nutrient profile. Quinoa is a highly nutritious food with protein quality and quantity in the seed that is superior to those of more common cereal grains, for example it contains more lysine than the wheat and the amino acid content of quinoa seed is considered well-balanced for human and animal nutrition, as good as to that of the casein. Unlike other grains and cereals, quinoa provides a complete protein, containing all the essential amino acids, making it an ideal food for all diets. Botanically, quinoa is related to beets and spinach. It is an annual dicotyledonous plant, grows to 0.5-3.0 m (1.0-1.5 m in average) and is predominantly self-pollinated. Cytological evidence has shown that quinoa is an allotetraploid species with chromosome number 2n = 4x = 36. Quinoa seeds, and to some extent its leaves, are traditionally used for human and livestock consumption in the Andean region and have exceptional nutritional qualities (Repo-Carrasco et al., 2003; Stikic et al., 2012). In recent times, quinoa has become an interesting species for research, production and consumption in United States, Europe, Asia and Africa. Its cultivation has spread to more than 70 countries. Quinoa was introduced to England in the 1970s, after which studies were started on the crop in Denmark. In 1993, a project was approved in the European Union, titled “Quinoa—A multipurpose crop for EC’s agricultural diversification,” with field trials in England, Denmark, the Netherlands, and Italy, in addition to laboratories in Scotland and France (Jacobsen, 2003). Additional countries have recently shown interest in the crop, including Sweden, Poland, Czech Republic, Austria, and Greece, who are all participating in the American and European Test of Quinoa, and Finland (Iliadis et al., 1997, 2001; Keskitalo, 1997; Ohlsson, 1997). In Romania, quinoa is almost unknown, being one crop yet unexploited by the researchers and growers, despite its advantages. It is sold in our country, especially in organic or natural foods stores. Quinoa has been selected by the Food and Agricultural Organization of the United Nations (FAO) as a good candidate to offer food security in the next century, especially in the face of the predicted future world scenario of increasing salinization and aridity (Karina et al., 2013). This is why the FAO declared 2013 to be the International Year of Quinoa. Quinoa has an amazing ability to adapt to adverse conditions of climate and soil where other crops cannot grow, especially at high altitudes (over 4000 m). This species is adaptable to different photoperiods, indeed there are even short-day and day-neutral cultivars (Bertero et al., 1999; Bertero, 2001; Casini, 2002). For European conditions the most suitable genotypes are those originating in Chile (0-500 m above sea), with short growth season, unramified habitus, long and compact inflorescence and big white or yellow seeds with low content of saponins. Quinoa exhibits high level of resistance to several predominant adverse factors, like frost, soil salinity, drought, diseases and pests (Jacobsen et al., 2003). It can tolerate soil pH from 4.8 to 9.5 because of mycorrhizal associations, thus maximizing the use of scarce nutrients (Tapia, 1979; Mujica, 1994). Quinoa can be sown from the end of April when soil temperature reaches 7-10°C. Earlier sowing can slow germination and cause bad competitive ability against weed. Number of plants in range from 100 to 500 plants per square meter is the most appropriate and does not affect significantly the yield. The most suitable soils for quinoa cultivation are sandy to sandy-loam. Heavy clay soils are not desirable. It can be successfully grown in poor soils also. Experimental results show that yields can be increased by preparing the soil well, applying 80-40-00, fractionated nitrogen during sowing and earthing up. The aim of this study was to evaluate four quinoa varieties for potential seed yield under climatic conditions from South Eastern of Romania; therefore to provide information about crop management and to determine whether some of varieties are worth-keeping for further experimentation and cultivation.

MATERIALS AND METHODS

Experimental site and set up

The trial was carried out in the experimental field of University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania, during the 2013 growing season. Bucharest is situated in the south eastern corner of the Romanian Plain (44°26' N latitude, 26°06' E longitude and 90 m altitude above sea level). The soil of trial site is chromic luvisol with medium alkaline pH and clay-loam texture. The experimental design was a randomized block, in three replications (10 m^2/plot). Plots size was 6 rows of 4 m, with an inter-row spacing of 0.5m and 3 cm sowing depth. Sowing date was 9 May 2013. During the season, plants were treated against weeds. Nitrogen (NH_4NO_3) was supplied at sowing (40 kg/ha) and again during vegetative growth before flowering (40 kg/ha). Harvest by hand on 23 September – 2 October 2013 was done at physiological maturity, which was defined as the date when seeds from the main panicle become resistant when pressed (Bertero et al., 2004).

Materials

Four quinoa varieties provided by the University of Copenhagen were evaluated for seed yield and morphological traits (Table 1).

Table 1. Quinoa varieties tested, their origin and phenotypic seed color

Varieties	Origin	Phenotypic seed color
Jason Red	France	Purple
Jacobsen 2	Denmark	Yellow
Mixed Jacobsen	Denmark	Mixed (red, white, yellow)
Jørgen 37	Denmark	Yellow

Parameters estimated

a) Plant height was measured at physiological maturity, in the field. For this purpose ten plants from each replication were randomly chosen for evaluation.

b) Maturity was taken (in days) from date of emergence to the date when the crop was ready for harvesting.

c) Dry weight (g/plant): dry above-ground biomass per plant.

d) Harvest index: percentage ratio between seed yield per plant and dry weight per plant.

e) Seed yield: the seed yield of all the plants of each plot were bulked and weighed and the seed yield/plot was converted to tonnes per hectare (t/ha).

Statistical analysis

The data collected was subjected to statistical processing following analysis of variance (ANOVA). The least significant difference (L.S.D.) for each character was calculated at 0.05 level of probability. Correlation analysis was performed to evaluate the relationships between seed yield and morphological traits.

RESULTS AND DISCUSSIONS

Weather conditions

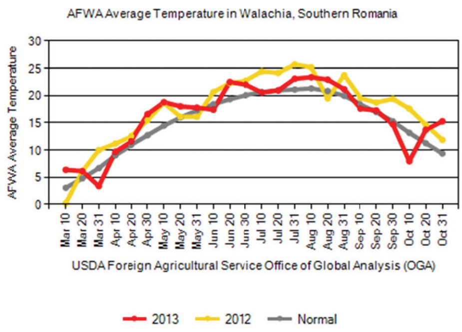
Bucharest has a transitional climate, with both continental and subtropical influences (Köppen climate classification *Cfa/Dfa/Cfb/Dfb*). Winter temperatures often dip below 0°C, sometimes even to -20°C. In summer, the average temperature is 23°C (the average for July and August). Temperatures frequently reach 35 to 40°C in mid-summer. Average precipitation and humidity during summer are low. During spring and autumn, daytime temperatures vary between 17 to 22°C, and precipitation during this time tends to be higher than in summer with more frequent yet milder periods of rain.

The weather conditions for the period over wich the study was conducted are summarized in Figure 1. The quantity and distribution of rainfall were highly variable throughout the growth period. Temperature was not limiting for quinoa growth; the values recorded over the active growth period (from initiation of flowering to pod filling between June – July) were relatively favorable in the 2013 growing season. Two additional irrigations were made, one in May after sowing for emergence and second before flowering.

Morphological parameters and seed yield

In Table 2 are shown phenological observations that are important for determining the days to maturity.

The mean values for morphological and seed yield traits are presented in Table 3. Performance of quinoa varied greatly between varieties in Romanian conditions. Seed yield ranged from 1.70 to 2.96 t/ha with Jason Red showing the lowest yield (1.70 t/ha).



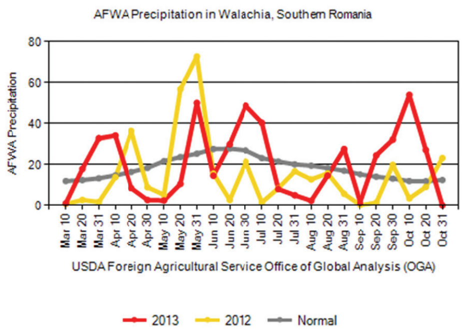


Figure 1. Average temperature and precipitation in Southern Romania, 2012-2013

Table 2. Quinoa varieties tested and phenological data; 2013 growing season

Varieties	Sowing date	Emergence date	Harvest date
Jason Red	09.05	17.05	23.09
Jacobsen 2	09.05	16.05	02.10
Mixed Jacobsen	09.05	17.05	01.10
Jørgen 37	09.05	16.05	27.09

The highest seed yield was exhibited by Jacobsen 2 (2.96 t/ha), followed by Mixed Jacobsen (2.53 t/ha) and Jørgen 37 (1.84 t/ha). Out of four quinoa varieties, only two showed above mean seed yield (2.25 t/ha). These two varieties Jacobsen 2 and Mixed Jacobsen also exhibited above average performance for all morphological traits: plant height, maturity, dry weight and harvest index.

Maturity ranged from 130 to 140 days. Late maturity genotypes, like Jacobsen 2 and Mixed Jacobsen grew taller than the ones that matured early as Jason Red and Jørgen 37, being superior in other yield components.

Results show that harvest index ranged from 44.52% to 57.03% with an average of 50.02±3.40, Jacobsen 2 exhibiting the highest value (57.03%).

Correlation study

The correlation coefficients are presented in Table 4. Seed yield was significant positive associated with plant height, length of the vegetation period, dry weight and harvest index. The maximum value was recorded for maturity (0.863). It is known that selection for lateness has resulted in more productive genotypes, similarly to yield obtained in high latitude (Jacobsen et al., 1996). The minimum value was exhibited for harvest index (0.492). Early maturity genotype as Jason Red, recorded a higher harvest index (50.33%) than Mixed Jacobsen late maturity genotype (48.20%) (Table 3). Harvest index low values for late and high values for early maturity genotypes supported similar findings by Spehar et al. (2005). Similar results have been reported by Bhargava et al. (2007), concerning significant positive association among quinoa seed yield and plant height, dry weight and harvest index.

Table 3. Morphological and yield parameters of 4 quinoa varieties

Varieties	Maturity (days)	Plant height (cm)	Dry weight (g/plant)	Harvest index (%)	Seed yield (t/ha)
Jason Red	130.00	122.50	24.08	50.33	1.70
Jacobsen 2	140.00	166.18	30.07	57.03	2.96
Mixed Jacobsen	138.00	152.33	24.67	48.20	2.53
Jørgen 37	135.00	148.45	20.19	44.52	1.84
Mean±S.E*.	135.75±2.51	147.36±1.03	24.75±1.89	50.02±3.40	2.25±0.24
$LSD_{0.05}$**	5.06	2.09	3.77	6.82	0.54

**S.E. – standard error; * LSD – least significant difference; $P \leq 0.05\%$;

Table 4. Correlation coefficients among five traits in quinoa varieties: seed yield, maturity, plant height, dry weight and harvest index

Traits	Maturity	Plant height	Dry weight	Harvest index
Seed yield	0.863**	0.745**	0.688**	0.492**
Maturity	x	0.960**	0.313*	0.167
Plant height		x	0.251*	0.144
Dry weight			x	0.569**

Level of significance: *P = 0.05, **P = 0.01

CONCLUSIONS

Seed yield and harvest index of the cultivar Jacobsen 2 and Mixed Jacobsen were much higher than the other quinoa varieties and its have a great potential for cultivation in Romanian conditions.

A growing period greater than 140 days (from May date of sowing to October date of harvest) would be too long under Romanian conditions. However, by choosing the best sowing time (April), different stages of plant growth can better develop that lead to increase of yield and to shorten the vegetative period.

Quinoa could be an alternative crop with favourable features for cropping systems in the climatic conditions of Romania.

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BIOLOGICAL PECULIARITIES AND FORAGE VALUE OF THE SPECIES OF THE GENUS ASTRAGALUS L. IN THE REPUBLIC OF MOLDOVA

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Abstract

One of the major problems of the revitalization and the development of animal husbandry sector is increasing and diversification of the production of fodder, balanced in terms of quantity and quality throughout the year, according to the physiological requirements of animals. The leguminous plants play an important role in increasing the quality of fodder because they have a significant content of protein, vitamins and calcium raising the nutritional value of the fodder and livestock products. We have studied the biological peculiarities, productivity and nutritional value of fodder leguminous plant species of the collection of nontraditional fodder plants of the Botanical Garden (Institute) of the ASM: Astragalus galegiformis L., Astragalus cicer L., Astragalus ponticus Pall, Astragalus sulcatus L. The traditional forage crop alfalfa (Medicago sativa L.) served as control variant. It has been established that Astragalus galegiformis L. grows and develops more intensively than the other species studied, ensures a higher productivity with an increased fodder quality. The fodder of Astragalus galegiformis plants has a high content of essential amino acids, especially methionine and lysine.Due to the productivity and high and stable quality of fodder, use of the plantation for a long period of time, high capacity of fixing atmospheric nitrogen, ensuring of a good harvest for the bees, the species Astragalus galegiformis can serve as initial material for enriching the range of forage crops.

Key words: *biological peculiarities, fodder leguminous plants, genus Astragalus, nutritional value, productivity.*

INTRODUCTION

One of the major problems of the revitalization and development of the animal husbandry sector is increasing and diversification of the production of fodder, balanced in terms of quantity and quality throughout the year, according to the physiological requirements of animals. In the world flora, have been identified more than 50 000 species of plants that animals use as food, but, in culture, are used about 150 species. This enormous reserve allows the mobilization of new species, which would extend the range of agricultural crops, increase the productivity and improve the quality of fodder.

It is known that the plants of the family *Fabaceae* Lindl. are characterized by a high content of protein and essential amino acids, but, of the approximately 19 000 species, very few are used as crop plants.

In the context of climate changes and rising oil prices, the plants of the family *Fabaceae* Lindl., are of a particular interest, because, due to the assimilation and storage of nitrogen in the soil (up to 100 kg N/ha per year) they may contribute to the reduction of the greenhouse gas emissions. This property of the species of the *Fabaceae* family contributes: to the reduction of the use of nitrogen fertilizers, which contain nitrogen protoxide with a heating potential which is 310 times higher than that of carbon dioxide; to a the better conservation of the nutrients by the reduction of the leakage into groundwater of nitrates and phosphates; to the reduction of the soil acidification and to the improvement of its structure (including the increase of the energy efficiency in soil treatment); to the improvement of the resistance to diseases and pests of crop plants in agrocoenoses; to the reduction of the use of herbicides and increase of biodiversity favourable for pollination. The fodder leguminous grasses play an important role in increasing the quality of feed, due to a significant contribution in protein, vitamins and minerals, which raise the nutritional value of the feed and the livestock production (Lüscher et al., 2013). The genus *Astragalus* L. comprises approx. 2,500 species and is the largest genus of angiosperms (Lock and Schrire, 2005). The most species of the genus

Astragalus are perennial and are spread in all the bio-geographical regions and are met more often in the cold, arid and continental zones of the Northern hemisphere and of South America. A lot of them are used as fodder, phyto-ameliorative, melliferous, medicinal or ornamental plants. On the territory of Eurasia, vegetate 849 species of the genus *Astragalus* L., 152 species of which are of interest as fodder plants (Laryn et al., 1951). Cicer milkvetch (*Astragalus cicer* L.), is widely used in Europe (Aniszewski, 2004, Belous et al., 2003) and in America (Davis, 1982; Townsend, 1993; Acharya et al., 2006;), because of their increased capacity to adapt to the soil and environmental conditions, the high ratio "leaf – stem", maintenance for a longer time of the leaves on the stem than alfalfa, clover or sainfoin, which equals to a greater digestibility *in vitro* of the dry matter (Loeppky et al., 1996).

In the spontaneous flora of the Republic of Moldova, there are 16 species (Negru, 2007), from these species, *Astragalus cicer* L. and *Astragalus ponticus* Pall possess a certain forage value. The plants are consumed by all the species of animals directly by grazing and as hay. The green mass of these species, used fresh, do not cause bloat at ruminant animals. The hay has a high content of leaves.

As promising forage species, were identified *Astragalus galegiformis* L. (native to the mountains Kaukaz) and *Astragalus sulcatus* L. (native to Eurasia and found on salty soils), which are studied in several scientific centres in USA, Russia, Ukraine, etc. (Davis, 1982; Ostapko and Shynkarenko, 2003; Belous, 2005; Chybys et al. 2011; Mandaeva, 2011. Voronyn et al. 2013)

It is well known that the productivity of the grasslands from the Republic of Moldova is very low, constituting 300 - 500 kg/ha of hay, and the share of fodder leguminous plants is decreasing. In order to redress the situation regarding the increase of the productivity and the quality of forage, it is necessary to extend the range of fodder leguminous species and to carry out reseeding works. One of the causes of the reduced use of the representatives of the genus *Astragalus* L. as feed for animals is the insufficient knowledge of the biological characteristics of these species, the biochemical composition of these plants and their forage value. These aspects have determined the choice of the object of study.

MATERIALS AND METHODS

The species of the genus *Astragalus* L.: *Astragalus cicer* L.*, Astragalus galegiformis* L.*, Astragalus ponticus* Pall., *Astragalus sulcatus* L., which were cultivated in the collection of non-traditional forage plants of the Botanical Garden (Institute) of the ASM, served as object of study. Alfalfa served as control variant. Foundation of experiments was performed with previously scarified seeds on chernozem usual in spring when the soil had reached the physical maturity. The seeds were planted at a depth of 1.5-2.0 cm, with soil compaction before and after sowing. The evidence area of the plot constituted 10 m^2. The number of repetitions - 4. The scientific researches on growth and development, productivity and nutritional value of the plants were carried out according to the methodical indications (Novosiolov et al., 1983; Ivanov, 1985; Ermakov et al., 1987).

RESULTS AND DISCUSSIONS

As a result of the performed researches, it has been established that, in order to germinate abundantly, the seeds of the studied species of genus *Astragalus* L. need to be scarified. In the first year of vegetation, these species, in comparison with alfalfa, have a slow growth and development, reaching only the step of forming of the stem with leaves. *Astragalus cicer* L. reaches the flowering stage, and reaches a height of 55.0 cm.

In the following years, the species of genus *Astragalus* L. beginning their vegetation 2-5 days later than alfalfa. It has been found that *Astragalus galegiformis* L. has the most delayed beginning of the vegetation, but this species has a more rapid growth and development. After 20 days from the beginning of vegetation, the plant reaches 61.4 cm high versus 27.2 to 39.6 cm at the other species (Table 1). This rhythm is maintained until the flowering, when the plants reach a height of 191.4 cm and from 64.3 to 103.8 cm respectively at the other species genus

Astragalus L. (Figure 1). The flowering stage of *Astragalus galegiformis*_L. begins 12 days earlier in comparison with alfalfa. A slower

Figure 1. General aspect of the *Astragalus galegiformis* L. in the Botanical Garden collection, 2013

development have the plants of *Astragalus cicer* L., which bloom 17 days later than alfalfa and 29 days later than the plants of *Astragalus galegiformis* L. The period of seed formation and ripening at the studied species of *Astragalus ponticus* Pall. and *Astragalus galegiformis* L. have a relatively short period of seed formation and ripening (with 22-28 days earlier than alfalfa). Analyzing the seed productivity, we can mention that the studied species of genus *Astragalus* L. have a higher seed yield in comparison with alfalfa. The plants of *Astragalus galegiformis* L. forms 60.4 g/m^2 or 7000 seeds/m^2, while the plants of *Astragalus sulcatus* L. formed 52.1 g/m^2 and the highest number of seeds - about 40 000 seeds/m^2.

The species of genus *Astragalus* L. have a different rate of accumulation of the aerial phytomass during the vegetation and content of dry matter. So, the plants of *Astragalus galegiformis* L. have the highest yield of natural fodder (6.42 kg/m^2) and the plants of *Astragalus ponticus* Pall. – the lowest (1.48 kg/m^2).

A higher dry matter content in the natural fodder is observed at the species *Astragalus sulcatus* L. and *Astragalus galegiformis* L.

Table 1. Biological peculiarities and fresh mass production of the species of the genus *Astragalus* L.

Indicators	***Medicago sativa* L. (control)**	***Astragalus cicer* L.**	***Astragalus galegiformis* L.**	***Astragalus ponticus* Pall.**	***Astragalus sulcatus* L.**
The period, days from the beginning of vegetation up to:					
- budding	70	79	61	66	73
- flowering	82	99	70	77	82
- seed ripening	143	145	121	117	145
Plant height, cm					
- at 20 days of vegetation	38.1	39.6	61.4	27.2	32.3
- at flowering	83.2	103.8	191.4	76.0	64.3
The yield:					
- fresh mass, kg/m^2	3.11	3.50	6.42	1.48	2.67
dry matter, kg/m^2	0.82	0.98	2.05	0.40	0.94
Seed production, g/m^2	27.14	34.3	60.40	40.90	52.1
The weight of 1000 seeds, g	2.67	3.10	8.66	8.44	1.31

The animal body, in order to maintain its vital functions and to give different production, needs permanently exogenous nutrients. Proteins are very important nutrients which provide assimilable nitrogen for the body. Analyzing the biochemical composition of the dry matter, from the plants of the genus *Astragalus* L., (Table 2) we find that *Astragalus ponticus* Pall. is distinguished by a very high content of raw protein (23.40%). *Astragalus galegiformis* L. has the same amount of raw protein as alfalfa and the plants of *Astragalus sulcatus* L. have the lowest index of this component (14.60%). In the conditions of Eastern Ukraine, it has been found a high content (25.0%) of raw protein at *Astragalus galegiformis* L. (Ostapko, Shynkarenko 2003). The forage of *Astragalus galegiformis* L. contains a high amount of fats (3.21%) and the forage of *Astragalus cicer* L. – of nitrogen-free extractive substances (56.48%). At all the studied species of the genus *Astragalus*, a high content of cellulose has been revealed - from 30.61 to 35.40%; *Astragalus galegiformis* L. has the highest index. We can mention that the natural forage of the plants of the genus *Astragalus* has a nutritional value of 0.21 - 0.27 nutritive units, at the species *Astragalus galegiformis* L., *Astragalus sulcatus* L. and *Astragalus cicer* L. it is superior to alfalfa. Regarding the amount of metabolizable energy for cattle, we find that the forage of the species of genus *Astragalus* L. exceed the forage of alfalfa. The natural forage of the species of genus *Astragalus* L. contains a normal amount of protein which corresponds to the zootechnical standards, so, to a nutritional unit, correspond 129.62-225.09 grams of digestible protein and the highest content is found in the forage of *Astragalus ponticus* Pall. – 225.09 grams, that is, with 37% more in comparison with alfalfa.

The presence of minerals in animal nutrition is indispensable for their growth and health, because they are essential components of all tissues and organs that maintain osmotic pressure at a constant level, participate in the regulation of acid-base balance, activate a number of enzymes, moderate the neuromuscular activity, prevent the emergence and development of diseases of animals (Suttle, 2010). The plants of *Astragalus sulcatus* L. have a high content of calcium (5.06 g/kg), and the plants of *Astragalus ponticus* Pall. – a high content of phosphorus (1.23 g/kg) of natural forage.

Table 2. Biochemical composition of the dry matter and nutritional value of the natural forageof the genus *Astragalus* L.

Indicators	***Medicago sativa* L. (control)**	***Astragalus cicer* L.**	***Astragalus galegiformis* L.**	***Astragalus ponticus* Pall.**	***Astragalus sulcatus* L.**
Biochemical composition of the dry matter:					
raw protein, %	17.03	16.30	16.63	23.40	14.60
raw fats, %	2.30	1.70	3.21	2.75	2.76
raw cellulose, %	33.31	30.61	35.40	31.90	33.10
nitrogen free extractive substances,%	39.41	56.48	38.32	32.35	40.74
mineral substances, %	8.01	7.91	6.46	9.60	8.80
1 kg of natural forage contains:					
nutritive units	0.21	0.26	0.27	0.21	0.27
metabolizable energy for cattle, MJ/kg	2.28	2.93	3.26	2.43	3.24
dry matter, g	263.70	280.00	320.00	272.40	354.00
raw protein, g	46.10	45.54	53.20	63.84	51.87
digestible protein, g	34.50	33.70	39.37	47.27	38.38
raw fats, g	6.20	4.84	10.18	7.90	9.83
raw cellulose, g	80.30	85.82	113.38	86.90	111.75
nitrogen free extractive substances, g	99.30	121.62	122.60	87.61	149.25
mineral substances, g	21.70	22.18	20.64	26.15	31.30
calcium, g	4.61	4.27	2.78	2.34	5.06
phosphorus,g	0.54	0.33	0.44	1.23	0.87
digestible protein, *g/ nutritive unit*	164.29	129.62	145.81	225.09	142.15

The quality of the protein is determined by the content in certain amino acids, which ensure the biological value of the forage. The content of essential amino acids, (Table 3) ranges from 2.507 mg/100 g dry matter (*Astragalus sulcatus* L.) to 4.524 mg/100 g dry matter (*Astragalus galegiformis* L.). This index is of 4.103 mg/100 mg dry matter at the alfalfa control. Analyzing the content of each essential amino acid in the species mentioned above, we have found out that *Astragalus ponticus* Pall. has the highest content of threonine (0.678 mg/100 g dry matter.), exceeding alfalfa with 20%.

The valine content at the species mentioned above has similar values, being about 16% higher than alfalfa. The plants of the species of the genus *Astragalus* L. have a lower content of methionine (from 0.028 at *Astragalus. sulcatus* L. to 0.098 mg/100 mg dry matter at *Astragalus galegiformis* L.), which also reduces the biological value of the protein of these species. The plants of *Astragalus ponticus* Pall. are characterized by a high content of lysine and isoleucine, while the plants of *Astragalus. galegiformis* L. – of leucine and phenylalanine.

Table 3. The content of amino acids in the natural forage (mg/100 mg dry matter) of the genus *Astragalus* L.

Amino acids	***Medicago sativa* L. (control)**	***Astragalus cicer* L.**	***Astragalus galegiformis* L.**	***Astragalus ponticus* Pall.**	***Astragalus sulcatus* L.**
asparagine	1.711	2.024	2.039	3.110	0.936
threonine	0.564	0.604	0.579	0.678	0.340
serine	0.687	0.681	0.698	0.767	0.407
glutamine	1.360	1.507	1.518	1.953	0.878
proline	0.922	1.077	1.063	0.765	0.723
glycine	0.550	0.593	0.574	0.676	0.360
alanine	0.674	0.678	0.728	0.570	0.408
valine	0.559	0.657	0.650	0.649	0.344
methionine	0.139	0.088	0.096	0.058	0.028
isoleucine	0.459	0.480	0.498	0.510	0.262
leucine	0.913	0.983	1.004	0.914	0.544
tyrosine	0.458	0.509	0.484	0.458	0.314
phenylalanine	0.850	0.878	0.971	0.794	0.560
histidine	0.326	0.602	0.523	0.411	0.251
lysine	0.619	0.700	0.726	0.760	0.429
arginine	0.655	0.607	0.627	0.306	0.351
total essential amino acids	4.103	4.390	4.524	4.363	2.507
% of essential amino acids from the total amino acids	35.85	34.65	35.40	32.61	35.14

CONCLUSIONS

Both the species of the spontaneous flora of the Republic of Moldova (*Astragalus cicer* L., *Astragalus ponticus* Pall.) and those introduced from different floristic regions (*Astragalus galegiformis* L., *Astragalus sulcatus* L.) pass consecutively all the ontogenetic stages of development ensuring a satisfactory seed production for the necessities of the establishment of plantations.

The studied plant species of the genus *Astragalus* L. (*Astragalus cicer* L., *Astragalus galegiformis* L., *Astragalus ponticus* Pall., *Astragalus sulcatus* L.) grow and develop quite rapidly, and at these indices they are not inferior to the control (*Medicago sativa* L.). The harvest of fresh mass has reached maximum levels at *Astragalus galegiformis* L. and constitutes 6.42 kg/m^2 or 2.05 kg/m^2 dry matter.

The fodder obtained from the studied species is valuable: rich in protein, essential amino acids, fats and a high level of metabolizable energy for cattle, exceeding the quality of the fodder from *Medicago sativa* L.

The fodder obtained from the studied species of the genus *Astragalus* L. contains an amount of protein which corresponds to the zootechnical standards.

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AGRO BIOLOGICAL PECULIARITIES OF GIANT KNOTWEED AND CUP PLANT AFTER FERTILIZATION WITH SEWAGE SLUDGE

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Abstract

In the context of climate changes and sharp rise in fossil energy prices, the development of the sustainable and efficient agriculture requires finding innovative solutions for adapting the technologies of plant cultivation and animal breeding which can ensure the food security and safety, favourable for improving the quality of life in the rural areas. An important role in solving the above mentioned problems is played by the implementation in the culture of herbaceous perennial plant species, which, on the one hand, can provide animals with fodder, and, on the other hand, can become a reliable source for obtaining biomass for the production of energy. The purpose of the research was to investigate the effect of fertilization with sewage sludge produced as a result of municipal wastewater treatment on the productivity and the quality of natural forage of the Gigant variety of giant knotweed (Fallopia sachalinense) and the Vital variety of the cup plant (Silphium perfoliatum). It was established that the application of urban sewage sludge in a dose of 50 t / ha contributes significantly to the productivity growth of the cup plant and giant knotweed. Also, the fodder obtained has a higher protein and fat content, and decreased cellulose content in comparison with the unfertilized plants. The implementation of these cultures can help to ensure the animals with qualitative feed, to produce renewable energy and to increase the share of agriculture in gross domestic product.

Key words: *cup plant, forage quality, giant knotweed, productivity, urban sewage sludge.*

INTRODUCTION

Agriculture plays a strategic role in all the world countries, since it is the main sector responsible for the food security of the population, having, at the same time, a special contribution to the overall process of sustainable economic development and environmental protection. The development of agriculture depends decisively on natural, social and economic factors, which affect not only the volume of production but also the structure and the pace of development, both globally and regionally.

In the context of climate change and sharp rise in fossil energy prices, the development of a sustainable and efficient agriculture requires finding innovative solutions to adapt the techniques and technologies of plant cultivation and animal husbandry to ensure food security and safety, favourable for improving the quality of life in rural areas. It is well known that in the modern and sustainable agriculture, animal husbandry plays an important role, ensuring a balance between phytotechny and zootechnics. Currently, the revitalization of the animal husbandry sector continues to be a serious problem for the Republic of Moldova because of the livestock reduction, deplorable state of pastures and hayfields, decreasing areas of traditional fodder crops, failure to ensure a continuity of fodder, unbalanced ration of vegetable protein, which acts negatively on physiological condition and productivity of animals. Mobilization, improvement and implementation of new suitable fodder species is an important first step in increasing the fodder production. Factors such as the longevity of the species, the type of soil and its fertility, the desired period of use, the type of use, the productive potential and the nutritional value of fodder should be taken into consideration in order to make the best possible choice. As a result of the scientific researches on mobilization and improvement carried out in the Botanical Garden (Institute) of ASM over many decades, new non-traditional plant species with a high potential of efficient use of solar energy and obtaining fodder with high content of vegetable protein have been identified (Teleuţă, 2010; Teleuţă and Ţîţei , 2012). By a high and stable productivity of over 100 t/ha of natural fodder, in the Republic of Moldova, are distinguished the species giant knotweed, *Fallopia sachalinensis* (124.2 t/ha) and cup plant, *Silphium perfoliatum*(142.2 t/ha) (Teleuţă et. al., 2013; Ţîţei et.al., 2013).

The giant knotweed or the Sakhalin knotweed, *Fallopia sachalinensis* Ronse Decr., syn. *Polygonum sachalinense* F. Schmidt, *Reynoutria sachalinensis* Nakai, *Tiniaria sachalinensis* Janch., fam. *Polygonaceae* Juss. is widespread in the wild flora of northern Japan, Sakhalin Island and Kurile Islands. It appears in Europe the second half of the 19th century, being implemented in culture during the 20th century due to its tolerance to the pedo-climatic factors and stable productivity, serving as fodder from early spring until late autumn (Tmenov, 2001).

The cup plant, *Silphium perfoliatum* L., fam. *Asteraceae L.*, is native to North America and was introduced in Europe in the second half of the 18th century as an ornamental plant in the botanical gardens of France and Great Britain, and in the 20th century - as a non-traditional fodder crop in Ukraine, Russia, France, U.S.A., for the maintenance of the branches of animal husbandry concerned with the meat and milk production (Vavilov and Kondratiev, 1975; Niqueux, 1981; Stanford, 1990; Abramov, 1992).

For the formation of 10 tonnes of natural fodder, the giant knotweed extracts from the soil 40-50 kg of nitrogen, 9-10 kg of phosphorus, 50-60 kg of potassium and 19-23 kg of calcium (Tmenov, 2001) and the cup plant - 46-54 kg of nitrogen, 6-9 kg of phosphorus, 48-50 kg of potassium and 53-57 kg of calcium (Vavilov and Kondratiev, 1975; Abramov, 1992). For the fulfilment of the genetic potential of the *Fallopia sachalinensis* and *Silphium perfoliatum* plants it is necessary to find fertilization methods and to form a positive balance of humus and bio file elements in the soil. Nowadays, because of the surging prices of mineral fertilizers and shortage of financial resources from the agricultural sector it is possible to use, at best, the mineral fertilization only with nitrogen of the wheat and sugar beet crops (Andrieş, 2007). The Republic of Moldova is currently facing a serious problem – the storage and use of the urban sewage sludge. According to the data presented by the JSK Apă-Canal Chisinău, yearly, at the wastewater treatment plant accumulate about 110-115 thousands m^3 of urban sewage sludge, that is dewatered since 2009 according to a new method - in geotubes. Compared with the method of dewatering on drying beds, the technique of dewatering the urban sewage sludge in geotubes reduces three to five times the dehydration time, the need of land surfaces and the spread of the disagreeable odour. Unconventional organic fertilizers (sludge and compost from wastewater treatment) can contribute to improving the situation regarding the preservation of soil humus, because they have variable nutrient content. The urban sewage sludge is a feasible source of phosphorus – one of the most important nutrients for crop production (Lixandru, 2005; Andrieş, 2007). The influence of urban sewage sludge on the chemical properties of the soil, forage productivity and quality were highlighted in numerous studies (Borkowska and Wardzinska, 2003; Lixandru, 2005; Denisov et. al., 2010; Vidican et. al., 2013).

The given species are currently investigated and implemented in different regions of the Earth not only as a source of obtaining fodder, but also as raw material for the pharmaceutical industry and bioenergetics (Ostapko and Poglyad, 2003; Majkowski et.al., 2009; Pichard, 2012; Usťak, 2012; Conrad and Biertümpfel, 2013; Seppälä , 2013).

The purpose of the researches was to investigate the effect of the fertilization with sludge obtained as a result of urban wastewater treatment on the agro-biological peculiarities of the plants giant knotweed *Fallopia sachalinensis* and cup plant *Silphium perfoliatum* in the conditions of the Republic of Moldova.

MATERIALS AND METHODS

The plants: giant knotweed *Fallopia sachalinensis*, the “Gigant” variety and cup plant *Silphium perfoliatum*, the “Vital” variety served as object of study. The varieties of the studied species were created in the Botanical Garden (Institute) of the ASM and registered in the catalogue of varieties approved in the Republic of Moldova. The sludge dewatered in the geotube, with the duration of storage of four months, from the wastewater treatment the JSK Apă-Canal Chisinău, with a moisture content of 75.5% was used as fertilizer. In the dry matter, the content of organic matter exceeds 80%; the nutrients valuable for plants reach values of 2.6% of nitrogen, 1.7% of phosphorus and 0.22% of potassium. The nitric nitrogen constitutes 95.5 mg/100g. The heavy metals in the analyzed sludge don't exceed the Admissible Concentration Limit (Rusu A. et al., 2012) with the values for lead of 310.75 mg/kg, cadmium - 30.8 mg/kg, chromium - 315.3 mg/kg, nickel - 86.3 mg/kg, copper 117.3 mg/kg, zinc 371.3 mg/kg.

The experiments were mounted on the ground with carbonate black earth on clay, with humus content of: 2.1%, nutrients: NO_3 -1.35 mg/100 g soil, NH_4-0.35 mg/100 g soil, P_2O_5 – 1.65 mg/100 g soil, K_2O – 30 mg/100 g soil (Macighin method), pH=7.5. The scheme of the experience includes the following versions: fertilization with sludge 50 t/ha (12.8 t/ha dry matter) and as control served the plants on plots without fertilization. The evidence area of the plot constitutes 10 m^2. The number of repetitions - 4. The experiments started at the end of March 2011 by planting rhizomes of giant knotweed at a depth of 8-10 cm and sowing seeds of cup plant (previously stratified) at a depth of 2 cm resulting from the density of 22 000 bushes/ha. The scientific researches on the growth, development and productivity of the plants were performed according to the methodical indications (Novosiolov et al., 1983; Ivanov, 1985), biochemical composition and nutritional value of the fodder (Ermakov et al., 1987; Petukhov et al., 1989).

RESULTS AND DISCUSSIONS

As a result of the study of the biological peculiarities in the first year of vegetation, we can mention that that during 20-25 days after planting the rhizomes of giant knotweed starts the development of the aerial part and by the end of May the plants reach a height of 47-63 cm, having formed 5-7 internodes with 19-23 cm long and 8-11 cm wide leaves. During the next period, the branching of the central stem is observed, forming first degree shoots which continue to branch out until the end of the vegetation by developing five and four degree shoots, being formed a bush with a height of 164-170 cm. At the cup plant, it was found that the emergence of plantlets was simultaneous 15 days after sowing in both versions and until the end of vegetation, the plants have developed a rosette composed of 16 to 18 leaves with a height of 37-43 cm. At both species, the root system developed and extended and the rhizomes were formed during the vegetation. In the first year of vegetation, no essential differences were observed regarding rate of growth and development of the giant knotweed and cup plant depending on the level of fertilization, but we found out that the plants fertilized with sludge have a darker coloration of the leaves. The fresh mass productivity of the plants of giant knotweed in the version with sludge was of 2.59 kg/m^2, which was by 10.4% more compared to the control version, and at the cup plant - 1.57 kg/m^2 respectively and 1.27 kg/m^2 at the plants grown on unfertilized soil.

In the following years, in spring, when the air temperature exceeded 5° C, at the studied species, started the growth and development of the shoots from the generative from buds formed on the rhizomes, the plants went through all stages of ontogenetic development. The vegetation of cup plant started 3-5 days earlier than the vegetation of giant knotweed. The growth and development of giant knotweed was faster, thus in the middle of April the giant knotweed plants exceeded a height of 65-70 cm, while the cup plants – only 31-37 cm. It was observed that, in the version with fertilization of the soil, at the studied species, the number of shoots increased, the internodes were longer and thicker, and the leaves were larger, fine, with a darker coloration.

In the second year of vegetation (2012) the first harvest of the natural fodder of giant knotweed was performed in the middle of May when the plants were over 2 m tall, having developed 16-18 leaves. The productivity of the harvested fresh mass, Table 1, of the plants which grew on soil fertilized with sludge was of 6.45 kg/m^2 or 1.46 kg/m^2 dry matter, the content of the leaves in the fodder constituted 48% and the productivity of the plants from the control version - 4.98 kg/m^2 or 1.23 kg/m^2 dry matter, respectively, with a content of 43% leaves in the fodder.

Table1. Agro-biological peculiarities of the giant knotweed *Fallopia sachalinensis* Ronse Decr. and cup plant *Silphium perfoliatum* L. fertilized with urban sewage sludge (2012 year)

Indices	**Giant knotweed *Fallopia sachalinensis***		**Cup plant *Silphium perfoliatum***	
	Control	**Sewage sludge fertilization**	**Control**	**Sewage sludge fertilization**
First harvest				
plant height, *cm*	219	238	185	180
natural fodder harvest, *kg/m²*	4.98	6.45	4.60	6.00
dry matter content,*%*	24.65	22.63	13.69	14.33
content of leaves in the fodder,*%*	43	48	43	56
Second harvest				
plant height, *cm*	149	208	49	108
natural fodder harvest, *kg/m²*	2.36	4.18	0.36	1.18
dry matter content,*%*	33.20	30,10	27.71	28.10
content of leaves in the fodder,*%*	37	45	100	55
Annual productivity				
natural fodder, *kg/m²*	7.34	10.63	4.96	7.18
dry matter, *kg/m²*	2.01	2.72	0.73	1.19

As it was previously mentioned, the growth of cup plant is slower and the first harvest of the fodder was performed in early June, when the shoots exceeded the height of 1.80 m, having developed 12-14 leaves and the leaves from the bottom of the plant reached the senility stage. It was found that in the version with sludge, the productivity of the harvested fresh mass, Table 1, had reached 6.00 kg/m^2 or 0.86 kg/m^2 dry matter, with a content of 56% leaves in the fodder in comparison with the productivity of 4.60 kg/m^2 fresh mass or 0.63 kg/m^2 dry matter, with a satisfactory content of 43% leaves in the fodder of the plants grown on unfertilized soil.

The restart of vegetation and revival of giant knotweed after the harvest was different. It was established that the plants from the version with sludge at 6-8 days restarted their growth and formation of new shoots which by the end of vegetation, in the middle of October, reached a height of 2.08 m. A more delayed and uneven growth and development was observed at the unfertilized plants which, at the end of the vegetation, had not exceeded the height of 1.49 m, this fact had a negative impact on the rate of formation of natural fodder and accumulation of dry matter. It was found that at the second harvest the productivity of the plants from the version with sludge was of 4.18 kg/m^2 fresh mass (1.26 kg/m^2 dry matter) having a content of 45% leaves in the fodder and in the control version - 2.36 kg/m^2 fresh mass (0.73 kg/m^2 dry matter) and 37% leaves in the fodder. So, the annual productivity of the giant knotweed in the version with sludge reached 10.63 kg/m^2 fresh mass and 7.34 kg/m^2 in the control version.

We mention that cup plant start growing slower after the first harvest in comparison with giant knotweed, probably due to the high temperatures of 25-30 ° C and the increasing deficit of humidity in the air and soil in this period of the year 2012. Thus, by the end of the vegetation (middle of October), the fertilized plants developed shoots with 7-8 leaves and a height of 1.08 m, reaching a fresh mass productivity of 1.18 kg/m^2 (0.42 kg/m^2 dry matter) with a content of 55% leaves in the fodder and the unfertilized plants developed only a rosette composed of 4-6 leaves and reached a fresh mass productivity of 0.36 kg/m^2 (0.10 kg/m^2 dry matter). We mention that the sludge fertilization contributes to the better fulfilment of the productive potential of cup plant reaching a mass fresh productivity of 7.18 kg/m^2 compared to 4.96 kg/m^2 in the control version and the accumulation of dry matter over the year under the influence of fertilization increases by 63%.

Analyzing the data presented in Table 1, we could mention that, in the next year, the fertilization also influences the rate of growth and development of the plants. So, the height of the fertilized giant knotweed plants at the first harvest in 2013 exceeds with 24 cm the control and the natural fodder harvest increases by about 37%, constituting 6.95 kg/m^2, having also a higher content of leaves. At cup plant the fertilization didn't influence essentially the growth and they were only 7 cm higher, but it influenced more the development, the shoots were thicker with bigger leaves, which influenced positively the formation of natural fodder harvest, reaching 8.01 kg/m^2 with a higher content of leaves, it also contributed to the accumulation of dry matter.

Table 2. Agro-biological peculiarities of the giant knotweed *Fallopia sachalinensis* Ronse Decr. and cup plant *Silphium perfoliatum* L. fertilized with urban sewage sludge (2013 year)

Indices	**Giant knotweed *Fallopia sachalinensis***		**Cup plant *Silphium perfoliatum***	
	Control	**Sewage sludge fertilization**	**Control**	**Sewage sludge fertilization**
First harvest				
plant height, *cm*	208	232	180	187
natural fodder harvest, *kg/m^2*	5.06	6.95	5.68	8.01
dry matter content,*%*	23.64	22.83	14.19	15.00
content of leaves in the fodder,*%*	45	51	43	56
Second harvest				
plant height, *cm*	163	218	103	168
natural fodder harvest, *kg/m^2*	2,86	4.03	2.16	3.78
dry matter content,*%*	31.81	32.10	27.50	28.03
content of leaves in the fodder,*%*	37	45	40	55
Annual productivity				
natural fodder, *kg/m^2*	7.92	10.98	7.84	11.79
dry matter, *kg/m^2*	2.10	2.88	1.39	2.27

Due to the quite favourable weather conditions from 2013, the restart of vegetation after the first harvest was more homogeneous at both species in comparison with the previous year, especially of cup plant, which, in both versions reached the stage of flower buttons formation. We could mention that the plants of the studied species from the version with fertilization grow and develop intensively until the end of vegetation. Thus, the fertilized plants of giant knotweed at the end of October reached a height of 218 cm, and those of cup plant - 168 cm, exceeding the control version plants with 55 cm and 65 cm respectively. The natural fodder harvest essentially changes due to the fertilization with sludge. It was found that at the second mowing the fodder harvest of fertilized plants of cup plant increases by 75% and giant knotweed – by 41% compared to the control version. The annual harvest of natural fodder is higher at cup plant (11.79 kg/m^2) and the dry matter accumulation at giant knotweed (2.88 kg/m^2). The fertilization with sludge contributed to the increase of the annual productivity of dry matter of giant knotweed by 37% and of cup plant – by 63%.

The annual productivity of natural fodder and dry matter of the studied species in 2013 increased in comparison with the previous year. A significant increase, in 2013, was found at cup plant, the annual harvest of natural fodder of the plants fertilized with sludge increased by 64% compared to 58% of the unfertilized plants.

It is well known that the amount of fodder depends on the dry matter content and its biochemical composition.

Analyzing the data presented in Table 2, we could mention that the accumulation of dry matter in the natural fodder is higher at *Fallopia sachalinensis* (262.20-265.15 g/kg) compared to *Silphium perfoliatum* (177.30 - 191.68 g/kg). It was found that the sludge fertilization essentially influenced the increase of the dry matter content in the fodder of cup plant (14.38 g/kg).

The urban sewage sludge fertilization influences the biochemical composition of dry matter in the fodder.

Proteins are very important nutritive substances, as the only source of essential amino acids, they are part of all cells, participate in the formation of ferments and participate in all the vital processes in the body forming different complexes (protein-lipid, protein-glucidic, protein-mineral, protein-vitamin, protein-hydric), participate in the maintenance of osmotic balance, in the distribution of water and substances dissolved in it in different parts of the body. The giant knotweed plants are characterized by a rather high content of raw protein – 42.16 -51.93 g/kg natural fodder. The increase of protein content due to the application of fertilization constitutes about 23% at giant knotweed compared with 15% at cup plant.

Table 3. The forage value and productivity of the giant knotweed *Fallopia sachalinensis* and cup plant *Silphium perfoliatum* fertilized with urban sewage sludge (y. 2013)

Indices	Giant knotweed *Fallopia sachalinensis*		Cup plant *Silphium perfoliatum*	
	Control	**Sewage sludge fertilization**	**Control**	**Sewage sludge fertilization**
1 kg of natural fodder has:				
dry matter, g	265.15	262.20	177.30	191.68
raw protein, g	42.16	51.93	25.78	29.65
digestible protein, g	27.71	31.68	21.39	24.61
raw fat, g	7.49	9.87	7.18	8.11
raw cellulose, g	102.13	67.19	65.82	40.80
nitrogen free extractive substances, g	94.61	113.69	62.62	98.92
minerals, g	16.96	17.52	15.90	14.20
Digestible protein, g/ nutritive unit	113.4	134.4	121.5	119.4
Annual productivity:				
digestible protein, t/ha	2.19	3.48	1.68	2.90
nutritive unit, t/ha	17.9	25.9	13.8	24.3
metabolizable energy, Gj/ha	184.2	271.1	140.2	252.2

The dry matter of the fertilized plants has a higher fat content, at giant knotweed by 31% and at cup plant by 13% compared to the control.

The sludge fertilization contributes to the reduction of the cellulose content by 34-38% and to the increase of nitrogen free extractive substance content by 20-58%. The highest indices are at the fertilized *Silphium perfoliatum* plants.

The content of minerals depending on fertilization at the species studied varies, so, at giant knotweed plants it increases insignificantly while at cup plant was observed a decrease of about 9.0%.

If we analyze the productivity of the plants based on the forage value, we mention that the fertilization increases more essentially the productivity of *Silphium perfoliatum* plants: digestible protein by 73%, nutritive units by 76% and accumulation of metabolizable energy for cattle by 80%, but at *Fallopia sachalinensis* – 59%, 45% and 48% respectively.

The provision with protein of a nutritive unit is in accordance with the zootechnical requirements. An influence of the fertilization on the increase of the digestible protein content was found at the fodder of giant knotweed - 134.4 grams per nutritive unit surpassing by 21.0 grams the control version.

The studied species can serve as a valuable source of pollen for bees and of obtaining raw material to produce thermal energy.

Dried stems of giant knotweed *Fallopia sachalinensis* and cup plant *Silphium perfoliatum* can be harvested in winter with the technical means of harvesting fodder and used to produce solid bio fuel, to make briquettes and pellets (Ţîţei and Teleuţă, 2012). In autumn, with the establishment of negative temperatures, we have found that all the leaves of the Sakhalin knotweed fall, but the leaves of cup plant remain attached to the stem until spring. The drying rate of the stems of the studied species is slower at the fertilized plants. The energy capacity of the harvested biomass does not change much depending on fertilization and is about 19.3-19.4 MJ/kg dry matter at *Fallopia sachalinensis* and about 18.1-18.3 MJ/kg at *Silphium perfoliatum* but with a higher content of ash (3%).

CONCLUSIONS

The studied species, giant knotweed *Fallopia sachalinensis* and cup plant *Silphium* *perfoliatum* starting with the second year, have an accelerated growth and development which allows obtaining high yields of fodder early.

The fertilization with urban sewage sludge (50 t/ha) contributes to a better fulfilment of the productive potential of plants. Under the influence of fertilization, the natural fodder production of giant knotweed and *Silphium perfoliatum* plants increases by about 45% compared to the control and the productivity of dry matter increases by 36% and 62% respectively.

The fertilization also increases at the giant knotweed and cup plant the yield of digestible protein (59% and 73%), nutritive units (45% and 76%) and metabolizable energetic capacity of the harvested fodder.

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EFFECT OF PLANTING DATE AND APPLICATION OF NITROGEN ON YIELD RELATED TRAITS OF FORAGE SORGHUM CULTIVARS

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Abstract

In order to study the effect of planting date and nitrogen nutrition on yield of two forage sorghum cultivars, a split factorial experiment with four replications was conducted on 2012 growing season in Fariman, Iran. Main factor belonged to planting dates, including June 10, June 26 and July 16. Combination of cultivars, Speedfeed and Jumbo, and nitrogen application, Control, 75 and 150 kg.ha^{-1} net nitrogen, were adjusted as sub plots. Results showed that with delaying of planting date, the total dry matter and fresh forage yield was decreased. The highest fresh and dry forage yield was achieved in June 10 treatment. Leaf area index, leaves number, tillering, and fresh forage yield were affected by nitrogen. Speedfeed was superior to Jumbo in its fresh and dry biomass, specially in the treatment of June 10, that this cultivar produced 87.2 ton.ha^{-1} fresh biomass.

***Key words**: forage sorghum, planting date, nitrogen, biomass.*

INTRODUCTION

Sorghum, *Sorghum bicolor* L., is an important fodder crop for both arid and semi-arid regions of the world. This importance is due to its higher water use efficiency, relatively good tolerance to drought and salt stresses, potential for tillering in high amounts, and good competitiveness with weeds in advanced growth stages. Planting date has a key role in establishment the crop specially in mild cold areas, where sorghum is damaged from early or late sowing dates. In such a climatic conditions, proper nitrogen application has an important role for fast growth and green forage production too.

Khalili Mohaleh et al. (2007) showed, the significant differences for Leaf Area Index (LAI) of sorghum hybrids. The highest LAI was belonged to cv. Sugargraze with 9.14 and the lowest one to cv. Jumbo about 7.86. Other experiments in Iran have shown the superiority of cv. Speedfeed sorghum compared to the others in forage yield (Sadeghi & Mohmmedi, 1994 ; Gholami, 1994). Beheshti (1994) has confirmed for the highest forage yield of Speedfeed cultivar in earlier planting dates. Forage sorghum has a great response to nitrogen nutrition (Ram and Singh, 2001). The rate of N fertilizers is varied from 45-224 kg.ha^{-1} related to soil fertility, climate and cultivar (Zhao et al., 2005). Evidences show the more effectiveness of N absorption by sorghum than corn resulted to higher dry matter accumulation (Young & Long, 2000).

MATERIALS AND METHODS

In order to characterize the evolution of planting date and application of nitrogen on related trait and yield of forage sorghum, a split factorial experiment with four replications was conducted on 2012 growing season in Fariman, Iran. Main factor belonged to planting dates, including June 10, June 26 and July 16. Combination of cultivars, i.e. Speedfeed and Jumbo, and nitrogen application, Control, 75 and 150 kg.ha^{-1} net nitrogen, were adjusted as sub plots. Nitrogen was supplied from the source of Urea fertilizer. In control treatment, did not used any kind of nitrogen based fertilizers. Plant density after emergence was adjusted to 360,000 plant.ha^{-1}. LAI was calculated via five different samplings with leaf area meter, in each samples the total shoot dry matter was measured too. At flowering period another traits, i.e. plant height, tiller and leaves numbers, was recorded. At harvest time fresh and dry yield of forage was measured. The data, collected from experimental plots, have been statistically processed and interpreted. Means of treatments was compared using Duncan's multiple range test.

RESULTS AND DISCUSSIONS

The analysis of variance showed a statistically significant effect of planting date on plant tillers, leaves number and fresh and dry weight of forage per hectare. But the LAI remained statistically unaffected (Table 1). The greatest LAI achieved in earliest planting date (Table 2). It seems that increasing of growing season and greater leaves number in first planting date have led to this superiority (Khalili Mohaleh et al., 2007).

The greatest yield of fresh and dry forage was obtained in first planting date too, that were 81.30 and 19.87 ton.ha^{-1} (Table 2).

Cultivars also showed a significant effect on all of the traits under consideration (Table 1). Speedfeed was superior to Jumbo in its fresh and dry biomass with 80.43 and 18.42 ton.ha^{-1} respectively. But Jumbo had the greater number of tillers i.e. 2.81 tillers per plant (Table 2).

All traits had a significant trend after using N fertilizer compared to control (Table 1). The more nitrogen application, the more forage yield as fresh and dry biomass, 78.21 and 14.5 ton.ha^{-1} respectively in 150 Kg.ha^{-1} net nitrogen (Table 2). Generally the greatest forage yield was obtained in combination of 150 kg.ha^{-1} net nitrogen×first planting date about 85.41 kg.ha^{-1}. But it was not statistically significant compared to combination of 75 Kg.ha^{-1} net nitrogen × first planting date (Table 2). So it seems that because of environmental precautions we must select the second combination with lower N application in forage sorghum production. This plant can produce more yield in two cuttings per growing season if its nitrogen requirement is balanced. At this conditions the nitrogen use efficiency of the crop is increased too (Seied Sharifi et al., 2009).

Table 1. Analysis of variance for morphological and yield of forage sorghum

Variation sources	df	Mean Squres: Tiller number	Leaf number	LAI	Total Fresh Biomass	Total Dry Biomass
Replication	2	0.049$^{n.s}$	178.330*	3.720$^{n.s}$	20.120$^{n.s}$	0.312$^{n.s}$
Planting date	2	0.683*	2053.320**	19.010$^{n.s}$	49.13*	17.120**
Eror$_a$	4	0.103	12.810	12.330	78.129	2.013
Cultivars	1	0.701**	828.320**	41.781**	1072.228**	109.472**
Nitrogen	2	0.263**	668.920**	19.053**	1603.712**	48.132**
PD×C	2	0.321**	72.910$^{n.s}$	127.348**	361.022$^{n.s}$	33.189**
PD×N	4	0.062$^{n.s}$	69.220$^{n.s}$	1.640$^{n.s}$	182.112$^{n.s}$	8.032$^{n.s}$
C × N	2	0.071$^{n.s}$	11.030$^{n.s}$	1.792*	361.372*	11.281*
PD×C×N	4	0.079$^{n.s}$	131.93$^{n.s}$	3.828*	38.118*	1.703*
Eror$_b$	30	0.058	74.81	4.986	155.41	6.413
%C.V	-	16.02	12.38	20.78	16.87	19.02

n.s, *, ** are Non significant and Significant at P≤0.05 and P≤0.01, Respectively.

Table 2. Mean comparison for morphological and yield of forage sorghum

Treatment	Tiller number	Leaf number	LAI	Total Fresh Biomass(ton/ha)	Total Dry Biomass (ton/ha)
Planting Date					
June 10	2.76a	81.61a	10.61a	81.30a	19.87a
June 26	2.68a	80.92a	9.36b	75.71b	15.23b
July 16	2.25a	68.93b	9.12b	67.42c	14.02b
Cultivars					
Speedfeed	2.63a	73.11a	10.81a	80.43a	18.42a
Jambo	2.81a	68.23b	9.02b	72.68b	14.93b
Nitrogen					
0	2.39b	69.03c	8.40c	63.28c	11.68b
75	2.61a	74.18b	9.28b	69.41b	12.73b
150	2.73a	83.72a	10.8a	78.21a	14.51a

Letters in each columns show significant differences based on Duncan's Test.

CONCLUSIONS

The fall chilling temperatures come soon at this area, so if effective growing period be more available for forage sorghum, its yield is increased undoubtedly. So early planting leads to better land and resources use productivity. Proper use of nitrogen is resulted to increasing of forage yield and lowering the environmental constrains. In this experiment the cv. Speedfeed produced more biomass and had more sensitivity to planting date and nitrogen fertilizers.

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EFFECT OF DROUGHT STRESS BY USING PEG 6000 ON GERMINATION AND EARLY SEEDLING GROWTH OF *Brassica juncea* Var. Ensabi

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Abstract

To study on effect of PEG 6000 stress on germination and early seedling growth of B. juncea (L.) Czern. var. Ensabi an experiment was conducted in the laboratories of Institute of Biological Sciences, University of Malaya, Malaysia. Seed germination and final germination rate of B. juncea var. Ensabi significantly affected by PEG 6000 concentration. By increasing osmotic potential of PEG 6000, seed germination and final germination were decreased. In distilled water, percentage of seed germination was highest. The higher amount of PEG 6000 concentration in this research (10 and 12 MPa) completely inhibited seed germination. Signs of germination for control and low PEG 600 osmotic potential occurred between 24 and 48 hours after sowing but at higher PEG 6000 osmotic solution it was being later. Most complete germination occurred at 25°-30°C. In PEG 6000 solution, the hypocotyl lengths of seedlings decreased with an increase in water stress. Shoots elongation significantly decreased by concentration of 2-8 MPa whereas no hypocotyl elongation at concentration of 10 and 12 MPa and shoot elongation completely inhibited.

Keyword: *Ensabi, germination, temperature, PEG 6000 concentration, hypocotyls.*

INTRODUCTION

Abiotic stresses, such as drought, salinity, extreme temperatures, chemical toxicity and oxidative stress are serious threats to agriculture and result in the deterioration of the environment.

Seed germination is an important stage in the life history of plant, affecting seedling development and survival, and population dynamics. Stress and strain are fundamental physical concepts that can be applied to biological systems. Physical scientists define stress as a force per unit area applied to an object. Strain is a change in a dimension of an object developed in response to a stress (Hopkins and Huner, 2003).

The Indian mustard (*B. juncea* L.) is an important oil-yielding crop that has been shown to be more heat and drought tolerant than the other spices, with a range of contributing characters (Mendham and Salisbury, 1995).

Salinity and drought affect the plants in a similar way. Reduced water potential is a common consequence of both salinity and drought. Water stress acts by decreasing the percentage and rate of germination and seedling growth (Macar, 2008).

Drought plays an important role not only in determining germination rates, but also influences seedling development (Macar, 2008). This stress type is one of the most important environmental stresses affecting agricultural productivity worldwide and can result in considerable yield reductions (Mohammadkhani and Heidari, 2008). It is one of the main causes for crop yield reduction in the majority of agricultural and natural regions of the world. The effects of sodium nitroprusside treatment on induced drought stress were investigated (Gomaa, 2010).

The principal aim of present study was to survey the effects of drought stress induced on germination and early seedling stage of two cultivars of *B. juncea* (L.) Czern. var. Ensabi.

MATERIALS AND METHODS

Germination and early seedling growth (10 days) of *B. juncea* var. Ensabi was studied in an experiment using distilled water (control) and osmotic potentials (-0.20, -0.40, -0.60, -0.80, -1 and -1.2 MPa), which were prepared adding polyethylene glycol (PEG 6000) to distilled water according to Michel and Kaufman (1983) to have the osmotic potential in PEG. Mature, healthy and equal sized seeds of Ensabi were previously disinfected by immersion in a calcium hypochlorite solution, containing 5% active chlorine, for one minute. The seeds were then washed three times with sterilized distilled water.

Seed germination tests were carried out in sterilized 9 cm petri dishes (that had been autoclaved for four hours) with Whatman No.1 filter paper. Each dish was moistened with the appropriate osmotic solutions (PEG-6000 solutions, osmotic potentials of -0.20, -0.40, -0.60, -0.80, -1 and -1.2 MPa) or distilled water for 0 MPa as a control. Germination tests were carried out in a growth chamber (Shel Lab, Model 2015-2E) at 20°C, 25°C and 30°C. Same appropriate solutions were added daily to each petri dish. Seeds were considered germinated when the radicle emerged with at least 2 mm long. The number of germinated seeds was recorded daily (germination rate), and the final germination percentage and rate were estimated.

The following parameters, previously reported by others such as Jefferson et al. (2003), were calculated for all four species:

A) Final germination (FG) %: The maximum average percentage of seeds that germinated during the experiment.

B) Mean period of final germination (MPFG) = $(\sum_{i=1}^{d} NiDi)/FG$

C) Rate of germination (RG) = $\sum_{i=1}^{d} \frac{Ni}{Di}$

D) Percentage inhibition or stimulation= (100- $\frac{FG\ in\ different\ solution(\%)}{FG\ in\ distilled\ water(\%)}$) Where,

N = daily increase in seedling number.

D = number of days from seed placement, the subscript i might be any integer value up through D.

At the end of eighth day, 5 seedlings were randomly selected and measured of the root, shoot and also seedling length of them. Additionally weight of oven dried (70°C for 48 hours) of root and shoot of seedlings were measured. The experimental design with respect to three factors arranged in a completely randomized design with three replications of 25 seeds per replicate. The first factor (temperature) had three levels (20 °C, 25°C and 30°C), the second one had seven levels (0, -0.20, -0.40, -0.60, -0.80, -1 and -1.2 MPa).

RESULTS AND DISCUSSIONS

Results showed the final germination rate and percent germination of *B. juncea* var. Ensabi significantly affected by PEG 6000 (Table 1, Figure 1). By increasing osmotic potential of PEG 6000, percent, rate and final germination were decreased. In distilled water, percentage of seed germination was highest. The higher amount of PEG 6000 concentration in this research (10 and 12 MPa) completely inhibited seed germination.

The first physiological disorder, which takes place during germination, is the reduction in imbibitions of water by seeds which leads to a series of metabolic changes, including general reduction in hydrolysis and utilization of the seed reserve (Ahmad and Bano, 1992). Osmotic stress limit the mobilization of reserves in several species (Sidari et al., 2008).

Effects of osmotic (polyethylene glycol) stress on seed germination of 98 genotypes of *B. juncea* were investigated by Kuhad et al., 1989. This stress type significantly reduced germination percentage, dry matter weight, shoot and root length of seedlings. Signs of germination for control and low PEG 6000 osmotic potential occurred between 24 and 48 hours after sowing but at higher PEG 6000 osmotic solution it was being later (Figure 1).

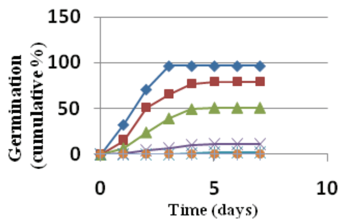

Figure 1. Cumulative mean percentage germination of *Brassica juncea* var. Ensabi seeds against time and decreasing external osmotic potentials of PEG 6000

Most complete germination occurred at 25°C - 30°C and these temperatures were the best temperature for germination percentage and 30°C was the best temperature for velocity.

Germination percentages improved with an increase in temperature under different PEG 6000 osmotic solutions. In spite of Fallah Toosi and Baki (2007) reported temperature significantly affected seeds germination of *B. juncea* var. Ensabi, there was no significant statistical difference between different temperatures.

Seeds have the highest resistance to extreme environmental stresses, whereas germination is considered as the most sensitive stage and seedlings are most susceptible in the life cycle of a plant (Qu et al., 2007; Sidari et al., 2008). Therefore, successful establishment of a plant population is dependent on the adaptive aspects of seed germination and of early seedling growth (Qu et al., 2007).

Hypocotyl length was affected by PEG 6000 osmotic stress (Figure 2). The hypocotyl lengths of seedlings decreased with an increase in water stress. Shoots elongation significantly decreased by concentration of 2-8 MPa whereas no hypocotyl elongation at concentration of 10 and 12 MPa and shoot elongation completely inhibited (Figure 2).

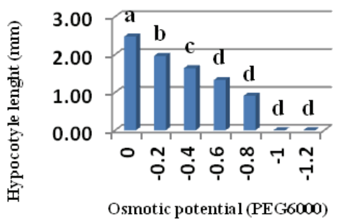

Figure 2. Mean shoot length in solutions of increasing PEG 6000 concentrations for *Brassica juncea* var. Ensabi. Different letters indicate statistically significant differences *(P* < 0.05) between different osmotic potentials (by Tukey's test)

Radicel elongation also significantly affected by PEG 6000 solutions (Figure 3). Results showed radicel growth was fast and by decrease PEG osmotic potential, radical elongation significantly increased. Low osmotic stress (-2 and -4 MPa) improves the root length of *B. juncea* var. Ensabi. These concentrations of PEG osmotic potential exhibited longer seedling roots and radicles were significantly longer to compare the control. Radical elongation declined by increasing concentration of the solution more than 4 MPa and completely inhibited at 10 and 12 MPa. It was not observed any significantly differences between control and 6 MPa PEG solutions (Figure 3).

These results agree with Murillo-Amador *et al.* (2002) in cowpea, Radhouane (2007) in pearl millet and Yagmur and Kaydan (2008) in triticale, they affirmed that a moderate and low osmotic stress (PEG) improves the root length of the seedlings.

Results showed growth of hypocotyl inhibited by increasing PEG 6000 solutions. It was no significantly differences between control and moderate of osmotic potential of PEG 6000 on shoot dry weight of *B. juncea* var. Ensabi (Figure 4).

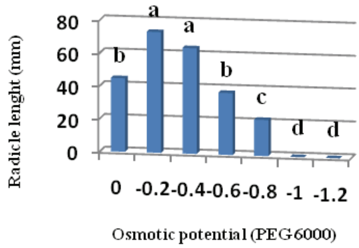

Figure 3. Mean root length in solutions of increasing PEG6000 concentrations for *Brassica juncea* var. Ensabi

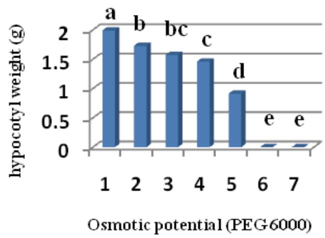

Figure 4. Mean hypocotyle weight in solutions of increasing PEG6000 concentrations for *Brassica juncea* var. Ensabi

Dry weight of Ensabi roots sharply decreased by increasing of PEG 6000 osmotic potentials. In spite of the length of roots that was significantly longer to compare with control in lower PEG solutions, the dry weight of roots in same solutions significantly lower to compare with control. This results indicated the roots that growth under drought were longer but they were very thin and delicate (Figure 5).

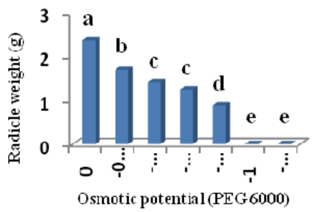

Figure 5. Mean radical weight in solutions of increasing PEG 6000 concentrations for *Brassica juncea* var. Ensabi

CONCLUSIONS

Drought is a major abiotic stress that plants encounter and can be responsible for the inhibition or delayed seed germination, poor seedling growth, and establishment.

The first physiological disorder, which takes place during germination, is the reduction in imbibitions of water by seeds which leads to a series of metabolic changes, including changed enzyme activities and general reduction in hydrolysis and utilization of the seed reserve (Ahmad and Bano, 1992). Upon imbibition, the quiescent dry seeds rapidly resume oxygen uptake and oxidative phosphorilation, processes required for supporting the high energy cost of germination (Baranova et al., 2006).

Osmotic stress examined in this work reduced the germination percentage of *B. juncea* var. Ensabi in respect to the concentration of PEG used. PEG, which is a non-penetrating agent, affects seed germination only by compromising water uptake. The marked differences in germination percentages observed with NaCl and PEG at the same osmotic potentials indicate specific ionic effects and point that germination is solely controlled by the osmotic potential.

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EFFECT OF DIFFERENT SOURCES OF NITROGEN FERTILIZER ON YIELD & YIELD COMPONENTS OF SUNFLOWER (*Helianthus annuus* L.)

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Abstract

In order to evaluation of yield and yield components of sunflower in response to different nitrogen fertilizer sources, an experiment was conducted with different chemical and biological nitrogen fertilizers and one cultivar of sunflower cv. Master . These treatments were arranged into a factorial experiment based on RCBD design with four replications. Chemical nitrogen treatments were: No using of nitrogen, Urea application, Ammonium sulphate, and Ammonium nitrate phosphate application. Biological nitrogen based fertilizers was included of application and no applied of "Nitroxin" in combination with all chemical nitrogen treatments. Results showed that, Ammonium sulphate produced the highest seed yield. Integrated application of this fertilizer with Nitroxin, produced less yield than Ammonium sulfate alone. But in the other treatments, Nitroxin increased the seed yield.

Key words*: Helianthous annus, nitrogen sources, nitroxin, biological nitrogen.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important oilseeds that contributes considerably to edible oil in the world with an intermediate water requirement and adapted to a wide range of climatic conditions.

Fertilization needs to be used rationally in order to avoid a negative ecological impact and undesirable effects on the sustainability of agricultural production systems. Excessive application of fertilizers also affects the farmer's economy (Zubillaga et al., 2002). Nutrients play an important role in crop growth and development. Among the nutrients, Nitrogen (N) is one of the important nutrients that enhance the metabolic processes based on protein, leads to increases in vegetative, reproductive growth and yield of the crop, thus is required in the largest amount from soil (Nasim et al., 2012). Nitrogen is readily absorbed by the plants in the forms of nitrate (NO3), urea ($CO(NH_2)_2$) and ammonium ion (NH_4^+). Nitrogen is the major nutrient required by sunflowers, and has the greatest impact on seed size, leaf size and number of leaves, test weight and yield. Insufficient N will limit crop yield, however, excess N applications can reduce oil content, and result in tall plants with large leaves more prone to lodging and disease. Nutrients play an important role in crop growth and development.

This study was carried out to evaluate the effects of different sources of nitrogen fertilizer on yield & yield components of sunflower in Mashhad, Iran.

MATERIALS AND METHODS

In order of evaluation of yield and yield components of sunflower in response to different nitrogen fertilizer sources, an experiment was conducted at the Khorasan Razavi Agricultural and Natural Resources Research Center, Mashhad, Iran.

The experiments were established with different chemical and biological nitrogen fertilizers and one cultivar of sunflower cv. Master. These treatments were arranged into a factorial experiment based on RCBD design with four replications. Chemical nitrogen treatments were: No using of nitrogen, Urea application, Ammonium sulphate, and Ammonium nitrate phosphate application.

Treatment levels in this study were: without chemical fertilizer, nitrogen in form of Urea, nitrogen in form of Ammonium sulphate and Ammonium nitrate- phosphate that combined with use Nitroxin biological fertilizer and without use biological fertilizer treatments. Soil samples were collected before planting and soil analysis on composite sample of collected soil, was done to know the nutrient status and physico-chemical characteristics of the soil, prior to experiment

According to soil analysis and sunflower fertilizer requirements, Phosphorus was applied at a rate of 50 kg P/ha using calcium super phosphate (15.5% P_2O_5). Potassium was applied at a rate of 50 kg/ha using potassium sulfate (48% K_2O). The rate of nitrogen for each plot based on soil analysis and sunflower fertilizer requirements was calculated 396 gr/plot pure nitrogen and it was equal of 1.886 kg/plot of Ammonium sulfate, 1.636 kg/plot Ammonium nitrate- sulfate and 0.861 kg/plot Urea. One half of nitrogen, all phosphorous and potassium fertilizers was applied before planting in strips with 5 centimeter distance with seeds in each plot.

Germinating sunflower seed is very sensitive to seed-placed fertilizer, and fertilizer should therefore be placed away from the seed.

The second half of nitrogen was applied when plants were at 6-8 leaf stage. The manufacturer's recommended rate of Nitroxin was 1.2 millilitre for seed treatment and 0.8 millilitre with irrigation for each plot. One part of Nitrioxin was treated with seeds in shadow situation and immediately was planted and second part was applied with irrigated water when plants were at 6-8 leaf stage. Sunflower variety used was Master.

During growth stages, date of star stage, flowering date, plant height, stem diameter and dry weight were recorded. Period to harvesting, from middle rows equal to 3.6 m^2 harvested for measurements. The data analyses were conducted by using the software package SAS and EXCEL.

RESULTS AND DISCUSSIONS

Result of analysis variance (Table 1) showed that the nitrogen fertilizer had a significant simple effect on seed yield but no significant simple effects were observed from the biological fertilizer on seed yield (Table 2). Based on results interaction effects of biological fertilizer and chemical fertilizers on seed yield was significant at ($p<0.05$) by Duncan test. Mahmoud et al. (1979) and Sahi (1979) reported that the biological fertilizer significantly increased seed yield of rainfed wheat. The increase in seed yield with the increase of ammonium sulphat might be due to the role of nitrogen in activating the growth and yield components. Similar results were obtained by Kasem & El-Mesilhy (1992), Salisbury and Ross (1994), Mojiri and Arzani (2003), Killi (2004), Özer et al. (2004) and Osman and Awed (2010).

Table 1. Analysis variance of different sources of nitrogen fertilizer on yield & yield components of sunflower

S.O.V	**df**	**F**		
		seed yield	**1000 seed weight**	**seed /head**
Rep	3	0.72^{ns}	1.6^{ns}	2.43^{*}
Nitrogen	3	4.06^{*}	2.8^{*}	6.85^{**}
Biological fertilizer	1	0.01^{ns}	5.49^{*}	1.23^{ns}
Interaction effects	3	2.97^{*}	3.23^{*}	1.89^{ns}
Error	21	-	-	-
%CV		15.30	16.82	16.83

Table 1. *(cont.)*

S.O.V	**df**	**F**	
		Stem diameter	**Seed weight/head**
Rep	3	1.66^{ns}	3.05^{*}
Nitrogen	3	0.27^{ns}	6.17
Biological fertilizer	1	2.43^{ns}	3.21^{*}
Interaction effects	3	1.70^{ns}	2.46^{*}
Error	21	-	-
%CV		10.79	26.102

^{ns} nonsignificant, *significant at 0.05 significance, **significant at 0.01 significance

Results showed that the chemical fertilizers did not affect 1000 seed weight significantly. According to Table 1 and 2 simple effect of Nitroxin significantly increased 1000 seed weight. Malik et al. (1996) reported that to compare between effect of urea and ammonium sulphate on 1000 seed weight of Highsun-33, all treatments with ammonium sulphate produced higher weight to compare the other treatments that treated with urea. Soleymani et al. (2013) reported that 1000 grain weight of sunflower, was significantly Influenced by nitrogen.

Results (Tables 1 and 2) indicated that simple effect of different sources of nitrogen significantly affected number of seed per head but no significant differences was observed when we used Nitroxin. Interaction effects of chemical fertilizer and Nitroxin also was not affect on seed per head. These results same to results of Marlik et al. (1996). Abrar and Singh (2010) and Bange et al. (1997) reported that the number of seeds per head depended on genotypes and environment.

Table 2. Effects of different sources of nitrogen fertilizer on yield & yield components of sunflower

S.O.V	Yield	1000 seed weight	Seed/head
Chemical fertilizer			
N_1	2675 b	63.9 b	733.5 b
N_2	3110 ab	74.1 ab	843.9 b
N_3	3485 a	81.4 a	1020.4 a
N_4	3274 a	76.5 ab	1019.2 a
Biological fertilizer			
O_1	3130 a	68.8 b	874.5 a
O_2	3130 a	79.2 a	934.0 a

Table 2. *(cont.)*

S.O.V	Stem diameter	Plant height	Head diameter
Chemical fertilizer			
N_1	1.9 b	173.9 ab	19.7 a
N_2	2.2 a	169.7 b	19.0 a
N_3	2.3 a	173.1 a	19.9 a
N_4	2.3 a	177.2 a	19.5 a
Biological fertilizer			
O_1	2.2 a	174.6 a	20.1 a
O_2	2.2 a	172.4 a	19.0 a

Figures followed by the same letters are not significantly different at $p<0.05$

Simple effect of chemical fertilizer strongly affected on seed weight per head but simple effect of Nitroxin and interaction effects of chemical fertilizer and Nitroxin increased the weight of seed per head but it was not significant. Effects of chemical and biological fertilizers on head diameter and plant height were not significant.

Based on results simple effect of different chemical nitrogen sources specially ammonium sulphat significantly increased stem diameter but no significant differences were observed when Nitroxin treated. Osman and Awed (2010) reported that by increasing amount of nitrogen stem diameter significantly increased.

CONCLUSIONS

Although based on our results seed yield was not affected by simple effects of Nitroxin with ammonium sulphate, in the rest treatments biological fertilizer increased the yield of sunflower. Even though the increasing of yield was not significant but it is recommended because of the high prices of sunflower seeds and it seems profitable with the economic point.

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STUDIES REGARDING DYNAMICS OF WATER AND NUTRIENTS ABSORPTION IN WINTER BARLEY AND WHEAT

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Abstract

Experience regarding the dynamics of water and nutrient absorption in plants of barley and winter wheat was made in agriculture year 2012 - 2013, in North Baragan Plain on a typical chernozem soil using different doses of fertilizers. Humidity and nitrogen, phosphorus and potassium elements were determined in different phases of vegetation, in the soil and in plants. We determined dry matter accumulation in plant and plant density also, in order to chase their accumulation dynamics in barley and wheat plants. Based on the results, it could make correlations between soil quality indices and content of macro-elements in plants, in order to apply the correct doses of fertilizer to prevent pollution and achieve higher yields possible.

Key words*: sowing density, sowing time, winter barley, Braila Plain.*

INTRODUCTION

The various elements required by the plant are not equal and the needs of various minerals amounts of another group of plants of one species to another and even from one kind to another. Thus, the critical nutrition is the appearance of the third leaf and early tillering. Maximum consumption period begins after tillering and extends up to flowering.

Studies have included soil and plant chemical analysis, biometric measurements and observations were made in dynamic irrigated wheat and winter barley to observe the morphological changes during vegetative growth and some physiological and biochemical indices characterizing metabolic processes in the plant, in correlation with agronomic measures applied. The literature reveals that the growth of wheat and barley plants, capacity tillering and stages of organogenesis are clues that are closely related to environmental factors, particularly temperature and humidity, but each variety having a specific period of organogenesis in function by its biology. Multiannual results on similar experiences showed that hardy and productive varieties are those that are characterized by a fast growth and development throughout the vegetation, which advocated the promotion and expansion of the production of wheat and barley who had the qualities mentioned.

On the other hand, observing the dynamics of absorption of water and mineral elements by plants compared to supply state of the soil, agro-technical measures that can be taken to encourage increased production of grain per hectare.

MATERIALS AND METHODS

Experience concerning by study on dynamics of water and mineral elements absorption in plants of wheat and winter barley was conducted in agricultural year 2012 - 2013, in the EC Chiscani of ARDS Braila, on a typical chernozem soil using different doses of urea fertilizer in winter with 2 graduations (100 kg/ha and 200 kg/ha).

The biological material used was represented by the Boema and Glosa varieties of wheat and Cardinal winter barley cultivar. Experience was located in subdivided plots, with 3 repetitions for each variable in the two graduations of nitrogen fertilization doses (Figure 1).

This experience represents a sub-experience within a complex experience with seeding densities and different sowing times. determined in different phases of vegetation, humidity and total content of dissolved salts (conductivity method) content of mineral elements: nitrogen, phosphorus and potassium in soil and in plants, in the forms of nitrate, nitrite, phosphate, total phosphorus, phosphorus pentoxide, total potassium and potassium oxide (Photometric method) and dry matter accumulation in plant (drying oven).

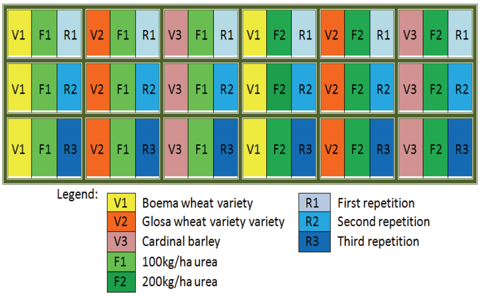

Figure 1. Experience locating in field

Dynamics of nitrogen, phosphorus and potassium absorption by plants during vegetative period was observed by analyzes of soil and plant extracts in the following vegetation stages: 1 leaf, 3 leaves, early tillering, end tillering, and dormant.
Also have done biometrics on plants, in the same phase of vegetation and plant density in order to study the dynamics of water and mineral elements absorption.
Based on the results, we could make correlations between indexes of soil quality and content of nitrogen, phosphorus and potassium elements in plants, in order to correct doses of fertilizer application to avoid pollution and getting higher yields possible.

RESULTS AND DISCUSSIONS

It is known that nitrogen in adequate quantities provide good tillering and rooting of plants, increases resistance to low temperatures, increases the number of fertile flowers in the ear, and improves the grain content in protein substances. If an excess of nitrogen occurs frequently danger of falling grain cereals.
Climatic characterization of the vegetative period of experimental variants revealed the following elements described below.
In terms of precipitation, autumn water intake was recorded precipitation of 68 mm, 28 mm below the multiannual average (96 mm), and in winter were more abundant precipitation (220 mm), providing the rain and December snow exceeding half of the intake and multiannual average (87 mm) by 133 mm.

Table 1. The main climatic elements of agricultural year 2012 – 2013

Climatic elements		Month values													Total agricultural year
		IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	
Precipitation (mm)	Normal	29	31	36	33	27	27	29	36	52	63	47	42	29	452
	Agricultural year 2012-2013	35	26	7	107	66	47	31	16	56	44	49	27	60	536
	Deviation	+6	-5	-29	+74	+39	+20	+2	-20	+4	-19	+2	-15	+31	+84
Air Temperatures (°C)	Normal	17,5	11,7	5,6	0,4	-2,5	-0,3	4,6	10,9	16,9	20,7	22,8	22,1	17,5	10,9
	Agricultural year 2012-2013	18,8	13,6	7,4	-1,5	-1,2	2,8	4,5	13,0	19,3	22,2	22,9	23,2	16,1	11,8
	Deviation	+1,3	+1,9	+1,8	-1,9	+1,3	+3,1	-0,1	+2,1	+2,4	+1,5	-0,6	+1,1	-1,4	+0,9
Air Humidity (%)	Normal	62	74	78	83	83	79	72	70	67	66	64	65	62	73
	Agricultural year 2012-2013	72	81	90	89	92	70	75	68	69	75	67	63	72	76
	Deviation	+10	+7	+12	+6	+9	-9	+3	-2	+2	+9	+3	-2	+10	+3

Meteorological Station of Braila

In terms of temperatures, autumn was warmer than multiannual monthly values from 1.3 to 1.9°C, and in winter there were these differences: December was 1.9°C cooler and the other two months were warmer than the multiannual, with 1.3°C-3.1°C in January and February (Figure 2).

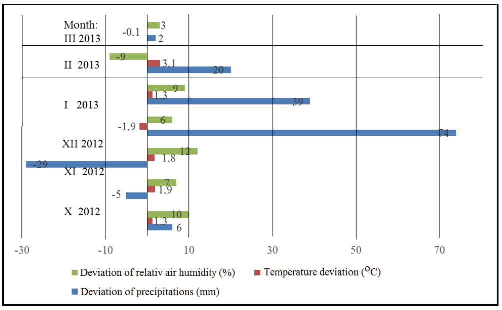

Figure 2. Deviations of climatic elements compared to normal in experimental period

Indices chemical analyzes on soil, in vegetation stage studies showed an increase in the total content of soluble salts in the first three phases and lower on end tillering and dormant stages (Figure 3), while agrochemical indices were a growing trend to early tillering and then gradually declined, so the dormant period reached based values (Figure 4).
Biometric measurements performed in different stages of vegetative period of winter wheat and barley are represented in Figure 5, where it can observing that wheat variety Glosa recorded an average number of leaves and tills than variety Boema, until the dormant. The Cardinal winter barley variety formed in tillering stage an

average number of eight tills to dormant, in conjunction with increased absorption of nitrogen in tillering stage.

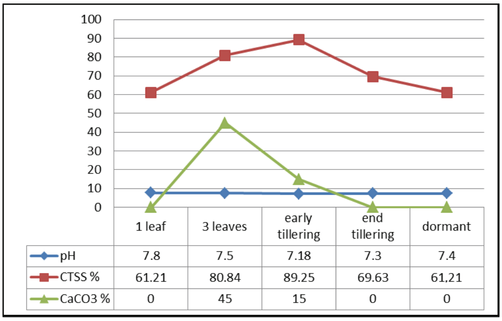

Figure 3. Total soluble salts content in soil, pH and calcium carbonate in soil, on vegetative period

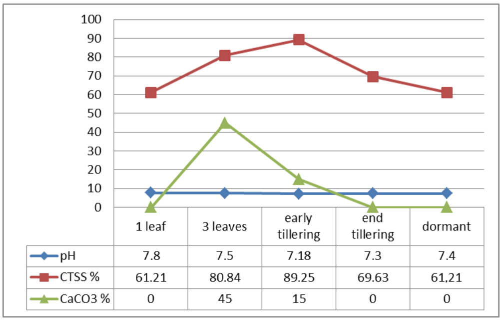

Figure 4. Content in fertilizer elements (NPK) in soil, on different stages of vegetative period

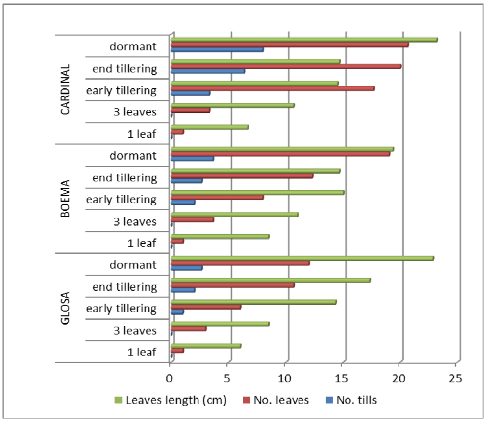

Figure 5. Results of biometric meansurements made in vegetative period

Based on the determination of water content from the soil and plants in the five phases of the vegetative period, it was observed root water uptake dynamics in these two species (Figure 6).

Positive correlation between soil water content and plant, indicating that the absorption of water by root cells must be in a hypotonic environment and the vacuolar juice must be hypertonic. The result of this situation is materialized through endosmotic current, i.e. a current penetration of water into the root cells, increasing their moisture (Figure 7).

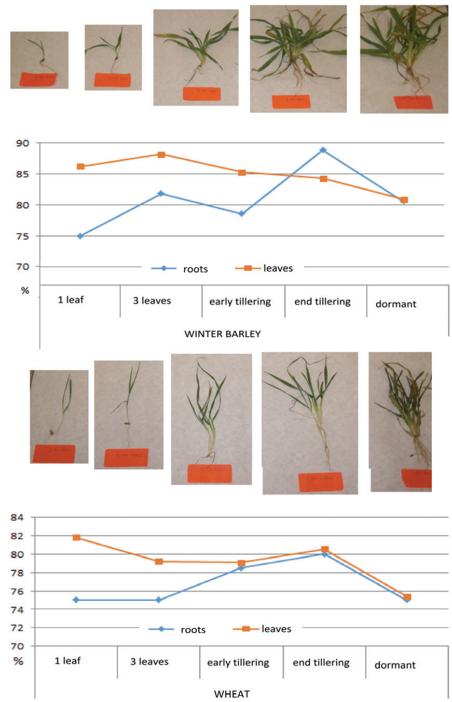

Figure 6. Water dynamics on plants

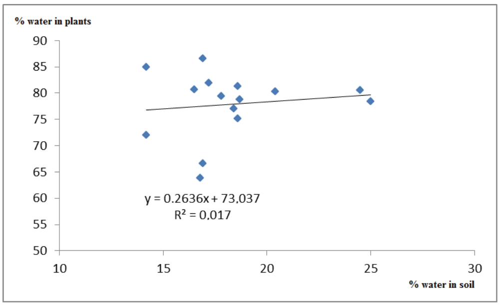

Figure 7. Correlation of water content in soil and plants

Analysis of dry matter content of plants showed similar dynamics in the two species studied. The dry matter content in root is higher than the dry matter content of leaves in the early stages of vegetation by the end tillering, when the

difference decreases and becomes equal in dormant stage (Figure 8).
Total content of dissolved salts in the plant extract 1:5 was between 52.8 and 92.06% values, with the maximum recorded in early tillering stage (Figure 9).

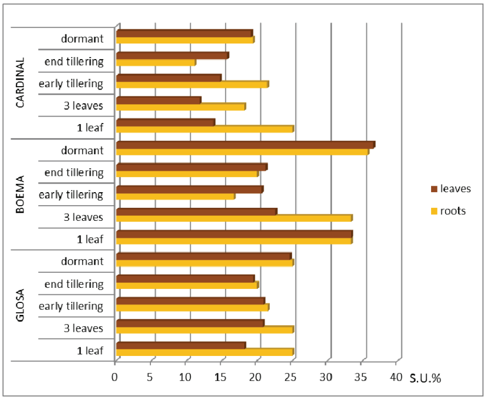

Figure 8. Dry matter content in plants in vegetative period

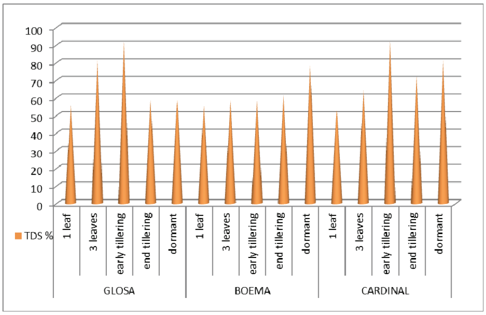

Figure 9. Total dissolved salts in plants extract in different stages of vegetative period

Laboratory analysis results showed that the absorption of nutrients (N, P, K) is very high in one leaf stage, then declines during the 3-4 leaf, then increase by 15-20% during tillering stage and falls again in dormant stage until the formation of straw, when it grows again with 20 to 25% (Figure 10).
Although the vegetation period of wheat and winter barley is longer, most of the nutrients are absorbed in a very short time at the beginning of training to baking straw in milk: 78-92% nitrogen, 75-88% phosphorus, potassium 85-88%. In this short time, wheat and barley cannot to secure to give high yields, the necessary nutrients from soil reserves only. Therefore, fertilization complex at seedbed preparation and corrective fertilization with nitrogen in winter are very necessary.
The influence of high doses of urea application on wheat and winter barley productivity elements was not very significant for normal plant densities of 500-600 pl. / Sq. (Figure 11).

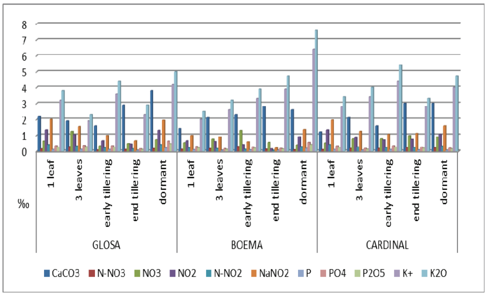

Figure 10. Dynamics of nitrogen, phosphorus and potassium content in vegetal extract, in different stages of vegetation

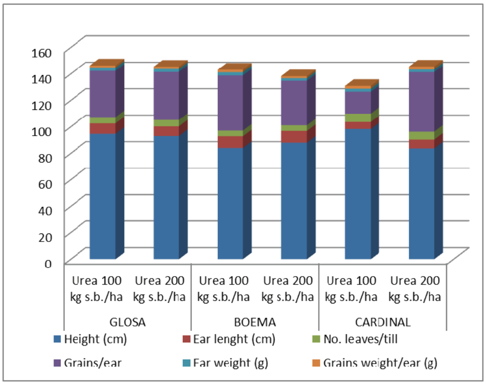

Figure 11. Graphic of biometric meansurements results at harvest time

But in the case of lower sowing densities and some late planting dates, fertilization with a higher dose of urea in winter (200 kg/ha) had favorable influence for increasing ear length, number of grains per ear, and grains weight per ear (Figure 12).
Therefore, it can be concluded that the administration of urea in an amount of 200 kg/ha, when it notice a decrease in density of plants per square meter, can increase the grain weight per ear by 40-50%, while on the normal or high densities, the influence of fertilization with the higher dose of urea on the growth of grains in the ear mass is below 15%.
Influence of urea corrective fertilization amount 200kg in the production was significant on both wheat and winter barley variants, with

increase of production by 3.18% for Glosa variety and 15.83% for Boema variety and only by 1.04% barley from Cardinal winter barley variety (Figure 13).

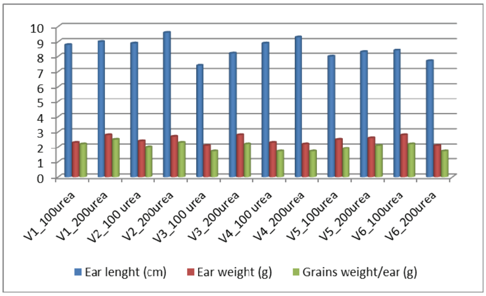

Figure 12. Fertilizer influence with urea on different density of sowing for ear lenght, ear wieght and grains weight per ear

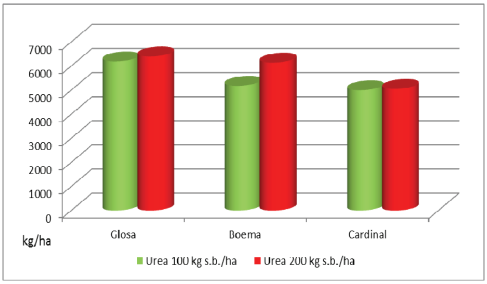

Figure 13. Differences of yields obtained by experimental variants with different fertilizer doses

CONCLUSIONS

Water absorption by barley and wheat plants is very high in 3-leaves stages and during tillering, then decrease in the winter period.

Tillering phase is the first critical phases of nutrition in winter wheat and winter barley during vegetative period, then decrease in winter, but immediately in spring the absorption increases by 20% in the training phase of the straw.

Corrective dose of nitrogen applied in late winter or in spring greatly influences grain yield in winter wheat and winter barley by increasing ear length and grain weight per ear.

In low densities of plants per square meter, we recommends the application of high doses of nitrogen in spring, calculated in correlation with the state of the soil supply in this element to prevent soil pollution.

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RESEARCH ABOUT INFLUENCE OF SOWING DENSITY AND SOWING TIME FOR PRODUCTION LEVEL OF WINTER BARLEY IN NORTH BARAGAN PLAIN CONDITIONS

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Abstract

Sowing density is very important to ensure the optimum nutrition at the area of crop plants, in order that the production of quality of barley. On the other hand, the time of sowing is very important in how the plants resistant to the environment in winter and to the attack of pathogens and pests, by spring. Experience presented in this paper, shows how sowing density and sowing time influences the production of barley, of Cardinal variety in the climatic conditions of the agricultural year 2012 - 2013, Chiscani Experimental Center, the Agricultural Research and Development Station of Braila on a typical chernozem soil type. For this, we used seven experimental factor graduations for sowing density and five experimental factor graduations for sowing time. During the vegetation were made biometric measurements on plant height, number of leaves per plant, number of grains per ear, grain weight per ear and yield of each experimental plot at harvest. Based on the results, and analysis of variance were performed for the two experimental factors and correlations were established between the experimental factors and biometric measurements. Synthesis results show that the experience of winter barley crop in the climatic conditions of Braila, the best sowing density is 550 g.s/m2 and optimum sowing period is 3-20 October.

Key words: *sowing density, sowing time, winter barley, Braila Plain.*

INTRODUCTION

Sowing time is essential, late sowing leading to significant reduction of plant density, and therefore to decrease the production of grains. Barley crop technology recommended 20 September to 10 October like optimal sowing time in conditions of our country, for winter barley should form 3-4 brothers, to accumulate in the node tillering, large amounts of sugars, and to develop strong embryonic root system and to start the formation of coronary root. The main objective of this study is to find out the optimum sowing time and density sowing of winter barley in the climatic conditions of North Baragan Plain.

MATERIALS AND METHODS

The field experiment was located in Agricultural Research and Development Station of Braila-Chiscani Experimental Center, organized in subdivided parcels method that it included 7 variants with 3 repetitions for sowing density and 5 variants with 3 repetitions for sowing time, the area for a variant being 180 m^2. The experience included two experimental factors: V (sowing density) and E (sowing time), the cultivated variety of barley was Cardinal and the graduations of the experimental factors were the following (Figure 1.):

- V1 – 200 g.s./m^2; E1- sowing time I (3 Oct. 2012);
- V2 – 250 g.s./m^2; E2-sowing time II (12 Oct. 2012);
- V3 – 350 g.s./m^2; E3-sowing time III(23 Oct. 2012);
- V4 – 450 g.s./m^2; E4-sowing time IV (12. Nov 2012);
- V5 – 550 g.s./m^2; E5-sowing time V (22 Nov 2012);
- V6 – 650 g.s./m^2;
- V7 – 750 g.s./m^2.

Figure 1. Placing the experience of sowing density and sowing time in winter barley

Different sowing densities were performed on October 3, 2012, and the sowing density for different periods was set at 550 g.s./m^2.

For setting up the experiments the following biological material was used: winter barley variety "Cardinal" with the following indices:

- Biological category – PB II;
- Physical purity [%] – 99%;
- Moisture [%] – 12,6;
- Total germination [%] – 75%;
- 1000 grain weight [g] – 40.9 g;
- Sanitary condition - good.

Laboratory analysis methods were:

1. Determination of physico-chemical properties in soil:
   - pH of the soil - the potentiometric method, with digital pH meter, an aqueous suspension soil: water 1:2.5.
   - CTSS - the total content of soluble salts - conductometric method by using digital Conductivity in aqueous extract soil: water 1: 5.
   - Mineral elements content in soil (N, P, K) were determined by the Photometric the aqueous extract of the soil to water of 1: 5.
   - Soil humus content - determined by titrimetric method.
2. Determination of physiological and chemical indices in plants:
   - Dry matter content of the plants - by the gravimetric method - drying in the oven.
   - Content of nitrogen, phosphorus and potassium in plants using the photometric method, analyzing the aqueous extract of the leaves at winter start (12.07.2012), at spring start, at earing.
   - Evaluation of production - Gravimetric method at harvesting.
   - Determining productivity elements of experimental variants after harvest (MMB - Gravimetric method, MH – with the Granomat, yield - Gravimetric method).

Statistical methods for interpreting results were used.

The content of nutrients in plants, in various stages of vegetation was graphically represented by comparing the five sowing time and seven different sowing densities.

Productivity elements were interpreted statistically by the analysis of variance and correlation method.

RESULTS AND DISCUSSIONS

Rising date, in the experience of different densities was on 11/10/2012, while in the experience of different sowing time was as following:

- E1 – 11.10.2012;
- E2 – 21.10.2012;
- E3 – 4. 11. 2012;
- E4 – 23.11.2012;
- E5 – did not rise by the start of winter.

At the start of winter, biometric measurements were performed for all variants of different densities, the results being represented in Figure 2.

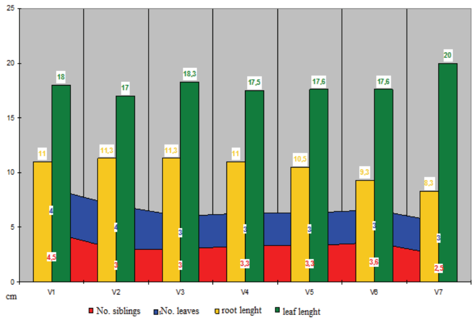

Figure 2. Results of biometric measurements performed for each variant, on the entry into winter (29/11/2012)

It was found that the experimental variant with 200 g.s./m^2 in the winter had the highest number of siblings, together with a large number of leaves, while the density 750 g.s. /m^2 version, recorded a small number of brothers and leaves, and the leaves had the largest length compared with other experimental variants (Figure 3).

Figure 3. Pictures of Cardinal barley plants sown at different densities at the entrance to winter (29.11.2012)

Dry matter content in plant, on entering the winter showed that the highest content of dry matter in roots was recorded in variant V5 (550 g.s./m^2), while the variant V4 (450 g.s/m^2) showed a low dry matter content, both in roots (20.04%) and in leaves (16.50%) (Figure 4).

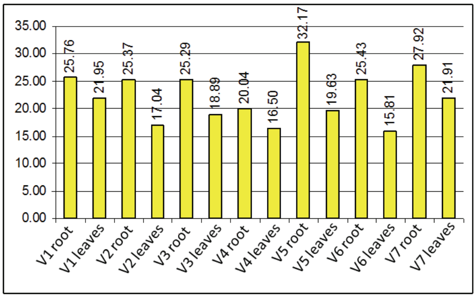

Figure 4. The dry matter content of barley plants Cardinal at the entrance to winter - CE Chiscani

Legend:

v1	200 g.s./m^2	v4	450 g.s./ m^2
v2	250 g.s./ m^2	v5	550 g.s./ m^2
v3	350 g.s./ m^2	v6	650 g.s./ m^2
		v7	750 g.s./ m^2

For the winter's end, the dry matter content of the plants is shown in Figure 5, were we see a significant decrease in the percentage of the dry matter of plants in all experimental variants, reversing the ratio of dry matter of the root and the leaves, which in the winter was higher in roots and at the end of the winter it became larger in leaves due to the excessive moisture in the soil, caused by the melting snow and leaf damage by partial wilting due to late frosts.

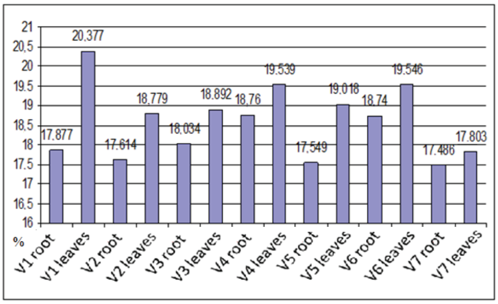

Figure 5. Dry matter content of barley plants at out of winter - CE Chiscani

The nutrients N, P, K, in various forms (nitrogen nitrate, nitrite, nitrite nitrogen, nitrite, phosphorus, phosphate, phosphorus pentoxide, potassium, potassium oxide) were analyzed in the 1:5 aqueous extract from the leaves of plants, the graphical representation being shown in Figure 6, the entry in the winter, and in Figure 7, at the end of winter.

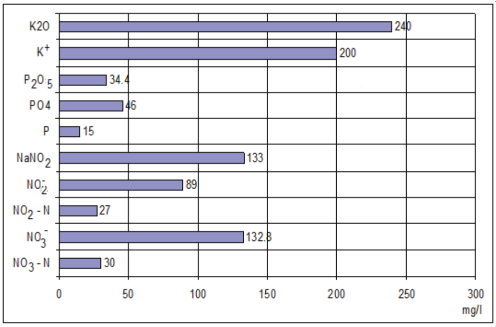

Figure 6. The contents of mineral elements in barley plants at the start of winter (29/11/2012)

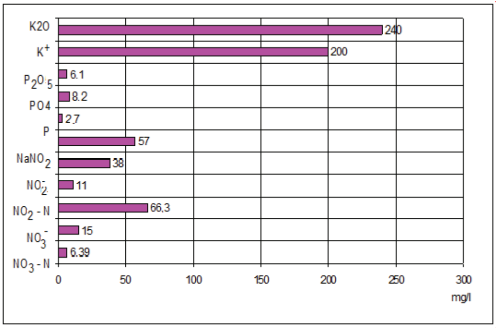

Figure 7. The contents of mineral elements in barley plants at the end of winter (03/07/2013)

It is noted that the output of the standard N and P content was lower than the aqueous extract of the leaves: water of 1:5, the barley plants, and the pH of the extract was slightly acidic.

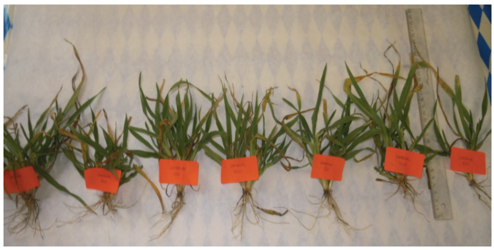

Figure 8. Pictures of Cardinal barley plants sown at different densities at the end of winter (03/07/2013)

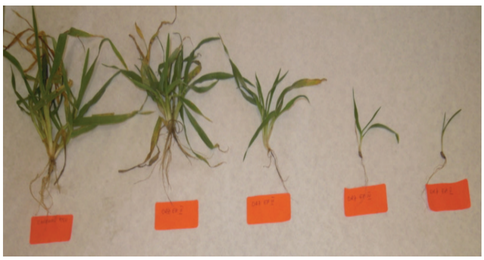

Figure 9. Pictures of Cardinal barley plants sown at different times at the end of winter (7.03.2013)

As shown in Figure 9, at the end of winter, barley sown at different times present different degree of tillering, the strongest degree of tillering being at the barley sown in the sowing time I and II, the sowing time III had two brothers in average, the sowing period IV had a brother on average and the barley from sowing period V didn't have any.

Regarding the average density of plants and the average number of siblings for each experimental variant, the results of determinations were centralized in Tables 1 and 2.

Table 1. The average number of siblings and plant density for the sowing density experimental factor at the end of winter

Determination	V1 200 g.s./m^2	V2 250 g.s./ m^2	V3 350 g.s./ m^2	V4 450 g.s./ m^2	V5 550 g.s./ m^2	V6 650 g.s./ m^2	V7 750 g.s./ m^2
Average Number siblings / pl	14	9	8	8	9	7	5
Average No. plants / m^2	140	232	184	272	352	324	404

Table 2. The average number of siblings and plant density for the sowing time experimental factor at the end of winter

Determination	Sowing time determinations and values				
	E1 3.X	E2 12. X	E3 23.X	E4 12.XI	E5 22.XI
Average Number siblings / pl	8	7	3	-	-
Average No. plants / m2	272	336	384	100	260

Results of the tests show that the seed sown in the fourth period began to germinate before the first frost and a lot of plants were lost. Instead, the seeds sown in the fifth sowing time have been preserved in the soil and germinated at the start of spring and they rises. Optimal plant density out of the winter was recorded in version V5 for the sowing density experimental factor - 550 g.s./m^2 and in E3 variant experimental for the sowing period factor - seeding at 23/10/2012. The worst results out of plant density at the end of winter were recorded in variant V1 (200 g.s./m^2) - 140 plants/m^2, for the sowing density experimental factor and in E4 variant (sowing time 4 - 12/11/2012) - 100 plants/m^2.

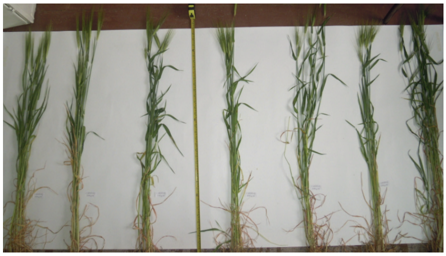

Figure 10. Images of the barley plants of the following experimental different densities on 13.05.2013

Average plant height was different in the experimental variants, both during the growing season (Figures 10 and 11) and physiological maturity (Figure 12), variants with the largest size being V5 (550 g.s/m^2) - 98.33 cm, V7 (750 g.s/m^2) - 95.33 cm and V1 (200 g.s/m^2) – 94.67 cm for the planting density experimental factor; for the sowing period, the highest average plant size was recorded in variant E2 (age II - 12/10/2012) - 86.37 cm, followed by variant E1 (age II - 10/03/2012) - 81cm.

Figure 11. Images of barley plants of different variants from the sowing time experiment, on 13/05/2013

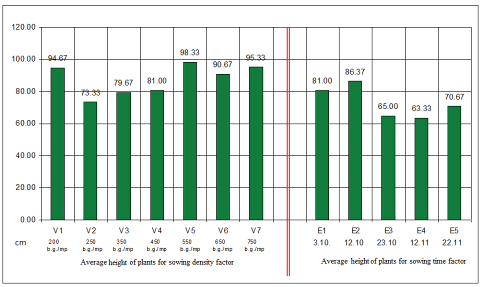

Figure 12. Average height of barley plants at physiological maturity for the two experimental factors

Thus, most barley plants were 81cm in height, followed in descending order by 88cm and 74cm plants (Figure 13).

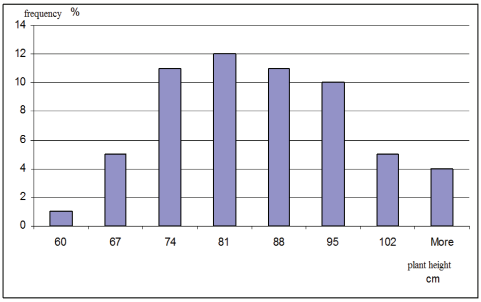

Figure 13. Histogram for barley plant height in the experience with different sowing densities and sowing times

Measurements on the average length of ear, showed that the highest values were recorded at E3 variant (III sowing time - 23/10/2012), followed in descending order by E5 (sowing time V), E4 (sowing time IV), V1 (d = 200 g.s./m^2) and V2 (d = 250 g.s./m^2) (Figure 14), but the highest frequency on the average ear length was of 6.3 cm, as shown in the histogram of Figure 15.

However, it was observed that ears with higher average length had a greater number of shriveled grains than smaller ears variants length, recording a lower yield than those. In Figure 16 are showed the average values of plant height, number of grains per ear and yield for each experimental variant, observing that the best performance was obtained in V5 variant (550 g.s./m^2 sowing density) and for sowing period, the highest yield was obtained in E2 variant (second sowing time - 12.10.2012).

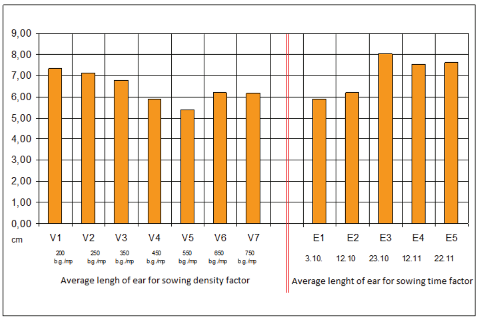

Figure 14. The average length of the ear of barley at physiological maturity in the experience with different densities and sowing times

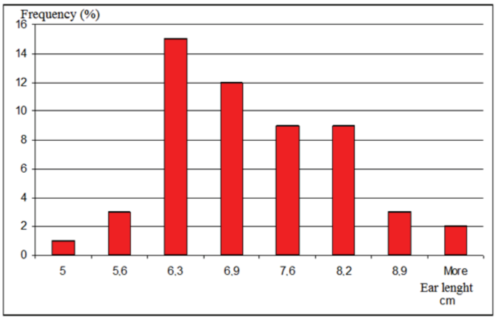

Figure 15. Histogram for the average ear length of barley in the experience with different densities and sowing times

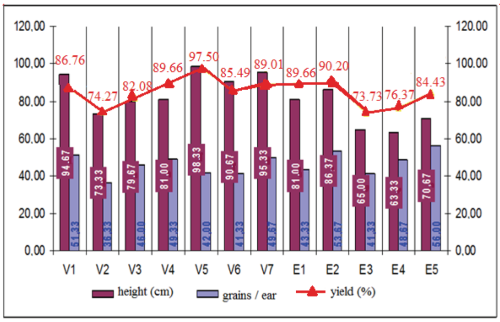

Figure 16. Graph with average values of plant height, number of grains per ear and yield in the experience

The greatest yields in the experience were obtained in the variants V5 (D = 550 g.s/m^2) with 6166kg/ha, followed in descending order by version V4 and E1 (D = 450 g.s/m^2 sowing time I = 10/03/2012) with 4726kg/ha and E2 variant (sowing time II = 12/10/2012) with 4518kg/ha (Figure 17).

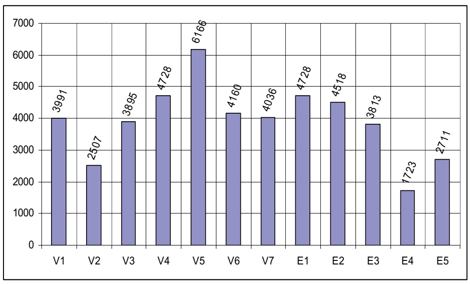

Figure 17. Average production per experimental variant, expressed in standard humidity of 14%

The significances of differences in production compared to the control, represented by the average of the experience were summarized in

Table 5.4, where it can be see that the variant V5 (D = 550 g.s/m^2) showed a highly significant positive output gap (2251 kg/ha) compared to the average of the experience, followed by variant V4 (D = 450 g.s/m^2) and E1, with a distinct significant positive difference (813 kg/ha).

The lowest yields, with very significant negative differences from the control were obtained in the E4 variant (sowing time IV) with a difference of 2192 kg/ha, V2 (D = 250 g.s/m^2) with a difference of 1408 kg/ha and E5 with the difference of 1204 kg/ha.

Thus, we can say that in the climatic conditions of the year 2012 - 2013 in the Chiscani, Braila County, the most recommended barley sowing densities are 550 g.s/m^2 and 450 g.s/m^2 and sowing period should not be later than October 20.

Table 3. Interpretation of the results of production by analysis of variance for different sowing times and densities for winter barley

Variant	Absolute production	Relative production	Differences		Significance
			Abs.	Rel.	
V1	3991	101.94	76	1.94	-
V2	2507	64.04	- 1408	- 35.96	ooo
V3	3895	99.49	-20	-0.51	-
V4	4728	120.77	813	20.77	**
V5	6166	157.50	2251	57.50	***
V6	4160	106.26	245	6.26	-
V7	4036	103.09	121	3.09	-
E1	4728	120.77	813	20.77	**
E2	4518	115.40	603	15.40	*
E3	3813	97.39	-102	-2.61	-
E4	1723.3	44.02	- 2192	- 55.98	ooo
E5	2710.6	69.24	- 1204	- 30.76	ooo
Control	3915	100	-	-	-

DL5% = 474.4 kg/ha; DL1% = 644.8 kg/ha; DL 0.1% = 863.6 kg/ha

The most resilient barley plants over the winter were sown in the first period (October 3) at a density of 550 g.s./m^2 this experimental variant achieving very significant production increases from the average experience (Figure 18).

To substantiate the results obtained in the experience, the test for the correlation between the biometric measurements, the experimental factors and the tests carried out, so that they may be associated with agro-technical measures in order to obtain the highest possible yields.

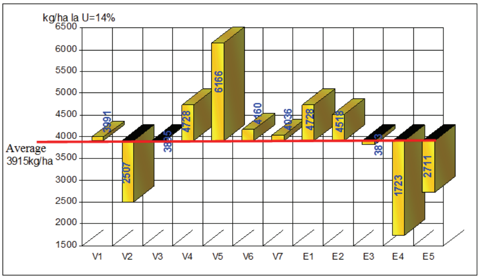

Figure 18. The differences in the experimental variants yields, compared to the control (average experience)

In Figure 19 it can be noticed a synthesis of the correlations between sowing density and some biometric measurements, observing a positive correlation between sowing density and number of leaves, yield production and plant height, and a negative correlation between sowing density and length and weight of ear. Between the sowing period and the biometric values at physiological maturity of winter barley were recorded positive correlations for ear length, ear weight, grain weight per ear and number of grains per ear, but negative correlations were recorded for plant height, the production yield and the number of leaves per plant.

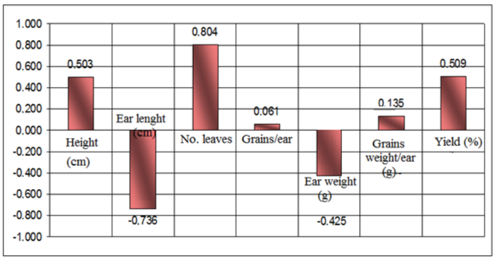

Figure 19. Correlations between sowing density and biometric measurement values at physiological maturity of winter barley

It can be concluded therefore that the extension of sowing in autumn favors growth in barley ear length, number of grains per ear, but many grains are shriveled in plants sown later and the production yield is even lower, as sowing period goes later than October 20 (Figure 20).

Summary for graphs of the correlations established between the experimental factors and biometric measurements made at physiological maturity are shown in Figure 21.

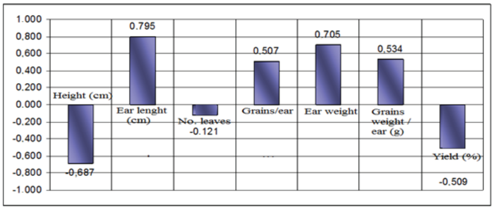

Figure 20. Correlations between sowing time and biometric measurements at physiological maturity of winter barley

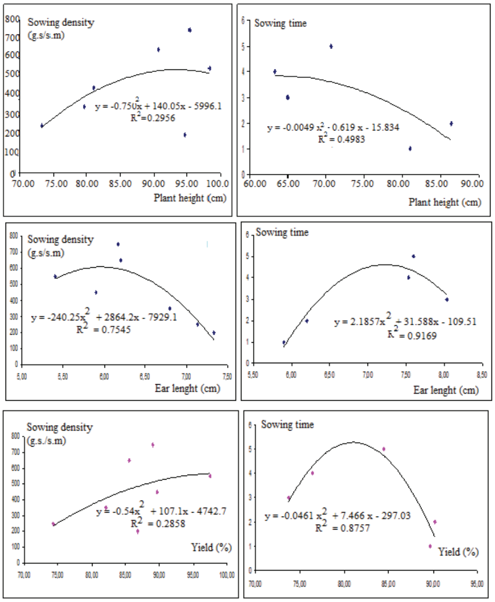

Figure 21. Correlations established between the experimental factors and biometric measurements at physiological maturity of winter barley

CONCLUSIONS

The sowing density and sowing time are very important for obtaining higher production from cereal grains sown during fall.

In the climatic conditions of the 2012 – 2013 agricultural year, the best results on winter barley were obtained in variants cultivated during the October 3 – 22 period, with seeding density of 550 g.s./m^2, which had an average of 6166 kg/ha, followed by 450 g.s./m^2 density, with an average production of 4728 kg/ha and the second period, with average production of 4518 kg/ha.

Significant positive correlations were recorded between sowing density and height of barley plants, number of leaves, grain weight per ear and yield of production and between the sowing period and ear length and weight as well as number of grains per ear.

Significant negative correlations were recorded between seeding density and ear length and weight and between sowing period and plant height and yield production.

Synthesis results of the experience show that the culture of winter barley in the climatic conditions of Braila, the better seeding density is 550 g.s/m^2 and optimum sowing period is 3-20 October.

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EFFICACY OF DIFFERENT FUNGICIDES IN WHEAT FOLIAR DISEASES MANAGEMENT

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Abstract

In Romania, major economic losses in wheat crop are registered for some foliar diseases: fusarium head blight or scab (Fusarium graminearum), septoria/stagonospora leaf spot/blotch complex (Septoria tritici, Stagonospora nodorum), powdery mildew (Blumeria graminis) and, for several years, tan spot (Pyrenophora tritici-repentis).
Foliar fungicides treatments are a major mean to prevent yield loses in wheat. Fungicides are the most effective when they are used as part of an integrated disease management strategy. Higher efficacy is expected when they are properly applied, in recommended dose and at optimal timing.
The efficacy of fungicides treatments in controlling foliar fungal pathogens was evaluated in field trials conducted between 2010 and 2012, in three different locations (Fundulea - Călăraşi; Iazu - Ialomiţa; Slobozia - Giurgiu).
Twelve fungicides (Artea, Alert, Amistar X-tra, Allegro, Capalo, Duett Ultra, Evolus, Falcon, Nativo, Opera Max, Osiris and Tango Super) applied in different schemes were tested. Fugicides efficacy was calculated based on foliar diseases incidence and severity compared to untreated control.
Foliar treatments under all schemes significantly reduced the diseases severity. Differences in fungicides efficacy have been registered and were depending on wheat cultivar, location and implemented schemes.

Key words: *wheat, foliar diseases, treatments, efficacy, cultivars.*

INTRODUCTION

Although wheat can be attacked by a large number of fungal diseases in Romania, only some of them are usually responsible for major economic losses: fusarium head blight or scab (caused by *Fusarium graminearum*), septoria/stagonsospora leaf spot/blotch complex (caused by *Mycosphaerella graminicola* sin. *Septoria tritici* and *Stagonospora*/*Phaeosphaeria*/*Septoria nodorum*), powdery mildew (caused by *Blumeria graminis*) and tan spot (caused by *Pyrenophora tritici-repentis*).
Foliar fungicides treatments are an important part of wheat production.
Fungicides are used to manage efficiently wheat disease problems that farmers occasionally face. The use of fungicides has been common in recent years.
Fungicides are more effective when used as part of an integrated disease management strategy.
Effective crop monitoring methods will help farmers to make the right decisions about when and in what case it is necessary to apply fungicides.
Through field-testing fungicides over multiple years (2010-2012) and locations (Fundulea-Călăraşi; Iazu-Ialomiţa; Slobozia-Giurgiu), we obtained a lot of information on fungicides efficacy on several wheat foliar diseases.
Higher efficacy is expected when the products are properly applied at recommended dose and at optimal timing.
Under certain environmental conditions, can occur serious economic losses (Ză1ă et al., 2004).
Measuring the ability of wheat breeders to offset disease and increase future wheat yields is important given the need to feed the large and increasing global population (Barkley et al., 2013).
The fungus *Pyrenophora tritici-repentis* produces oval an “eyespot” type of symptom, which is usually distinctive for the disease (Figure 1).

Mature lesions of *Stagonospora nodorum* are generally lens-shaped without the distinct yellow border typical of tan spot lesions (Figure 1).

Figure 1. Mixed infection: tan spot and stagonospora spot on wheat leaves; note tan necrosis spot in center and yellow halo

The lesions of *Mycosphaerella graminicola* are restricted to the leaf veins, giving the appearance of parallel sides.
Fusarium graminearum shows bleached spikelets, splayed awns, often pink or orange-red in color, especially at the base of the glumes; *Blumeria graminis* f. sp. *tritici* is easily recognized by cottony white fungus on leaves, stems, and heads.

MATERIALS AND METHODS

The objective of this research was to estimate the degree of attack of some foliar wheat diseases.
The efficacy of fungicides treatments on foliar fungal pathogens was evaluated in field trials conducted between 2010 and 2012, in three different locations (Fundulea - Călăraşi; Iazu - Ialomiţa; Slobozia - Giurgiu).
Twelve fungicides: Artea 330 EC, Alert SC, Amistar XTRA 280 SC, Allegro SC, Capalo SE, Duett Ultra SC, Evolus EC, Falcon 460 EC, Nativo 300 SC, Opera SE, Osiris LS and Tango Super SE applied in different schemes were tested at the recommended dose from CODEX (Henegar and Andru, 2013).
Fungicides efficacy was calculated based on attack degree (which is calculated based on frequency and intensity).
The attack value is represented by frequency (F%), intensity (I%) and attack degree (AD%).
Frequency is the percentage of plant attacked out of 100 examined wheat plants.
Intensity indicates the degree to which the wheat plant is attacked under examination. Intensity was noted directly in percentage.
The attack degree which present the severity of diseases was calculated based on frequency and intensity, using the formula:

$$A.D. = \frac{F\%\ x\ I\%}{100}$$

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.
Differences in the efficacy of the fungicides were determined by direct comparison result of the tests in the field.
Cultivars treated were Arlechin, Apache and Glosa. Observations were made under natural contamination at growth stage BBCH 61 (Witzenberger et al., 1989).

RESULTS AND DISCUSSIONS

The scoring attack for *Blumeria graminis*, *Fusarium graminearum*, *Septoria tritici*, *Stagonospora nodorum* and *Pyrenophora tritici-repentis* has a particular importance for the wheat in establishing the need for chemical treatments during the vegetation season.
The data presented in Table 1 show the results on the behaviour of the cultivar Arlechin to the pathogens *Pyrenophora tritici-repentis* and *Stagonospora nodorum*.
It is noteworthy that there was no attack of *Pyrenophora tritici-repentis* in the variants treated with fungicides Capalo + Duett; Tango + Opera; Tango + Alegro; Tango + Osiris; Tango + Duett, where efficacy was 100%. Also, there was no attack of *Stagonospora nodorum* in the variants treated with fungicides Capalo + Duett and Tango + Duett.
Efficacy for prevention of *Pyrenophora tritici-repentis* attack, ranged from 88.1% (in the variant Artea + Amistar) to 99.5%. (in the variant Falcon + Nativo).

Table 1. Fungicides efficacy in cultivar Arlechin (Fundulea – Călăraşi, year 2010)

Variants	Pathogen							
	Pyrenophora tritici-repentis				*Stagonospora nodorum*			
	F (%)[1]	I (%)[2]	AD (%)[3]	E (%)[4]	F (%)[1]	I (%)[2]	AD (%)[3]	E (%)[4]
Untreated control	81.0	1.36	1.1	-	95.0	3.08	2.93	-
Artea + Amistar	54.0	0.25	0.13	88.1	74.0	1.06	0.78	73.4
Alert + Acanto	27.0	0.1	0.03	97.3	77.0	1.29	1.0	65.9
Falcon + Nativo	13.0	0.04	0.005	99.5	77.0	1.01	0.78	73.4
Capalo + Duett U	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
Tango S + Opera	0.0	0.0	0.0	100.0	32.0	0.1	0.03	98.9
Tango S + Allegro	0.0	0.0	0.0	100.0	20.0	0.03	0.006	99.8
Tango S + Osiris	0.0	0.0	0.0	100.0	60.0	0.3	0.18	93.8
Tango S + Duett U	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
DL 5% = 73.3%; DL 1% = 82.8%; DL 0.1% = 91.9% - for efficacy								

[1]F (%) = Frequency; [2]I (%) = Intensity; [3]AD (%) = Attack degree; [4]E (%) = Efficacy of fungicide treatment.

Table 2. Fungicides efficacy in cultivar Apache (Iazu – Ialomiţa, year 2011)

Variants	Pathogen							
	Mycosphaerella graminicola				*Stagonospora nodorum*			
	F (%)[1]	I (%)[2]	AD (%)[3]	E (%)[4]	F (%)[1]	I (%)[2]	AD (%)[3]	E (%)[4]
Untreated control	40.0	0.8	0.32	-	11.0	0.38	0.04	-
Tango	10.0	0.07	0.007	97.8	6.0	0.1	0.006	85.0
Duett U	25.0	0.26	0.07	78.1	0.0	0.0	0.0	100.0
Tango + Duett U	19.0	0.22	0.04	87.5	9.0	0.11	0.009	77.5
Tango + Alert	0.0	0.0	0.0	100	0.0	0.0	0.0	100
Alert	33.0	0.4	0.13	59.3	7.0	0.25	0.017	57.5
DL 5% = 69.2%; DL 1% = 81.6%; DL 0.1% = 88.4% - for efficacy								

Table 3. Fungicides efficacy in cultivar Glosa (Slobozia – Giurgiu, year 2012)

Variants	Pathogen							
	Mycosphaerella graminicola				*Stagonospora nodorum*			
	F (%)[1]	I (%)[2]	AD (%)[3]	E (%)[4]	F (%)[1]	I (%)[2]	AD (%)[3]	E (%)[4]
Untreated control	100	5.3	5.3	-	26.0	1.0	0.26	-
Capalo + Duett U	33.0	3.9	1.29	75.7	2.0	1.0	0.02	92.3
Capalo + Opera	40.0	3.4	1.36	74.3	3.0	1.0	0.03	88.5
Tango + Duett U	25	1.5	0.37	93.0	1.0	1.0	0.01	96.2
Tango + Allegro	0.0	0.0	0.0	100	0.0	0.0	0.0	100
Tango + Osiris	15	1.0	0.15	97.2	1.0	1.0	0.01	96.2
DL 5% = 73.1%; DL 1% = 86.5%; DL 0.1% = 90.4% - for efficacy								

Efficacy on *Stagonospora nodorum* attack, ranged from 65.9% (variant Alert + Acanto) to 99.8% (variant Tango + Allegro).

In 2011 (Table 2) were manifested only *Mycosphaerella graminicola* and *Stagonospora nodorum*.

There was no attack of *Mycosphaerella graminicola* and *Stagonospora nodorum* in the variants treated consecutive with fungicides Tango + Alert, while in other variants efficacy ranged from 59.3% (variant Alert) to 97.8%. (Tango Super) for *Mycosphaerella graminicola* and from 57.5% to 97.8%. (in the same variants) for *Stagonospora nodorum*.

Blumeria graminis appeared sporadically.

In 2012 (Table 3) fungicides efficacy on *Mycosphaerella graminicola* and *Stagonospora nodorum* was 100% in the variant with Tango Super applied to the first treatment and Allegro applied to the second treatment.

Fungicide efficacy on *Mycosphaerella graminicola* ranged from 74.3% (variant Artea + Amistar) to 99.5%. (variant Capalo + Opera) and on *Stagonospora nodorum* ranged from 88.5% (variant Capalo + Opera) to 96.2%. (variants Tango + Osiris and Tango + Duett).

In the three years of research *Fusarium graminearum* appeared sporadically in control variants (Figure 2).

CONCLUSIONS

The presence wheat disease varies from one year to another, from one variety to another and from one location to another.

Almost in all cases in which Tango fungicide was applied in different combinations the efficacy was 100%.

The management of foliar diseases of wheat can provide direct benefits by preventing yield losses in many cases.

Foliar fungal diseases of primary concern in romanian cereal production include the following: *Mycosphaerella graminicola*, *Stagonsospora nodorum*, *Blumeria graminis* and *Pyrenophora tritici-repentis*.

Figure 2. Typical symptoms fusarium head blight or scab

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MISCELLANEOUS

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Holocacista rivillei (Stainton, 1855) (*Lepidoptera Heliozidae*) – A LEAFMINER SPECIES RECORDED ON *Vitis vinifera* L. FROM SOUTHERN ROMANIA

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Abstract

Holocacista rivillei Stainton is an European grapevine leafminer distributed in southern Europe and western Asia (Nieukerken et al., 2012). This small butterfly was described from Malta and is considered a minor pest in vineyards being a monophagous species. Another two lepidopteran leafminers occur in European vineyards, both species being originated from North America, i.e. Antispila oinophylla van Nieukerken&Wagner, 2012 (Lepidoptera: Heliozelidae) and Phyllocnistis vitegenella Clemens, 1859 (Lepidoptera:Gracilariidae). Few years ago mines in grapevine leaves were observed in a vineyard located in southern part of the country (Voluntari, Ilfov county). The leaves with symptoms were collected and larvae were reared in laboratory to obtain adults. Identification of the species was done based on their morphological characteristics. Photographs of mines, adults, pupae and genitalia slides are here showed. Preliminary observation on the behavior of this pest are reported.

Key words*: moth, mines, vineyard, genitalia, Antispila oinophilla, Phyllocnistis vitegenella.*

INTRODUCTION

In Europe grapevine (*Vinis vinifera* L.) is a culture damaged by few lepidopteran leafminer species. Nevertheless in past years two species originated from North America, invaded Old Continent and they are now considered as serious pests for vineyards, especially in Italy (Nieukerken et al., 2012). These species are *Phyllosticnis vitegella* Clemens, 1859 (Lepidoptera: Gracillariidae) found in Italy since 1995 and *Antispilla oinophylla* van Nieukerken &Wagner 2012 (Lepidoptera: Heliozidae) which was detected and identified in Italy since 2006 as *Antispilla* sp. (Baldesssari et al., 2009) and finally identified in 2012 (Nieukerken et al., 2012). In Europe the only native leafminer on grape is *Holocacista rivillei* (Stainton, 1855). This species was described from Malta and later was reported in Italy, France, Greece, Russia, Slovenia, Spain (www.faunaeuropea.org), Croatia, Bulgaria, Ukraine, Turkey, Georgia, Kazakhstan, Uzbekistan, Turkmenistan (Nieukerken et al., 2012).

According to the Romanian check list and also fauna europea site in our fauna there is no record of *Holocacista rivillei*. There were recorded only two genera from Heliozidae Family: Antispila *(Antispila metallella* Denis&Schiffermüller, 1775 on *Cornus* spp; *Antispila treitschkiella* Fisher & Röslerstamm, 1843 on *Cornus* spp.) and Heliozela *(Heliozela hammoniella* Sorhagen, 1885 on *Quercus* spp; *Heliozela sericiella* Haworth, 1828 on *Betula* spp; *Heliozela resplendella* Stainton, 1851 on *Alnus* spp.) (Rakosy, 2007).

MATERIALS AND METHODS

A survey was carried out in a private vineyard from Ilfov county (near Bucharest) since 2003 having main objective detection of leafminer fauna in this perimeter.

Several leaves with mines were collected and larvae and pupae were reared to obtain adults. Identification was carried out based on morphological characters. Material examined: 3 ♀ (all dissected).

Accurate species identification requires examination of the genitalia structures. Methods for preparation of genitalia requires removing the abdomen then placing in a 10% KOH solution for 12-24 h at room temperature. To examine genitalia remove the abdomen from KOH place it in a Petri dish filled with water for few minutes, then place it in a drop of glycerin to study. Microscopic slides were made in Hoyer solution. For microscopic observation of wings they are stained in double stain solution (EAF, fuchsine acid, lignin pink) and then mounted also in Hoyer solution. Identification was made to the genus and species level according to Nieukerken et al. (2012). Photographs of moths, genitalia slides and wing slides were taken with a Leica DFC 295 digital camera attached to a Leica DMLB microscope, using Leica LAS software (Figures 5, 6, 7 and 8) and Leica DC 300 digital camera attached to a Leica stereomicroscope MZ $_{12,5}$ (Figures 3 and 4) and pictures showing symptoms with Canon camera (Figures 1 and 2).

RESULTS AND DISCUSSIONS

As a result of our investigation in the studied area were observed leafmines on leaves produced by a lepidopteran species at the end of June-beginning of July (Cean, 2011).

Figure 1. *Holocacista rivillei* mines

Larvae had produced characteristic mines (Figure 1) between two epiderms of leaf started with a narrow, long and transparent gallery which became finally more or less an oval blotch inside being visible frass.

Finally larva before pupate cuts out an oval excision from blotch leaving a hole in the leaf (Figure 2).

Figure 2. Oval cut-off in leaf and other mines

Larvae drop in soil or other substrates in these cut-outs, shields or cases (Figure 3) and pupate. They can be found on leaves, soil (in summer period) or in the crevices of stem and large branches (in winter).

Figure 3. Empty shield of *Holocacista rivillei*

After rearing of the larvae and pupae we obtained adults which were identify as *Holocacista rivillei* (Stainton, 1855) a very small moth from Heliozidae Family. They are hardly visible due to their small size.

The morphological characteristics observed were according to Balachovski (1966), Balsedessari et. al. (2009) and Nieurkerken (2012), namely lanceolate forewings (Medvedev, 1989), bright black with four triangular golden yellowish spots (Figure 4) two placed in alaire region and other two in the basal area. The apical spot presented in

Antispilla oinophylla species is lacking at this species. Wingspan between 3.5-4 mm. The antenna is ringed, forelegs are black and other pairs are silvery in color (Balachowski, 1966).

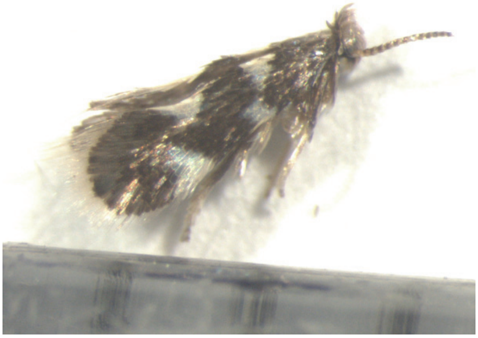

Figure 4. *Holocacista rivillei* (female)

As Nieukerken et al. (2012) showed the venation is reduced for both wings (Figures 5 and 6). Cu venation is lacking in the forewings, A1+2 a strong separate vein.

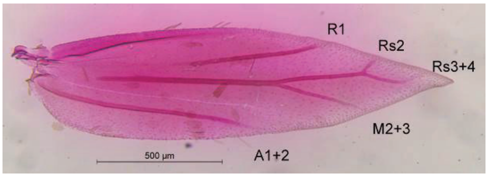

Figure 5. Forewing of *Holocacista rivillei*

Hindwing cu Sc barely visible, Cu and A1+2 separet veins.

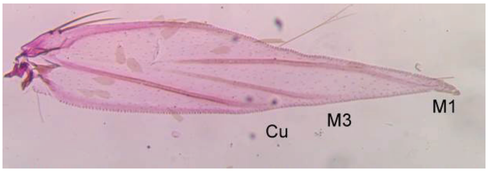

Figure 6. Hidewing of *Holocacista rivillei*

Comparing morphological details of female abdominal segments between our specimens and those illustrated by Nieukerken et al. (2012) we don't find any differences.
Number of lateral cusps on the ovipositor are reduced comparing with *Antispila oinophylla* which has 4-5 cusps and also the shape and dimensions are different being more unequal and smaller with rounded end at *Holocacista rivillei*.

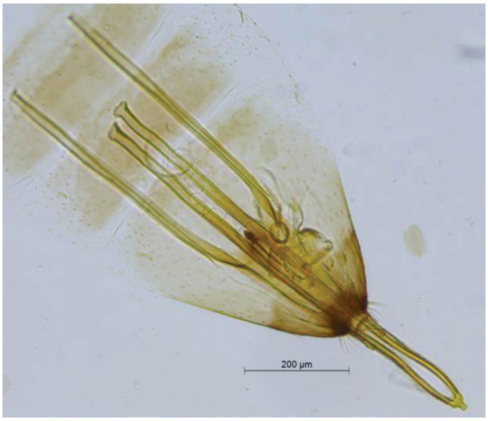

Figure 7. Abdominal segments of female showing apophyses and ovipositor

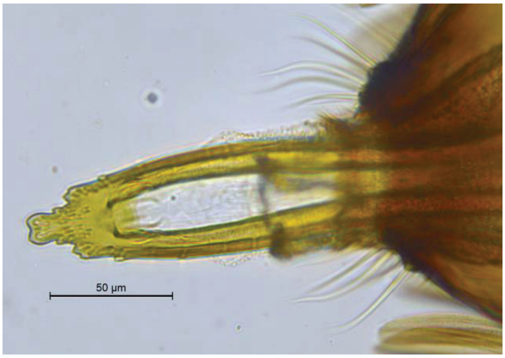

Figure 8. Detail of ovipositor tip showing cusps

CONCLUSIONS

Based on bibliographic research work we can conclude that in Romania there were not known lepidopteran leafmining species on *Vitis vinifera* L.
Holocacista rivillei (Stainton, 1855) is a native European leafminer but through this paper we want to draw attention about appearance of this moth in Romania at least in south part of the country.
Identification of the pest by a specialist is needed having regards apparition in Europe of two other lepidopteran leafminers on *Vitis vinifera*, from Nearctic Area.

We observed two generations per year with a peak in June-July and other in September.
However *Holocacista rivillei* can became a pest for vineyard at heavy infestation reducing the photosynthetic capacity of the leaves.

ACKNOWLEDGEMENTS

I would like to thank Mr. Erik Nieukerken, from Netherlands Centre for Biodiversity for confirmation of the pest.

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THE INFLUENCE OF MODERN DAY TRACTOR CAB ERGONOMICS ON PRODUCTIVITY

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Abstract

This paper critically examines agricultural tractor operation and the effect ergonomics have on performance and productivity in modern cabs. Manufacturers of tractors, globally, are continually developing cab and operator control systems to increase productivity AGCO (2012). This research project specifically investigates the claimed increase in productivity from active control arms fitted to modern day tractors. Through practical testing and theoretical research, conclusions have been drawn, on how effective these systems are, how much productivity is increased by the use of them and the cost effectiveness in today's economic environment. This project critically evaluated five agricultural tractors with differing cab layouts, three of the tractors having a conventional cab layout, with manually operated controls, the other two tractors fitted with active control armrests. Methodology adopted four strategies using a time and motion exercise, calculating efficiency rates, calculating cost effectiveness and finally operator movement through functional anthropometrics. Results showed a minimal increase in productivity, however, a major reduction in operator movement indicates the possibility of potential health problems in the long term.

Key words: *tractor cab ergonomics, active control armrest, operator control systems, functional anthropometrics.*

INTRODUCTION

The present research work has the following aims:

- To prove if the use of an active control arm increases productivity. This will be tested in the form of a time and motion study.
- If productivity is increased, and by how much? By using the data collected from the time and motion study, efficiency rates can be calculated.
- How much work has to be done before the additional cost of the unit is recuperated. By carrying out fuel efficiency tests on the tractors chosen and collecting price data, a cost analysis can be formulated.
- To what degree is operator movement within the cab reduced by using an active control armrest. By recording and measuring operator movement during the time and motion study, statistical data on functional anthropometrics can be formulated.

High tech farming that has brought the innovation of the active control armrest. The concept of controlling tractor functions and associated implements has been under development for many years (Hoyningen-Huene et al., 2009). The International Harvester company first patented a design for a 'vehicle control armrest in a vibration isolated control module' on the 10th December 1975 (Kestian et al., 1975). He describes in detail the reasons for such armrests 'The consequence of tractor vehicle development is the increase in equipment that is remotely controlled from the operator's work station. Not only does the tractor operator have to attend to vehicle speed and direction as usual, but he is now concerned with operating ancillary equipment. This combination of increased speed and the broadening of operators responsibility for equipment control, imposes a significant work load on the vehicle operator if he is to work the tractor at its optimum efficiency.

These statements clearly paved the way for development within this specific area of cab design. Engineers and designers had looked into areas of single lever control. A large area at the time was powered wheelchairs for invalids (Kestian et al., 1975).

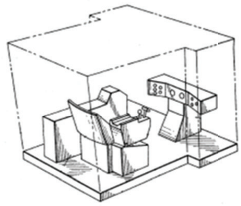

Figure 1. Perspective arrangement of the modular control cab

However, in the early years of armrest development, the main limitation factor came from the control linkages from the armrests (Whisler et al., 1984). 'The armrests were large and cumbersome' due to the cables and hydraulics used in their construction. Machines with such multiple control mechanisms required operators who were highly skilled (Proud et al., 2010). After a period of operating hours, the operators became fatigued, with no place to rest the hand or arm while operating the machine (Proud et al., 2010). Only in the early 1990's, with the development of electronics, did control armrests start to become more advanced. It wasn't just the agricultural sector that was trying to develop these armrests (Attebrant et al., 1997). In October 1992 Caterpillar had a patent passed for a 'Vehicle Control Console Having Finger Tip Controls' (Mackoway, 1992). This console, fitted to bulldozers, being the first to use electric switches linked to a micro-processer.

Manufacturers also began to establish that there was an element of operator fatigue as a result of using such armrests. Garberg et al. (1998) states 'The operator of a working vehicle is required to manipulate control mechanisms, often over long periods of time, as well as drive the vehicle. It is important that the mechanisms be positioned for comfortable operation.'

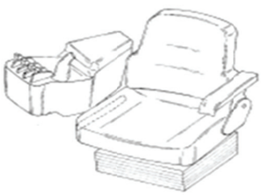

Figure 2. View of the console shown in connection with a seat

It had also been recognised that the operators forearm and hand, if left in an un-natural position, would soon lead to fatigue (Epple, 1997).

This change of thought by leading manufacturers has yet again led to new designs and patents being introduced. John Deere in 2001 designed an 'Ergonomic Tractor Seat Armrest and Hand Control.' The design of this armrest allowed the operator's right elbow to be supported on an armrest. This supporting point then becomes the fulcrum point for forearm movement to the control levers and switches (Arthur et al., 2001). This design also accommodated different operator sizes, as an operator with a larger torso would not have his elbow in the same lateral location as an operator with a slender torso (Arthur et al., 2001). Manufacturers have also recognised that if an operators hand has to move from one element to another, there may be a delay between work tool manipulations. This therefore resulted in poor quality work or low production. This analogy directly links into ineffectively placed controls or non ergonomical locations to suit all machine operators (Proud et al., 2010).

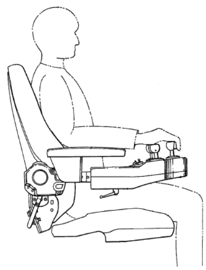

Figure 3. Typical operator position while using an active control armrest

Figure 4. Operator's right arm position when using a John Deere CommandARM

MATERIALS AND METHODS

Five tractors were selected for the programme: 1986 Ford 5610, 72bhp; 2009 Kubota M7040, 71bhp; 2009 John Deere 6230, 100bhp; 2009 Fendt 415, 150bhp; John Deere 7280R, 280bhp
A range of specific tests were carried out in order to form a comprehensive conclusion which comprised of the following:

- Fuel consumption test: to establish fuel used per horsepower hour using a Froment Sigma 5 dynamometer and physically measuring the fuel used during each test.

Figure 5. Collecting power/fuel consumption data

- Time and motion test: to establish the time taken to complete the exercise using a Tag Heuer timer for accuracy.

Figure 6. Tag-Heur timer

- Functional Anthropometrics: to establish the amount of body movement during the exercise.

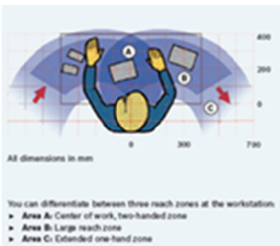

Figure 7. Anthropometric body movement

Whilst carrying out a standard three point headland turn, a typical manoeuvre for a tractor while carrying out field operations such as power harrowing. This turn sequence was replicated under test conditions in a prescribed test environment. The task being broken down into four prescribed phases:
1. Start of sequence: implement lift;
2. Directional change into reverse;
3. Directional change into forwards;
4. End of sequence: implement lower.

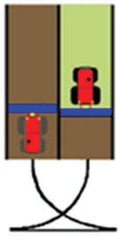

Figure 8. Planned manoeuvre

From carrying out the time and motion study it was found that the expected outcomes for this test were correct. From the range of tractors tested, there was a total difference of 16.84 seconds. Therefore operation time from an old conventional tractor to one with an active armrest fitted is halved. However, what became unexpected were the tractors fitted with active control armrests had significant differences in the time taken to complete the manoeuvre.
The three tractors tested with a conventional cab layout had similar average times having only a difference of 2.46 seconds between them. This is quite significant, as the cab layouts and control positions differ enormously between the Ford 5610 and the John Deere 6230. Again it was expected that as the tractors age decreased so the efficiency of the turn would increase, due to advancements in technology, such as shuttle control.
The most surprising differences occurred when testing the tractors fitted with active control armrests. An average difference of 10.55 seconds between the manufacturers being recorded. When comparing the Fendt 415 and the John Deere 7280R in a standard sequence there was a difference of 5.02 seconds. However, when a recorded operation sequence was added to the Fendt 415 the time doubled to 10.55 seconds. On further analysis of these

manoeuvres, it was found that the time delay came from the direction changes within the sequence. Both tractors were fitted with a constantly variable transmission, but used different principles to achieve this. The John Deere uses a clutch pack system whereas the Fendt uses a hydrostatic system. There was a greater time delay in the John Deere's transmission when a direction change was being carried out, and the operator being unable to accelerate when doing this, as the power take up became too harsh. Whereas in the Fendt, the direction change is smooth and acceleration in reverse could be achieved.

By taking these time and motion figures and placing them into the average field size for the UK of 5.8 Hectares (Ha) Britt *et al* (2000) while using an implement of 4m wide a total of 120 theoretical headland turns would be made. This data can be added to the time and motion times and 'non productive' times can be forecast.

RESULTS AND DISCUSSIONS

Fuel efficiencies in agricultural machinery have increased steadily since the 1980's (Grisso et al., 2010). This has been made possible by improved engine and transmission design and the improved ability to match tractors and implements to given field conditions (Grisso et al., 2010). The table below shows average tractor fuel efficiency rates over the past 30 years.

Table 1. Agricultural diesel engine fuel efficiency increases since 1980

Year	Average Kwh/L	% Increase efficiency
1980	2.3 Kwh/L	
2000	2.6 Kwh/L	11 %
2010	3.1 Kwh/L	16 %

It became clear from analysing the fuel data recorded, that the fuel efficiency data was inconclusive, and would make a minimal impact on productivity costs relating to tractors fitted with active control armrests.

From carrying out the time and motion study it was found that the expected outcomes for this test were correct. From the range of tractors tested, there was a total difference of 16.84 seconds. Therefore operation time from an old conventional tractor to one with an active armrest fitted is halved. However, it became apparent that tractors fitted with active control armrests had significant differences in the time taken to complete the manoeuvre.

Table 2. Average fuel cost per headland turn

Tractor	Fuel used ml/sec	Turn time average (Sec)	ml of fuel per headland turn	Fuel cost per turn.
Ford 5610	1.36	32.29	43.9	3.2 p
Kubota M7040	1.92	30.88	59.3	4.3 p
John Deere 6230	2.15	29.83	64.1	4.6 p
Fendt 415	3.30	20.98	69.2	5.0 p
(Teaching)		15.45	50.9	3.7 p
John Deere 7280R	9.80	26.00	255	18.6 p

The three tractors tested with a conventional cab layout had similar average times having only a difference of 2.46 seconds between them. This is quite significant, as the cab layouts and control positions differ enormously between the Ford 5610 and the John Deere 6230. Again it was expected that as the tractors age decreased so the efficiency of the turn would increase, due to advancements in technology, such as shuttle control.

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greater time delay in the John Deere's transmission when a direction change was being carried out, and the operator was unable to accelerate when doing this, as the power take up became too harsh. Whereas in the Fendt, the direction change is smooth and acceleration in reverse could be achieved.

Table 3. Non-productive time during headland turn

Tractor	Average turn time (seconds)	None productive time (Mins)
Ford 5610	32.29	64
Kubota 7040	30.88	61
John Deere 6230	29.83	59
Fendt 415	20.98	41
Fendt 415 (teaching)	15.45	30
John Deere 7280 R	26.00	52

Table 4. Comparison between none productive time and cost

Tractor	None Productive Time (Minutes)	Non Productive Cost
Ford 5610	64	£67.20
Kubota 7040	61	£64.05
John Deere 6230	59	£61.95
Fendt 415	41	£43.05
Fendt 415 (teaching)	30	£31.50
John Deere 7280 R	52	£54.60

Table 5. Extra tractor hours needed to work in order to re-co-operate extra capital outlay for tractors fitted with an active control armrest

Tractor Model	Difference between a model with and without an armrest	Hours worked to re-pay the difference
John Deere 6190	£860	819
New Holland T7.210	£6,333	6031
Massey Ferguson 7615	£6,551	6239
Case Maxxum EP140	£2,274	2165
Fendt 716	N/A	
Valtra N143	£7,706	7339

By taking these time and motion figures and placing them into the average field size for the UK of 5.8 Hectares (Ha) Britt et al. (2000) while using an implement of 4m wide a total of 120 theoretical headland turns would be made. This data can be added to the time and motion times and 'non-productive' times can be forecast.

Calculating the overall time consumed during the total number of headland turns for the prescribed area indicated a significant amount of non-productive time during the operation.

Calculating the costs created through the non-productive time associated with headland turning they showed little difference between each tractor, although adding a significant cost to the operation.

However, with operator movements decreasing by such a large amount are there new areas for operator concern by using active control armrests? Health problems directly linked to musculoskeletal fatigue are increased within the upper torso and neck. Lower limb, circulation problems could develop due to lack of leg movement and pressure points centred around the seat pan.

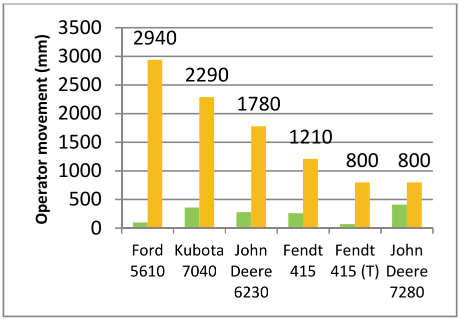

Figure 9. Anthropometric distance travelled

Intermediate work zone Immediate work zone

This section of results shows the gradual downward trend of anthropometric distances travelled by the operator in the selected tractors. It is surprising the total distances travelled by the operator while carrying out the simulated manoeuvre. This can be related directly to operator fatigue and therefore the effect on overall productivity. Questions can also be raised concerning the lack of operator movement in the Fendt with the 'teaching' facility on, with the whole process being controlled from the function lever on the armrest.

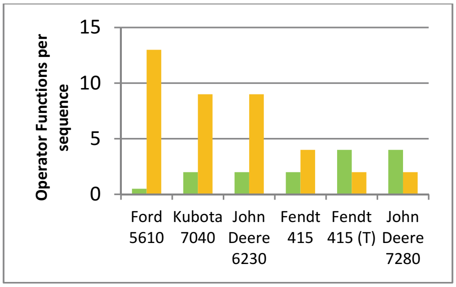

Figure 10. Number of anthropometric zones an operator enters when carrying out a simulated headland turn

The distances travelled in the two anthropometric zones show that even if the tractor is fitted with an active control armrest the amount of operator movement within the immediate work zone is minimal. This however doesn't reflect a true picture due to the immediate work area having smaller distances to travel.

As expected, the conventionally laid out tractors have more operations in the intermediate work zone, whereas the tractors with the active control armrests have a better immediate work zone ratio. The functions per turn are somewhat reduced with armrest control although using the Fendt in standard work mode creates more movement in the intermediate work zone as the hydraulic lift and lower function is located on the side console and not on the armrest.

CONCLUSIONS

After completing the study it is clear that active control armrests do increase productivity but not in the areas that were first predicted. Initial predictions in the area of time saving and the benefits to having one of these active control armrests fitted to a tractor is minimal. Manufacturers and their marketing departments lead the purchaser into thinking that the addition of one of these units will increase output from the machine and therefore lead to increased profit. This has been proven not to be the case. Commonly, the initial outlay for such a system far exceeds the increased profit the system brings.

After closer examination of the marketing statements one can interpret them in a different way, relating them to operator fatigue. It is clear that by using an active control armrest, operator movements are decreased, and therefore less physical fatigue occurs on the operator over the period of a working day. Fendt is the only manufacturer to refer to this operator fatigue directly in their sales literature. Meaning an operator might be able to work longer and therefore increase productivity.

However, with operator movements decreasing by such a large amount are there new areas for operator concern by using active control armrests? Health problems directly linked to musculoskeletal fatigue are increased within the upper torso and neck. Lower limb, circulation problems could develop due to lack of leg movement and pressure points centred around the seat pan.

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ASPECTS OF FLORISTIC DIVERSITY IN THE COMMUNITY TOPOLOG (TULCEA COUNTY): II – GRASSLANDS FLORA

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Abstract

Flora of grasslands, located at the base of hills around the Topolog commune, comprises important species for diversity of vegetation in this area and, also, in our country: most of the species, of the thirty-six identified in the course of our reports, made in July-August, 2010-2012, have a limited area of distribution; eight species are rare in Romania and one of them – Campanula romanica Săvul. - is an endemic one, found only in Dobrogea. According to the sozological categories, four species are considered vulnerable and two have endangered status.

***Key words**: endemic, grasslands, primary vegetation, xerophilic.*

INTRODUCTION

Dobrogea is a region with a high concentration of rare taxa for our country due to special conditions of climate and soil that favoured the installation of plant species of Pontic, Balkan, or Mediterranean origin, along those of Eurasian, Central-European, European or others. (Brandza, 1898; Sârbu et al., 2006; www.parcmacin.ro). Some of them are inventoried in European or Romanian Red Lists, considered of international importance, having the status of threatened, vulnerable or endemic plants (Dihoru and Negrean, 2009; Oltean et al., 1994; www.iucnredlist.org). Such species can be found in areas already protected by law or can be scattered in other places, sometimes restricted to small surfaces, it being necessary to report and apply measures for the conservation *in-situ* (Petrescu, 2004).

Dobrogea grasslands may be mesophilic and mezohigrophilic, in the Danube Delta and Meadow and in the valleys of the important river, or xerophilic, installed on slopes unsuitable for agriculture, hills rocky surface, at the borders of fields, on terraces or on communal pastures (Dihoru and Doniţă, 1970; Popescu et al., 2008). Excessive grazing affected in time primary xerophilic steppes' vegetation, so the basic components disappeared and were replaced by other species or they appear insular (Dihoru and Doniţă, 1970). However, where the substrate is stony, the rare flora species, typical of Dobrogea, may be found (Petrescu, 2004).

The authors continue presenting flora of places surrounding the Topolog communities with the species identified in xerophilic grasslands, located on different land categories.

MATERIALS AND METHODS

Physical-geographical description of the territory where the observations were made was done in the previous paper-work.

Field observations were conducted in July - August, 2010 - 2012.

The itinerary study method has been chosen for the flora inventory, covering portions of land occupied by grassland vegetation at the infield ends, base of the hills or near wooded areas.

The taxonomic classification of the species and the analysis of the life forms, geographical elements and the spread in the country were based on literature (Ciocârlan, 1994; Ciocârlan, 2009, Cristea et al., 2004).

Data on the vulnerability or endemic status of the species is in accordance with The Red List of higher plants in Romania (Oltean et al., 1994) and The Red Book of vascular plants in Romania (Dihoru and Negrean, 2009).

RESULTS AND DISCUSSIONS

The discussions are based on data included in Table 1.

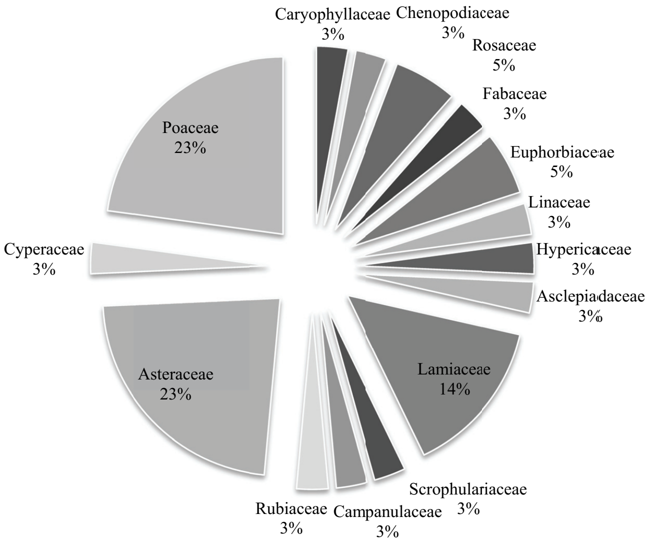

Figure 1. Analisys of floristic composition

Floristic composition

Following the observations made in the field there were 36 recorded species belonging to 15 families. From a systematic point of view species of *Asteraceae* and *Poaceae* (eight species) are prevalent followed by those of *Lamiaceae* (five species), *Rosaceae*, *Euphorbiaceae*, *Scrophulariaceae* (two species). *Fabaceae, Linaceae*, *Hypericaceae*, *Asclepiadaceae*, C*ampanulaceae*, *Rubiaceae* and *Cyperaceae* are represented by a single species. The share of each family is shown in Figure 1.

According to Dihoru and Doniţă, in Babadag Plateau specimens of the *Chrysopogon gryllus* or *Stipa* genus represent vestiges of primary steppe grasslands while individuals of *Campanula romanica* and *Dianthus nardiformis* appear in places with rocky substrate. *Euphorbia* species are indicative of degraded grasslands and *Carduus thormeri* specimens are found in fallow lands, on rendizine (Dihoru and Doniţă, 1970).

Life-cycle and forms of life

Of the 36 species, five are annual, four - biennial and 27 perennial. Life forms analysis shows that among the perennial species, three are of Chamaephyta, 3 of Geophyta and 21 of Hemycriptophyta.

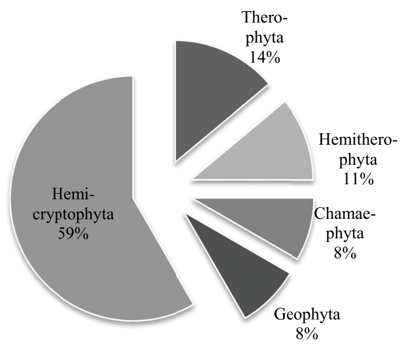

Figure 2. Analisys of forms of life

The small percentage of the Terophytes and Hemiterophytes - 14%, and 11%, respectively (Figure 2), indicates a low intervention of the anthropic factor. The dominance of the Hemicryptophytes - 59% of all species, with which are Geophytes (8%) and Chamaephytes (8%), reveal a climate of water shortage where are edified steppe grasslands mainly by perennial grass species.

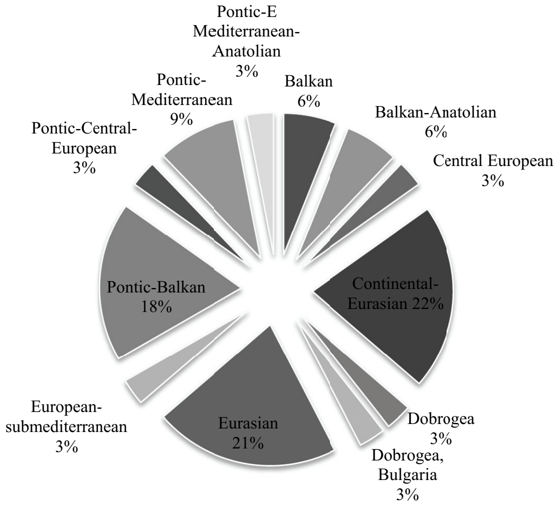

Figure 3. Analisys of floristic elements

Floristic elements (Geographical distribution)

Analysis of the floristic elements (Table 1, Figure 3) shows that, of all species, 55% are Eastern origin (Ciocârlan, 1994): 22% Continental Eurasian and 33% Pontic (broadly); the predominance of the Eastern elements highlights the steppe character of vegetation. 21% of all species are of Eurasian and 3% of Central European origin. The presence of European species is according to European character of the Romanian flora. Xerophilic and thermophilic vegetation character is emphasized by the presence of the southern and south-eastern elements: Balkan - 6%, Balkan - Anatolian - 6% European - Mediterranean - 3%. 6% of all species inventoried represents plants characteristic of Dobrogea (endemic). We notice the absence of cosmopolitan and adventives species which underlines again the low level of human intervention. Our data are comparable to those in the other studies of the Dobrogea flora and vegetation (Andrei and Cristurean, 2006; Ciocârlan, 1994; Dihoru and Doniţă, 1970, Popescu et al., 2008, www.parcmacin.ro).

Distribution in the country and sozological category

The importance of grassland flora surrounding the villages of Topolog community is evidenced by the large number of species with limited distribution in our country; they are in a proportion of 43%, against 47% frequent species (Figures 4 and 5). Of rare taxa, in accordance with Dihoru & Negrean, 2009, four are considered as vulnerable and two are endangered (Table 1). One species - *Campanula romanica*, is an endemic one, found only Dobrogea and another, *Potentilla emilii-popii*, is found only in Romania (Dobrogea) and Bulgaria.

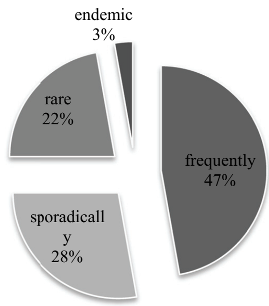

Figure 4. Analisys of sozological category

CONCLUSIONS

Grasslands around the villages of Topolog community are, through the floristic composition, important areas for diversity of the higher plant species, characteristic of Dobrogea.

Table 1. Grasslands species around Topolog community (Tulcea county)

Species	**Family**	**Life-cycle**	**Form of life**	**Floristic elements (Geographical distribution)**	**Distribution in the country and sozological category**
Dianthus nardiformis	*Caryophyllaceae*	p	Ch	Balk.	rare (Dobr.) VU (D&N); VU (Olt.&al.)
Salsola kali subsp. *ruthenica*	*Chenopodiaceae*	an	T	Euras.	frequently
Filipendula vulgaris	*Rosaceae*	p	H	Euras.	frequently
Potentilla emilii-popii	*Rosaceae*	p	H	Rom.-Dobr. Bulg.-NE	rare (Constanța county) VU (D&N)
Onobrychis gracilis	*Fabaceae*	p	H	Pont.-Balk.	rare (Ialomița, Constanța, Tulcea, Galați, Bacău county)
Euphorbia agraria	*Euphorbiaceae*	p	H	Pont.-Balk.	frequently
Euphorbia cyparissias	*Euphorbiaceae*	p	H	Euras.	frequently
Linum austriacum	*Linaceae*	p	H	Euras.	frequently
Hypericum perforatum	*Hypericaceae*	p	H	Euras.	frequently
Cynanchum acutum	*Asclepiadaceae*	p	H	Pont.- Medit.	sporadically/ frequently in SE
Ajuga chamaepytis	*Lamiaceae*	an	T	Pont.- Medit.	sporadically
Salvia amplexicaulis	*Lamiaceae*	p	H	Balk.	rare (Caraș-Severin, Mehedinți,Constanța, Tulcea county); EN (D&N, Olt.&al.)
Stachys angustifolia	*Lamiaceae*	p	H	Balk.-Anatol.	rare (Dobr.) VU (D&N); EN (Olt.&al.)
Stachys annuua	*Lamiacaea*	an	T	Eur.(submedit.)	frequently.
Thymus callieri	*Lamiaceae*	p	Ch	Balk.	rare (Dobr., jud.Dolj) VU (D&N)
Linaria genistifolia	*Scrophulariaceae*	p	H	Cont.Euras.	frequently
Veronica spicata subsp. *barrelieri*	*Scrophulariaceae*	p	H	Pont.-E.Medit.-Anat.	rare (jud.Constanța)
Campanula romanica	*Campanulaceae*	p	H	Rom-Dobr.	endemic (Dobr.) EN (D&N)
Galium humifusum	*Rubiaceae*	p	H	Pont.- Balk.	sporadically (Olt., Munt.,Mold., Dobr.)
Achillea coarctata	*Asteraceae*	p	H	Pont.- Balk.	sporadically (Ban., Olt., Munt., Dobr.,Mold)
Artemisia austriaca	*Asteraceae*	p	Ch	Cont.-Euras.	frequently
Artemisia scoparia	*Asteraceae*	bienn	Ht	Cont.-Euras.	frequently
Carduus thoermeri	*Asteraceae*	bienn	Ht	Pont.- Balk.	sporadically (Dobr.)
Carlina vulgaris	*Asteraceae*	bienn	Ht	Euras.	frequently
Centaurea diffusa	*Asteraceae*	an	T	Pont.- Balk.	sporadically
Chondrila juncea	*Asteraceae*	bienn-p	Ht - H	Cont.-Euras.	frequently
Inula conyzae	*Asteraceae*	p	H	Centr.Eur.	sporadically
Carex liparocarpos	*Cyperaceae*	p	G	Pont.-Medit.	sporadically
Agropyron cristatum subsp. *pectinatum*	*Poaceae*	p	H	Pont.-Centr.Eur.	sporadically
Bromus inermis	*Poaceae*	p	H	Cont.Euras.	frequently
Bromus squarrosus	*Poaceae*	an - an hib.	T - Ht	Cont.Euras.	frequently
Chrysopogon gryllus	*Poaceae*	p	G	Euras.	frequently
Cleistogenes bulgarica	*Poaceae*	p	G	Pont.	sporadically
Festuca callieri	*Poaceae*	p	H	Pont.- Balk.	rare (Dobr.)
Koeleria macrantha	*Poaceae*	p	H	Circ.	frequently
Stipa capillata	*Poaceae*	p	H	Cont.Euras.	frequently

Life-cycle: an – annual; an. hib. – annual hibernante; bienn – biennial; p – perennial.
Form of life: Ch – Chamaephyte; G – Geophyte; H – Hemicryptophyte; Ht – Hemiterophyte; T – Therophyte.
Geographical distribution: Anat. – Anatolian; Balk. – Balkan; Bulg. – Bulgaria; Centr. Eur. – Central European; Circ. – Circumpolar; Cont. Euras. – Continental Eurasian; Dobr. – Dobrogea; Eur. – Europe; Euras. – Eurasia; Medit. – Mediterranean; Pont.- Pontic; Rom. – Romania; submedit. – submediterranean.
Distribution in the country and sozological category: EN - endagered (*threatened by extinction*: taxon faced with an extremely high risk of extinction in the wild in the near future); VU - vulnerable (taxon faced with an extremely high risk of extinction in the wild in the medium future); D&N – Dihoru and Negrean, 2009; Olt.&al. – Oltean et al., 1994.

A reduced anthropogenic action is indicating by the presence of those plant species characteristic to primary steppe grasslands and the scarcity of cosmopolitan and adventitious elements.

Relatively high number of vulnerable, endangered or endemic species gives those areas an international importance.

Maintaining these grasslands with their characteristics will allow both the preservation *in-situ* of the endemic, vulnerable or endangered species and plant formations.

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Figure 5. *Dianthus nardiformis* Janka (vulnerable taxon)

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COLLECTIVE ACTION FOR AN EQUITABLE FOOD PRODUCTION SYSTEM

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Abstract

Collective political action in agriculture is crucial in order to achieve a more equitable food system allowing food producers to live from their production. This paper will examine two cases of interventions organizing food producers in Niger and Romania to represent their interests in the political decision-making process. The Grow Campaign in Niger was initiated by Oxfam. One of the key aspects of the campaign is bringing together different groups that have an important contribution to food production worldwide, but are socioeconomically marginalized and excluded from the political decision-making process, in order to give them a common voice and political weight to influence policies that directly affect them. In Romania, the Pro Agro Federation is working to make food producers' voice heard at the national and European level, in order to achieve better conditions for farmers and rural development.

Key words: *collective action, Grow Campaign, political weight, Pro Agro.*

INTRODUCTION

Individuals choose to adhere to groups when they consider that the group is able to represent their interests and achieve their goals through collective action.

Thus, associations of individuals occur when a common goal needs to be achieved. To use the example this paper will examine, farmers can get organized into an association that will try to achieve legislation favorable to its members.

Yet, according to the collective action theory, it is not sufficient for individuals to have a common interest in order to form a group (Olson, 1978). Although classical group theories argue that forming an association to protect and promote their common interest is a natural tendency, or even an instinct people possess, Olson maintains that the founding and organization of a group does not only depend on the existence of a common interest.

According to him, organizational costs are increasing as the number of individuals in the group increase due to the fact that, the larger a group, the smaller the fraction of the advantage obtained through collective action will be received by each member of the group. As a consequence, individuals in smaller groups will more readily resort to collective action than individuals in larger groups, as the former will perceive the advantages of collective action as being higher than the latter.

A large group, according to Olson's theory, will not reach its goal without coercion or another type of exterior intervention that will incentivize the members of the group to work together in their common interest.

Smallholder farmers and agricultural producers are undoubtedly one of the largest 'latent' (unorganized) groups in the world, as about 73% of the workforce in the Least Developed Countries (LDCs) and 59% in all developing countries are employed in agriculture (Elijah, 2006). They face high organizational costs, which, coupled with their relatively low incomes, result, most of the time, in their inability to organize themselves into well-functioning groups that could represent their interests in the political decision-making process. This is worsen by the attitude governments have towards smallholders, which are consider by authorities, according to Harisson (2001), as individuals lacking innovation initiative, and thus historical agency, and upon whom development and change have to be imposed by force.

Teodor Shanin (1971) classifies peasant political activism into three categories: independent class action (equivalent to what is called 'collective' or 'group' action in the paper), guided political action (political action triggered by exterior intervention) and amorphous political action.

He argues that the first type of action, constituting in the formation of a nationwide organization, with its own identity (as expressed through an ideology and certain symbols) and political leaders emerging from within, is the least frequent in the case of smallholders.

The second category, guided political action is very important in the case of smallholders, as only an exterior intervention can break "the conservative cyclical stability of both the farm and the village and the political implications of this" (Shanin, 1971).

The third category, spontaneous and amorphous political action is the dominant type or peasant reaction. As Harrisson also states, smallholders have historically protected themselves against political change unfavorable to them with the "weapon of the weak", subterfuge and sabotage of the programs imposed upon them, rather than publicly advocating for a change in policies (Harisson, 2001).

Shanin foresaw, however, that trends might were subject to change, due to the spread of mass communication which made easier the construction of smallholder cultural and political cohesion, while the increasing importance of international trade lowered their political bargaining power as they lost the 'monopoly' of food production.

And it was trade, indeed, what created a sense of urgency (the 'crisis' necessary for the formation of collective identity) and incentivized the creation of the largest worldwide peasant organization.

La Via Campesina is an international network of peasant/farm organizations, created in 1992 and now regrouping approximately 150 organizations from 56 countries in Europe, Asia, Africa and North and South America (viacampesina.org).

It was born in 1992, after the Uruguay round of trade negotiations, out of opposition to neoliberal interests promoted by the World Bank and the IMF and facilitated by the World Trade Organization, and one of its main goals is to organize smallholders to advocate for food sovereignty and peasant's rights at the global level, through protests at WTO gatherings, public meetings, conferences, workshops, and non-violent protests that can be followed by negotiation with authorities (Desmarais 2007).

The organization has managed to bring together smallholders across continents, despite their cultural, political and ideological differences, by "resurrecting peasant identity" (Desmarais, 2007) - making explicit the smallholder's 'latent' group identity.

The collective action of agricultural producers, regardless of the level of development and geographical position of the area where these producers are located or to the practical reason that brought them to group together, is increasingly necessary in today's globalized world in order to assure the equitability of the food production system, and that agriculturalists gain enough in order to live off of their own production.

This paper analyzes two cases, in Niger and Romania, of interventions attempting to enhance the collective organization of smallholders and agricultural producers' groups in order to improve the political and legislative framework on issues that directly affect them.

MATERIALS AND METHODS

To characterize the importance of cooperation among agricultural producers, several indicators have been taken into account, such as collective action, association, cooperation, organization of farmers, political weight, agricultural sector development and efficiency.

For the Niger case-study, information was collected in Niamey between August and December 2013, through direct observation of Grow Campaign meetings and events and individual qualitative interviews with members. For the Romania case study the survey method was used, which is a quantitative method of gathering information, using questionnaires as survey tools. The questionnaire we used in the market research regarding the analysis of the agricultural cooperatives in Romania was composed of 38 questions. Data collected from the Ministry of Agriculture and Rural Development, COPA (Committee of Professional Agricultural Organizations of the European Union) and members of the National Federation PRO AGRO, were processed and interpreted, and extrapolated given trends existing in Europe.

RESULTS AND DISCUSSIONS

I. Niger Case-study

Oxfam is a confederation of 17 affiliated non-governmental organizations working in 90 countries worldwide to fight poverty and injustice. In addition to engaging humanitarian responses in times of crisis, Oxfam also attempts to empower the poor to influence political decisions that affect their livelihoods. In order to do so, Oxfam builds partnerships with local organizations in its countries of intervention, to project the voices of the vulnerable that these organizations represent and make them heard by policy makers.

Grow is one example of an advocacy campaign initiated by Oxfam in 2011, aiming to promote a more equitable and sustainable food production system, that would allow for a just access to food in a world of increasingly scarce resources. The campaign is active in more than 50 of the Oxfam intervention countries, and is managed at the global level by the Oxfam International office, while at local levels it is being implemented by one Oxfam affiliate on each national scene. The four thematic areas of the Grow campaign are land rights, small-scale agriculture investment, climate change and food prices. Each national campaign chooses among these themes the most relevant to focus on given country specificities.

The Grow campaign in Niger

In Niger, the Grow campaign (translated to 'Cultivons' in French, the official language of the country) was launched in March 2013. In line with the four thematic areas of the global campaign, the Niger branch decided on four national objectives. The first one is to encourage, in a participatory and inclusive manner, Nigerien authorities to develop a national pastoral and agriculture policy, with a special focus on family farms. The second one is to advocate for the allocation by the state of at least 20% of the national budget to agriculture and livestock. The third objective is to encourage effective investment in strengthening the resilience of populations vulnerable to food crises. And the last objective is to increase the level of processing and consumption of locally-produced agro-pastoral products.

In order to define the country specific objectives and work at achieving them, Oxfam partnered with fourteen local organizations, including producers' groups (like the Federation of Horticultural Cooperatives, the Federation of Rice Producers' Cooperatives, pastoral associations, etc.), peasant movements, women and youth associations, etc. Not only did each partner participate in defining the Grow campaign's objectives by including their own objectives and aspirations, but they were also able to include in the campaign's operational plans activities that were part of their own operational plans. Thus, on the one hand, the organizations received funding support from Oxfam, and, on the other hand, Oxfam ensured that the campaign was appropriated and implemented by the local civil society.

Figure 1. Potato harvest during the official launching ceremony

Some of the main activities the campaign included thus far were: organizing conferences, debates and meetings to commemorate events relevant to the campaign (such as World Food day, International Women's day, etc.), participating in the Agricultural entrepreneurship's week (an agricultural business fair organized by Oxfam, where high state authorities and the public are invited to visit agricultural producer's stalls), promotion of the campaign through a song and posters in the local media (television, radio and newspapers), the official launching ceremony (where high-level political figures were invited as guest speakers), presenting the campaign to national and international partners through meetings organized with various ministries and international institutions, conducting several studies on the situation of the agricultural sector in Niger and the points on which the campaign could intervene to encourage improvements, and a field trip organized with high-level officials to visit two sites managed by Grow-member organizations to raise their awareness on issues encountered by producers on the ground, and innovative solutions proposed by the civil society to these issues.

Although only one year old, the Grow campaign can already count two important achievements. The first one is that it was able to bring together fourteen local organizations representing marginalized groups involved in agriculture and enabled them to identify and acknowledge their common interest, as well as to start together towards achieving their common goal by projecting a unified voice to be heard by policy makers.

Figure 2. Smallholders during field trip visit

While a few years before, according to one campaign member, it was unconceivable that representatives of cultivators and animal breeders, for example, would be reunited around a discussion table, the Grow campaign's achievement to have them agree con common objectives cannot be considered negligible.

The second achievement, which is linked to the political goal of the campaign, is that policy makers are increasingly aware and interested in the campaign. While at first organizers encountered difficulties in bringing high-level politicians to attend Grow events, the last few have seen the participation of many high officials (among which the Prime-Minister). Some Nigerien politicians have made the connection between the Grow campaign and the State's anti-hunger 3N Initiative ('les Nigeriens nourissent les Nigeriens' – 'Nigeriens feed the Nigeriens'), which brings the prospect that the Government will take into account the requests brought forth by the campaign in the implementation of their national initiative. It remains to be seen if, and to what degree the Nigerien authorities will actually adopt Grow objectives into their political program.

Analysis of the Grow campaign in Niger

The Grow campaign in Niger is a complex and innovative type of intervention in terms of smallholder political empowerment, combining together elements of exterior and interior intervention. It is, on the one hand, an exterior intervention of the type which, according to Olson, is required in order to incentivize smallholder farmers and agricultural workers to surpass the state of 'latent' group and get organized to advocate for their communal interests.

Yet, as recent developments have shown, exterior intervention is no longer absolutely necessary in order to form peasant organizations, as smallholders themselves have started groping together to advocate for their rights with their own voice. Thus, the fourteen local organizations representing producers and vulnerable groups, which are now Grow members, existed before the initiation of the campaign. Oxfam's intervention was, however, important in making each pre-formed group transcend its sector-specific identity and integrating a group with a broader, more inclusive identity, that of agriculturalists. This movement grouping the fourteen already existing organizations is large enough to give real political weight to its claims (which wasn't true of each organization taken separately).

The Grow Campaign, on the other hand, can be considered as designed and implemented entirely by local members (so it is an interior intervention): it was the members of local organizations who decided on and tried to achieve or put into practice its goals and actions. Oxfam was only there to facilitate the discussion and support financially some of the projects.

According to Olson's explanation, the individual interests of the members of a group should not be in direct competition with those of the other members of the group, in order for this not to block collective action. Yet, if we consider the fourteen Grow organizations as our units of analysis, it is not the existence of contradictory interests, but, more importantly, the perceptions that they do not share common interests but are competitors that prevented the local associations from having a common conversation.

The Grow campaign was thus an occasion for them to identify the interests they have in common, and to realize that these are more important than the points on which they are direct competitors. The organizations were able to perceive that their common goal, once achieved, will offer satisfaction to all of them, and none will be excluded from enjoying the advantages obtained (another necessary condition, according to Olson, for groups to get organized). Once this was achieved, the organizations built a common project, whose success is impossible to evaluate at present, but which has great potential for the future.

II. Romania case-study

Global agriculture is subject to significant pressure to meet the demands of a growing population as well as increasing costs, particularly energy costs, with farmers having to pay more for diesel fuel, electricity, fertilizers, pesticides, etc.

In Romania, more than in other countries, competition for agricultural exploitation is tough, under globalization and competition with European countries with a thriving economy. The family farm and other associative forms cannot afford to purchase upstream and downstream services they need, the first alternative would be giving up to buy themselves these too expensive services, and to focus exclusively on primary agricultural production, hence the necessity and importance of linking farmers in cooperatives and associations to solve the problems that they themselves cannot solve.

Romanian farmers' mentality began to change, realizing the importance of associations. In the present and near future the benefits offered by professional and inter-professional organizations and cooperatives should be promoted by promoting values, professionals, fairness highlighted by best practices (Bercu, 2012).

Agricultural cooperatives in Romania can revitalize the cooperative sector for it to become a means of improving the living conditions of people in rural areas, to ensure sufficient revenue to producers, to strengthen the economic role of professional producers' entities, and to develop the agricultural sector and implicit the national economy.

The fundamental purpose of the cooperative is building a countervailing power to the monopoly position of large companies, thus improving the cooperative members' terms of trade. Cooperatives are expected to operate in a competitive environment and must adapt effective management and operating practices. The effective operation requires minimizing costs and persistence in cooperation with non-cooperative businesses offering similar services.

Currently Romania is at the beginning of a new path in reconsidering the idea, resumption and promotion of cooperatives. Cooperatives remained the main if not the only means of organizing agricultural activities, especially among small farms.

According to a study by F. Bercu (2012), co-operatives in our country are still in their infancy compared to European ones, which operated on the same principles for decades. Analyzing business sectors in which agricultural cooperatives have been recorded, we find that the majority are those with production (34%) and marketing activities (42%) and much less cooperatives with processing activities (7%) and services (4%). The total number of members of agricultural cooperatives analyzed amounted to 23.412 national and cooperatives average 85 members. Cooperative members were self-classified as follows: small farmers (49.84%), medium farmers (36.93%) and large farmers (13.1%).

Analyzing the most serious problems and constraints in agricultural cooperatives in Romania it resulted that 9.62% of cooperatives think constraints are due to the limited number of members, 4% to limited patronage or scope, 6,1% to weak organizational structure and management, 11.9% to lack of entrepreneurial and managerial skills, 41.9% to the lack of financing, 20.3% to technology, 25.9% to market; 23.8 % to lack of information, 17.2% to external market environment, while 17.4% mentioned other problems.

Besides agricultural cooperatives, in Romania there are 50 professional and inter-professional organizations recognized by the Ministry of Agriculture and Rural Development on the sectors of agriculture, aquaculture, fishing, forestry and hunting, food, beverages and tobacco. (MARD) The strongest one of them is the National PRO AGRO Federation (National Federation of Agricultural, Food and Related Services Producers in Romania), an umbrella organization which seeks to meet the challenges facing its members by promoting and supporting a sustainable rural economy where agriculture is essential for the future, an important pillar of the Romanian economy.

PRO AGRO is composed of 14 professional and inter-professional organizations representative of the agriculture and food industry. Two years after its establishment, the National Federation PRO AGRO has consolidated its position in the agricultural sector, becoming the most representative organization for farmers. The federation meets the representativeness criteria in the sectors of agriculture, aquaculture, fishing, forestry and hunting, food, beverages and tobacco.

PRO AGRO objectives

An important objective of the federation is the creation of the PRO AGRO Mutual Fund. It will be the first mutual agricultural fund in Romania and will be accredited by the Ministry of Agriculture and Rural Development. Thus, in 2014 farmers will be able to enroll in the Agricultural Mutual Fund PRO AGRO, which will compensate members for economic losses caused by animal diseases, plant, an environmental incidents or any other insurable risk.

Other objectives for 2014 are:

1. Active representation of agricultural producers' (and related services) interests nationally and in the working groups and advisory groups of the European Commission for Agriculture and Rural Development;
2. Active participation in developing the PNDR (National Rural Development Program) 2014-2020 measures for agriculture and food;
3. Complete steps to improve the legislative framework for inter-professional organizations on the Product branch;
4. Supporting steps to maintain TVA on bread to 9% and reduced TVA of meat, vegetables, fruit and sugar;
5. Reviewing the legal framework in agriculture and food industry.

Intervention channels

PRO AGRO represent the interests and needs of its members, coordinating and supporting professional organizations on agricultural, economic, legal, fiscal, educational and social issues with the European Commission, European Parliament and Council of Ministers.

<u>At the national level</u>

PRO AGRO is a dialogue partner of the Ministry of Agriculture and Rural Development, participating in meetings of the Commission for Social Dialogue, bringing their contribution to an important series of legislative projects in the sphere of activity of its members, such as : the Mutual Fund Law, the law financially supporting representative federations, the law to reduce TVA on bakery products, the certificates of deposit law, welfare standards for pigs and poultry, the National Rural Development Program 2014-2020, etc (PRO AGRO).

Generally, when MARD refers to: repealing, amending, or supplementing a bill or when sector specific proposals to repeal, amend, supplement a law and new legislative initiatives are made, a working group composed of representatives of the authorities (ministries or agencies connected with that approach) and representatives who operate associative forms involved (among which PRO AGRO) is formed.

Following discussions in the working group the legislative act, amendment / supplement are made, its passport of signatures to be taken from MARD and other ministries (Finance, Justice, Waters and Forests, etc.) or advising institutions is made. Advising institutions make recommendations to change if deemed necessary and submit the necessary adjustments to be made before signing. After signing, the document is taken, depending on the form, is submitted for discussion and approval to the Parliament.

<u>At the European level</u>

PRO Agro is a member of Copa Cogeca, thus enabling Romanian farmers to express their views having a direct impact on their earnings at European level. COPA (Committee of Professional Agricultural Organizations in the European Union) and COGECA (General Confederation of Agricultural Cooperatives in the European Union) represents the interests of farmers and the supply and marketing sector of the food industry at 70 %.

The principle underlying the Copa - Cogeca activity is reaching a common position on policy areas relevant to farmers and agricultural cooperatives. The ability to influence decisions at EU level is based on the principle of the common position. There must be a willingness to reach a compromise when the situation demands it, which is essential for the success of lobbying. Copa - Cogeca lobbies not only at the European Commission (through participation in consultative groups organized by it), but also at the European Council and the European Parliament, in close collaboration with our member organizations.

Their voice is heard at European level because they represent 13 million farmers and 38,000 agricultural cooperatives in all Member States, and the organization has a multi-sector and cross-sector nature and is operating at both vertical (specific commodity) and at horizontal level. Through PRO AGRO, Romania is among the big states receiving 12 votes (maximum number of votes allocated to a country) at Copa-Cogeca in the internal process of decision-making and, therefore, plays an important role in influencing decisions. But this is possible only through active participation when there is an interest in promoting a certain orientation.

European agricultural legislation is constantly changing and it is essential that Romanian farmers participate in discussions when decisions are adopted so that their voice is heard. It is not just about politics, but about the reality on the ground and on improving the lives of farmers.

CONCLUSIONS

The fact that food producers worldwide constitute a very important group in terms of number of members has been, historically, a disadvantage for their organization and social cohesiveness, thus translating into a weak political impact. However, the two case studies presented in the paper, demonstrated that, once the initial organizational obstacles are overcome, the numerical preponderance of agriculturalists is what provides weight to their political stances and claims. It is thus crucial for food producers to form well-organized groups in order to successfully advocate for the transformation of the food production system into a more equitable one through collective action in the political and legislative spheres.

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MORPHOLOGY AND DISTRIBUTION OF *Longidorus euonymus* (NEMATODA) FROM ROMANIA

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Abstract

Longidorus euonymus Mali et Hooper, 1974 from three localities in Romania is described and illustrated on the basis of adult and juvenile specimens. This species was recovered in association with barley, strawberry, blackberry, cherry, sour cherry, plum and represents a new geographical record for Romanian longidorid fauna.

***Key words**: Longidoridae, new record.*

INTRODUCTION

The genus *Longidorus* Micoletzky, 1922, includes a number of large ectoparasitic nematode species that are polyphagous on many plants, including various agricultural crops, and that cause damages by direct feeding on root cell as well as by transmitting nepoviruses (Taylor and Brown, 1997). Peneva et al. (2013) listed 158 *Longidorus* species and their associated type host plants. Hitherto, *Longidorus elongatus* de Man, 1876 was the only one *Longidorus* species recorded in Romania (Popovici, 1973).
Longidorus euonymus was originally described by Mali and Hooper (1974) from the rhizosphere of spindle trees (*Eunoymus europaeus* L.) that were often infected with euonymus mosaic virus (EMV) in different localities of the Bratislava district (Slovakia).
With one exception (Syria by Lamberti et al., 1999), this species has been recorded from Continental Europe only (Oro et al., 2005).
Longidorus euonymus has a wide plant host range, being associated with numerous annual, perennial and woody plants: grasses, corn, strawberry, carrot, blackberry, black currant, rose, nettle, grapevine, peach, tobacco, quince, willow, apple, walnut (Lamberti et. al., 1983), *Pinus nigra* and *Pinus sylvestris* (Peneva and Choleva, 1992a) from Bulgaria; poplar, cherry, (Oro et al., 2005), *Sambucus nigra* L., *Amorpha fruticosa* L. (Barsi and Lamberti, 2003) from Serbia; natural grassland from Lithuania (Stanelis, 2003); wheat, barley, potato from Slovakia (Liskova and Brown, 2003), plum from Czech Republic (Kumari and Decraemer, 2007). It is interesting to mention that Barsi (1994) described a bivulval female of *L. euonymus* in the rhizosphere of poplar from former Yugoslavia.

MATERIALS AND METHODS

Soil samples containing *L. euonymus* were collected from Moscu (Galați county), Mărăcineni (Argeș county) and Voinești (Dâmbovița) in the rhizosphere of barley (*Hordeum vulgare* L.), strawbery (*Fragaria* x *ananasa* Duch), blackberry (*Rubus fruticosus* L.) cherry (*Prunus avium* L.), sour cherry (*Prunus cerasus* L.) and plum (*Prunus domestica* L.) at a depth of 20-40 cm.
Nematodes were extracted from 200 cm^3 soil by a sieving and decanting technique, heat killed at 55-60ºC for two minutes and fixed in a 4% formaldehyde solution. The specimens were processed and subsequently mounted on permanent microscopic glass slides (Seinhorst, 1959).
Photographs were taken using an Axio Imager. M2-Carl Zeiss compound microscope equipped with a digital camera (ProgRes C7) and specialized software (CapturePro Software

2.8). Measurements were made using a system of Olympus BX41 light microscope, a digitising tablet (CalComp Drawing Board III, GTCO CalCom Peripherals, Scottsdale, AZ, USA), Digitrak 1.0f programme (Philip Smith, Scottish Crop Research Institute, Dundee, UK) or Leica DMLB microscope fitted with Leica DFC 295 camera and LAS V 4.2 software.

RESULTS AND DISCUSSIONS

Longidorus euonymus Mali et Hooper, 1974
Description (Figures 1-6; Tables 1-4)
Females: habitus a more or less open C to a single spiral, when killed; body slender, cylindrical. Lip region slightly expanded, flat frontally and rounded laterally. Amphidial pouches more or less asymmetrically bilobed. Tail conical, dorsally convex with mostly bluntly rounded terminus.
Moscu (*H. vulgare*) population. Cuticle thickness at postlabial region 2-3 µm, at mid-body 3-4 µm, on postanal region 5-6 µm. Pharyngeal bulb measuring 121 (114-127) µm x 18 (16-19) µm; anterior uterus 234 (192-262) µm long; posterior uterus 282 (195-260) long; rectum 30.4 (26-39) µm long; prerectum 363.2 (237-488) µm long.
Mărăcineni (*R. fruticosus*) population. Cuticle thickness at postlabial region 2.5-3 µm, at mid-body 3.5 µm, on postanal region 4-5 µm. Pharyngeal bulb measuring 120 µm x 17.5 µm; anterior to nerve ring 185, 195 µm; anterior uterus 240, 245 µm long; posterior uterus 257, 270 µm long; rectum 30-35 µm long; prerectum 283, 285 µm long.
Mărăcineni (*F.* x *ananassa*) population. Cuticle thickness at postlabial region 2 µm, at mid-body 3-4 µm, on postanal region 4-5 µm. Pharyngeal bulb measuring 107, 116 µm x 18 µm; anterior to nerve ring 182, 181 µm; anterior uterus 199, 189 µm long; posterior uterus 177, 199 µm long; rectum 32, 28 µm long; prerectum 270, 235 µm long.
Voinești (*P. avium*) population. Cuticle thickness at postlabial region 2-3 µm, at mid-body 3-6 µm, on postanal region 4.5-5 µm. Pharyngeal bulb length 117 (110-122) µm x 17.9 (17-19) µm; anterior uterus 279.4 (233-330) µm long, posterior uterus 256 (337-280) µm long, rectum 25.6 (23-27) µm long, prerectum 311(238-432) µm long.
Male: not found.
Juveniles: Separated in four juvenile stages: on barley, strawberry and cherry all stages present; on blackberry first stage juvenile not found (Figures 3-6). They resemble adults except body size and tail which is conoid and almost of the same length in all juvenile stages; tail in first stage juvenile elongate conoid and in successive stages it becomes progressively blunter and wider, bluntly conoid in the fourth stage.
The morphometrics overlapped for *L. euonymus* populations from Moscu, Voinești and Mărăcineni, except for the size of pharyngeal bulb for Mărăcineni (strawberry) population. Length of hyaline part of tail and body diameter of hyaline part was longer and wider (9.5-11 µm *vs* 8-10 µm; 20-21 µm *vs* 10-19 µm).
The morphometric characters recorded from Romanian populations were within the range of original description (Mali and Hooper, 1974) and of those reported for Bulgarian (Peneva and Choleva, 1992a) and Serbian (Oro et al., 2005; Barsi and Lamberti, 2003) populations.
The most abundant was barley population (35 spec./ 200 cm^3 soil) followed by cherry (15 spec./ 200 cm^3 soil), blackberry and strawberry (6 spec./ 200 cm^3 soil) populations.

CONCLUSIONS

Measurements and morphological data of female specimens and juvenile stages of *L. euonymus* are provided for the first time for Romanian populations. This species was relatively common in the studied area occurring in 6 out of 34 sites sampled.

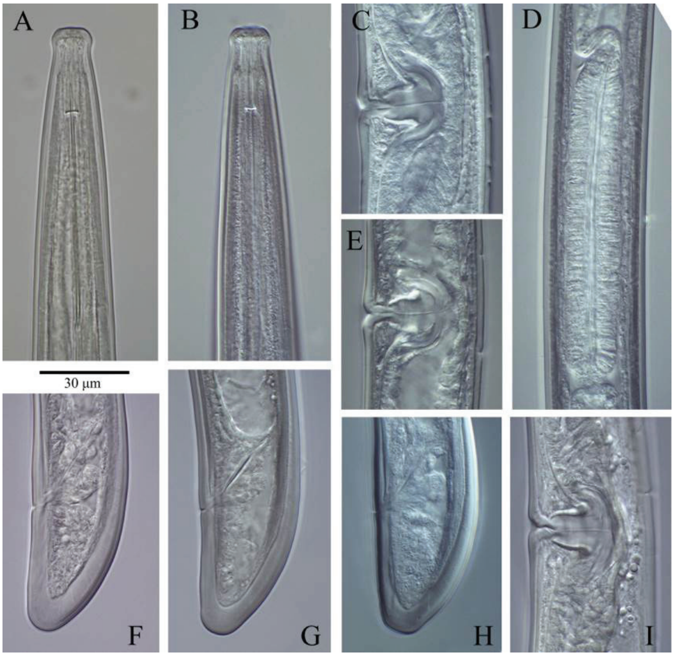

Figure 1. *Longidorus euonymus. Females*. A, B, anterior ends; C, E, I, vaginal regions; D, pharyngeal bulb; F-H, variations in tail shape. Origin of populations: A, F, G, I – Mărăcineni; B-E, H – Voinești; *Scale bar*: 30 µm

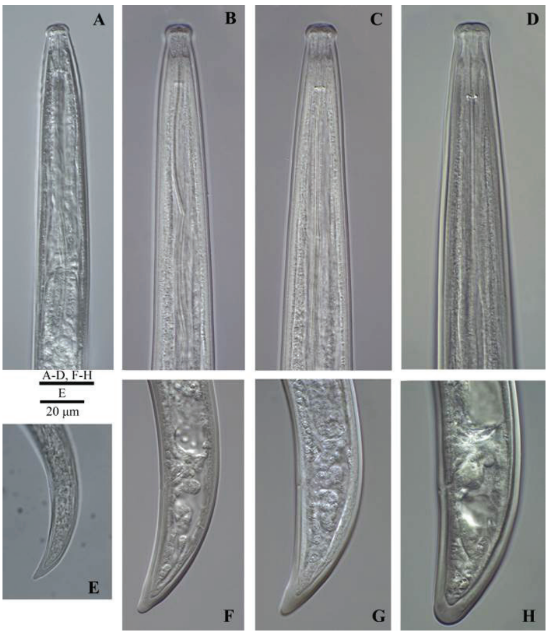

Figure 2. *Longidorus euonymus. Juveniles*. A-D, Anterior ends of first – to fourth-stage juveniles; E-H, Tails of first- to fourth – juvenile stages, females and male. Populations: A, E – Moscu; B, C, F, G – Mărăcineni; D, H – Voinești; *Scale bars*: 20 µm

Table 1. Measurements of *Longidorus euonymus* on barley (*Hordeum vulgare*) from Moscu (mean ± standard deviation, with range), in micrometers, except body length (mm)

Character	Female	J1	J2	J3	J4
n	11	1	2	7	14
L	6.76±0.61 5.98-7.87	1.40	1.64, 2.26	3.28±0.28 2.84-3.60	4.89±0.33 4.52-5.41
a	156.1±11.1 138.3-174.6	62.5	75.5, 90.8	93.5±9.7 77.7-103.7	131.0±18.8 109.7-175
b	17.7±2.0 14.7-21.3	6.5	6.4, 8.1	10.4±1.4 7.5-11.7	14.0±2.2 11.1-18.7
c	146.5±14.4 116.1-171.9	29.3	35.9, 47.0	63.2±7.4 55.1-74.0	100.7±10.4 79.9-113.1
c'	1.3±0.2 1.0-1.6	3.2	2.8, 2.5	2.1±0.2 1.8-2.5	1.6±0.2 1.4-2.1
V (%)	50.9±1.9 48.6-54.3	-	-	-	-
G1 (%)	6.6±0.7 5.0-7.3	-	-	-	-
G2 (%)	6.3±0.5 5.3-7.0	-	-	-	-
d	0.3	2.1	2.2, 2.1	2.2±0.1 2.0-2.4	2.1±0.2 1.9-2.3
d'	0.8±0.1 0.8-1.1	1.5	1.6, 1.5	1.6±0.1 1.4-1.8	1.5±0.1 1.4-1.7
Anterior end to guiding ring	28.6±1.2 27-31	16	18, 19	22.9±0.9 21-24.5	25.4±1.4 23-27
Odontostyle	84.2±3.0 80-89	51	58, 60	65.5±2.4 62-69	73.5±2.1 71-77
Replacement odontostyle	-	55	63, 64	73.1±2.9 70-77	83.3±3.2 77-88
Odontophore	62.3±5.7 54-76	33	41, 41	51.2±2.8 47-56	57.8±2.3 54-61
Pharynx length	385.5±31.2 320-435	218	258.5, 278	320.3±38.8 277-379	355.7±47.8 271-423
Tail	46.5±4.6 39-53	48	46, 48	52.1±3.5 49-60	48.9±4.7 41-59
Length of hyaline part	8.8±1.1 7-11	8	6.5, 6	8.9±2.1 6-12	8.0±1.4 6-11
Body diameter at: - lip region	13 ±1.1 11-15	8	8, 9	10.5±0.7 9.5-11.5	11.9±0.6 11-13
- guiding ring	19±0.7 18-20	12	13, 14	16.4±0.6 16-18	17.8±0.9 16-20
- base of pharynx	36±1.7 34-38	22	21, 26	30.7±1.3 29-32	34.0±1.4 31-36
- mid-body/at vulva	43.3±1.9 41-46	22.5	22, 25	35.4±4.3 30-42	38.1±4.2 30-44
- anus	35.6±5.4 32-51	15	16, 19	24.8±1.7 22-27	30.3±1.6 28-33
- hyaline part	13.1±1.8 10-16	6	6, 7	10.4±1.3 8-12	13.7±1.3 12-15

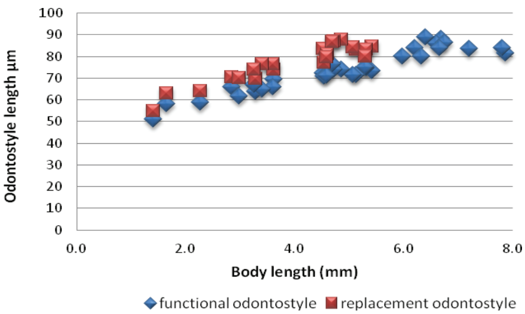

Figure 3. Scatter plot of functional and replacement odontostyle in relation to body length of *Longidorus euonymus,* Moscu population on *Hordeum vulgare*

Table 2. Measurements of *Longidorus euonymus* on strawbery (*Fragaria* x *ananasa*) from Mărăcineni (mean ± standard deviation, with range), in micrometers, except body length (mm)

Character	Female	J1	J2	J3	J4
n	3	1	8	4	3
L	6.57, 6.34, 5.82	1.3	2.06±0.14 1.85-2.32	2.87±0.13 2.68-2.98	3.09, 4.34, 3.68
a	154.3, 169.6, 147.9	66.3	78.8±6.6 70- 89	99.4±12.1 85.0-113.7	92.1, 133.2, 111.5
b	17.2, 17.9, 14.6	5.5	7.4±0.5 6.6-8.2	9.3±0.7 8.5-10.1	9.5, 11.3, 11.7
c	142.4, 154.2, 130.6	34.4	41.7±3.8 34.9-46.9	61.1±6.4 54.2-69.6	54.3, 82.7, 87.0
c’	1.4, 1.3, 1.4	2.5	2.7±0.2 2.3-3.1	2.1±0.1 2.1-2.3	2.4, 1.9, 1.5
V (%)	53.2, 54.6, 52.1	-	-	-	-
G1 (%)	6.9, 6.7, 7.5	-	-	-	-
G2 (%)	6.8, 6.2, 6.8	-	-	-	-
d	2.1, 2.2, 2.6	2.5	2.5±0.2 2.2-3.0	0.4	2.1, 2, 1.7
d'	1.5, 1.5, 1.6	2.1	2.1±0.2 1.6-2.3	2.1±0.2 1.8-2.3	1.9, 2.1, 1.9
Anterior end to guiding ring	27, 27, 34	15	19.8±0.8 19-21	22.6±0.8 22-24	26, 25, 23.5
Odontostyle	81, 81.5, 82	48	55.0±1.4 52.5-57	60.6±1.5 58.5-62	64, 71, 64
Replacement odontostyle	-	56	63.0±1.5 60-64.5	68.5±1.3 67-70	79, 80, 77
Odontophore	74, 66, 58	32	41.2±4.9 31-46.5	47.3±3.7 42-50	51, 54, 45
Pharynx length	383, 355, 399.5	240	277.5±15.3 249-299	310.1±28.2 285-349	324, 386, 313
Tail	46, 41, 45	38	49.7±4.1 47-59.5	47.4±3.5 42.5-50	57, 52.5, 42
Length of hyaline part	11, 11, 9.5	6	6.5±0.8 5-8	8.7±1.2 7.5-10	12, 7, 8
Body diameter at: - lip region	13, 12, 13	8	9.4±0.6 8.5-10	10.5±0.5 10-11	11, 12, 11
- guiding ring	20, 18, 21	12	14.1±0.4 13.5-15	15.4±0.6 15-16	16, 17, 18.5
- base of pharynx	36.5, 34, 34	20	24.4±1.4 23-27	27.7±1.4 26-29	30, 30, 32
- mid-body/at vulva	43, 37, 39	20	26.3±2.7 23-30	29.2±2.4 26-32	33.5, 33, 33
- anus	33, 31, 32	15	18.8±1.1 17-20	22.2±1.5 20.5-24	23, 28, 27
- hyaline part	21, 20, 21	6	6.7±0.9 5-8	9.0±0.6 8.5-10	10, 13, 16

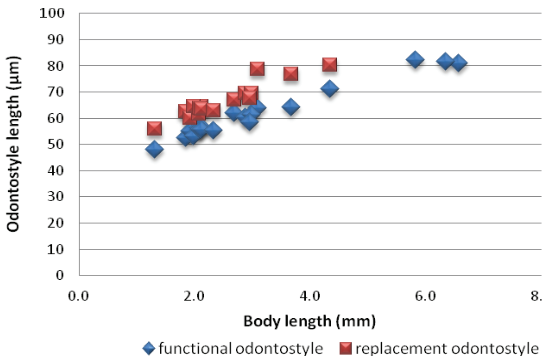

Figure 4. Scatter plot of functional and replacement odontostyle in relation to body length of *Longidorus euonymus,* Mărăcineni population on *Fragaria* x *ananasa* Duch

Table 3. Measurements of *Longidorus euonymus* on blackberry (*Rubus fruticosus*) from Mărăcineni (mean ± standard deviation, with range), in micrometers, except body length (mm)

Character	**Female**	**J2**	**J3**	**J4**
n	3	1	5	2
L	7.40, 7.08 5.76	2.36	3.31±3.27 3.00 - 3.77	4.75, 4.92
a	170.6,-,142.2	78.9	99.8±4.8 96.6-107.9	132.1, 144.7
b	17.5, -, 14.2	8.0	10.5±1.0 9.0-11.7	12.1, 10.3
c	201.3, -, 169.0	51.5	70.0±9.1 61.1-78.5	95.7, 111.3
c’	1.2, 1.2, -	2.3	2.1±0.2 1.9-2.3	1.7, 1.6
V (%)	52.4, 54.6, 50.6	-	-	-
G1 (%)	6.3, -, 8.3	-	-	-
G2 (%)	6.8, -, 9.7	--	-	-
d	2.3, 2.0, 1.7	2.2	2.0±0.1 1.9-2.1	1.9, 1.6
d'	1.5, 1.4, 1.3	2.2	1.5± 0.1 1.4-1.7	2.0, 2.2
Anterior end to guiding ring	29, 28, 26	21	23.2±1.4 22-25	26.5, 28
Odontostyle	85, 82, 77	52	62.8±2.2 60-65	70, 71
Replacement odontostyle	-	61	68.6±2.2 65-70	75, 81
Odontophore	61, 60, 60	46	52.8±1.8 50- 55	53, 60
Pharynx length	423, -, 405	297	315.6±13.4 302-334	392, 480
Tail	37, 42, -	46	48.8±5.3 42-55	50, 44
Length of hyaline part	9, 11, 7	8.5	8.8±1.1 7-10	8, 8
Body diameter at: - lip region	-	-	-	8, 8
- guiding ring	13, 14, 14.5	9.5	11.5±0.3 11-12	12, 12
- base of pharynx	19, 19, 19	16	17.1±0.8 17-19	18, 18
- mid-body/at vulva	35, -, 34	27	29.8±2.3 27-33	33, 31.5
- anus	43, -, 40.5	30	33.2±2.6 30-36	36, 34
- hyaline part	32, 34, 31.5	20	23.8±3.0 21-27	30, 28
Anterior end to guiding ring	17, 18, 15	8	10.6±0.7 10-11	12.5, 14

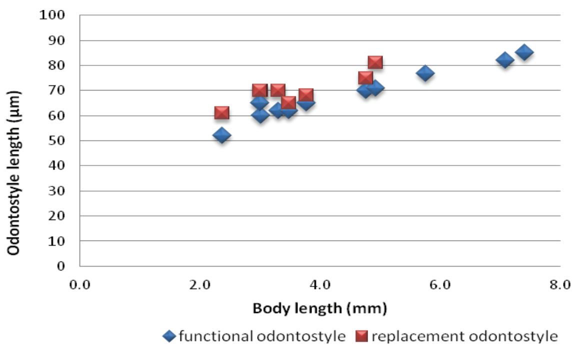

Figure 5. Scatter plot of functional and replacement odontostyle in relation to body length of *Longidorus euonymus,* Mărăcineni population on *Rubus fruticosus* L.

Table 4. Measurements of *Longidorus euonymus* on *Prunus avium* fromVoinești (mean ± standard deviation, with range), in micrometers, except body length (mm)

Character	Female	J1	J2	J3	J4
n	7	2	8	7	7
L	6.5±0.47 5.8-7.2	1.41, 1.64	2.1±0.15 1.9-2.3	3.2±0.31 2.7-3.5	4.6±4.2 4.2-5.3
a	151.5±7.8 139.1-164	64.4, 74.7	81.3±2.2 79.0-84.4	106.2±8.4 93.0-115.2	134.9±21.9 115.5-173.4
b	15.8±1.5 14.2-18.3	6.7, -	7.7±0.6 6.6-8.3	10.1±0.6 8.9-10.9	12.5±1.8 9.7-14.7
c	140.7±8.7 126.1-151.2	33.7, 35.7	43.7±3.3 37.5-47.3	63.2±3.4 59.3-67.0	98.6±12.2 83.8-110.0
c'	1.4±0.05 1.3-1.4	2.8, 2.70	2.5±0.2 2.3-2.8	2.2±0.1 2.1-2.5	1.6±0.1 1.5-1.8
V (%)	51.8±1.1 50.0-53.1	-	-	-	-
G1 (%)	7.4±0.74 6.5-8.2	-	-	-	-
G2 (%)	7.3±0.5 6.7-7.8	-	-	-	-
d	2.1±0.08 2.0-2.3	2.0-2.1	2.1±0.2 1.8-2.6	2.1±0.1 2.0-2.2	2.1 2.0-2.1
d'	1.4±0.05 1.3-1.5	1.8, 1.75	1.5±0.1 1.4-1.7	1.5 1.4-1.5	1.4±0.1 1.2-1.5
Anterior end to guiding ring	28.2±1.3 26.6-30	16, 17	20.3±1.5 19-23	23.3±0.8 22-24	24.6±0.6 24-25
Odontostyle	81.7±1.2 80-84	50, 51	55.4±1.4 53-58	62.7±2.8 60-67	71.1±1.8 69-73
Replacement odontostyle	-	55, 55	62.4±2.9 59-68	70.8±2.5 67-74	81.7±2.7 78-85
Odontophore	60.6±2.6 55-63		45.9±2.2 42-49	52.3±2.6 50-55	55.7±2.8 52-60
Pharynx length	411.8±24.8 371-450	210	281.4±26.4 242-315	324.1±25.2 285-355	379.4±45.8 330.0-465
Tail	46.3±1.6 44-48	42, 46	49.5±2.6 46-53	53.1±2.1 51-56	47.7±4.3 41-52
Length of hyaline part	8.7±0.8 8-10	7, 6	6.8±1.1 5-8	8.2±0.5 8-9	7.1±0.7 6-8
Body diameter at: - lip region	13.1±0.37 13-14	8, 8	9.7±0.6 9-10	11.2±0.2 11-12	11.9±0.2 12-12
- guiding ring	19.1±0.4 18-20	14, 14	14.7±0.7 13.5-16	16.6±0.4 16-17	16.8±1.4 14-18
- base of pharynx	30.7±1.4 34-37	21, -	25.3±2.0 23-29	28.2±2.8 23-31	32.3±1.5 30-34
- mid-body/at vulva	43.0±1.40 41-45	22, 22	26.4±1.4 25-28.0	30.7±2.0 28-33	35.0±3.1 31-39
- anus	32.5±0.6 32-33.5	15, 17	19.6±0.9 18-21	23.7±1.7 21-25	30.0±1.6 28-33
- hyaline part	17.6±0.74 17-19	5, 6	7.4±0.9 6-8	10.1±0.7 9-11	13.5±0.5 12-14

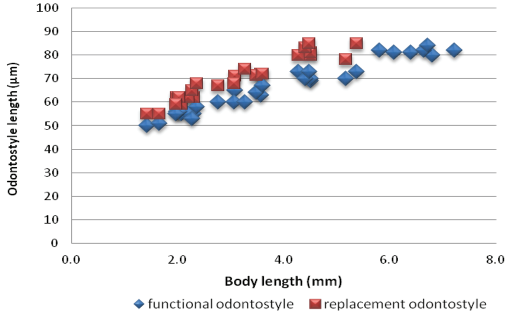

Figure 6. Scatter plot of functional and replacement odontostyle in relation to body length of *Longidorus euonymus,* Voinești population on *Prunus avium* L.

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AUTOMATION AND COMPUTER-BASED TECHNOLOGY FOR SMALL VEGETABLE FARM HOLDERS

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Abstract

The present paper relates a method of computer controlled irrigation/ fertigation/ chemigation which : a.) optimizes water/ nutrients/ pesticides inputs and protects natural resources (water, soil and soil nutrients), b.) uses the correct rates of nutrients and water for plants, being essential not only for the improvement of irrigation system but also for reducing inputs costs and increasing crop yield. The concept of this research is to save water and to apply fertilisers and pesticides responsibly – based on an intelligent and interactive control system for effective irrigation/fertigation and chemigation scheduling. It will be easy to use and reliable for small and medium vegetable farms (2 ha or less) which dominate the vegetables market in Romania. The connexion with precision agriculture and variable rate technology is direct and strong. The use of electronics in fertigation/chemigation process brings many benefits due to its accuracy, powerful calculation software and automation. Electronics is involved in the detection of the environment parameters (humidity, temperature, in soil and in the air, wind direction, rain sensors, clouds detection, colour of the plant leaves), in the management of the inputs (water level control, mixing the fertigants), system control (pressure control, cleaning of the tanks) and data processing (data storage, computation, data reports, real-time clock). The electronic equipment of the automated interactive system for the optimisation of water, nutrients and pesticides inputs contains a central processing unit, a data acquisition unit and a driving unit mounted together on a mobile platform (tractor or car driven) comprising various tanks for water, fertilizers, pesticides, associated with automation elements which makes this unit an independent and flexible one. The connection with water supply and electricity is also provided.

Key words*: vegetable farms, chemigation, wireless sensors, computer, automation.*

INTRODUCTION

With the rapid rise in demand for both agricultural crop quantity and quality and with the growing concern of non-point pollution caused by modern farming practices, the efficiency and environmental safety of agricultural production systems have been questioned (Gebbers and Adamchuk, 2010).

While implementing best management practices around the world, it was observed that the most efficient quantities of agricultural inputs vary across the farmland due to various naturally occurring, as well as man-induced, differences in key productivity factors such as water and nutrient supply. Identifying and understanding these differences allow for varying crop management practices according to locally defined needs (Pierce and Nowak, 1999). Such spatially-variable management practices have become the central part of precision agriculture (PA) management strategies. PA is an excellent example of a system approach where the use of the sensor fusion concept is essential.

Among the different parameters that describe farmland variability, topography and soils are key factors that control variability in crop growing environments (Robert, 1993). Variations in crop vegetation growth typically respond to differences in these microenvironments together with the effects of management practice. Our ability to accurately recognize and account for any such differences can make production systems more efficient. Traditionally differences in physical, chemical and biological soil attributes have been detected through soil sampling and laboratory analysis (Wollenhaupt et al., 1997; de Gruijter et al., 2006). The cost of sampling and analysis are such that it is difficult to obtain enough samples to accurately characterize the landscape variability. This economic consideration resulting in low sampling density has been recognized as a major limiting factor.

Remote sensing involves the deployment of sensor systems using airborne or satellite platforms. Proximal sensing requires the operation of the sensor at close range, or even in contact, with the soil being measured, allowing *in situ* determination of soil characteristics at, or below, the soil surface at specific locations (Viscarra Rossel et al., 2011). Alternatively, the crop itself can be viewed as a bio indicator of variable growing conditions. Yield maps summarize the overall impact of management activities and of natural conditions, such as weather and soils. However, yield data provide only a retrospective analysis and does not allow the user to address any spatial and temporal inconsistencies in crop growth during the corresponding growing season. Therefore, different in-season sensing scenarios have been implemented to provide feedback on crop performance in time to alter management decisions according to local needs. It has been demonstrated that detection and identification of weeds using machine vision systems is feasible as well; other crop status sensing techniques such as laser florescence, thermal imaging and ultrasonic proximity sensing are the subject of ongoing research.

One of the main limitations of any sensor-based management is that virtually every layer of information can respond to more than one soil, landscape, or crop property used to describe growing conditions and process. This makes a corresponding decision-making strategy uncertain and/ or complex when attempting to deploy it over different production settings (McBratney et al., 2005). Using a combination of conceptually different sensing techniques and integrating the subsequent data holds promise for providing more accurate property estimates, leading to more robust management and increased adoptability of sensor-based crop management.

The concept of the whole project is saving water and applying fertilisers and pesticides responsibly - manage irrigation and fertilization together to optimize efficiency. This project proposes an intelligent and interactive control system for effective irrigation/fertigation and chemigation scheduling. It will be easy to use and reliable for small and medium vegetable farms (2 ha. or less) which dominate the vegetables market in Romania.

The goal of this publication is to discuss the concept of sensor fusion relevant to precision agriculture, a method of computer controlled irrigation/ fertigation/ chemigation which optimizes water/ nutrients/ pesticides inputs and protect natural resources (water, soil and soil nutrients) and also to provide a framework for future research in this area.

MATERIALS AND METHODS

It is the *purpose* of the project of the above organizations to provide a method of irrigation/ fertigation/ chemigation that uses the correct rate of nutrients and water for plants using an intelligent system, computer based. Our project relays on *variable rates* irrigation/ fertigation/ chemigation which, in our opinion, is very essential not only for the improvement of irrigation system but also for reducing the inputs costs and for increasing crop yield. Intelligent control based irrigation is necessary to maximize efficiency and production. The originality of the project consists in proposing such a system which uses a computer based decision support (Figure 1).

The use of electronics in fertigation / chemigation process brings many benefits due to its accuracy, powerful calculation software and automation. Electronics is involved in the detection of the environment parameters (humidity, temperature, in soil and in the air, wind direction, rain sensors, clouds detection, colour of the plant leaves), in the management of the inputs (water level control, mixing the fertigants), system control (pressure control, cleaning of tanks) and data processing (data storage, computation, data reports, real-time clock).

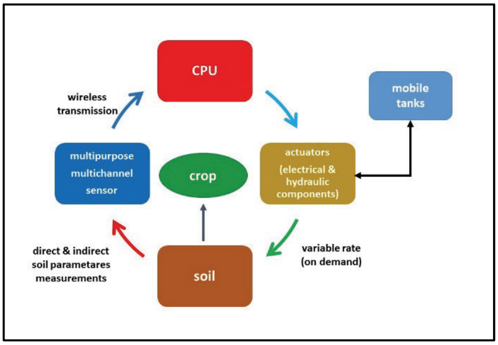

Figure 1. The concept of computer-based irrigation/fertigation/chemigation system

Our system will: **a.)** monitor the state variables within the agricultural system, **b.)** compare the state variables with their desired or target values, **c.)** decide what actions are necessary to change the state of the system, **d.)** carry out the necessary actions.

The electronic equipment to control the automated interactive system comprises a central processing unit, a data acquisition unit and a driving unit.

The **central processing unit** is built around a microcomputer structure which embedded software will supervise the control elements and will drive the execution elements accordingly to manage the irrigation process.

The microcomputer-based control system consists of a combination of hardware and software that acts as a supervisor with the purpose of managing irrigation and other related practices such as fertigation and pesticide treatments. Our computer-based control system will be a *fully automatic* one which means that it controls performance of the system by automatically actuating pumps, valves, etc., in response to feedback received from a sensor-based monitoring system.

The central processing unit will be provided with a robust, easy-to-use interface for an external operator, and with an intelligent machine specifically programmed to react properly to any changes of parameters monitored by sensors. The automatic functions are activated by feedback from field units (sensors) and will make corrections in the flow parameters by controlling devices in the irrigation system until the desired performance level is attained. This automatic systems will also perform auxiliary functions such as stopping irrigation in case of rain.

The embedded software will process data acquired from soil and plants through sensors in real time and will command appropriate quantities of chemicals to be pumped. Thus waste of water and energy will be prevented, specially when a natural soil humidity exists. The System is conceived for a medium size farm and to easily be transported into and from the field.

A step of novelty is the development of a software for vegetable growers, a versatile and useful tool to enables every grower to master irrigation, fertigation and chemigation at a professional level. The software will be conceived as a practical and efficient tool to calculate (based on information which determine the crop's needs) irrigation and fertilisation needs for vegetables using drip/sprinkle irrigation, under set conditions described by the user. It will be interactive, which means that they can be seen, modified, printed, etc.

This programme will use: **a.)** information of crop, soil texture and number of drips (size of the irrigated area and irrigation time), **b.)** information of the EC (electrical conductivity) of water from source, percentage of water availability, and nutrient content of the water. Nutrient content of the irrigation water is useful, so that any nutrients found here can be deducted from the fertiliser, **c.)** fertiliser data base (name and type of fertiliser - to obtain the fertigation proposal), to select and calculate the optimal fertilizer quantity, based on water/soil composition and growing needs (to avoid undesirable chemical combinations, over-fertilizing or under-fertilizing, damage to soil or water sources, salinity build-up).

The **data acquisition unit** will collect information from distributed multichannel, multipurpose sensors for humidity, temperature, level of the liquid in the tank, etc. The information is transferred into the central unit either directly, from sensors in the pipeline, or from intermediate data acquisition unit which collects the data from a number of sensors and then process and store them temporarily for further transfer to the central unit. All kind of input parameters like air temperature, soil moisture, radiations and humidity are collected and modelled. Various sensors, tensiometers, relative humidity sensors, rain sensors, temperature sensors control these processes scheduling. These sensors provide feedback to the controller to control its operation.

The **driving unit** will be the interface between the central processing unit and other elements of the system such as pumps, electro valves. The field devices such as valves, regulators, pumps, etc. are fitted with electrically operated servo-devices which enable actuation of the pumps, closing and opening of valves, and adjusting pilot valves of flow regulators. This type of system will also permit the system to govern flow from the central computer by controlling flow parameters such as pressure and flow rate, according to specific needs at the given time, and to receive immediate feedback on the response of the system. The system has also features that enable an operator to transmit commands back to the various control units of the irrigation system. The energy for the electronic equipment will be supplied from the mains (230 V/50 Hz).

Also, the whole system and acquisition data unit can plan a strategy to get profit and save money on chemicals, to apply to and to use special treatments database (herbicides/ insecticides/ fungicides): name of the treatment, month(s) in which we want the program to remind us to apply it/them, and which variety to receive treatment; discount the days when special treatments are applied from those when fertilisation was planned; and to obtain and keep a historical database: all the treatments proposals are stored, to easily find out what was done, to facilitates planning, a.s.o.

Safeness and safe use of equipment are other priorities of the project. The whole philosophy is to realize a product that is not harmful to the environment and complies to European Union regulations. To achieve this goal it is taken into consideration the following aspects: **a.)** water excess, which could bring to a salty soil or specific water diseases, will be prevent because of the interactivity of the System by permanent monitoring of the soil humidity in several points, **b.)** avoid harmful substances (all electronic components will comply to the Directive 2002/95/EU on Restriction of Hazardous Substances in Electrical and Electronical Equipments (RoHS), to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE), and to Regulation (EC) No. 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH); that means the soldering process of electronic modules will use the lead-free technology, the electronic components and the printed circuit board finishing will not contain Pb, Cd, Hg or other harmful substances.

Physically, beyond electronics, the system will contain various tanks, of various volumes for water and chemical substances. The substances will be mixed in water and pumped through the drip irrigation system which can be manually or automatically operated. Water can be obtained from a fountain or from a large stationary reservoir. A network of smaller diameter polytubes, poly fittings and accessories to make connections and emitting devices at plants complete the System.

Using automation and microcomputers, the calculation process is automated, and different alternatives can be analysed to provide the necessary nutritive elements for crop. A computer program is easier to use if it is complemented by one or more data bases; this saves much time in planning for technicians responsible for setting up nutritive programmes on the estates they manage. Real time feedback is the application if irrigation based on actual dynamic demand of the plant itself, plant root zone effectively reflecting all environmental factors acting upon the plant. Operating within controlled parameters, the plant itself determines the degree of irrigation/ fertigation/chemigation required.

Drip irrigation at variable rates may help achieving water conservation by reducing evaporation and deep drainage when compared to other types of irrigation such as flood or overhead sprinklers since water can be more precisely applied to the plant roots.

Traditional pesticide application is by sprayer; however, spray application may not be efficient due to a variety of factors, such as spray drift, and spray operator skill. Chemigation, or

injection of insecticides, pesticides, herbicides, etc. through irrigation systems, offers an alternative strategy for efficient and economical application of pesticides to targeted zones in soil. Improving water distribution uniformity of drip irrigation systems has been studied extensively, but the specific evaluation of a designated pest control agent's uniformity throughout drip lines is lacking, especially for the microbial bio-pesticides before they are used for field trials.
Using irrigation systems to apply fertilizers and pesticides is commonly referred to as fertigation and chemigation. Fertigation / chemigation via drip irrigation has advantages compatible with environmental stewardship: no worker exposure to foliar pesticide residues, reduction of waste from cleaning out spray tanks, elimination of drift, and less exposure of biological control organisms to pesticides in integrated pest management programs. Systemic pesticides seem particularly well suited for application by drip chemigation and would be compatible with Integrated Pest Management if plant uptake was rapid enough to allow delay in application until a pest problem was developing. Insecticides of the neonicotinoid class, including imidacloprid, thiamethoxam, and acetamiprid, may be particularly suitable for drip chemigation. They have systemic properties, but they are arguably considered reduced risk pesticides.
Use of fertigation/chemigation makes producers strive to be more efficient with production inputs and practice good environmental stewardship. It is usually practiced with high value crops such as vegetables, turf, fruit trees, vines, and ornamentals. The main advantage of fertigation is the application of nutrients at the precise time they are needed and at the rate they are utilized. Yields are optimized and fertilizer costs are reduced because the nutrients are applied when, where, and in the soluble form needed. Overall, fertigation conserves water and nutrients.

RESULTS AND DISCUSSIONS

Using the proposed system it is possible to reduce fertilizers needs by **70-90%**. Because fertilizer is absorbed as needed, and in small doses, the farmer uses far less fertilizer to achieve superior results. Since most of the fertilizer gets absorbed directly into the plant, fertilizer run-off is virtually eliminated. Fertigation also improves the plant's efficiency in holding water due to an increase in root mass thereby reducing total water needed.
The system, in its conception, can save of **20-50%** on water usage through fertigation (increased uptake efficiency by the plant). It is possible to cut back the watering time in each zone by 10%. Further cuts can be made based on how fertile the soil becomes and if there are used products that help to trap water in the root zone.
The computer-based system will reduce herbicides and pesticides needs, in addition to reducing water and fertilizer needs.
Drip application of pesticides includes: reduced risk to environment and farm workers: drift to non-target areas is eliminated; farm workers do not come into contact with residues on plant foliage; beneficial organisms not directly exposed; longer residual activity (not subject to loss from rain and UV light; not subject to plant growth dilution effects).
If managed correctly it will improve the crop's health and vitality, automatically.

CONCLUSIONS

This automated system, as it is developed now, can:

- reduce chemical application rates;
- uniformly apply chemical substances;
- apply any kind of treatment on time;
- reduce soil compaction;
- produce less crop damage;
- minimize environmental hazards;
- minimize operator hazards.

With respect to economic benefits, there is savings in labour, savings in water, fertilizer, herbicides and pesticides, energy and increased plant productivity and overall profit. With regard to environmental benefits, water and fertilizer resources are saved, the use of environmentally harmful chemicals is reduced, run-off into water sources is reduced, erosion is reduced, and the amount of land tied up in agriculture is reduced. While the project has been founded and started with reference to specific embodiments, it will be apparent that numerous variations, modifications and alternative embodiments are possible, and accordingly all such variations, modifications and alternative embodiments are to be regarded as being within the scope and spirit of the present project.

The consortium as it was constructed, by putting together the electronic designer partner and the technological designer partner, is favourable for obtaining maximum benefits resulted by applying the rules of Design for Manufacturing (DfM) concept and concurrent engineering methodology by taking into account in the early stage of the design of all the problems of the entire life cycle of the end-product. As known, the good application of DfM methodology leads to the best quality of a product, the lowest production costs, the reduction of the time-to-market and customer satisfaction. This is a guarantee of a competitive price of the end-product.

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STUDY ABOUT BIODIVERSITY OF *Raphanus raphanistrum* PETALS COLOR

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Abstract

Weed Raphanus raphanistrum L. (RAPRA in code Bayer) is one of the important species in the white luvicsoils. Populations from cultivated surfaces have high competitive capacity through: high density and rapid rate of growth. Because of this, obviously affected crops, giving large losses, dangerous. The plant grows in both winter crops, as well as the spring. In the biological cycle, weed blooms in May for the spring generation and September to autumn generation. Biodiversity study was done on analyzing plant flowers two aspects: lamina petals color and lamina vines color. The data obtained were the dominant colors: yellow-white base, pale yellow and bright yellow, with different percentages depending on the ecosystem studied: wheat in May, the field before spring sowing, and autumn generation weed in September (new field plowed). From time to time were determined plants with white petals. The color of veins petals varied by the flowering season and by location: wheat and plowed field (weed vegetation increased in a short time). The yellow petals-white base have dominant purple vines in May and grey and purple in September. Petals pale yellow were dominant colors of gray and purple in spring and only grey in autumn. Bright yellow petals have veins in higher proportion in the gray, yellow and purple in spring and grey and yellow in September. In the present study R.raphanistrum have had the yellow-white base petals the best represented as the spring (34.8 %) and in autumn (48.4%). The veins best represented were gray (42.2%) and purple (36.0%) in May and gray veins in autumn season (48.2%).

Key words: *wild radish, biodiversity, petals color, veins color, field crops.*

INTRODUCTION

Weed species of importance to agriculture is wild radish, *Raphanus raphanistrum* L. Being a *Brassicaceae* family plant, it has flowers grouped in a raceme inflorescence, consisting of four petals arranged opposite one, two by two. Us, the plant has three varieties: *ochroleucus* with yellow-brown petals, pale yellow, purple veins, *luteus* with yellow petals and yellow and brown veins, *purpurascens* with purple petals and purple veins (Nyárady, 1955). Neither here or elsewhere does not make reference to the particular color dominance of the petals and veins of this plant. The world found that the color flowers of this weed are plentiful, diverse. Such were observed petals color: yellow with shades, cream, brown-yellow, white, pink, violet and purple. Veins which are in the petal structure, may vary from very light shades to the dark. Panetsos & Baker (1967) described the type of vein colors: yellow, green, brown, blue and purple. In Australia were found 17 colors, of which only the yellow and white were the most common (Cheam, 1995). In England, Kay (1976) noted a link between the color and the percentage of pollinated flowers with dominance role in ensuring some form or another in an agricultural area. Then, seeds of the plants collected from flowers yellow, white, purple, differ in time to maintain the viability of the other (Cheam, 1984). This character print a pronounced dominance of such plants in those areas. In other studies it was shown that yellow flowers are common in northern England (Benthan et al, 1954), and the white in South (Chapman et al., 1962). On this occasion they discovered a new variety: *aureus*, with golden yellow petals without veins. Later it was found that flowers with yellow petals are the most common (Stace, 1991), while white flowers are rare (Perring, 1968). Veins biodiversity on the weed petals could not be characterized in terms of geography. In other observations (Rich, 1991; Cheam & Code, 1995) found that plants with yellow flowers had a much higher prevalence compared with whites and purple. In other studies (Holm et al, 1997) shows greater spread of yellow flowers, white and purple in Poland, the white and purple in Hungary, Yugoslavia, northern Greece and Turkey. Such research, with reference to some plant characters as colored petals and veins, could give some information in different areas of agricultural biodiversity. Maintain and possible increase of plants biodiversity, including all weeds, is obvious and necessary character of sustainable agricultural surfaces. Biodiversity of wild radish is best determined by studying ecotypes, resulting in the history of land cultivation and adaptation to geographical ecology (Figure 1).

Figure 1. RAPRA, yellow petals with white base

MATERIALS AND METHODS

In order to observe the color diversity of *R.raphanistrum* petals were identified and analyzed a total of 10 ecosystems with dense populations. The plants were in the intense flowering period, in two moments: May and September.

Choosing ecotypes. Each population was chosen with high density in areas of natural infestation. In May were analyzed 3 wheat ecosystems and 3 autumn plowed ecosystems before spring sowing. In September were investigated a field with stubble (wheat) and 3 plowed ecosystems. In the plowed ecosystems, regardless of season, the weed growing up and flourished accelerated, characteristic.

Sampling. He went in a zig-zag direction along the length of weed population. Every 5 steps was selected a higher plant that flowers were in young blooming. The procedure was repeated 50 times from each field.

Petal analysis. Petal color was observed on the top of them, the clear color on the circular portion (peak). To ignore the color of the base under angle portion, which may have a different tint. For veins was examined bottom flower petals and tone noted as such. The analysis of the two color directions: petals and veins, resulting combinations, e.g. pale yellow petals with green veining.

To study biodiversity weed flower color was using Excel to develop graphs. Expression data was done by participation rates. They show their petals by biotypes color variability and by specific dominant colors in the researched area.

RESULTS AND DISCUSSIONS

Flower color analysis demonstrated variability of *R. raphanistrum* species, depending on ecosystem analysis.

Variability of petals and veins color depending on ecosystem and season. Of all the comments made were found specific groups. The dominant colors of the petals were yellow-white base, pale yellow, bright yellow and white. Veins had a wider range of colors: white, green, yellow, purple, gray and brown. Were differences between these colors. So in winter wheat dominant was weed petals with pale yellow color (32.4%), followed by the yellow- white base and bright yellow, with percentages close. The white color was in a proportion of 1.6% (Figure 2). Veins were dominant colors: gray (42.8%) and purple (34.4%). Other colors have been found to a lesser extent.

If weed bloom on autumn plowed ecosystems, the pale yellow petals have large percentage (35.5%), followed by the yellow-white base type and less for those bright yellow (Figure 3). Veins colors were dominant in almost equal proportions, the gray (40%) and violet

(40.5%). In both cases yellow vines were third place, with similar percentages: 14%. Analyzed flower petals showed different situations (Figure 4). Thus petals have dominant yellow-white base (48.4%), followed by the other two yellows: pale and bright.

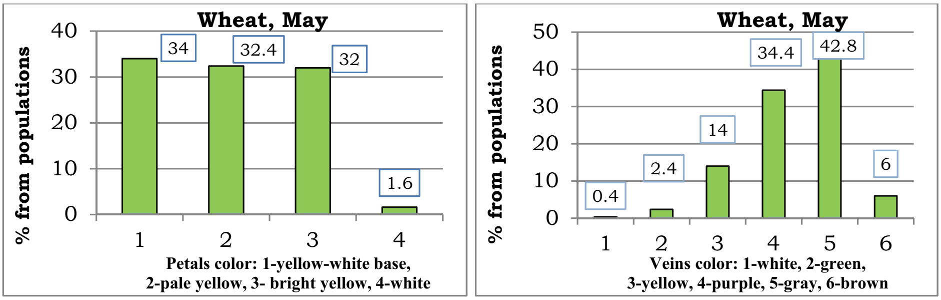

Figure 2. The structure of weed petals color and veins color from winter wheat, May

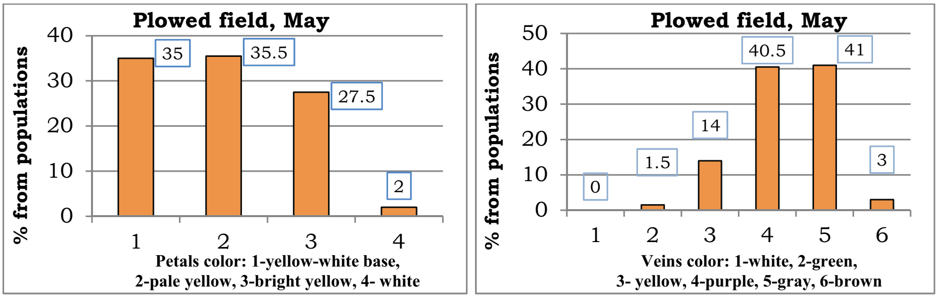

Figure 3. The structure of weed petals and veins color from plowing field before sowing, May

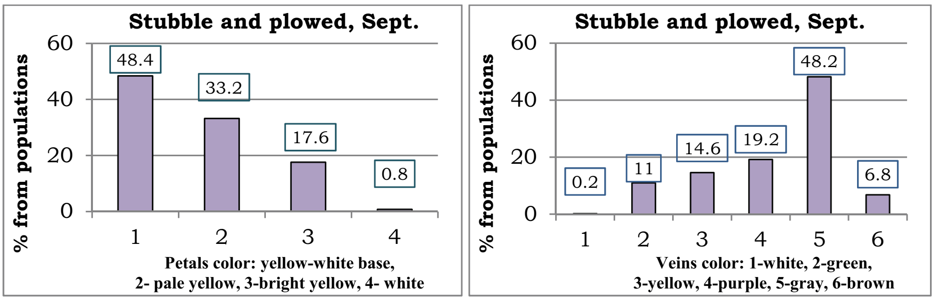

Figure 4. The structure of weed petals and veins color from stubble and plowing field

<u>Veins color variability of the main biotypes.</u> Analysis of the veins color shows the biotypes color petals with yellow-white base, the pale yellow and bright yellow, compared the spring and the autumn state. If yellow-white base formed in May were dominant purple veins (45.98%) and grey (Figure 5). At the September, dominated the gray (46.28%) and the purple stood at somewhat lower values (33.47%).

Yellow petals with grey veins were dominant in May (42.25%), followed by purple (38.1%). Among other shades followed of brown and yellow (both 7.74%), and the last green ones (3.57%). In September only gray veins dominated (53.01%), the other being below 20% (Figure 6).

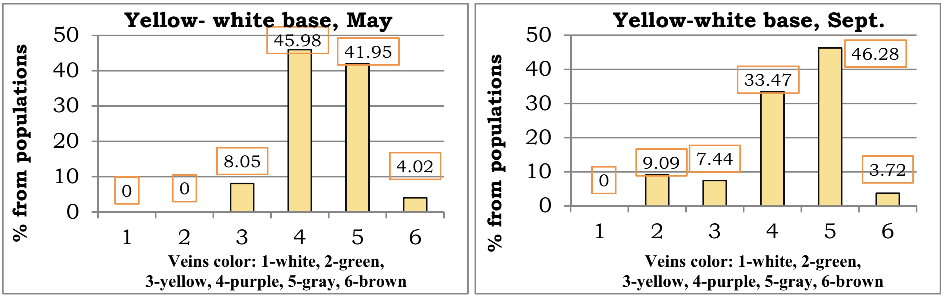

Figure 5. The veins color structure of yellow-white base petals, May and September

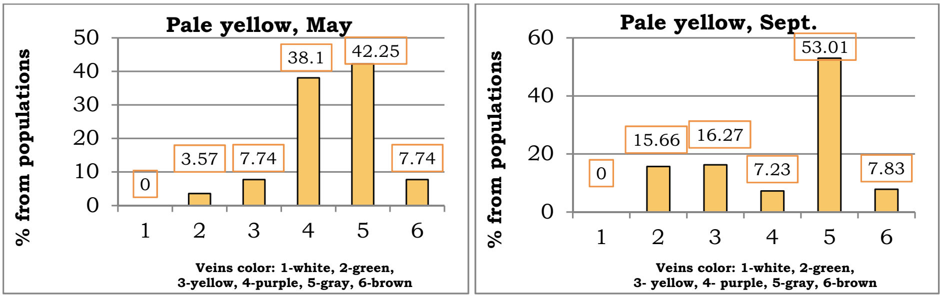

Figure 6. The veins color structure of pale yellow petals, May and September

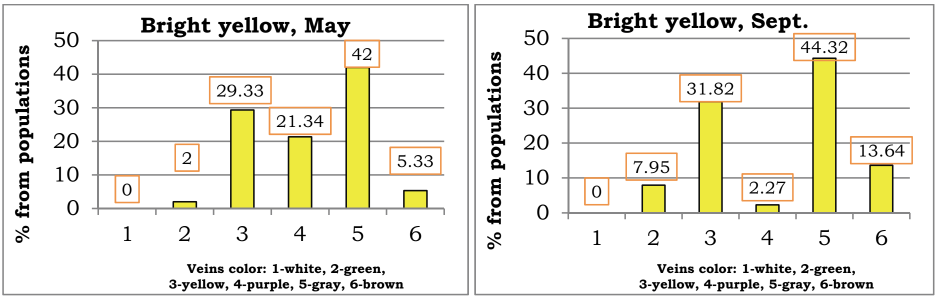

Figure 7. The veins structure of bright yellow petals, May and September

Category bright yellow petals were several categories of veins evident in May (Figure 7). The gray dominated (42%), followed by the yellow (29.33%) and then the purple (21.34%). In September gray was dominant (44.32%) and were followed by yellow (31.82%) and brown (13.64%).

Characterization color flower petals and veins of R.raphanistrum. In general, the color of the weed biotypes petals expressed by three dominant: the yellow-white base, pale yellow and bright yellow, and a secondary biotype with white petals (Table 1 and Figure 8).

Proportions differed between the two seasons of bloom. Veins color had a larger structure, but the gray was dominant, followed by the purple in both periods analyzed (Table 2).

Table 1. The *R. raphanistrum* petals color structure (%) by flowering seasons

Petals color	May	September
Yellow type, white base	34.8	48.4
Pale yellow	33.6	33.2
Bright yellow	30.0	17.6
White	1.6	0.8

Figure 8. Wild radish with white petals

Table 2. The *R. raphanistrum* weed petal veins color by flowering seasons

Veins color	May	September
White	0.2	0.2
Green	1.8	11.0
Yellow	14.2	14.6
Purple	36.0	19.2
Gray	42.2	48.2
Brown	5.6	6.8

CONCLUSIONS

The color of petals and veins showed variability depending on the ecosystems examined. Petals were four categories: yellow-white base, pale yellow, bright yellow and white. Veins had their colors: white, green, yellow, purple, gray and brown.
In the ecosystem analyzed were the dominant colors of the petals of the first three categories, both in May and in September. Thus, the most dominant in wheat was yellow petals-white base, in the plowed field (May) pale yellow ones and the yellow-white base (September). The two dominant veins were in May: gray and purple both in wheat and in the field plowed, and in autumn dominated only gray veins.

Ecotype with yellow petals-white base was gray and purple veins dominant in both seasons. Pale yellow ecotype had more gray and purple veining in May, and only gray in September. Bright yellow ecotype was most evident in the colors gray, yellow and purple veining in May, and gray and yellow veining in September.
The structure of color petals at blooming between the two seasons show a similarity in the relative dominance between the yellow-white base and pale yellow.
The base veins were gray in both seasons, followed by the purple, and then the yellow. Green veins were observed more over the flowering of the September, the brown in the both periods, and white was under-represented.

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THE ROLE OF ESCORENA (EUROPEAN SYSTEM OF COOPERATIVE RESEARCH NETWORKS IN AGRICULTURE) IN AGRICULTURE KNOWLEDGE SHARING AND TECHNOLOGY TRANSFER

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Abstract

ESCORENA system was established in 1974 by FAO and European research institution. The European System of Cooperative Research Networks in Agriculture is an umbrella for cooperation between research institutions focused on food, agriculture and related fields. The ESCORENA is a bridge between FAO and agriculture to e.g. inform about newest FAO priorities elaborated in 2013, namely: supporting farm and production restructuring including agriculture, forestry and fishery; fostering land consolidation process; supporting local development strategies through participatory approach; strengthening capacity for rural stakeholder; integration of smallholders and SMEs into the value chain; providing support on adding value to products and services, activity and income diversification. Joint activity of high ranking specialists and agriculture research centers within ESCORENA under auspices up to now is characterized by e.g. organizing some thousands global consultations, conferences, workshops, seminars, and some knowledge share-fairs etc., which took place not only in Europe but in Near East, Africa, Asia, North and South America. ESCORENA and Networks which belong to ESCORENA publish recognized Journals like: Journal of Natural Fibers (in co-operation with INF&MP), Scientific Bulletin of ESCORENA (in co-operation with Arad University, Romania), EUROFLAX Newsletter, Buffalo, Nuts and allied. The examples of spreading/sharing knowledge and technology transfer e.g. in the scope of bast fibrous plants: starting production of linseed and derived products in Balkans countries (after the FAO/ESCORENA conference in Banja Luka, B&H, 2004), growing interest in production and processing of flax and linen goods in China (after conference in Shenyang, 2001) and renewed interest in flax and linen in Norway, Finland, Sweden (after conference in Tampere, 1998), also in East European and Asian countries after the FAO/ESCORENA congress at famous Vavilov Institute (1998) in St. Petersburg, Russia. Plans for future: elaborate more farmer focused approach, improve efficiency of technology transfer, continuation of publishing and organizing workshops and meetings, apply for funds e.g. through COST Actions and other.

Key words*: ESCORENA, knowledge sharing, technology transfer.*

INTRODUCTION

ESCORENA - the European System of Cooperative Research Networks in Agriculture, established in 1974 by FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS and European research institutions, was an umbrella for cooperation between research institutions focused on agriculture, food, and related expertise and activities.

The main objectives of the system, was predicted to: promote voluntary exchange of information and experimental data on selected subject matters; support joint applied research on selected subject matters of common interest according to an accepted methodology, agreed division of tasks and timetable; establish close links between European researchers and institutions working on the same subject and to stimulate interaction; accelerate the transfer of European technology advances to, and cooperation with, developing countries; facilitate voluntary exchange of persons, Germplasm and technologies. (FAO Report, 2002), (Majewska et al., 2008). The European System of Cooperative Research Networks in Agriculture has been supervised, sponsored and promoted, by the FAO Regional Office for Europe, Rome, Italy. Since 2007, the new approach has been realized by Mr. Michal Demeš, Information and Knowledge Management Officer of the FAO Regional Office for Europe and Central Asia (REUT), Budapest, Hungary, namely, to provide the better ESCORENA Networks visibility on the

base of the web communication, provided by FAO. The relevant website of ESCORENA system, created due to FAO initiative, funds and encouragement can be found at the address: http://www.escorena.net. It means that ESCORENA recently became modern web-based networking and knowledge sharing platform for people around the world (Majewska et al., 2008).
ESCORENA is the multidisciplinary platform, which joins together twenty (20) thematic Networks namely: Agromarketing Network, Apricot Network, Buffalo Network, CAPNUTRA - Capacity Development Network in Nutrition, CENTAUR Biomedical Technology, Epidemiology and Food Safety Network, Cotton Network, Farm Animal Welfare (FAW) Network, Flax and other Bast Plants Network, Museum Network, Networks of Aquaculture Centres in Central Eastern Europe (NACEE), MAP – Medicinal and Aromatic Plants Network, Network on Nuts, Olives Network, Organic Edunet, Pastures & Fodders Network, Rice Network, Sheep & Goats Network, Sunflower Network in addition to the inter-disciplinary networks namely Sustainable Rural Energy Network (SREN) and Recycling of Agricultural, Municipal and Industrial Residues in Agriculture Network (RAMIRAN) (Demeš, 2011).
The ESCORENA Focal Point and secretariat is run by the Institute of Natural Fibres and Medicinal Plants (INF&MP), Poznan, Poland with Prof. Dr. Ryszard M. Kozlowski, with a help of Eng. Maria Mackiewicz-Talarczyk – the ESCORENA secretary and Dr Jorge Barriga Bedoya ESCORENA web support. The ESCORENA Focal Point is being financed by the management of INF&MP (Kozlowski and Mackiewicz-Talarczyk, 2012)

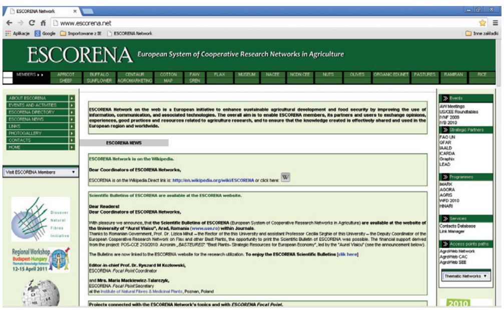

Figure 1. ESCORENA webpage

SHARING AND TECHNOLOGY TRANSFER

The ESCORENA is a bridge between FAO and agriculture to e.g. inform about newest FAO priorities elaborated in 2013, mentioned in details in the abstract and the ways how to achieve the goals described in the priorities.
The knowledge sharing has been conducted and achieved through joint activity of high ranking specialists of the agriculture research centers within ESCORENA by e.g. organizing some thousands global consultations, conferences, workshops, seminars, and some knowledge share-fairs e.g. at FAO, Rome, Italy in 2009 etc. Those events took place not only in Europe but in on other continents as well. In order to provide some certain examples of spreading/sharing knowledge and technology transfer the authors have chosen the following examples (known due to the authors' expertise):

1. Still growing interest in production and processing of flax and industrial hemp (to obtain high quality textile and non-textile products) in China derived from the achievements of the conference in Shenyang, 2001. The developing co-operation resulted for example in the EU project: FIBRA - Fibre Crops as a sustainable source of Biobased material for Industrial Products in Europe and China (2013-2015) (Spychalski and Wladyka – Przybylak, 2013).
2. The results derived from the FAO/ESCORENA conference in Banja Luka, Bosnia and Herzegovina held in 2004 e.g. in the scope of oil proving plants as linseed (oil flax) bast fibrous plants: more and more people are interested in linseed products in this country, excellent linseed oil is produced at the Agricultural Institute of the Republic of Srpska, and a few pressing machines have been installed in private farms. The interest in linseed and flax production is spread to other Balkans countries as well.
3. The renewed interest in flax and linen in Finland, Norway, and Sweden (after conference in Tampere, 1998) is aiming in the renaissance of linen production in those Scandinavian countries, where linen

production was still well developed up to 1970s.

4. The congress devoted to flax at N.I. Vavilov Research Institute of Plant Industry, held on 1998 in St. Petersburg, Russia turned attention to the diverse possibilities of utilization of entire flax plant and derived products and by-products not only in Europe, but also in Asian countries.

The ESCORENA Focal Point coordinator Professor Kozlowski has delivered and published dozens of presentations and elaborations regarding the weakness of technology transfer and the ways to improve its effectiveness. The major indications cited by the authors of the presentation, delivered recently at the 12th ICFPAM 2013 – The International Conference on Frontiers of Polymers and Advanced Materials, Auckland, New Zealand, 8-13 December 2013 were: **"**For improvement of technology transfer is needed creation of maximum connection between R&D and industry, fighting bureaucracy in agencies which finance and evaluate results of research, reorganization of system of evaluation of R&D and their results, improvement of policy concerning patents, licenses and royalty distribution, further globalization on the field of international collaboration between scientists and industry, create the opportunity to employ in R&D centers high ranking specialists from all over the world, creating new independent non-profit institution, which would act a missing link between R&D centers and industry". (Kozlowski et al., 2013). The ESCORENA Focal Point Coordinator Prof. Dr. Ryszard M. Kozlowski is involved recently in the organization of the special event devoted to technology transfer, namely the 2-nd Melpin Conference on Technology Transfer for the Development of New Products, 12-13 June 2014, Melpin, Poland.

1. COOPERATION WITH DEVELOPING COUNTRIES AND TRANSFER OF TECHNOLOGY ADVANCES

Cooperation with developing countries within ESCORENA activities was carried out in the form of e.g. distribution of publications to institutions and individual researchers from developing countries in Latin America and Asia, attendance of some representatives from other regions at network meetings, direct participation of 12 Near East countries in interregional networks (FAO Report, 2002).

2. JOINT APPLIED RESEARCH WITHIN THE NETWORKS

Several joint projects have been developed as a result of the ESCORENA Networks meetings. Some of these projects were financed by European programs. Particular results were obtained in the joint research programs, exchange of germplasm, in collection, conservation and utilization of plant genetic resources, sustainable management of natural resources, diversification of agricultural production (e.g. use of marginal lands for non-food agricultural production, such as flax and industrial hemp in industrially polluted areas) and in the development of sustainable production systems including improvements in quality of typical local products in support of rural employment and improvements in the economic position of rural population. (Kozlowski and Mackiewicz-Talarczyk, 2000).

The activities connected with joint research within bast fibres have been conducted e.g. within Round Robin Test; the ESCORENA Flax and other Bast Plants Network committed its activities uniformity of qualification of bast fibrous plant fibres and to the improvement of the quality and homogeneity as well as viz. the experts from 12 countries conducted two steps of the Inter-Laboratory European Round Robin Test, having rich documentation of conducted tests and their statistical assessment at our Coordination Centre. The Network members continue to work in scope of quality assessment of bast plants and fibres within the EU program: COST Action 847 "Textile Quality and Biotechnology", where one of the Groups is devoted to quality assessment of bast fibres and several scientific sessions have been conducted (Kozlowski et al., 2010).

The outstanding achievements in the scope of joint research and exchange of germplasm and products could be observed and documented by the Institute of Natural Fibres and Medicinal Plants, Poznan, Poland in terms of activities of the Gene Bank of flax, hemp, linseed and a Bank of Natural Fibres at the INF&MP (FAO

Report, 2002; Spychalski and Wladyka – Przybylak, 2013; Kozlowski and Mackiewicz-Talarczyk, 2000).

3. PUBLICATIONS WITHIN ESCORENA FOR KNOWLEDGE SHARING

The ESCORENA system has got the bulletin since June 2009: Scientific Bulletin of ESCORENA, bi-annual journal aiming to provide the research papers of interdisciplinary Networks as well as the information about the activities of the particular Networks within the ESCORENA. The free access to 8 bulletins on the website: http://www.uav.ro/en/journals/scientific-bulletin-of-escorena/volumes. The publisher and sponsor is the "Aurel Vlaicu University" in Arad, Romania, which gained the relevant funds due to the project: Project POS-CCE 210/2010: ACRONIM „BASEURES": "Bast Plants- Strategic Resources for European Economy" (2010-2013) (Kozlowski and Mackiewicz-Talarczyk, 2012).

ESCORENA and Networks which belong to ESCORENA publish recognized Journals like: Journal of Natural Fibers (in co-operation with Institute of Natural Fibres and Medicinal Plants (INF&MP, Poznan, Poland), Newsletters of Buffalo, Nuts, and Sunflower Networks, EUROFLAX Newsletter of the Flax and other Bast Plants Network and allied. The Handbook of Natural Fibres vol. 1 and vol. 2, edited by ESCORENA Focal Point coordinator prof. R. Kozlowski and written by ESCORENA Networks' experts (about 40 experts from the whole world), is the new, very important publication in area of natural fibres, which was published by Woodhead Publishing Ltd., Cambridge, UK within the Woodhead Publishing Series in Textiles in October 2012 (Kozlowski and Mackiewicz-Talarczyk, 2012).

CONCLUSIONS

The role of ESCORENA in agriculture knowledge sharing and technology transfer could be concluded in the following inputs:

KNOWLEDGE SHARING

The ESCORENA is a bridge between FAO and agriculture to e.g. inform about newest FAO priorities, their aims, ways to achieve optimal results.

Knowledge sharing conducted and achieved through: joint applied research within the networks activities, joint activity of specialists of the research centers within ESCORENA through global consultations, conferences, workshops, seminars, and some knowledge share-fairs.

Knowledge sharing through publications of individual Networks within ESCORENA system, presented on the ESCORENA website, in the Scientific Bulletin of ESCORENA, in Handbook of Natural Fibres, in the newsletters of particular Networks, and in the proceedings of the conferences.

TECHNOLOGY TRANSFER

The educational role of ESCORENA Focal Point through:

organization of conferences devoted especially for knowledge transfer,

delivered and published presentations and elaborations regarding the weakness of technology transfer and the ways to improve its effectiveness,

presentation of the technologies and techniques, having potential of implementation in the industrial practice.

ACKNOWLEDGEMENTS

The activities of ESCORENA were facilitated by the Food and Agriculture Organization of the United Nations umbrella, patronage and support. The running of ESCORENA Focal Point is possible due to the support of the Polish Ministry of Science and Higher Education, and management of the Institute of Natural Fibres and Medicinal Plants, Poznan, Poland.

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‘OUR DAILY BREAD’: HISTORY… AND STORIES

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Abstract

Bread is one of the most popular wheat-based foods, often considered the essence of human civilization thanks to its significance that extends beyond simple nutrition. Often called ‘the staff of life’, it is part of the world heritage as all peoples on the earth have developed specific bread-centred myths, symbols and rituals. The importance of this essential aliment is reflected in its wide variety of shapes, flavours and recipes created over 10,000 years of existence, which acknowledges bread-making as a way to retrace the lost connection with Mother Earth and provides the simple enterprise with a mythical status. The metaphysical connotation of the common food has been extensively illustrated in universal literature, from the Bible to such renowned poets as Omar Khayyam, Kahlil Gibran and Dylan Thomas, and further on to contemporary writers like Anna Adams, Carol Rumens, Penelope Shuttle and Myra Schneider. Their lines praise the virtues of the gift of nature to humankind, the fundamental aliment that operates as an agent of communication and solidarity, contributing to the development of self-identification by reinforcing interaction with others.

Key words: *bread, crop, cuisine, nourishment, staple food.*

INTRODUCTION

We live our lives under the auspices of bread. We take it for granted, just like we take a breath or a chance. We share our joys and sorrows, worries and cheers with a little piece of bread every day, Monday to Sunday, summer or winter. We, sometimes carelessly, bite and chew the humble slice smeared with butter and jam, or filled with ham, salami or cheese. Have you ever stopped to think who made the first loaf of bread, what it looked like, where or when it was first made – or even why it has become so indispensable to our existence?

In what follows we attempt to unveil some of the mysteries of the modest and yet complex food.

MATERIALS AND METHODS

Our paper proposes a double understanding of how important bread is both to the real world and the realm of ideas. Therefore, the first part deals with expository information, based on the scholarly monograph *Plante şi miresme biblice. Hrană pentru suflet si trup* (*Biblical Plants and Scents. Food for the Body and Soul*) by Ovidiu Bojor and Dumitru Răducanu, as well as *Biologia şi tehnologia plantelor utile* (*Biology and Technology of Useful Plants*) by Dr Florea Dincă from the University of Craiova.

The second part consists in the literary analysis of several poems from classics (Omar Khayyam, Kahlil Gibran and Dylan Thomas) to contemporary writers (Anna Adams, Carol Rumens, Penelope Shuttle and Myra Schneider) whose lines praise the virtues of one of the oldest items of food in the world.

RESULTS AND DISCUSSIONS

History

Wheat is the main raw material for bread-making. Out of the 20 de species known nowadays, the most widely cultivated species is common wheat (*Triticum aestivum vulgare*). Grown in the plains of Mesopotamia and the Syrian Desert around 7500-6500 BC, it has spread to the Mediterranean basin, Europe, Central Asia and India, and then to the entire world.

The Egyptians are considered the first bread-makers in the world as archeological evidence indicates that unleavened bread was part of daily life in ancient Egypt while the unleavened

type was saved for ritual or sacred occasions. The Greeks came second, producing a large range of breads: it was reported that ever since the 1st century AD the ingredients included honey and milk, sesame or poppy seeds.
In Britain, cereal growing and bread-making were brought by the Romans. Stories from the Middle Ages tell of huge loaves, about 4.5-5 kg, made of a mixture of wheat, barley, millet and rye, aimed to feed the whole family for several days. In the 13th century, a law called the Assize of Bread and Ale was passed, regulating the weight, quality and price of bread and beer; although unpopular with manufacturers, the law continued for about 450 years, which proves the importance of providing this item of food for the entire population.
It is perhaps worth noting that in medieval Europe, bread was not only food but the old pieces also served as plates, being eaten after the main course or given to animals or to the poor; it was only in the 15th century that it began to be replaced with wooden plates. Also, the aristocrats preferred white bread for centuries while poor people ate a darker version. The change occurred in the 20th century when people became aware of the high nutritional value of the latter; nowadays white bread is associated with ignorance in issues of nutritions.
The history of wheat-growing and bread-making shows that *Triticum aestivum* has gradually become one of the most important agricultural crops, the raw naterial for bread, pasta, starch and glucose.
The main source of calories for humans, the seeds, known as grains, contain: mineral salts and catalytic elements (calcium, magnesium, sodium, potassium, chlorine, sulphur, silicium, zinc, manganese, cobalt, copper, iodine, arsenic), phosphorated fat, starch, vitamins A, B, E, K, D and PP, ferments, diastase.
The above chemical composition sshows that wheat contains all the elements that are necessary for the proper functioning of the human body, as it is the basis of natural food, particularly as bread. It is prescribed in all chronic and degenerative diseases, in vegetative disorders, sterility, as well as endocrine, digestive, kidney, liver and heart diseases. Last but not least, in neurological disorders: even though the brain is only 2% of the body weight, it uses 20% of the total energy; consequently, owing to the significant proportion of complex carbohydrates, bread is a reliable partner of the brain and its cognitive functions.
The nutritional effects of bread have been acknowledged worldwide and thus it has become a staple food on all continents, with various techniques depending on the wheat variety grown in the region, as well as the cultural specificities of each people.
Consequently, depending on the wheat variety, the ground seeds (flour) give various types of doughs when mixed with water, resulting in 'strong' (i.e., highly visco-elastic doughs holding gas during fermentation, preferable for bread-making) and 'weak' types (i.e., highly extensible doughs with low elasticity, used for producing cakes, biscuits and cookies).
On the other hand, the customs, traditions, culinary habits, and imagination of the different peoples around the globe have led to a wide range of breads. According to the manner of preparation, bread can be: hand-made or machine-processed, with or without yeast and other additives, topped with poppy, sesame or sunflower seeds, oats, cracked wheat, grated cheese, chopped olives, sea salt or herbs, etc.
Also, national variety should not be overlooked: flatbreads, unleavened or yeast breads, dry breads, quick breads, sweet breads, fruit breads, sourdough, pancakes, rolls, buns – they have specific names, most of them renowned brands: Italian *ciabatta*, French *baguette*, Greek *pita*, Portuguese *broa*, Swiss *zopf*, Mexican *bolilo*, Indian *chapati*, Chinese *mantou*, Ethiopian *injera*, Moroccan *rghifa*, Jewish *challah*, Armenian *lavash*, English *cottage loaf*, etc.
Although consumption has massively decreased over the past decades, bread remains one of the favourite food in the UK. Owing to its vast range and quality of flour available, the UK alone produces over 200 types of bread, among which typically national brands: *bannocks*, *bloomers*, *farls*, *stotties*, *scones*, *scufflers*, *Cornish splits*, the Welsh *bara briths*, the Scottish *buttery rowies*, etc.

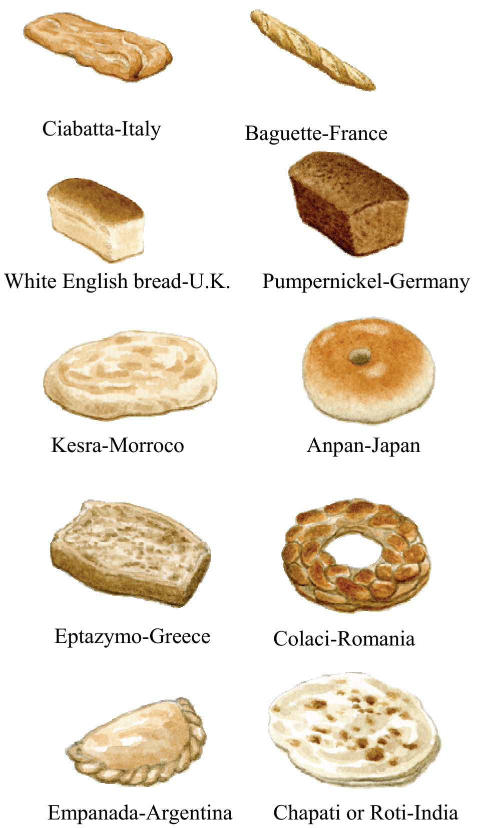

Figure 1. Different types of bread
(Source: http://letourdumondeen80pains.com/liste-des-pains/)

Naturally, like all the languages of the world, English records numerous idioms related to this basic food. Here are some of the most frequent expressions that occur naturally in the everyday conversations of the English-speaking people:

- *"bread and water"* (a minimal meal);
- *"bread and butter"* (basic income or livelihood);
- *"a bread-and-butter letter"* (a thank-you note or letter);
- *"bread and circuses"* (activities intended to keep people happy so that they do not complain about problems);
- *"the greatest thing since sliced bread" (*a very useful invention);
- *"to break bread with someone"* (to share a meal);
- *"to cast one's bread upon the waters"* (to act generously);
- *"to know which side one's bread is buttered on"* (to be aware of one's source of income), etc.

The English language also includes numerous proverbs and sayings, independent fragments of millennial experience:

- *"Bread always falls on the buttered side." (When things go wrong, they go completely wrong);*
- *"Bread is the staff of life." (Food is necessary for people to survive);*
- *"Man does not live by bread alone." (People need more than physical things like food and shelter in order to survive).*

… and stories

Often considered the most important food for survival, bread has acquired an undisputed importance since ancient to modern times, proven not only in the every-day human enterprises but also in the cultural representations of this essential aliment. In some languages, the word itself means *"food"* and in some cultures, bread is blessed before being eaten. It is perhaps worth remembering that most rebellions and revolutions were the result of famine – that is, the absence of bread.

The central prayer in Christianity, 'The Lord's Prayer', has a key phrase in the development of worship. *"Give us this day our daily bread"* is a personal request to the supreme authority for safety and durability, a humble appeal to moderation and communions, dispelling any high expectations of riches and abundance.

The Bible also contains numerous other references to this extremely important item of food. In old Israel, the bread offered by priests to God was made of flour. On Easter Sunday and throughout the following week, meals consisted, among others, of unleavened bread baked under hot ashes or on heated stone slabs.

Bread, along with wine, is the great Christian symbols of prosperity and communion in the Old Testament. In the Genesis, Abraham charitably treats his God-sent guests with *"a little bread"* made of *"choice flour"* (Genesis 18:5-7). In the Exodus, the Lord tells the Israelites to take Passover: *"Seven days you shall eat unleavened bread"* (Exodus 12:15). Further on, worshippers are instructed to offer God "unleavened bread, unleavened cakes mixed with oil, and unleavened wafers spread with oil”, made of *“choice wheat flour.”* (Exodus 29:2)

In the New Testament, bread acquires metaphysical connotations as the Holy Eucharist, established by Jesus Christ as both sacrament and sacrifice. Matthew recollects the Parable of the Yeast told by Jesus to his disciples: *“The kingdom of heaven is like yeast that a woman took and mixed in with three measures of flour until all of it was leavened.”* (Matthew 13:33), while John appeals to the metaphor of the bread in an attempt to decode the mystery of Christ’s identity: *“I am the bread of life. [...] This is the bread that comes down from heaven, so that one may eat of it and not die. I am the living bread that came down from heaven. Whoever eats of this bread will live forever...”* (John 6:48-51)

Bread-making, among all household activities, is constantly praised in poetry. From ancient lines to contemporary verses, the description of routine minutiae occasions reflections on inner tranquility and moderation as vital principles of life. Beyond their cyclical predictable nature, kneading and baking of the essential food have an empowering condition, securing spiritual accomplishment, peace of mind and certainty of identity.

In ‘Bread Recipe Poem’, the contemporary British poet Anna Adams (1926-2011) describes this routine activity whose intimacy and immediacy validate particular aspects of the self. The hyperbolical lines provide each ingredient and each action with a mythical status. Enlightened by the spirit, the concrete substances used for making the dough gain unique metaphorical meanings:

“Sweet water, bloodwarm, makes
yeast seabed breathe. It wakes.
So boulders rise and surface, grow
islands in archipelago.
This foaming land amalgamates
to continents that swallow straits.” (Adams 1-6)

The couplet rhymes and iambic tetrameter seem to mimic the repetitive movements of kneading the dough, conferring a metaphysical aura to the innocuous routine enterprise. It is the quiet rhythm of comfort, safety and peace provided by the domestic space which gains thus a mythical dimension, as the action seems developed by giants in charge with the making of the world:

“Omnipotence sees mountains rise,
and arms itself – stirs and destroys.
Chaos is come with wooden spoon:
mixes the sea in cratered moon.” (Adams 7-10)

The stylistic patterns stress the cosmic order of the process in parallel constructions *(“Now desert lives, now cities swell, / societies grow cell by cell”* – Adams 11-2), as a perfect illustration of the Miltonian remark in *Areopagitica*, according to which *“a good cook is the precious life-blood of a master spirit, embalmed and treasured up on purpose to a life beyond life.”* (Milton 6)

However, religiousness dissolves in humour as the cosmic operation reaches its final stages:

“but cataclysmic heatwave stills
the social sponge, as oven kills
each inmate, till stiff crust has sealed
the micro-Pompeii yeast exhaled.” (Adams 13-6)

In this domestic ritual where the cook becomes an enchantress performing magic for the benefit of a tighter or larger community, the supernatural potions gain uncommon importance. The bread-maker is both life-giver and sustainer, and making bread is a way to retrace the lost connection with Mother Earth: conceiving the very substance of life is going back to the essence of femininity whose positive energy acts like a spiritual link between the members (and close non-members) of the family.

The kitchen thus becomes the place of gastronomical alchemy where the mixture of ingredients and aromas open the senses toward communication, mediating and solving conflicts by mythical projections of the universe in the microcosm of the family. ‘Letter from a Far Country’ is an imaginary letter from a fictitious woman for all men, in which the Welsh poet Gillian Clarke (1937-) praises the creative contribution of anonymous women to the history of the world is immeasurably vast. Her bold ‘Letter’ is a small contribution to feminist protest, a meditation on traditional woman’s work – as the poet puts it herself, *“the sort of letter you write in your mind and never post.”* (Clarke 1) The symbolic *“far country”* is childhood, womanhood, the private place to which any woman is entitled.

The letter is addressed to men as an answer to their questioning of women's energies wasted in daily routine, looking after home and family – that is, in itself a great work, unfinished until the woman's life comes to an end:

"Dear husbands, fathers, forefathers,
this is my apologia, my
letter home from the future…" (Clarke 8-10)

The long poem about the daily management of household affairs appraises the religiousness of the familiar: cleaning, gardening, washing, sewing, ironing, cooking – all the small everyday gestures gain a spiritual value as the common heritage of humankind. Each activity requires persistent effort, accuracy, honesty, perseverance; their performance brings about spiritual improvement and a sense of personal and cosmic infinity:

"The chests and cupboards are full,
the house sweet as a honeycomb.
I move in and out of the hive
all day, harvesting, ordering.
You will find all in its proper place,
when I have gone." (Clarke 35-40)

For Clarke, women are the guardians of the race; their little jobs are often overlooked and minimised although their unuttered, customary relation with time has long gained a mythical dimension: *"There's always been time on our hands."* (Clarke 60) There are anonymous generations of women who have passed obedience and duties on to their female descendants in unpretentious chronicles of labelled jars of pickles and marmalade, jellies and syrups. Cosmological performance or not,

"It has always been a matter
of lists. We have been counting,
folding, measuring, making,
tenderly laundering cloth
ever since we have been women." (Clarke 134-8)

It pertains to women's culture to ensure that human race survives, irrespective of governmental theories or policies. For love, the universal driving force, is the basis for the continuation of the routine rites performed by the meek house-makers, humble priestesses who preach and teach the religion of the quotidian:

"It is easy to make of love
these ceremonials. As priests
we fold cloth, break bread, share wine,
hope there's enough to go round." (Clarke 181-4)

Commitment to action is verbalised through a transfer of moral responsibility for the bond of blood and experience is more powerful than fleeing to the land of imagination. Women's atemporal world is assertively related to traditions and customs, all quintessentially gathered in the ritual of bread-making, so it is but natural to pass the secret further on, like a mysteriously self-assertive globule of magical words having the power to reinforce spatial reference:

"(The recipe for my best bread,
half granary meal, half strong brown flour,
water, sugar, yeast and salt,
is copied out in the small black book.)" (Clarke 210-213)

However, there is an awareness that their evasion would only lead to disturbance and anarchy: escape is illusive, for women are by nature home-makers and care-takers. Since they cannot abandon their caryatidic mission, they devise a strategy to connect to the world through the domestic space and culinary art, restoring thus individual peace of mind and harmonising the self with the others.

Mixing the ingredients together pertains to a ritual that projects human condition outside the self through the agency of emotions. As the Lebanese-American poet Kahlil Gibran (1883-1931) remarks in his philosophical reflections on labour and diligence, *"Work is love made visible."* (Gibran 28)

In his view, work without passion has only one desirable alternative: retreating from action and appealing to others' charity, for *"if you cannot work with love but only with distaste, it is better that you should leave your work and sit at the gate of the temple and take alms of those who work with joy. / For if you bake bread with indifference, you bake a bitter bread that feeds but half man's hunger."* (Gibran 29-30)

To Gibran, appreciation for the others is the perfect path to reach absolute knowledge. Without generosity and selflessness, the work of mind and arms cannot gain durability: the work of the soul is a pre-condition to attain ultimate bliss. Self-giving assigns value to immediate materiality and secures the preservation of the individual within a specific geography and chronology, a certain sense of

durability through temporal and spatial presentness.
This synchronicity with time and space, self and others, can be achieved not only by selfless giving, under the form of bread-making for family and friends, but also by taking, i.e. eating bread. There are numerous poems where the magic of creation is supplemented by the act of consumption, without overlooking *"that part that goes beyond merely eating to live – that is, the various social, anthropological, psychological, and philosophical gestures in the non-consuming aspects of food and rituals of eating. Eating our slice of daily bread, but not for the intake of that slice alone"* (Halpern 1), as the American ecological poet and publisher Daniel Halpern remarks in his 1993 book, suggestively titled *Not for Bread Alone. Writers on Food, Wine, and the Art of Eating*.
In his 'Song of the *Poppadum*', the Indian guru Ramana Maharshi (1879-1950) reiterates a ritual harmonised with ancestral vibrations captured in the description of the bread-making process and its metaphysical connotations:
"Try and make some poppadums.
Eat them and your longing satisfy.
Don't roam the world disconsolate.
Heed the word, unique, unspoken
Taught by the teacher true who teaches
The truth of Being-Awareness-Bliss.
Try and make some . . . satisfy." (Maharshi 1-7)
The lines take over the apparently prosaic issue of kneading and baking the Oriental type of bread in order to draw attention to their significance, sometimes conferring them a mythical aura. The intermingling trochaic hepta and octosyllabic lines, as well as the occasional rhyme, bring to mind the mysterious dynamics of dough pressing, stretching and folding.
At the same time, the repetitive imperative *"satisfy"* at the end of each stanza to generate magic energies that give new meanings to the actual process, going beyond the physical action into the realm of philosophy. The urge to fulfill the needs extends from pure bodily ingestion of the life substance to the spirit, as bread also becomes food for the soul and spirit, while its making turns cosmic, as if reshaping the universe into free forms of intellectual energy and spiritual potency.
Kneading dough and shaping loaves becomes an identity quest that requires abandonment of self-centredness in favour of benevolent public spirit:
"Take the black-gram, ego-self,
Growing in the fivefold body-field
And grind it in the quern,
The wisdom-quest of 'Who am I?'
Reducing it to finest flour.
Try and make some . . . satisfy." (Maharshi 8-13)
The *"fivefold body-field"* refers to the five sheaths recognised by the Hindu doctrines: the physical, vital, mental, intellectual, and the blissful sheaths; each sheath is included in the three human bodies: material, subtle, and causal. All the five sheaths function harmoniously to integrate the self into the physical and metaphysical world. And, owing to its spiritual significance, bread-making seems to be an efficient agent that facilitates closeness to the Absolute, since it is regarded not as a simple, profane technical operation but as a creative enterprise demanding imagination, patience, precision in order to reach completion to ultimate perfection.
Aromatic substances interfere subtly in the change into the new status, both shape and content, by transmuting the raw matter into a sophisticated corpus:
"Mix it with pirandai-juice,
Which is holy company,
Add mind-control, the cumin-seed,
The pepper of self-restraint,
The salt of non-attachment,
And asafoetida, the aroma
Of virtuous inclination.
Try and make some . . . satisfy." (Maharshi 14-21)
Herbs, seeds and the omnipresent white crystal compete to the cosmological science of kneading dough, as if reviving the best-kept secrets of alchemy: they decompose and recompose the living matter, restoring communion with ancestral spirits and thus bringing the mortals closer to the paradisiacal state of bliss and peace. Only comfort and contentment can help the individual apprehend the essence of things: the *poppadum* is brought out of the oven and its consumption, materially and spiritually, provides another dimension of life – a new self-awareness in close relationship with both spirit and matter:
"Eat and taste the Self as Self,

Abiding as the Self alone.
Try and make some . . . satisfy." (Maharshi 33-35)
Either Western or Oriental, the world shares the same perception of its primordial food. The lines of the Indian sage are echoed by Daniel Halpern who acknowledges the mental comfort and spiritual fulfillment induced by bread-making: *"The first time you make a loaf of bread, you usually experience, particularly if you are a child, an exciting sense that you are actually giving life to an inert lump of flour and water. You watch the dormant yeast become active [...]. Then you knead the dough and feel it transformed from a sticky, lumpy paste to a cohesive mass that is smooth and resilient and bouncy under the heels of your hands. When you poke it, it springs back at you. It is alive. Sometimes it forms bubbles and blisters in its eagerness to expand; it doubles, triples in volume. And then after it has been punched and tamed, it responds to the heat of the oven, rising again, settling into the shape you have given it, and sending forth the most tantalizing aroma as it bakes. No wonder that through the ages we've endowed bread with symbolic meaning: the staff of life, the bread of heaven, the body of Christ."* (Halpern 36)
The Welsh poet Dylan Thomas (1914-1953) captures the religious significance of bread in his poem 'This Bread I Break', where the protagonist provides a philosophical interpretation of the act of ultimate giving – Jesus Christ's symbolic giving of his self to his companions:
"This bread I break was once the oat,
This wine upon a foreign tree
Plunged in its fruit;
Man in the day or wine at night
Laid the crops low, broke the grape's joy."
(Thomas 1-5)
There is resignation in the speaker's tone: in an ecclesiastical reading, it could be Christ addressing his disciples in a narrative of consent to anticipated physical torment and psychic disturbance. The variation of iambic octosyllables with the diameter of the third line alludes to the acceptance of lonely suffering and, at the same time, the desire to transcend weakness and achieve psychological relief by converting matter into spirit. Transubstantiation occasions the gratitude of the soon-to-be-dispossessed human body, as it is brought along to soothe the still-anguished soul:
"This flesh you break, this blood you let
Make desolation in the vein,
Were oat and grape
Born of the sensual root and sap;
My wine you drink, my bread you snap."
(Thomas 11-15)
The ritual of sharing bread aims to establish harmony and solidarity between individuals, to create communication and communion: by sharing the basic food, the self can search into the unknown inside in order to discover spiritual stability that can erase all differences. The result: an absolute balance that gives certainty and infallibility to the ritual practitioner.
The same equilibrium is remarkable in love poetry where private emotions function like a natural Eucharist, enhancing a vast range of possibilities for the development of identity in relationship with the other.
Like bread, love is food for the soul: it assigns worth and meaning to the individual reassessing existence according to unpretentious laws of mutual affection. In 'Ballad of the Morning After', the contemporary British poet Carol Rumens asserts the value of ardent passions that make the self become the perfect complement of the other, like *"liberty, equality, / Fraternity and bread."* (Rumens 35-36)
Another contemporary British poet, Penelope Shuttle articulates a Biblical parable under the name of 'Bread and Butter', a mundane metaphor for the incomprehensible laws shaping wholeness and complete harmony between the lovers who *"drift into the fields of butter / the meadows of bread / They lie on warm beds of pastry."* (Shuttle 1-3)
If Shuttle humorously reverses the poetic image of Plato's idealistic androgynous figure, the Persian poet Omar Khayyam (1048- 1131) preserves the symbol of original non-differentiation reunited in spirit through the power of infinite emotion. In 'Eleven', the poet proclaims the immortality off complex relationships in a sequence of enumerations whose accumulation creates the perfect paradise of simplicity, modesty and accomplishment:

"Here with a Loaf of Bread beneath the Bough,
A Flask of Wine, a Book of Verse – and Thou
Beside me singing in the Wilderness –
And Wilderness is Paradise now." (Khayyam 1-4)

The quatrain appeals to verbal symmetry in order to construct an accomplished individual space consisting in bread – food for the body, book – food for the mind, and the beloved – food for the soul. This symbolic trinity encodes self-sufficiency and the joy of mirroring selfhood in the physically and spiritually equal other while simultaneously cherishing otherness (in its highly equivalent form) in the self. And, just as love intensifies common human experiences, leading to the discovery of the external self and the concurrent interior other, so does poetry, the *"Book of Verse"*, whose committed mission is to reconcile the different sameness and the familiar strangeness as a condition of absolute freedom of the self.

Poetry, in its pure form, resonates within the being and creates signification by transgressing personal boundaries, while the poet's purity of language and sincerity of self-expression connects inside otherness within with outside sameness, in a constantly interchangeable play. Myra Schneider, another contemporary British poet, praises the virtues of this very special art in her poem 'Caedmon', a long poem dedicated to the first known English poet and his tribulations of refining and his spiritual self for the aesthetic gratification of the others:

"I began to pick words for a poem,
wove lines together far into
the night and next morning carried
the new garment of song to the Abbess.
She found it fitting, said:
Like a grey dove on a tree, grace
has settled on you. Your work should be
crafting word pictures with pleasing sounds,
for as bread feeds hungry bodies
so your poems will nurture minds." (Schneider 46-55)

The words of the Abbess (here, the metaphorical Muse of Poetry) consecrate Caedmon's artistic completion. Just like dough, the word needs someone whose generosity of spirit and self-abnegation concur for the purpose of providing nourishment for those in need.

Just like bread, the poem is an artifact that is summoned to satisfy hunger. And poetry is the art that is summoned to make ultimate sense of the self by elevating personal and natural values, a process inconceivable without the freedom of the self.

CONCLUSION

Human history is intertwined with the history of bread. If the grain seed symbolizes harmony and solidarity between plant and human being, bread is the essence of Nature's philosophy: generosity, taught by the tiny grain that gives itself for nourishment and thus guarantees life on earth. The gift of human beings is the warmth of their heart, treasured as much as a piece of bread offered to the famished. With bread by his side, man has learned to overcome wrath, greed, sloth, pride, lust, envy and gluttony, and cherish peace, generosity, honesty, loyalty, courage, kindness and morality.

In the introductory interview to his 2007 book, *Ameliorarea grâului* (*Wheat Breeding*), Professor Vasile Siminel, corresponding member of the Academy of Science of Moldova, metaphorically explained the undeniable fascination with this basic food all over the world: '… the bread phenomenon is the human phenomenon, the memory of bread is the memory of humanity. Can anyone measure the depth of such a memory, or the depth of human feelings?' (Siminel 4)

Black or white, flat or leaf, loaf or roll, *ciabatta* or *baguette*, *pita* or *poppadum*, bread is revered and highly regarded everywhere in the world, for life without it would seem at least incomplete if not impossible.

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MORPHO-ANATOMIC FEATURES AND CHEMICAL COMPOUNDS IN SOME AQUATIC PLANT SPECIES – PRELIMINARY DATA

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Abstract

Plants live everywhere, populating all major habitats (air, land, water). Their life cycle takes place under the influence of environmental factors and is therefore subject to large variations in abiotic factors. In this context, plants have changed over time their structures, organ shape and appearance, resulting from their adaptation to living environment. Some changes in the structure and function of the vegetative organs, arising as a result of their adaptation to the plant were followed by one of the greatest figures in literature and the founder of morphology as a science – J.W. von Goethe, who in 1790 formulated a theory of plant metamorphosis (adaptive change). This paper highlights such adaptive changes but seeks and identifies chemical elements in plant composition under study (Hydrocharis morsus-ranae, Anubias barteri, Hygrophila odora, Bacopa caroliniana) – the first step in trying as thorough knowledge of aquatic plants to establish their possible uses.

Key words: *aquatic plants, metamorphosis, chemical elements.*

INTRODUCTION

The aquatic plants can live underwater (submerged) or can float on water surface (natant).

Some of them have adapted their morphology to aquatic environment: large intercellular spaces in lamina are connected with aeriferous canals from petiole that extend as aerenchyma in the rhizome and roots, ensuring their oxygenation.

Other plant species compensate the underdeveloped aerenchyma by highlighting the mechanical and conducting tissues.

The aim of thus study was to investigate the morpho-anatomic features and chemical compounds in the following aquatic plant species: *Hydrocharis morsus-ranae*, *Anubias barteri*, *Hygrophila odora, Bacopa caroliniana.*

Hydrocharis morsus-ranae (Alismatales, Hydrocharitaceae) or frogbit, native to Europe and parts of Asia, is a free-floating annual herbaceous aquatic plant, but its leaves can become emergent when the vegetation is dense enough (O'Neil, 2007).

Anubias barteri (Alismatales, Araceae), a West African species, survives either totally or partially submersed (http://www.liveaquaria.com/).

The *Hygrophila* species usually are growing emersed along natural bodies of water (http://naturalaquariums.com/). *Hygrophila odora* (Lamiales, Acanthaceae) is a plant species distributed in Western Africa; its emersed form has a strong, ascending to upright stems that lignify at the basis, and lanceolate leaves (http://www.flowgrow.de/db/aquaticplants/).

Bacopa caroliniana (Lamiales, Scrophulariaceae) comes from South America, where it is found growing in swampy areas, emerged and submerged. One of the basic characteristics of this plant is lemon smell of the leaves when they are broken (www.aquascaping.ro).

MATERIALS AND METHODS

For identification and description purposes, we used preserved material belonging to four aquatic plant species: *Hydrocharis morsus-ranae*, *Anubias barteri*, *Hygrophila odora, Bacopa caroliniana.* Macroscopic observations were performed on plants with the help of identification handbooks. Microscopic

observations and micrometric measurements were made on numerous cross-sections of the studied plants (Andrei, 2003).
Observations were carried out with a ML-4M IOR microscope belonging to the laboratory of Biology, UASVM Bucharest. The photos were taken with the digital camera Panasonic Lumix DMC - LS60 (6MPX, 3X optical zoom).
Sodium and potassium levels were determined by flame photometry, using 2% acetic acid (extractant ratio 1:20).

RESULTS AND DISCUSSIONS

Results regarding morpho-anatomic structure of aquatic plant Hydrocharis morsus-ranae (frogbit)

Hydrocharis morsus-ranae (Figure 1) is a natant hydrophyte plant. It has long, slender stolons and long-petiolate, ovate kidney-shaped leaves. It is common in stagnant or slowly flowing waters.

Figure 1. *Hydrocharis morsus-ranae* (original)

Hydrocharis morsus-ranae leaf's petiole has an epidermis formed from a single row of cells, covered with a thin cuticle (Figure 2).

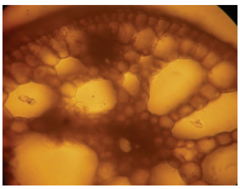

Figure 2. *Hydrocharis morsus-ranae*: petiole cross-section (original)

Fundamental parenchyma is highly developed, having many aerifer channels of varying sizes.
The mechanical elements are reduced. Phloem is limited and the wood is reduced to a single vessel.
Tissue dimensions from *Hydrocharis morsus-ranae* leaf's petiole are shown in Table 1.

Table 1. Tisues measurement from leaf petiole belonging to *Hydrocharis morsus-ranae*

NR.	TISSUE	MEAN (µ)
1	Epidermis	72
2	Cortex, Central cylinder	2448
3	Conducting fascicle	216

Hydrocharis morsus-ranae has a bifacial leaf with a dorsiventral heterofacial, structure, presenting a mesophyll tissue lie between upper and lower epidermis (Figure 3).

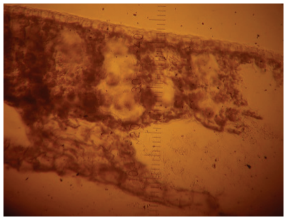

Figure 3. *Hydrocharis morsus-ranae* : leaf structure (original)

The mesophyll presents a palisadic tissue with long cells, rich in chloroplasts including idioblasts. The lacunar tissue has big, intracelular spaces (aeriferi parenchyma) (Figure 3).
The ribs present a very weak developed xylem. Between ribs and lower epidermis, an angular colenchyma is differentiated, that gives lamina's resistance.
Tissue's leaf dimensions in *Hydrocharis morsus-ranae* plant are indicated in Table 2.

Table 2. Tisues measurements from *Hydrocharis morsus-ranae* leaf structures

NR.	TISSUE	MEAN (µ)
1	Upper epidermis	28.8
2	Mesophyll	360
3	Lower epidermis	57.6

Results regarding morpho-anatomic structure of aquatic plant Anubias barteri

Anubias barteri (Figure 4) is a plant commonly found in aquariums.
In cross section, the adventitious root presents exodermis, cortex and vascular cylinder. No aerenchyma tissues are differentiated.

Figure 4. *Anubias barteri* (original)

In the vascular cylinder (Figure 5) numerous phloem vessels alternates with xylem, with lignificated cells between those two layers. The pith contains lignificated cells.

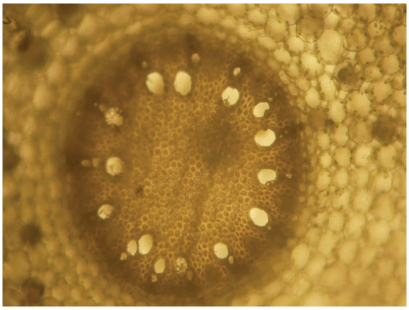

Figure 5. Cross section through *Anubias barteri* root (original)

Dimensions recorded for *Anubias barteri* root's tissues are shown in Table 3.

Table 3. Tisues measurements from *Anubias barteri* roots

NR.	TISSUE	MEAN (µ)
1	Exodermis	28.8
2	Cortex	576
3	Endodermis	14.4
4	Vascular cylinder	662.4
5	Pith	360

Table 4. Tisues measurement from leaf petiole belonging to *Anubias barteri*

NR.	TISSUE	MEAN (µ)
1	Cuticle	14.4
2	Epidermis	28.8
3	Conducting fascicle	57.6
4	Sclerenchyma	72

In cross-section (Figure 6), leaf's petiole has a unistratified epidermis, covered with a thin cuticle. The cortical parenchyma is very poorly developed; phloem and xylem vessels (with sclerencyma caps) are disorderly arranged, the petiole being polistelic. The tissue's petiole micrometric measurements in *Anubias barteri* are indicated in Table 4.

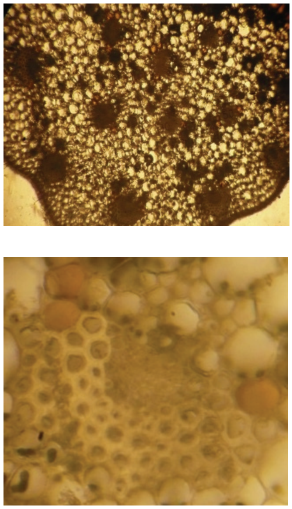

Figure 6. Cross-section through petiole belonging to *A. barteri*

The leaves are large, green, ovate-lanceolate, with pinnate venation. In cross section, presents a very thin cuticle, upper epidermis, mesophyll, lower epidermis (formed by cells of different size) (Figure 7).

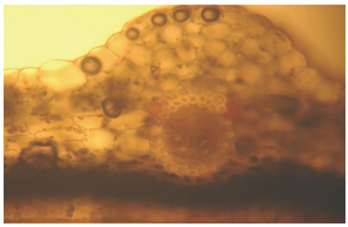

Figure 7. Cross section through a *A. barteri* leaf

The mesophyll is homogeneous, consisting of several rows of cells without intercellular spaces. Rows below the upper epidermis are rich in chloroplasts. The ribs have vascular bundles surrounded by sclerenchyma (Figure 7). Dimensions recorded for leaf's tissues measured in *Anubias barteri* are shown in Table 5.

Table 5. Tissue dimensions in *Anubias barteri* leaves

NR.	TISSUE	MEAN (μ)
1	Cuticle	14.4
2	Upper epidermis	72
3	Mesophyll	316
5	Lower epidermis	28.8
6	Midrib	144

Results regarding morpho-anatomy of Hygrophila odora aquatic plant

Hygrophila odora (Figure 8) is an aquatic plant species.

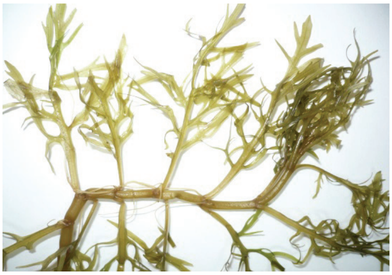

Figure 8. *Hygrophila odora* (original)

The cylindrical stem has nodes and internodes, with dorso-ventral flattened, pinnate leaves in nodes. It forms adventive roots.

In cross-section, the root appears to be formed by rhizodermis lacking absorbing hairs (one layer of cells); cortex is very well developed, with large intercellular spaces found in aerenchyma (Figure 9).

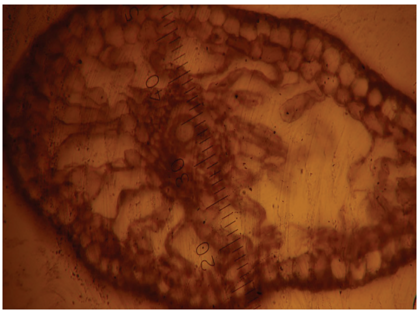

Figure 9. *Hygrophila odora*: root cross section (original)

The mechanical elements and central cylinder are very reduced (Figure 9).

The dimensions for measured tissues in *Hygrophila odora* root are indicated in Table 6.

The stem has a unistratified epidermis, covered by a thin cuticle (Figure 10).

Table 6. Tissue dimensions from *Hygrophila odora* roots

NR.	TISSUE	MEAN (μ)
1	Rizhodermis	28.8
2	Cortex	244.8
3	Central cylinder	115.2

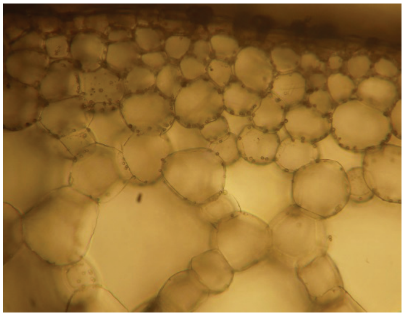

Figure 10. *Hygrophila odora*: cross section of a cortex (original)

In the highly developed cortex, there are three or four layers of colechyma but the major part is occupied by aerenchyma with intercellular spaces by different sizes (Figure 10), forming air chambers.

The last layer of the cortex, endodermis, is formed by one single row of different size cells.

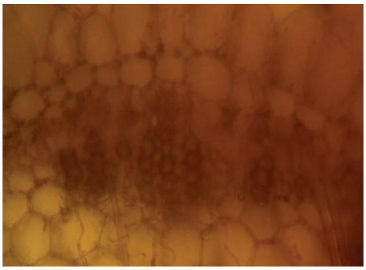

Figure 11. *Hygrophila odora*: cross section of a central cylinder (original)

The conducting tissue is formed by poor developed collateral fascicles, orderly arranged (Figure 11).

The dimensions for measured tissues in *Hygrophila odora* stem are shown in Table 7.

In cross section, the leaf of *Hygrophila odora* presents the upper epidermis with smaller cells on one single row, covered by a thin cuticle and the lower epidermis formed by bigger cells (Figure 12).

Table 7. Measurements for stem tissues in *Hygrophila odora*

NR .	TISSUE	MEAN (μ)
1	Cuticule	14.4
2	Epidermis	43.2
3	Cortex	1584
4	Endodermis	28,8
5	Collenchyma	144
6	Pith	1008
7	Central cylinder	1224
8	Conducting fascicle	259.2

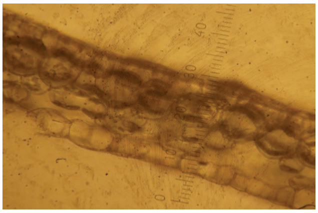

Figure 12. *Hygrophila odora*: cross section of leaf (original)

Below the upper epidermis, the mesophyll, presenting cells rich in chloroplasts (Figure 12), and it is crossed by different size air chambers.

The ribs are poorly developed. The dimensions for measured tissues in *Hygrophila odora* leaves are presented in Table 8.

Table 8. Tissue dimensions from *Hygrophila odora* leaves

NR.	TISSUE	MEAN(μ)
1	Upper epidermis	28.8
2	Lower epidermis	57.6
3	Mesophyll	115.2
4	Rib	100.8

Results regarding morpho-anatomic structure of aquatic plant Bacopa caroliniana (water hyssop)

Bacopa caroliniana is an aquatic plant (Figure 13), ubiquitous in aquariums for many years.

In stem's nodes there are adventive roots and leaves (oblong, succulents, opposite arranged).

In cross-section, the adventive root presents rhizodemis, exodermis, cortical parenchyma and central cylinder (Figure 14). The rhizodermis is lacking in absorbent hair; the cortex has cells with thin cell walls and few intercellular spaces (aerenchyma). The last layer of the cortex, endodermis, is well differentiated, presenting Casparian strips.

Figure 13. *Bacopa caroliniana* (original)

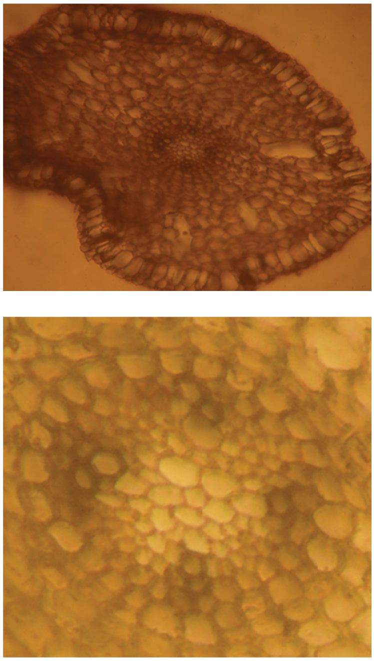

Figure 14. *Bacopa caroliniana:* root cross section (original)

In central cylinder, there are four liberian fascicles, respectively four wooden fascicles, separated by medullary rays formed by cells with cellulosic, thin walls.

The pith is formed by cells with slightly lignificated walls.

The dimensions for measured tissues, in *Bacopa coroliniana* roots, are shown in Table 9.

In cross-section, the stem presents the epidermis, cortex and central cylinder (Figure 15).

The unistratified epidermis is covered by cuticle. The cortex is occupied with aeriferous canals by different size (aerenchyma) separated through a single layer of cells. The cells have cellulosic, thin walls. The endodermis is well developed. The central cylinder is represented by many xylem and phloem vessels arranged on two concentric circles.

Table 9. Tissue dimensions measured in *Bacopa caroliniana* roots

NR.	TISSUE	MEAN (μ)
1	Rizhodermis	72
2	Cortex	288
3	Central cylinder	144

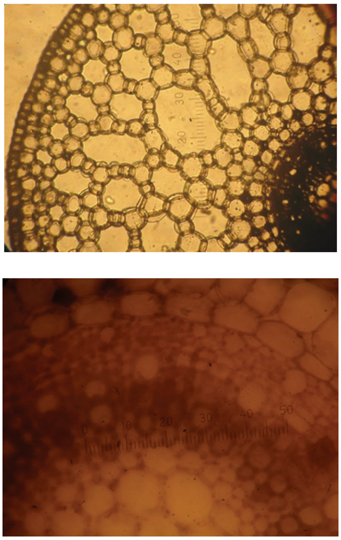

Figure 15. *Bacopa caroliniana:* stem cross section (original)

The pith is formed by parenchimatous cells. The dimensions for measured tissues from *Bacopa caroliniana* stem are shown Table 10.

Table 10. Tissue dimensions measured in *Bacopa caroliniana* stalk

NR.	TISSUE	MEAN (μ)
1	Cuticle	14.4
2	Epidermis	57.6
3	Cortex	1728
4	Central cylinder	864

In cross-section, the morpho-anatomic structure of *B. caroliniana* leaves presents: a very thin cuticle; the upper epidermis formed by larger thin walled cells; mesophyll; the lower epidermis containing different size cells (smaller than those of the upper epidermis) (Figure 16).

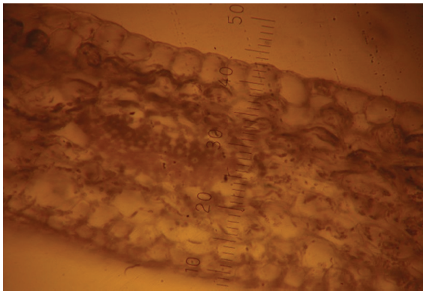

Figure 16. *Bacopa caroliniana:* cross section of a leaf (original)

The mesophyll is homogeneous, undifferentiated, formed by several layers of cells lacking intercellular spaces or these spaces are reduced. Beneath the upper epidermis there are layer of cells rich in chloroplasts.
The ribs have poor developed collateral fascicles (woody-adaxial and liberian-abaxial).
The measurements for leaf's tissues in *Bacopa coroliniana* are indicated in Table 11.

Table 11. Tissue dimensions measured in *Bacopa caroliniana* leaves

NR.	TISSUE	MEAN (μ)
1	Upper epidermis	28.8
2	Lower epidermis	28.8
3	Mesophyll	288
4	Midrib	187.2

Results regarding determination of potassium and sodium in aquatic plant: Hydrocharis morsus-ranae, Anubias barteri, Hygrophila odora, Bacopa caroliniana
Results regarding sodium and potassium chemical identifying in the studied plant composition are shown in Table 12.

Table 12. Potassium and sodium determination in the studied aquatic plants

Samples	K^+, ppm	Na^+, ppm
Hydrocharis morsus-ranae	1112.97	639.40
Anubias barteri	839.08	747.17
Hygrophila odora	919.17	779.52
Bacopa caroliniana	461.18	638.82

CONCLUSIONS

Although the specialist literature presents aquatic plants having a well developed aerenchyma and reduced mechanical and conducting elements, the submerged plant species *Anubias barteri*, *Hygrophila odora* and *Bacopa caroliniana* show important differences regarding these morpho-anatomic structures.

Aerenchyma's absence both in root, petiole and leaves (*Anubias barteri*) is correlated with developed conducting elements and sclerenchyma's presence. The aeriferous tissues recorded in *Bacopa caroliniana* are reduced, correlated with numerous conducting elements.

Hygrophila odora presents a well developed aerenchyma in organ's structures; the mechanical and conducting elements are reduced, although the xylem vessels are numerous in stem's structure.

Potassium and sodium identification in the studied plant species (*Hydrocharis morsus-ranae, Anubias barteri*, *Hygrophila odora*, *Bacopa caroliniana*) represent a first step in trying as thorough knowledge of aquatic plants to establish their possible uses.

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'THE BEAUTIFUL WORLD GERMINATES…': CORN – HISTORY… AND STORIES

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Abstract

To Europe, the concept of the New World corresponded to the human need to escape from the common, every-day habitat to a blessed realm, a land of affluence and eternal bliss. The inhabitants of the Old World were charmed by the wonders of the Americas even since the first encounter, and one of the most active and effective ways of contact and communication was food. American cuisine was an illustrative instance of commonality since turkey, duck and rabbit, corn, sunflower and beans, peppers, potatoes and tomatoes, squash, pumpkin and wild ginger, cranberries, blueberries and raspberries, all were soon adopted and adapted to suit the taste buds of the Old World. Corn, in particular, was an extremely important staple food grown not only for its nutritive value but also for its high adaptability to a variety of soils and weather conditions. However, its importance extended far beyond its immediate benefit for the original corn growers developed an entire philosophy of life centred around the plant belonging to the Poaceae family. For the original American tribes, corn was a god: it was either Father Corn or Mother Corn, and had to be paid every form of respect in order to assure the necessary food supply. Feasts and festivals, chants and songs, dances and prayers, stories and games were dedicated to every stage of the agricultural process (from sowing to harvesting), in an attempt to determine and direct reality. This paper aims to briefly introduce some of the corn-related Amerindian customs, rituals and traditions believed to help the individual experience identity with the original forces of the earth in the eternal rhythm of life.

Key words: *corn, maize, Native Americans, staple food, Zea mays* L.

INTRODUCTION

Maize (*Zea mays* subsp. *mays*), also known as corn, has ancient roots in its area of origin, the Americas, where archeological discoveries indicate that care given to agriculture was paramount.

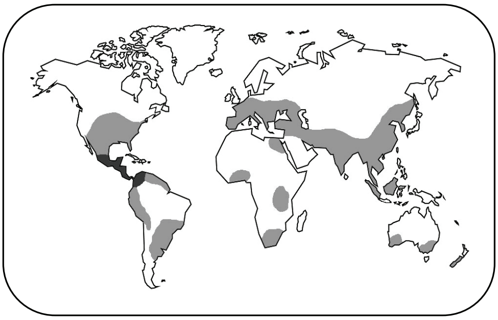

Figure1. ■ Region of origin ■ Region of cultivation (Source:http://www2.mpizkoeln.mpg.de/pr/garten/schau/ZeamaysL./Maize.html)

The Olmec and Mayans cultivated it in numerous varieties throughout Mesoamerica, cooked, ground or processed. Beginning about 2500 BC, the crop spread through much of the Americas: Central America, Peru, Mexic and Guatemala, as well as the upper Amazon basin, are considered the original regions that developed a trade network based on surplus and varieties of maize crops. After the European contact with the Americas was established in the late 15th and early 16th centuries, explorers and traders carried corn back to Europe and introduced it to other countries. Owing to its ability to grow in diverse climates, the plant subsequently spread to the rest of the world. Sugar-rich varieties called sweet corn are usually grown for human consumption, while field corn varieties are used for animal feed and as chemical feedstock.

If corn had been the basic food before the European colonization, it did not lose its importance after the conquest of the Americas. It surpassed the other plants by far, as it was able to adapt to a wide variety of soils and climatic conditions. Its great plasticity resulted in numerous varieties suitable for various purposes. Furthermore, its high productivity was undeniable. All these essential qualities converged into worldwide appreciation for 'the greatest blessing of the country', 'the greatest blessing God ever gave to man', as the renowned American farmer and agricultural scientist William Corbbett called the cereal plant (quoted by Hardeman 2).

MATERIALS AND METHODS

Our paper is primarily based on data collected from scientific literature, basically the 1957 monographic study dedicated to *Zea mays* by the Romanian Academy under the co-ordination of Prof. Traian Săvulescu and the 1977 book written by Mihai Cristea, PhD, *Rasele de porumb din România* (*Races of Maize in Romania*). They are completed with the excellent study of the American historian Nicholas Perkins Hardeman, *Shucks, Shocks, and Hominy Blocks: Corn As a Way of Life in Pioneer America* (1981). The scientific facts and data from specialist literature are supplemented with an exegetical approach to several representative extracts from American Indian literature, aiming to illustrate the cultural dimension of corn crop in its original area of evolution.

RESULTS AND DISCUSSIONS

History

The English dictionary records two words for the domesticated cereal plant, which can be confusing to a non-native speaker of English:

- 'maize' originates from the Spanish *maiz*, a word coined after the Taino *mahiz* – an extinct Native American language spoken in the Caribbean region at the time of the Spanish Conques. The term is formally preferred in science, and particularly in agriculture, as it specifically refers to the large grain plant belonging to the Panicoideae subfamily.
- 'corn' derives from the Old English word *corn* referring to a grain still containing the seed inside rather than the particular plant, and is related to 'kernel', 'pomegranate' and 'granule', among others. In the United States, Canada, Australia and New Zealand, the term basically refers to Zea mays, as an abbreviated form of 'Indian corn'.

This paper will make deliberate use of the latter term, given the cultural approach to Native American songs and rituals.

In a similar manner, the origin of the plant has been long disputed and debated: which came first, teosinte (Zea spp.) or maize (Zea mays)?

Concerning its systematics, the Genus *Zea,* Subtribe *Tripsacinae*, Tribe *Andropogoneae*, Subfamily *Pooideae*, Family *Poaceae,* Order *Poales,* includes one single species, i.e. *Zea mays* L. (maize or corn)*,* first grown in Mexico 5,200-3,400 years BC (McNeish, quoted by Cristea M., 1977).

Nevertheless, its wild form is unknown, which results in a large number of hypotheses concerning the provenience of the species and its original centres. It is possible that corn descended from the tall grass native originating from southern Mexico and Central America or from some other wild relative. Most researchers defend the American origin of corn; there are, however, different opinions regarding its exact location (Table 1).

Table 1. Possible areas of origin for corn (Cristea M., 1977, quoted by Roman Gh. V., 2011)

No.	Year	Researcher	Possible area of origin
1.	1829	Saint-Hilaire	Lowlands of Paraguay
2.	1836	Bonafous	Asia, North Africa
3.	1883	Darwin	Peru
4.	1885	De Candolle	Columbia
5.	1885	Kornicke	Lowlands of Paraguay
6.	1893	Harschberger	Mexico or Central America
7.	1931	Vavilov	Mexico or Central America
8.	1936	Weatherwax	Mexico or Central America
9.	1937	Kompton	Mexico or Central America
10.	1939	Mangelsdorf, Reeves	Lowlands of Paraguay
11.	1945	Anderson	Asia, North Africa
12.	1959	Randolph	Mexico or Central America
13.	1967	Brandolini	Polycentric origin: Zone I, primary centre in Mexico and Guatemala Zone II, primary centre in Peru-Bolivia

As concerns the provenience of the current form of corn, several hypotheses have been formulated, as summed up in Table 2.

Table 2. Possible hypotheses regarding corn provenience (Cristea M., 1977)

No.	Year	Researcher	Hypothesis
1.	1829	Saint-Hilaire	Derived from pod corn (tunicate maize) (*Zea mays* var. *tunicata*)
	1935	Vavilov	
2.	1880	Ascherson	Derived from teosinte by mutations
	1940	Langham	
	1941	Longley	
3.	1972	De Wett and Harlan	Derived from teosinte
4.	1901	Harchberger	Derived from teosinte by hybridation
	1919	Collins	
	1922	Penzig	
5.	1910	Goebel	Derived from *Tripsacum* by hybridation
6.	1931, 1945	Mangelsdorf and Reeves	Derived from tunicate maize or from teosinte by crossing tunicate maize with *Tripsacum dactyloides*
7.	1949	Mangelsdorf and Smith	
8.	1936, 1957	Weatherwax, quoted by Săvulescu	Derived from a common ancestor of *Zea, Tripsacum, Euchlena*
9.	1959	Mangelsdorf and Reeves	Tripartite hypothesis
10.	2004	Eubanks	Cross between teosinte and gamagrass (*Tripsacum*)

The interest in unveiling the mystery related to the origin of this crop plant proves its scientific, agricultural importance. Corn is quite vigorous, compared with other annual herbaceous species. Its root system is adventitious and its root type is fasciculated. The first 2-5 lower knots rising above ground form adventitious roots that have mainly two roles, i.e. to anchor the plant in the soil and to produce food for the plant. Corn has no taproot but its roots can penetrate deeply into the soil, sometimes reaching 2 m.

From the morphological viewpoint, although corn exhibits a wide range of quantitative variations compared with the other grain crops, it has several general characteristics.

Thus, stalk height can vary from 1.5 to 3.0 m, displaying 7 to 15, rarely 21, internodes filled with marrow. Alternate leaves composed of sheath and limb are attached at a node. The length of the linear-lanceolate limbs varies between 50 and 80 cm, while width varies between 4 and 12 cm. The top side of the limb is rough-pubescent while the bottom side is hairless, shiny, with a highly prominent midrib. The ligule is emarginated, ciliated and pubescent. Total leaf number depends on the vegetation period, and temperature plays a significant role in leaf emergence and development; however, leaf number on the main stalk generally varies from 8 to 48. Leaf length extends from 30 to 150 cm and width from 4 to 15 cm.

Corn is a plant producing monoecious flowers, i.e. having the male and female reproductive organs in separate flowers on the same plant.

The male inflorescence, or tassel, is the pollen-producing organ. It is located at the top of the plant and consists of a central spike and about 10-40 spikelet-bearing branches; the number and position of branches, as well as the size of the tassel, varies with each hybrid. Each spikelet contains two florets, the upper and lower floret, and is protected by a pair of hairy leaflike glumes; wihin the glumes, the florets have three stamens and are further protected by a pair of thin scales called lemma and palea.

The female inflorescence, or ear, arises between the leaf sheath and the stalk at at internode, 50 cm to 1 m below the tassel or about midway on the stalk. The ear branch, or shank, consists of nodes and short internodes, and is completely covered by several layers of leaves called husks. The thick axis of the ear, the cob, produces numerous pairs of spikelets, like its male counterpart, the tassel. Each spikelet is enclosed by a pair of glumes and contains two florets, of which only the upper one is fertile, producing an ovary with an elongated style (silk) covered with hairs (trichomes).

Pollination of corn is allogamous and anemophilous, i.e. pollen is carried by the wind from the male to the female flower on the same plant. When the tassel reaches maturity, the anthers of the stamens release pollen which is dispersed by the wind, sometimes falling a few metres far from the tassel.

The corn fruit is a kernel (caryopsis) of variable forms and sizes, depending on the variety. The enbryo is about 10-15% of the kernel volume, the endosperm about 80-85% and the pericarp 5-6%.

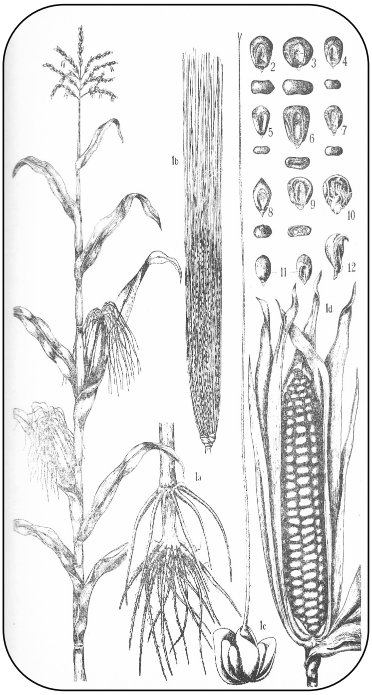

Figure 2. *Zea mays* L. (1a-root system, 1b-female inflorescence during flowering after leaf removal bracts, 1c-female flower, 1d-matur cob relaesed from husks, 2-12-caryopses of different convariety viewed from the front side) (Source: Săvulescu T. et al., 1972)

As seen from the above, corn crop has some very specific features that recommend corn as the 'quiet monarch that has reigned supreme in America for thousands of years.' (Hardeman 2)
The crop is widely adaptive, from Africa to Europe and Asia; it can grow in temperate as well as semi-arid areas, at elevations ranging from sea level to almost 4,000 metres in the Andes Mountains. The diverse morphology of the plant makes it conspicuous among all the crop plants: height variation between 60 and 700 cm; leaf number on the main stalk between 8 and 48; leaf length from 30 to 152 cm; leaf width from 4 to 15 cm; number of stalks per plant between 1 and 12. These various characteristics provide numerous opportunities for phenotype combination and selection.
Among other qualities there is the high multiplication ratio of corn, as one seed can produce a plant bearing between 400 and 1,000 subsequent seeds, which makes it highly productive. It is also undemanding of soil preparation, conservation tillage and mechanisation level, and extremely resistant: it can remain in the field if weather conditions prevent harvesting operations.

… and stories

Among their numerous rituals, the original Americans carried out agricultural rites, since nature consisted of plant life, as well as bird and animal life. Like human beings, the world itself was born, bloomed, withered and died – phases marked by seasonal feasts and dances. There were ceremonies to take place at every stage of the agricultural process: when the seed was set in the ground, when the crops were growing, when the harvest was reaped. There were ceremonies to bring rain, to cast off drought, to ensure fertility, to minimize crop damage. By performing the suitable ritual, the food supply could be assured. Every crop had its own festival: the Squash Festival, the Bean Festival, the Acorn Festival, the Wheat Festival, the Corn Festival.
As the main staple food, corn was essential in the daily life of the native tribes; consequently, corn could not be exempted from their spiritual manifestations. Food was an element of cohesion and solidarity, reinforcing interactions at both physical and metaphysical level. Food sharing was part of the human capacity to interact with others: it gave the participants a sense of belonging, as aliments were considered a contributing factor to the development of self-identification. For the original American, to partake in a meal was to become a member of a ceremony which dissolved distinctions and limitations – and to share the same spirit: the spirit of Mother Corn, the First Woman, the Unknown Woman, Atna of the Arikara tribe, Selu of the Cherokee, Chicha of South America, or even the male god of corn Mandaamin of the Ojibwe.
By far the most important agricultural ceremony was the Corn Dance. There were festivals for the Fresh Corn, the Green Corn, the Young Corn, the Mature Corn. However, the form of the ceremony followed the same general pattern: the first day featured introductory speeches, thanksgiving addresses, the smoking of tobacco, and religious prayer; the second day displayed a great dance; the third day was spent singing both individual and collective ceremonial songs, in a concert of

solos and choruses; and the fourth day was devoted to playing of games.

Every evening, thanks and praises were raised to the Great Spirit, Lord of the Corn and of all living things. This annual feast took place and still takes place in the villages of the Rio Grande; it had been described at length in such books as Hartley Burr Alexander's *The World's Rim* and D.H. Lawrence's *Mornings in Mexico*.

In their practically-oriented religions, Native Americans attempt to secure divine intervention for a specific purpose, a concrete achievement, a tangible thing. The rituals are seldom used for mere entertainment or for exclusively individual purposes; the word, song and dance are summoned to exert a strong influence and bring about a certain change – in this case, the very word brings the plant to life and gives it strength to produce roots, stem, leaves, for the word is the powerful agency that brings about everything the individual desires most: fertility, germination, growth. The word carries the message of spiritual regeneration, restoring the power of a simple and disciplined life.

In Native American culture, word and thought are believed to determine and to direct reality: only by concentrating his thoughts on the corn plants, the native feels that he can influence its growth and maturation. After having planted the corn seeds, the Southeastern tribes try to tame the earth with their drums throbbing in the rhythm of blood and growth, and with their voices united in a soft chant:

"Blue evening falls,
Blue evening falls,
Near by, in every direction,
It sets the corn tassels trembling" (Astrov 32)

Thus, they become part of the creative divinity that lives everywhere, experiencing identity with the original forces of the earth in the eternal rhythm of life. Joining the supernatural powers, man himself will be recreated and renewed. The words that are believed to promote fertility fructify not only the soil that has received the corn seed but also the soil of the human soul.

Even events and phenomena of the objective world are described in terms of germinating processes, of growth, unfolding or vanishing, or as mere outlines, as fleeting colours, or as hardly perceptible movements:

"'The beautiful world germinates.
The sun, the yellow dawn germinate.'
Thus the corn plants say to one another.
They are covered with dew.
'The beautiful world germinates.
The sun, the yellow dawn germinate.'
Thus the corn plants say to one another.
They bring forth their young" (Astrov 11)

Figurative language of a metaphorical or allusive type abounds in American indigenous prayers: the sun 'comes out standing to his sacred place', the corn plants 'stretch out their hands to all directions calling for rain'.

Rain is one of the most revered presences of nature in the life of the aboriginal Americans. With this song, the Pima tribe is supposed to summon rain:

"Hi-iya naiho-o! The earth is rumbling
From the beating of our basket drums.
The earth is rumbling from the beating
Of our basket drums, everywhere humming.
Earth is rumbling, everywhere raining"
(Russell 332)

The sound of the basket drum urges the gathering of the clouds, symbolized by the feathers of the eagle:

"Hi-ihiya naiho-o! Pluck out the feathers
From the wing of the Eagle and turn them
Toward the east where lie the large clouds.
Hi-ihiya naiho-o! Pluck out the soft down
From the breast of the Eagle and turn it
Toward the west where sail the small clouds.
Hi-ihiya naiho-o! Beneath the abode
Of the rain gods it is thundering;
Large corn is there. Hi-ihiya naiho-o!
Beneath the abode of the rain gods
It is raining; small corn is there" (Russell 332)

The Papago, a tribe from southern Arizona and northern Mexico, display the same specific practical aims in their rain song destined to secure rain and good crops. The repetitive structures elevate ordinary communication to high conceptual levels since, for the Amerindians, the word is the bearer of never-ending existence:

"A cloud on top of Evergreen Mountain is singing,
A cloud on top of Evergreen Mountain is standing still,
It is raining and thundering up there,
It is raining there,

Under the mountain the corn tassels are shaking,
Under the mountain the horns of the child corn are glistening" (Densmore 141)

The highly metaphoric character of Native American poetry is at work here as the delicate metaphor in the last line reveals the complex nature of the entire web of relationships and connections between the human and the vegetal realms. There is an unparalleled image of infinite tenderness: the human being acts like the guardian spirit of the corn in its process of maturation, under the sparkling light reflected in rain or dew drops.

Slow rhythms and spontaneity are tightly linked to the necessity of securing food but simplicity is only apparent; the ancient values are pervasive, as a sign of self-expression and cosmic integration, more evident in the corn-grinding ritual chant of the Laguna, a tribe from New Mexico:

"I-o-ho, wonder-water,
I-o-ho, wonder-water,
Life anew to him who drinks!
Look where southwest clouds are bringing rain;
Look where southeast clouds are bringing rain!
Life anew to him who drinks!
I-o-ho, wonder-water,
I-o-ho, wonder-water,
Life anew to him who drinks!" (Grove-Day 84)

Despite the repetitive patterns exposed in song and dance, the native nations possess an extremely rich imagination and an overwhelming inward intensity. Word, step and gesture are carefully planned to convey the inner spiritual strength to the outside powers which live under the skies and inside the earth.

'Corn Song' is one of the forty songs of the House God which are performed as part of the Night-Chant ceremony, a major Navajo ritual that lasts for many days:

"The corn grows up.
The waters of the dark clouds drop, drop.
The rain descends.
The waters from the corn leaves drop, drop.
The rain descends.
The waters from the plants drop, drop.
The corn grows up.
The waters of the dark mists drop, drop" (Yeadon 18)

Addressed to another 'nature person' indispensable for life on earth – the Sun, the one who is able to witness everything from above. Its spirit is highly revered in prayers and the Havasupai of the Grand Canyon are no exception:

"Sun, my relative
Be good coming out
Do something good for us.
Make me work,
So I can do anything in the garden
I hoe, I plant corn, I irrigate…" (Spier 286)

It is obvious that there is a two-fold function of the ritual: in performance, the individual gains power for himself first, then he enhances the power of the phenomenon in the outside world; thus, the creative potency of the act induces germination and hastens growth:

"While I sleep you come up.
Go on your course many times.
Make good things for us, men.
Make me always the same as I am now" (Spier 286)

The particular architecture of corn often stands as a symbol of maturity, strength and potency. There are numerous songs and rituals about leaving the age of innocence and incompleteness, striving to self-improvement and, ultimately, perfection. This Apache ceremonial song of the sacred corn conjures physical and mental stamina and robustness by appealing to the image of the leafy cereal plant:

"At the east where the black water lies stands the large corn, with staying roots, its large stalk, its red silk, its long leaves, its tassel dark and spreading, on which there is the dew". (Grove Day 82)

They are simple but powerful songs telling of the creative union with nature, universe and divinity, which involves an acute sentiment of the self and also a comprehensive worldview, realizing that the individual and the plant are wholly reciprocal:

"At the west, the red corn,
See me!
I come forth and grow tall…
At the east, the white corn,
See me!
I come forth and grow tall" (Underhill 250)

By joining the supernatural forces in the recurrent process of creation, the individual hopes to be recreated from the depths of the being. The words that are believed to enhance fertility will fructify the soil that has received the corn seed and the soil of the human soul, at once.

The Native American believed in the power of the word. The spoken word was the bearer of eternal life, the reality above all tangible realities, empowering the mortal with the feeling of greatness, space and freedom. A word possessed holiness and permanence – as the contemporary Native American writer N. Scott Momaday said,

"A word has power in and of itself. It comes from nothing into sound and meaning; it gives origin to all things. By means of words can a man deal with the world on equal terms. And the word is sacred." (Momaday 33)

The word is life, substance, reality; it is thought to precede the Creator: in the beginning was the thought, the dream, the word. They encapsulate the creative union of the human with the earth, the universe and the divinity, in simultaneous simplicity and complexity.

CONCLUSIONS

The variety and excellence of Native American agricultural-related rituals and poems could remind the world the ancient values and annul the modern oppositions, for they live in a world where human being and the world are the same, wisdom requires fantasy and fantasy requires wisdom.

Although not immediately comprehensible nowadays, it is nevertheless worth remembering that their rich metaphors and allusive language sprang from basic human needs and emotions. They still preserve the substance of the ancient life force: deeply spiritual nations, Native Americans endow everything with divine essence, going beyond all ages and reaching the age of wonder where all the oppositions are annulled and perfect harmony reigns forever.

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ANALYSIS OF WATER BALANCE FOR DETERMINE CROPPING PATTERNS FOR FOOD CROPS IN WATERSHED KARANGMUMUS-THE PROVINCE OF EAST KALIMANTAN

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Abstract

The experiment objectives was to determine cropping patterns of food crop in watershed Karangmumus. The geographical position 116°49' EL – 117°08' EL dan 0°34' SL – 0°45' SL, with extent of the 644.2 km² whereas covers 8 village or 38.58% of total Samarinda City. Have the Area Class III (1500 – 2000 mm/ year,. with the Bimodel or Double Wave rainfall models with C patern. The hight rainfall depth periode at December and April, therefore the low rainfall depth at September and November. Have a value Q = ± 9.9%, or rainfall tipe A (very wet area with tropical wet vegetation) and E1 agroclimtic zone. Modified method of Thornthwaite and Mather of bookkeeping system of water balance was used based on monthly data. Water Balance monthly indicated that this area have potential growing season about 9 months, have to water surplus 7 month (478, 8 mm year^{-1}) and water deficits about 4 months (44.5 mm/year). In these area rice could be planted twice a year without irrigation. Futher for non-irrigation land with monthly high rainfall, the result showed that the area had potency of growing periods of 182 days through the year. Planting dates might be started from October 1 until December 1, with sequence of rice-rice or rice-rice-other food crops.

***Key words**: water balanced, growing season, cropping patterns.*

INTRODUCTION

Considering that the East Kalimantan Province having the wet tropical climate, generally it can be said that the rainfall in the entire region is sufficient for agriculture. Even, in the dry land, where the distribution of rainfall throughout the year in many areas is uneven, the production could be comparable with those in the irrigated land, if it is managed properly.

Therefore, the principal constraint of agriculture in Watershed Karangmumus areas is the water distribution. This is due to the existing irrigation facilities are inadequate, both in terms of technology and limited irrigation canals.

Although there are a lot of rains, plants can not directly utilize it from the river or the rain, but it should first be transformed so that it can be used by plants. By considering that the availability of water is very essential for agricultural planning, therefore, the success of farming will also be determined by how much we can expect the availability of water for plants. Various attempts were made to reduce the risk of crop failure is to compile information about potential the time of planting, especially for crops. Method of Thornthwaite and Mather (1957) is one approach that is commonly used to determine the level of availability of water to determine the potential growing season and croping patterns.

Water balance iss simply a statement of the details of the law of energy conservation, which applies also to the water issue. Knowledge of the water balance is the basis for the development of agricultural production, crop selection, and determination of cropping pattern (Oldeman and Frere, 1982 in Sujalu, 2000). Preparation of the water balance is the basis of the development potential of climate, soil, and plants that are very useful for planning the development of agricultural production. It is intended to provide important information on the net amount of water that can be obtained, the value of the surplus water which can not be accommodated, and when the water balance occur. Therefore, these data can be used as a basis for planning and management of various activities, such as making a water dam (for water storage and distribution), and the possibility of natural water utilization for a variety of other activities.

MATERIALS AND METHODS

A. Time and Place Research

The study was conducted at Watershed Karangmumus for approximately 6 (six) months (July-December 2012) in an area of approximately ± 64 420 hectares.

B. Data Collection

Data collected from both primary and secondary data related to the research, include:

a. Climate, particularly rainfall and evaporation
b. Physiographic, particularly land slope
c. Soil Conditions, those related to soil water status
d. The vegetation, especially the dominance of vegetation, land cover

C. Water Balance Analysis

Analysis of water balance the form of integral equations by simplifying some similarities, method of Thornthwaite and Mather of bookkeeping system (1957). So that the water balance of a land area can be expressed in the form of the equation:

$$CH = ETA \pm \Delta\ WCS \pm Li$$

Whereas:

CH = rainfall (mm $months^{-1}$)

ETA = actual evapotranspiration (≤ETP)

Δ WCS = soil water content changes (mm $months^{-1}$)

Li = runoff (surplus or deficit depending on its value) (mm $months^{-1}$)

C.2. Analysis of Soil Water Content (WCS)

Changes in Water Content of Soil (WCS) is the difference in soil moisture content on a period to prior periods between sequential. For each change in soil water content, can be calculated with the formula R-ETP that if a negative value, there will be a deficit (lack of) water for (ETp=ETa). Conversely, if (R-ETP) is positive, then there will be a surplus/excess of water (R-ETp-ΔWCS), so that soil water availability decreases water exponentially and expressed by the equation:

$$ASW = WHC \times k^{a},$$
$$WHC = FC - PWP,$$
$$WCS = PWP + ASW$$
$$K = ((Po + P_1) / WHC$$

Whereas:

ASW = Availability of Soil Water (mm)

WHC= water holding capacity or availability of Maximum Soil Water (mm)

WCS = Actual Soil Water Content (mm)

FC = Field Capacity (mm)

PWP = Permanent Wilt Point (mm)

a = Accumulate Potential Water Loss (APWL)

Po = 1.000412351 (constant)

P_I = -1.07380730 (Constant)

C.1. Analysis of Evapotranspiration Potential

Calculation the potential evapotranspiration (ETp) using equation from Buckman and Braddy (1969) quoted bay Sujalu (2002, 2011, 2013) as follow:

$$EPTi = 616 \times \left(10 \times \frac{Ti}{I}\right)^{a1}$$

$$\mathbf{I} = \sum_{jan}^{des}\left(\frac{Ti}{5}\right)^{1.514}$$

whereas;

ETP = Potential Evapotranspiration

Ti = Temperature of the month to the first monthly

I = Index monthly heat

a = $6.75x10^{-7}I^3 - 7.71 \times 10^{-5}1^2 + 1.792 \times 10^{-2}I + 0.492$

RESULTS AND DISCUSSIONS

A. Preview Area Watershed Karangmumus

Geographically located of the region Watershed of Karangmumus is part of the Mahakam river basin is located at coordinates 116°49' EL – 117°08' EL dan 0°34' SL – 0°45' SL, with extent of the 644.2 km^2 whereas covers 8 sub-district or 38.58% of total Samarinda City, i.e. Samarinda Utara, Samarinda Ilir, Samarinda Ulu, Lempake, Sungai Pinang, Mugirejo, Gunung Kapur, and Muara Badak.

Watershed Karangmumus divided into 9 (nine) sub-watershed (river), namely Karangmumus, Lantung, Pampang, Muang, Karangasam, Bayur, Jayamulya, Siring and Betapus as well as several other small rivers. This area has varied topography, with elevation ranging topographic region from 1-120 m above sea level with a diverse variety of heights.

Table 1. The Area Land Use Type

No.	The Area Land Use Type	Area (ha)	Area (%)
01.	Farm (dry land farming)	403.13	0,65
02.	Forest	292.15	0,46
03.	Shrub	13.996.25	22,23
04.	Mixed Garden	8.473.44	14,21
05.	Bush	29.501.36	46,07
06.	Wetland	1.248.99	2,06
07.	Garden	2.106.64	3,52
08.	Settlements	4.267.78	7,21
09.	Settlement expansion (Pp)	415.61	0,69
10.	Slough/swamp area	1.815.63	2,91
Amount		64.420, 98	100

Source: Anonim (2001), Trisusanto (2002)

B. Condition Elements the Climate

Based on rainfall data from 3 (three) climate observation station in the basin area Watershed Karangmumus year period from 2001 to 2010 showed that rainfall monthly average ranged from 101-220 mm month^{-1} or an average of 168 mm month^{-1}, whereas the average rainfall ranging from 1500-2850 mm year^{-1} or average of 2018 mmyear^{-1}. Rainfall occurred on rainy days (rd) monthly rates ranging from 9-14 rd with an average rainfall occurred 11 rd month^{-1} (Table 2).

Analysis of rainfall characterization includes four main components, namely:

1. Annual Rainfall spread of this area falls within Class Region III (rainfall between 1500-2000 mm year^{-1}).
2. Type Rainfall has a period of dry months (months with rainfall of <100 mm month^{-1}). Thus obtained value of Q = ±9.8%, or rain type A (which may imply that the Watershed Karangmumus is very wet areas with dense vegetation of tropical rain forest).
3. Rainfall patterns or Bimodel Dual (Double Wave) with the notation Pattern C, periods of high rainfall occurred in December and April, while periods of low rainfall occurred in September and November.
4. Agro-climate zones, this area has a dry month (DM), 8 months humid (HM) and 3 wet months (WM), including agro-climate zones E1.

C. Water Balance

Watershed Karangmumus in general has not been irrigated that is highly dependent on rain water. Table 1 was the result of water balance analysis was used as a reference in determining the initial forecasts of alternative commodities and time of planting on land that does not have a irrigation.

The calculation result in soil water status were obtained from analysis of soil physical properties in the laboratory soil Assessment Institute for Agricultural Technology (BPTP) East Kalimantan Province from Heriansyah (2004) quoted by Ismail (2005) showed that soil available water content (WCS) in the range 244-299 mm or average 268 mm

The analysis of water balanced implies about the details of the input and outputs of water in one place at a certain time period, compiled in the form of quantitative equations, which provide information in the form of quantitative values of each component of input and output water, can be seen in Table 1.

Tabel 1. Monthly Water balance Analysis at Watershed Karangmumus
(116°49' EL – 117°08' EL dan 0°34' SL – 0°45' SL)

Elements	Month											
	Jan.	Feb.	Mar	Apr.	May	June	July	Agst	Sept	Oct.	Nov.	Des.
Rain fall/CH (mm)	194.0	143.0	233.0	333.0	183.0	113.0	178.0	121.0	104.0	134.0	198.0	214.0
Evapotr.Pot. /ETP (mm)	139.0	138.7	139.6	140.2	139.6	138.4	137.2	138.1	138.4	139.3	139.3	138.7
CH – ETP (mm)	55.0	4.3	94.4	192.8	42.4	-25.4	40.8	- 17.1	- 34.4	- 5.3	58.7	75.3
APWL (mm)	0	0	0	0	0	0	0	-17.1	-51.5	-61.8	0	0
Soil Water available/SWC (mm)[1]	268	268	268	268	268	242,6	268	250.9	198.5	136.7	185.4	260.7
Δ WCS	0	0	0	0	0	-25.8	0	- 17.1	- 58.0	- 62.0	- 3.3	0
Evapotr. Akt./ETA (mm)[2]	139.0	138.7	139.6	140.2	139.6	138.4	136.9	142.0	152.0	196.0	139.3	138.7
Defisit (mm)	0	0	0	0	0	0	0.3	3.9	13.6	26.7	0	0
Surplus (mm)	55.0	4.3	94.4	192.8	42.4	0	0	0	0	0	58.7	75.3

Note : [1]. Water Content of Soil (WCS) at Field Capacity (FC)
[2]. Actual evapotranspiration (ETA) in the period of time deficit (R<ETP) was obtained from R (mm) + Δ WCS. While at the time of surplus (R> ETP) the amount equal to ETP

Table 2. Climate Data Average Monthly at Watershed Karangmumus
(116°49' EL – 117°08' EL dan 0°34' SL – 0°45' SL)

Climate Elements	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Rainfall (mm month^{-1})	194	123	233	333	183	113	178	121	104	134	198	214
Rainy Days (days)	12	11	12	14	12	11	9	10	9	11	11	12
Temperature (^{0}C)	26.8	26.7	27.0	27.2	27.0	26.6	26.2	26.5	26.6	26.9	26.9	26.9
Humidity (%)	87.2	86.3	89.2	90.2	88.6	86.5	85.6	86.2	83.4	85.9	87.1	86.3
Sun Radiation (Kkal cm-^{2})	0.55	0.48	0.51	0.53	0.53	0.51	0.51	0.49	0.41	0.44	0.44	0.52

Monthly Water Equilibrium analysis of the results mentioned above can be seen that these areas have a surplus during the eight months that occurred in a period of months from January to June and in November-December. The monthly water surplus in detail is in January amounted to 27.0 mm, 57.3 mm in February amounted, in March amounted 119.7 mm (the highest monthly surplus), in April amounted to 72.8 mm, 48.4 mm in May, months of June amounted to 19.6 mm (the lowest monthly surplus), the month of November amounted to 58.7 months in December and amounted to 75.3 mm in overall water surplus reached 478.8 mmyear^{-1}.

In addition to having monthly water surpluses, the region normally monthly cumulative water deficit in a period of months from June to October as a whole as much as 44.5 mm year^{-1}, with details of the deficit in June amounted to 0.4 mm month^{-1}, July amount 0.3 mm month^{-1}, the month of August amounted to 3.9 mm month^{-1}, the month of September amounted to 13.6 mm month^{-1} and in October of 26.7 mm month^{-1}.

As has been previously communicated its position Karangmumus river divides the city of Samarinda especially Watershed of Karangmumus, and considering the amount of potential run-off that occurred in the region and also by considering the conditions Karangmumus area topography, the watershed Karangmumus very possible to build dams or reservoirs, which have various functions.

Although the main function is to accommodate the construction of the dam monthly surplus water run off resulting in the potential is big enough in this area, as well as water reserves in the period in the months of water deficit that can be utilized by a variety of purposes including drinking water

E. Analysis of Cropping Periods (Growing Season)

To determine the length of cropping period (the length of growing season) can be done based on the ratio P/PE (ratio precipitation and potential evapotranspiration), defined as the time interval in a year that have a ratio P/PE>0.5 plus the time needed for PE 100 mm of ground water is considered available in the soil (FAO, 1978). Results of analysis ratio P/PE can be seen in Table 3 below.

Table 3. Ratio rainfall (R) and potential evapotranspiration (EP) monthly

Climate Elements	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Rainfall (mm / month)	194	123	233	333	183	113	178	121	104	134	198	214
Evapotr.Pot. / ETP (mm)	139.0	138.7	139.6	140.2	139.6	138.4	137.2	138.1	138.4	139.3	139.3	138.7
Ratio P/PE	1.4	0.9	1.7	2.4	1.3	0.8	1.3	0.9	0.8	0.9	1.4	1.5

Based on this analysis the ratio P / PE ratio of the above in mind that the P / PE in the rain fall average monthly cumulative throughout 12 months is always>0.5. Therefore, according to the restrictions provided FAO (1978), the Watershed of Karangmumus areas have planting period (the length of growing season) for 12 months or all year round.

F. Cropping Patterns for Food Crops

Table 1 shows that in this type of land use, have the potential for considerable length of time of planting is about 270-330 days as paddy fields will be planted with rice twice a year. The results of the water balance analysis showed that both the use of land for irrigated land and non-irrigated land at watershed Karangmumus (generally) in East Kalimantan Province still has the potential to grow rice at least once a year.

In watershed Karangmumus, the area of irrigated rice can be planted with rice twice a year. So for the region can be planted rice twice a year if just relying rainfall. Thus as long as farmers can grow rice twice a year because of the additional water from rain. This region does not have irrigation but can still grow rice twice a year (Table 4), due to adequate rainfall with the potential for 293 days of planting time and planting time beginning November 1. Whereas during the dry season still has the potential to grow rice at least once a year

Based on conditions the elements of the climate and the results of analysis of water balance, Watershed Karangmumus at least once a year. In rainy season (wet season) can be used 2 periods cultivation of rice and second crop by 1 periods for a year. Whereas during the dry season can be used 1 periods cultivation of rice and second crop by 1 periods for a year, with one priods (July-September) fallowed land.

CONCLUSIONS

Based on the description as a whole can be concluded that Watershed of Karangmumus at irrigated or non-irrigated land area has a all year round (12 month) potential planting period (growing season).

Table 4. Pattern of Cropping

Subject	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Ratio P/PE	1.4	0.9	1.7	2.4	1.3	0.8	1.3	0.9	0.8	0.9	1.4	1.5
Pattern of Cropping[1]	**Rice II**		**Second Crop**				**Rice I**				**Rice II**	
Pattern of Cropping[2]	**Rice I**		**Second Crop**				**fallowed**				**Rice I**	

Note: [1] Pattern of Cropping at Wet season
[2] Pattern of Cropping at Dry Season

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DYNAMICS AND DISTRIBUTION OF *Diaphorina citri* (Hemiptera:Psyllidae) IN A CITRUS ORCHARD IN TERENGGANU, MALAYSIA

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Abstract

Population fluctuation of Diaphorina citri was monitored once every four week for a period of seventeen months from March 2011 – July 2012, in a pesticide free citrus orchard. High number of adult D. citri were found on the upper canopy, north cardinal point and leaves growth stage 1. D. citri adults and immatures were found on C. suhuinensis on all sampling dates, except in the months of December, 2011 and January and May 2012, for immatures. Peak population of D. citri adults were found in months of March and June in both years, while in immatures peak populations were identified in the months of July, 2011 and March, 2012. Correlation analysis of D. citri adults and immatures with flush growth leaves and weather parameters shows adult D. citri population to correlate with number of flush leaves (r = 0.93) and temperature (r = 0.45). While immature D. citri population only correlated with flush leaves. Findings of these study give an insight into dynamics of D. citri populations in citrus orchard, which is usefull in monitoring and management of the pest.

Key words: *citrus*, *Diaphorina citri*, *Malaysia, population fluctuation.*

INTRODUCTION

Diaphorina citri Kuwayama (Hemiptera: Psyllidae) is one of the most important pest of citrus (Sule et al., 2012a) its ability to vector the bacteria that cause citrus greening or huanglungbing disease make it the most destructive pest of citrus globally (Sule et al., 2012b; Hall et al., 2011).

Adults and nymphs of the psyllids transmit the disease through feeding and citrus tree infected with greening diseases produce bitter, inedible, and misshapen fruits and eventually die within 5–10 years of infection (Mann et al., 2010).

Many factors are responsible in the occurrence and development of *D. citri*. Temperature, relative humidity and rainfall are the main factors that influence the development of *D. citri* population (Aubert, 1987). Fluctuations in population of psyllids are closely related with the occurrence of new young flush, but outbreak of the psyllids can occur at any time of the year, once environmental conditions are favourable and young flush leaves are available (Hall, and Albrigo, 2007).

Knowledge of the seasonal abundance, trends in the population build up and preferred canopy site by the psyllids has become imperative for effective control schedule against the pest.

Therefore, the objectives of this study are 1) to observe distribution and fluctuation in population of *D. citri* on citrus in relation to environmental factors. 2) To determine preferred canopy strata and cardinal point by the pest.

MATERIALS AND METHODS

Study site

The study was conducted from March 2011 to July 2012 in a pesticide free citrus orchard in Pusat Pertanian Padang Ipoh, Kuala Berang, Terengganu, Malaysia.

The orchard has an area of 20.4 hectares, divided into sixteen blocks. Two Blocks of citrus plant (limau madu), D5 (N 05 02' 57.4" E 103 00' 55.2") and D6 (05 02' 55.6" E 103

00' 54.6") measuring 1.2 hectare and containing 596 citrus trees were selected for the study.
The citrus trees were planted at 5m x 4m spacing and agronomic practices such as weeding and application of manure were given to the citrus plants at regular intervals.

Population sampling
One hundred and thirty five citrus trees of similar size (1.6m – 1.7m high) making 25% of the total trees planted in the two blocks were selected randomly as sample trees. One sampling visit was made every four weeks for a total of seventeen sampling visits to survey population of *D. citri* in the selected trees from March 2011 to July 2012.
The canopy of each tree was partitioned in to two strata; upper and lower, thereafter each stratum was divided into four quadrants (Compass direction), namely north, south, west and east. From each quadrant three shoots were randomly selected during each sampling visit for observation, counting and recording the number of *D. citri* (immature and adults), also number of flush shoot and leaves growth stage on which *D. citri* adult occurred were counted and recorded.

Data Analysis

Population distribution of *D. citri*
To determine whether mean population of *D. citri* adults differed significantly between the two canopy strata (upper and lower), the cardinal points (North, South West and East) and on the different growth stages of *C. suhuiensis* leaves.
The number of *D. citri* counted on the canopy strata, cardinal points and leaf growth stage during each sampling visits were subjected to analysis of variance using computer software SAS 9.1 for windows. Least significant difference (LSD) at 0.05% level of probability was used to separate the means.

Population fluctuations of *D. citri*
Population fluctuation of adults and immature *D. citri* were determined by plotting the total number of adults and immature stages of *D. citri* per sampling visit against time, the number of flush growth leaves (leaf growth stage 1 and 2) and weather parameters; mean monthly temperature and relative humidity and total monthly rainfall and rainy days. The total number of adults and immature *D. citri* were also correlated with flush growth leaves (leaf growth stage 1 and 2) and weather parameters; mean monthly temperature and relative humidity and total monthly rainfall and rainy days, further stepwise regression was performed between observed population and observed environmental parameters (rainfall, rainy days, temperature and relative humidity) and flush leaves growth stage.

RESULTS AND DISCUSSIONS

Population distribution of *D. citri*
The population distribution of adult *D. citri* in relation to tree canopy strata is presented in Figure 1. Significantly ($P < 0.05$) high numbers of adult *D. citri* were found in the upper canopy compared to the lower canopy.
When cardinal points is been considered, significantly ($P < 0.05$) high number of adult *D. citri* were recorded in the northern cardinal point (Figure 2) although not different statistically with the number of adult *D. citri* recorded in the western cardinal point, and the least population of adult *D. citri* was obtained in the southern cardinal point which was not different from the number obtained in western and eastern cardinal point statistically.

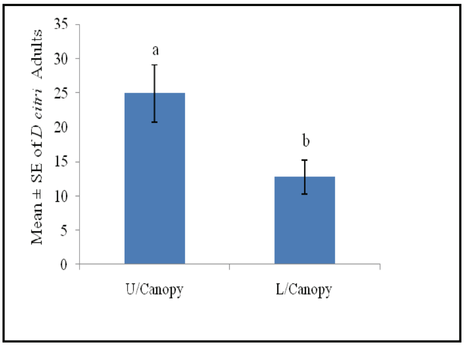

Figure 1. Effect of tree strata on distribution of adult *D. citri*

Similar results were obtained earlier (Albertus et al., 2008), using citrus and orange jasmine plant; however their studies report a no significant difference in population distribution of *D. citri* among cardinal directions (north, west, south and east), on both citrus and orange jasmine trees.

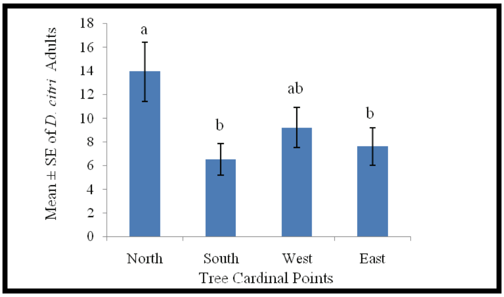

Figure 2. Effect of cardinal point on distribution of adult *D. citri*

Also studies by (Van den Berg et al., 1990) on dispersal of citrus psylla, *Trioza erytreae* indicated that during winter and summer months more citrus psylla were trapped in northern and southern row edges than in the other rows. The high population of adult *D. citri* on the upper canopy and north cardinal point in the present study is attributed to influence of other physical factors such as exposure to sunlight, temperature and relative humidity

With regard to flush leaf growth stage, significantly (P = 0.001) higher number of adult *D. citri* were recorded in flush leaves growth stage 1, followed by leaves growth stage 2 which was not different statistically with the number of adult *D. citri* recorded in flush growth stage 3 (Figure 3), and the least number of adult *D. citri* was recorded in leaves growth stage 4. The observed high number of adult *D. citri* on leaf growth stage 1 may be attributed to the tenderness of the leaves and colour, psyllid being a sucking pest need a tender tissue which may be easier to insert their stylet for feeding and anchoring their eggs.

Population fluctuations of *D. citri*

Population fluctuations of *D. citri* (adults and immatures) in relation to rainfall, rainy days, temperature and relative humidity are shown in Figure 4 and 5

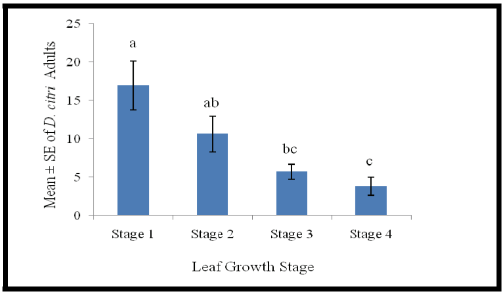

Figure 3. Effect of leaf growth stage on distribution of adult *D. citri*

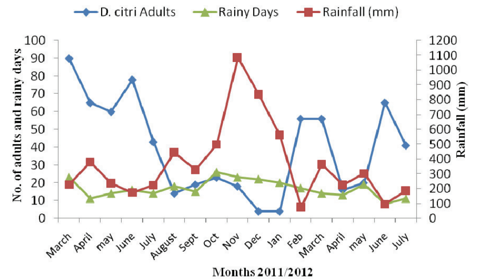

Figure 4. Population fluctuation of *D. citri* adults in relation to rainfall and rainy days from March, 2011 to July, 2012

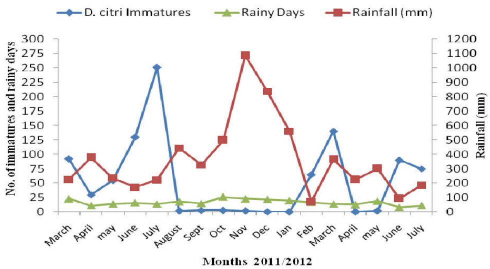

Figure 5. Population fluctuation of *D. citri* immature in relation to rainfall and rainy days from March, 2011 to July, 2012

Population of *D. citri* adults and immatures in the study area from March, 2011 to July 2012 had four and two apparent population peaks appearing in months of March and June, 2011, and February - March and June, 2012 for adult *D. citri* and the months of July, 2011 and March, 2012 for immatures. These population peaks seems to correspond with period when temperature is relatively high and relative humidity is relatively low (Figures 6 and 7) and new flush shoots are available (Figure 8).

The Correlation analysis (Table 1) shows that adult *D. citri* population is significantly correlated with number of flush leaves (r = 0.93) and temperature (r = 0.45). While immature *D. citri* population only correlated with flush leaves.

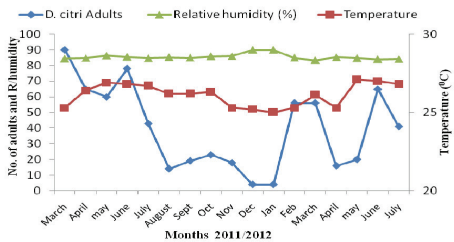

Figure 6. Population fluctuation of *d. citri* adults in relation to temperature and relative humidity from March, 2011 to July, 2012

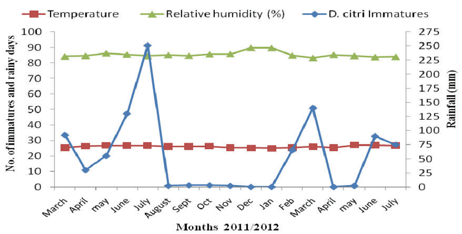

Figure 7. Population fluctuations of *D. citri* immature in relation to temperature and relative humidity from March, 2011 to July, 2012

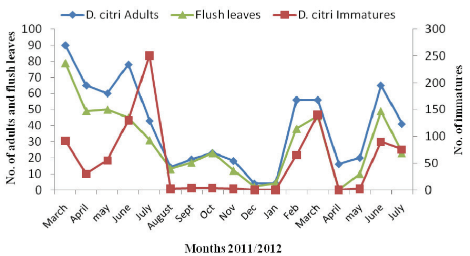

Figure 8. Population fluctuations of immature and adult stages of *D. citri* in relation to number of flush leaves from March, 2011 to July, 2012

However, the stepwise regression analysis between the observed population and the environmental parameters showed that both factors (flush leaves and rainfall) contributed to the population build up/ fluctuation of adult and immature *D. citri* populations, respectively (Table 2).

Population fluctuation of *D. citri* was studied by many authors in citrus and orange jasmine. Psyllid number was reported to be high in the months of May, June, and July in the citrus groves of east-central Florida (Hall, 2009). Qureshi et al., (2009) reported greater number of adult psyllid on citrus trees in April-June in the eastern coastal region, May and July in the southwest region and June, July, and September in the central region of Florida

Table 1. Coefficient of correlation between *D. citri* and environmental factors

D. citri	**Rainfall**	**Rain days**	**Temp.**	**R/Humidity**	**Flush leaves**
Adult	-0.61**	NS	0.45*	-0.52*	0.93**
Immature	-0.62**	NS	NS	-0.65**	0.80**

*significant at P=0.05, **significant at P=0.01, NS=not significant

Table 2. Stepwise regression for *D. citri* against environmental factors

		Regression parameters			
D. citri	Predictor variable	Intercept	Beta	R^2	Significance
Adult	Flush leaves	1.175	0.958	0.918	0.0001
Immatures	Rainfall	138.247	-0.615	0.378	0.009

In the present study, population of *D. citri* (adults and immatures) fluctuated throughout the duration of the study and were generally higher during the dry season in February-July than during the rainy/wet season from August to January. These results were in agreement with those reported by (Leong et al., 2011) and Marcado et al., (1991) which showed population of psyllid to fluctuate in relation to seasonal conditions. Outbreaks in population of Asian citrus psyllids are reported to be most commonly during April-July in Florida (Hall, 2009)

Population fluctuations between periods of times could occur as a result of difference in temperature, humidity or other environmental factors. During the flushing cycles (February – March, June – July) in the present study, total rainfall was low and irregular with low relative humidity and high temperature , these conditions influenced the physiology of the citrus plant to produce new flush shoots, which in turn provide conducive environment for *D. citri* proliferation. The high number of *D. citri* during the flushing cycles may be associated with high number of flush leaves and low rainfall and relative humidity; this can be observed by looking at the result of correlation analysis of those parameters which showed that rain fall and humidity were negatively correlated with psyllid population (Table 1). Chong et al., (2010) found that the density of adults, *D. citri* on orange jasmine plants was negatively correlated with relative humidity in Coral Gables, while it was positively correlated with relative humidity in Doral, but densities of eggs and nymphs were not correlated to any of the environmental factors recorded in all the communities

CONCLUSIONS

Population of *D. citri* on *C. suhuinensis* are more abundant on the upper canopy and north cardinal points of the tree and the population fluctuate throughout the year with population peaks in the months of February-March and June for adult *D. citri* and the months of July and March for immature *D. citri*. It seems to correspond with period when new flush shoots are available, and rainfall and relative humidity are low. However, number of rainy days and temperature has no significant influence on immature *D. citri* population.

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