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PEDOLOGICAL STUDY IN THE SOUTHWESTERN PART OF MEHEDINȚI COUNTY, VRANCEA AREA

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Abstract

The town of Vrancea, Mehedinți County, belongs to Burila Mare Commune and it is located in the south-western part of the county wich is part of the west Oltenia Plain being located on the fluvial terraces of the Danube. On the studied territory there were formed and occur as soil units, Reddish Preluvosol on carbonate deposits, mollic Reddish Preluvosol on carbonate deposits, mollic Psamosol on aeolian deposits. The specific meso-relief of the reddish preluvosol is represented by the Danube terraces - the II Corabia terrace, altitude 15-22 m, and the psamosol - the Danube terraces - the IV terrace - Flamanda, with an altitude between 50 and 60 m. Preluvosols are characterized by a low content of humus, 2.70-2.93%, slightly acidic reaction, pH 6.13-6.43, low content in nitrogen and medium in phosphorus and potassium. Calcium carbonates are present in a high percentage, in the Cca horizon, and the chemical neoformations represented by $CaCO_3$ concretions have been identified. Psamosols have a medium humus content, 2.64%, a slightly acidic reaction, pH 5.83-6.23, medium-low nitrogen content, medium phosphorus and weak potassium.

Key words: *soil profile, soil horizon, humus, soil reaction, fertility.*

INTRODUCTION

The soil, the layer on the surface or "Earth's epidermis" (Lavelle & Spain, 2002; Raducu et al., 2022), represents the ecological environment for plant life. This quality, this complex and fundamental function, is determined both by its intrinsic properties and by the pedogenesis factors (climate, relief, bedrock, etc.), which contributed to its evolution. The properties of soils, as well as their geomorphological distribution, are totally influenced by these factors.

The local conditions of relief, groundwater, lithology, determine the variety of soils in a certain area, which proves that the distribution of soils is determined not only by bioclimatic zonation but also by local factors, which sometimes play a fundamental role in the distribution of soils in a certain area (Amuza et al., 2023).

As a life support for plants, the soil has a fertility, which is influenced by the natural factors that acted in its genesis and evolution. The relief, through its components, altitude and exposure, largely determines its variety. (Tărău et al., 2007).

Plant growth and fruiting are influenced by the physical, hydro - physical and chemical properties of the soil. The aero-hydric regime, microbiological activity but also the transformation of nutrients in the soil is indirectly influenced by the physical properties of the soil (Drăgănescu, 2002).

In order to be able to ensure good conditions for the growth and fruiting of plants, the soil components must also be maintained in the optimal natural ratio, any disturbance causing a decrease in productive capacity (Popescu, 2020).

Soil is a natural and precious resource that mankind has inherited over time. He had a close connection with humans, throughout the history of mankind, through its cultivation, in order to obtain the products necessary for life. As the need to obtain higher yields productions, through the development of civilizations, it became more and more necessary, in order to increase the productivity of the soil, the application of fertilizers, pesticides and in this way, the beneficial intervention of man was felt (Datta et al., 2016).

The humans, through their intervention, however, modified the natural framework in which the soil was formed and thus the soil processes were disturbed (Popescu, 2018).

By using the soil for agricultural needs, soil works have influenced the physical properties, especially the structure, porosity, resistance to penetration, plasticity, adhesiveness (Cârciu et al., 2019; Cornavski, 2010). In this way, the structure of the soil was degraded, by doing agricultural works at unfavorable moments of humidity or by performing a large number of passes with agricultural machineries (Mihalache, 2014).

By changing the structure of the soil, its total porosity changes, it decreases, and in this way creates unfavorable conditions for the growth and development of plants (Mușat et al., 2023), in the sense that the microbiological activity is reduced, the permeability for water and air is small, and the root system of the plants develops hard. In specialized literature, it is known that the root system of plants develops properly, at a value of bulk density between 1.0 and 1.4 g/cm^3. By decreasing the porosity of the soil, as a result of the degradation of its structure, compaction is evident and it influences all other physical properties of the soil (Richard et al., 2001).

Soil compaction is closely interdependent with total porosity, with soil densities, all of which, in turn, are decisively influenced by the texture, the content in organic matter and of course the quality of the agricultural works performed (Canarache, 1990).

As it is well known, the good conditions for plant development are when the soil has total porosity between 50 and 55% of the soil volume, capillary porosity 30-35% of the soil volume or 60-70% of the total porosity, and aeration porosity 15-20% of the soil volume or 30 – 40% of the total porosity (Popescu, 2019).

When the human intervention is beneficial, i.e. the soil works are executed properly, thoughtfully, all its physical properties are favorable, causing the total porosity to increase, the apparent density to decrease. Also, it positively influences the thermal regime of the soil, the microbiological activity, but also its chemical properties. In order to be able to ensure good conditions for the growth and fruiting of plants, the soil components must also be maintained in the optimal natural ratio, any disturbance causing a decrease in the productive capacity (Popescu, 2020).

The decrease in soil fertility implies numerous shortcomings related to its health and quality, to the level of production. This aspect should be a wake-up call for all those who work cultivate the soil, for all agricultural workers, who must intervene to preserve and increase the fertility of the soil, to reduce or eliminate its degradation. (Zafiu & Mihalache, 2021; Mihalache et al., 2012; 2015; Marin et al., 2015; Marin et al., 2015).

Anthropogenic activity, in general, decisively influences large spaces, the intensity of relief modeling, which in turn, as we said before, determines soil variability. It can be noted, through an overview of soil conservation, that farmer has intervened on it, according to his requirements and needs. For the territory under study, it can be said that human influence in this area had negative and positive consequences. Over time, the studied area has benefited from radical land improvement works. We can mention here the construction of the Crivina - Vanju Mare irrigation-drainage system, which covers the territory of Burila Mare - Vrancea, Mehedinti County, and which led to the transformation of waterlogged soils in arable land and replacing of the former fens into cropping soil.

Desiccation and drainage led to the exploitation of the physical and chemical properties of the soil. By removing excess moisture, through deep loosening, the aero - hydric regime was improved, which determined positive aspects regarding the mineralization of organic matter, humification, structuring, mitigation or removal of gleization process.

The negative influence of human intervention in the reference area on the soil was made through massive deforestation of the protective zones and by carrying out tillage in inadequate humidity conditions, which led to the modification of the physical properties of the soil and especially the structure.

Starting from all these aspects, a pedological study was carried out in the area of Vrancea town in Mehedinți County, in order to establish the natural conditions in which the soils were formed in this area and what are their physical and chemical properties by using them in the agricultural production process.

MATERIALS AND METHODS

The pedological study was carried out in the south-western part of Mehedinti County, in the area of Vrancea locality, in a heterogeneous natural areal.

In this sense, the natural conditions of soil formation in this area were studied, a survey of the territory was carried out, on the occasion of which the location points of the soil profiles were set up, depending on the characteristics of the relief, so that each profile of soil to be as representative as possible, for as large a surface as possible, according to the methodology established by the Institute of Research for Pedology, Agrochemistry and Environment Protection Bucharest (IRPAEP Bucharest).
After digging the soil profiles, they were studied in the field, from a morphological point of view (Munteanu and Florea, 2009).
Soil profiles were made and studied in 2022 year.
The soil samples collected from the land with a modified soil structure and in natural structure, were prepared and analyzed in the laboratories of the Office for Pedology and Agrochemistry (OPA) Dolj.
The following analytical methods were used:
1. For chemical properties:
- The humus content was determined by the Walkley-Blak method;
- The pH value by the potentiometric method, in aqueous solution;
- $CaCO_3$ content by the gasometric method, using the Scheilbler calcimeter;
- The nitrogen content was determined by Kyeldahl method;
- Soluble potassium, by Egner-Riehn-Domingo method;
- Soluble phosphorus, by Egner-Riehn-Domingo method;
- Hydrolytic acidity, by Kappen method;
- The exchange capacity for bases, by Kappen method;
- The degree of saturation in bases, by calculation with the relationship V% = SB/T x 100
2. For physical properties:
- The size fractions were determined by wet sieving, siphoning and pipetting, and the soil texture was established with the texture triangle;
- The bulk density was determined by the 100 cm^3 metal cylinder method;
- The density was determined by the pycnometer method;
- The total porosity was determined by calculation;
- The hygroscopicity coefficient was determined by drying the soil sample at 105^0C, after saturating it with water in a desiccator with water vapor, created by a 10% sulfuric acid solution;
- The wilting point, by calculation according to the value of the hygroscopicity coefficient;
- The field capacity, by the centrifugation method;
The interpretation of the results was carried out according to the methodology in force (Institute of Research for Pedology and Agrochemistry, IRPA, 1987).

RESULTS AND DISCUSSIONS

The town of Vrancea, Mehedinti County, belongs to the Burila Mare commune and is located in the south-western part of the county. From a geomorphological point of view, the territory is part of the Western Oltenia Plain, and is located on the fluvial terraces of the Danube, the Corabia terrace, the Băilești terrace and the Flamanda terrace (Coteț, 1957).
Hydrologically, the studied territory belongs to the Danube hydrographic basin, comprising size particles ranging from clays, sandy clays to dune sands.
The climate regime is characterized by average annual temperatures of 11.7^0C and average annual precipitation of 520.1 mm. The drought was also present in this area, as in fact in all of Oltenia region, in recent years (Bonea, 2020). The natural vegetation specific to the area is that of oak forests.
In heterogeneous natural conditions, there were identified the reddish preluvosoil, the mollic reddish preluvosol, soils specific to the terrace meso-relief - Corabia II terrace, with an altitude of 15-20 m, formed on carbonate deposits and the psammosoil, on the IV-a Flamanda terrace, with an altitude between 50-60 m (Florea & Munteanu, 2012).
Soil profile 1 – Reddish Preluvosoil (Figure 1)
Relief: plain
Meso-relief: 2nd terrace of the Danube, Corabia terrace;
Bedrock: loessoid deposits;
Groundwater depth: over 10 m;
Global drainage: imperfect;
Use: arable, barley crop.

Figure 1. Reddish Preluvosoil

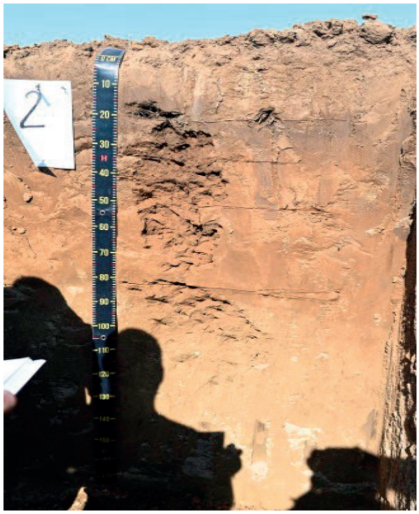

Figure 2. Mollic reddish Preluvosoil

Morphological characterization:
Ao horizon, 0-20 cm, grayish brown color, 7.5YR 4/4, loamy-clay texture, granular structure, compacted, clay films on the surface of structural aggregates, dense spots of iron and manganese, does not make effervesce, gradual passing to the next horizon;
AB horizon, 20-40 cm, grey-brown color, 7.5YR, fine porous, medium compacted, prismatic structure, dense spots of iron and manganese, does not make effervesce with HCl 1/3, clear passage to the next horizon;
Bt horizon, 40-80 cm, reddish brown color, 7.5YR,4/3, clay-clay texture, very compacted, prismatic structure, many iron and manganese concretions, does not make effervesce, gradual transition to the next horizon;
BC horizon, 80-105 cm, light brown color, 7.5YR 5/3, low compacted, low structured, low effervescence;
Cca horizon, below 105 cm, yellowish brown color, 6/3 10 YR, unstructured, very frequent carbonate concretions, strong effervescence.

Soil profile 2 - mollic reddish Preluvosoil (Figure 2)
Relief: plain;
Meso-relief: second Danube terrace, Corabia terrace, altitude 15-22 m;
Bedrock: loessoid deposits;
Groundwater depth: over 10 m;
Global drainage: imperfect;
Use: arable, sunflower crop.

Morphological characterization:
Ap horizon, 0-21 cm, grayish brown color, dark, 7.5YR 4/2, granular structure, loamy-clay texture, fine porous, good biological activity, does not make effervesce, gradual transition to the next horizon;
Am horizon, 21-43 cm, grayish brown color, 7.5YR , loamy-clay texture, medium compacted, fine porous, good biological activity (coprolites and cervotocins), frequent spots of iron oxides and concretions of iron and manganese, gradual passage to the next horizon;
AB horizon, 43-52 cm, grayish brown color, 7.5YR, loamy-clay texture, medium granular structure, low biological activity, and frequent iron oxide stains, clear passage to the next horizon;
Bt horizon, 52-86 cm, reddish brown color, 7.5YR, well-formed prismatic structure, clayey texture, very compact, frequent spots of iron and manganese oxides, frequent ferromanganese concretions, from 2 mm to 6 mm, does not make effervescence, gradual transition to the next horizon;
Cca horizon, below 86 cm, brownish yellow color, unstructured, frequent spots of calcium carbonate and carbonate concretions, strong effervescence.

Soil profile 3 – Mollic psamosoil (Figure 3)
Relief: plain, with a wind-drift appearance;
Meso-relief: 4th terrace of the Danube, Flamanda terrace, altitude 60-60 m;
Bedrock: aeolian sandy deposits;

Groundwater depth: over 10 m;
Overall drainage: very good;
Use: arable, wheat crop

Figure 3. Mollic psamosoil

Morphological characterization

Am horizon, 0-27 cm, dark gray color, 10YR2.5/1, poorly developed structure, friable in wet state, low cohesive, dense roots, does not make effervesce, gradual transition to the next horizon;

AC horizon, 27-40 cm, light gray color, 10 YR, livid, unstructured, non-cohesive, frequent roots, clear transition to the next horizon;

Cn1 horizon, 40-75 cm, very pale brown color, 10YR 7/2, moist, unstructured - monogranular, non-cohesive, does not make effervesce, frequent spots of white mica ore, and quartz grains;

Cn2 horizon, below 75 cm, light color, unstructured, non-cohesive, does not make effervesce.

Physical Properties – Reddish Preluvosoil, soil unit 1 (S.U.1)

In the reddish preluvosoil (S.U.1), from a particle size point of view, the coarse fraction, fine sand, predominates in the soil composition, with a percentage of 48.74%, in the Ao horizon and reaches 58.4% in the Cca horizon. It is followed by clay, with 31.4% in the first horizon and 17.6% in the last, and by the silt fraction, 17.7% and 12.4% respectively in the same horizons (Figure 4).

The soil is loosened in the surface horizon where the bulk density has the value of 1.26 g/cm^3 (Figure 5), the density of 2.32 g/cm^3 (Figure 6) which indicates a low compaction degree and it becomes compacted in the Bt clay accumulation horizon, where the values are the highest (1.66 g/cm^3 and 2.69 g/cm^3, respectively).

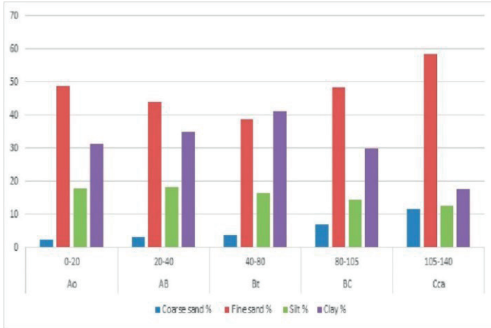

Figure 4. Particle size composition with S.U.1

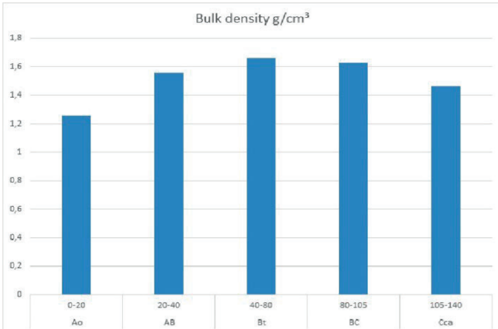

Figure 5. Bulk density with S.U.1

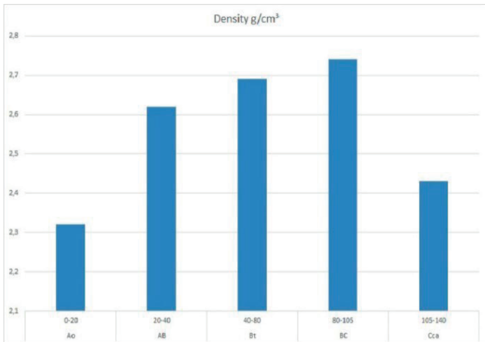

Figure 6. Density with S.U.2

Interpreting the values obtained by the hydro - physical indices for the reddish preluvosoil on carbonate deposits, it can be seen that they are in full concordance with the content of fine fractions of soil (Figure 7).

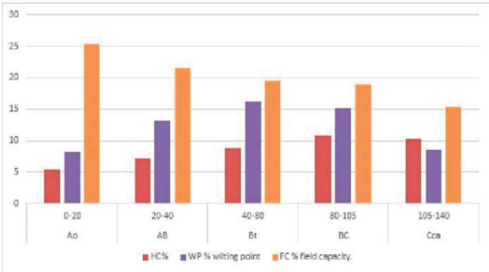

Figure 7. Hydro - physical indices with S.U.1

Chemical Properties – Reddish Preluvosoil (S.U.1)

Analyzing the humus content, at soil unit 1, in the area of Vrancea, Mehedinti County (Figure 8), it can be seen that it is low in the horizons Ao (2.7%), AB (1.58%), Bt (1.52%) and very low in BC (1.10%) and Cca (0.61%) deep horizons.

The soil reaction is low acidic in the first three horizons (pH 6.13-6.61), neutral in the BC horizon (pH 6.86) and low alkaline, pH 8.14, in the Cca horizon.

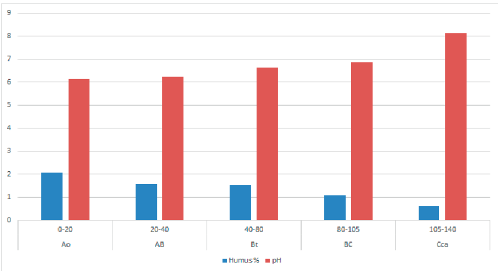

Figure 8. Humus content and pH values at S.U.1

The total nitrogen content in this soil is low in all horizons, decreasing with soil depth from 0.107% in the Ao horizon to 0.032% in the Cca horizon.

The soil is average supplied with soluble phosphorus in the Ao, AB, Bt and BC horizons, values that decrease from 33.0 ppm, in the Ao horizon, to 18.8 ppm, in the BC horizon. The content of soluble phosphorus is low (9.7 ppm), Cca in the horizon.

Regarding the potassium content, in this soil unit, it can be found that it is average in the surface horizons, in Ao it is 162 ppm and in AB 154 ppm, low in the Bt and BC horizons (112, respectively 88 ppm) and very low (52 ppm), in the bedrock material (Figure 9)

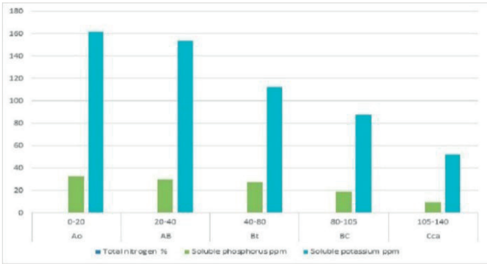

Figure 9. Nitrogen, phosphorus and potassium content with S.U.1

The base saturation degree (BS %), is in the eubasic range, in the first 4 horizons and in the deep horizon, Cca, the soil is saturated in bases, BS % = 100, and calcium carbonate ($CaCO_3$) is present with this soil unit, only at the level of the Cca horizon, in a percentage of 14.9 (Figure 10), as a result of the presence of calcium carbonate concretions in the bedrock material (Figure 11).

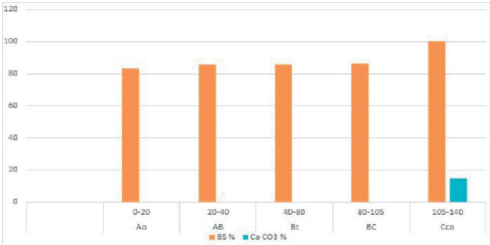

Figure 10. Base saturation (BS %) and calcium carbonate content with S.U.1

Figure 11. The presence of calcium carbonate concretions in the Cca horizon, at S.U.1

The mollic reddish preluvosoil (S.U.2), is generally similar both in terms of physical and chemical properties, both were formed on carbonate deposits, an aspect illustrated by the presence in this soil unit, in the Cca horizon, of calcium carbonates, in a slightly lower percentage, 13.6%, compared to 14.9%, in the reddish preluvosoil (Figure 12) and of chemical neoformations represented by $CaCO_3$ concretions (Figure 13).

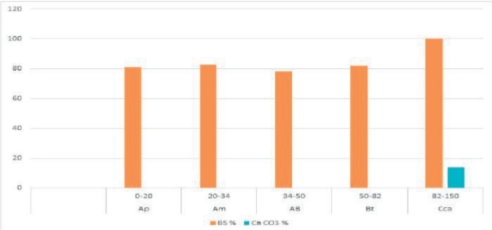

Figure 12. Base saturation (BS %) and calcium carbonate content with S.U. 2

Photo. 13. The presence of calcium carbonate concretions in the Cca horizon, at S.U. 2

Physical Properties – Mollic Psamosoil (S.U.3)

The particle size percentage that predominates is the sand fraction that exceeds 74% in all horizons. Coarse sand reaches a percentage of 66.09% in the Ao horizon, 53.5% in the AC horizon, 65.4% in Cn1 and 66.1% in depth. Fine sand increases on the soil profile, from 18.57% n the Ao horizon to 26.29% in the AC horizon. Silt has a value of 6.54% in the surface horizon, increases to 7.12% in the AC horizon and decreases to 4.10% in Cn1. The fine fraction, clay, registers the lowest values, except for the surface horizon, Ao, where it reaches 8.1% (Figure 14). This particle size composition gives the soil a sandy-clay texture in the first two horizons and sandy in the bedrock material.

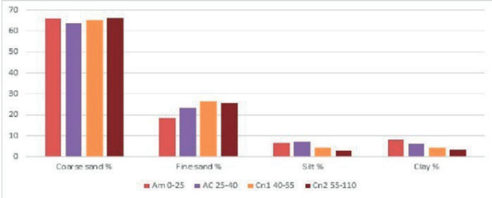

Figure 14. Particle size composition with S.U.3

Through the graphic representation of the bulk density of the mollic psamosoil on aeolian deposits (Figure 15), it is found that the soil is loosened in the surface horizons, where the value is 1.16, respectively 1.42 g/cm^3, and becomes compacted in depth, where values of 1.56 g/cm^3 are recorded in the Cn1 horizon and 1.56 g/cm^3 in Cn2.

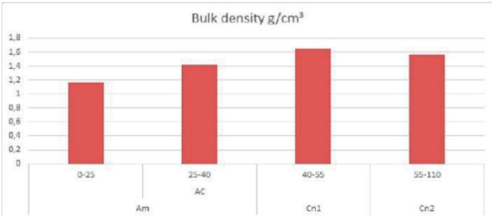

Figure 15. Bulk density with S.U. 3

The small content in clay fractions makes the hydro - physical indices very low. HC %, registers slightly above the value of 1, namely, 1.12-1.23%, and the value even becomes subunit (0.7%), in the Cn2 horizon. In the same sense, the values of the field capacity for water of the soil are highlighted, 15.23%, in the Ao horizon and 10.9%, in Cn2 (Figure 16).

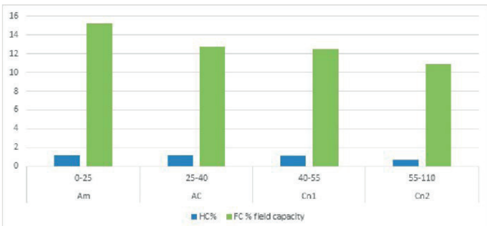

Figure 16. Hydro - physical indices with S.U.3

Chemical Properties – Mollic Psamosoil (S.U.3)

From a chemical point of view, the mollic psamosoil on aeolian deposits (S.U.3) is characterized by a medium humus content in the surface horizon, Ao (2.64%), low in the AC

horizon, 1.29% and very low in the bedrock material, 1.10% in the Cn1 horizon and 0.75% in the Cn2.
The soil reaction is slightly acidic throughout the depth of the soil profile, the pH value increases from 5.83, in the surface horizon, to 6.23, in the Cn2 bedrock material (Figure 17).

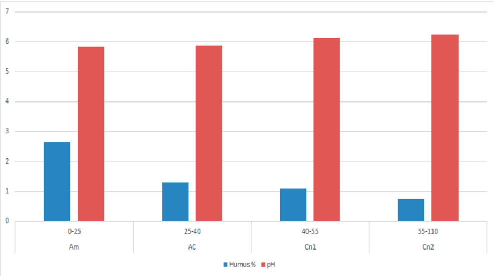

Figure 17. Humus content and pH values at S.U.3

From the point of view of the content of nutrients, the mollic psamosoil on aeolian deposits is characterized by a medium-low content in total nitrogen, in the Ao horizon, 0.135% and low - very low in the underlying horizons, the percentage reaching 0.039 in Cn2 %. The supply of soluble phosphorus is in the middle range, in the first three horizons (29.7, 25.3, 20.1 ppm) and small (16.0), in the Cn2 horizon. As for phosphorus, the values recorded for this nutrient show a poor supply of the soil, throughout its depth. Soluble potassium, decreases on the soil profile, from 130 ppm, in the Ao horizon, to 72 ppm, in the Cn2 horizon (Figure 18).
As it can be seen from Figure 19, the mollic psamosoil on aeolian deposits does not contain calcium carbonate and it has a base saturation degree between 68.1 and 83.9%.
Based on the processing of data regarding the natural conditions and properties of the soils in the studied area, the quality classes for arable use were established, which has a significant importance in Vrancea locality, Mehedinti County. The surface occupied by the three soil units was classified into two classes: the third quality class, which includes the surface occupied by the reddish preluvosoil on carbonate deposits and the mollic reddish preluvosoil on carbonate deposits, and the fourth class of quality, in which the surface on which the mollic psammosoil is found spread on aeolian deposits is included.

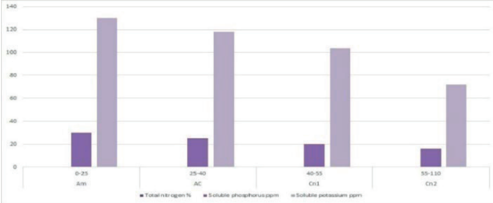

Figure 18. Nitrogen, phosphorus and potassium content with S.U.3

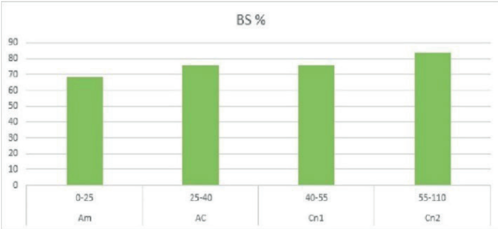

Figure 19. Base saturation (BS %) and calcium carbonate content with S.U.3

The object of agricultural activity, in the farm that operates in this territory, as well as for private producers, on the arable surfaces is the crops of wheat, barley, sunflower and corn.
The favorability classes for these crops are presented as follows: wheat, the 5th favorability class, for the soil units reddish preluvosoil on carbonate deposits and mollic reddish preluvosoil on carbonate deposits and the 8th favorability class, for the mollic psamosoil on aeolian deposits; barley, the 5th favorability class, for the soil units reddish preluvosoil on carbonate deposits and mollic reddish preluvosoil on carbonate deposits and the 8th favorability class, for the mollic psamosoil on aeolian deposits; corn, class VIIth of favorability, for the soil units reddish preluvosoil on carbonate deposits and mollic reddish preluvosoil on carbonate deposits and class IXth of favorability, for mollic psamosoil on aeolian deposits; sunflower, the 6th favorability class, for the reddish preluvosoil soil unit on carbonate deposits and the mollic reddish preluvosoil on carbonate deposits and the 8th favorability class, for the mollic psamosoil on aeolian deposits.
In relation to the nature and intensity of the restrictive factors, for agricultural production, the lands were grouped into suitability classes for arable use: class II, lands with reduced limitations in the case of arable use. In this class are included the soil units, reddish preluvosoil

on carbonate deposits and mollic reddish preluvosoil on carbonate deposits and class III, land with moderate limitations in case of arable use. Mollic psamosoil on aeolian deposits is, also, included in this class.

CONCLUSIONS

The territory of the town of Vrancea, Mehedinti County, is part of the large unit of the Romanian Plain (Western Oltenia Plain) being located on the Danube terraces.

The predominant bedrock, on which the soils within the studied territory have evolved, is varied, from leossoid deposits to sandy loams to dune sands.

From a hydrographic point of view, the studied territory is part of the Danube hydrographic basin.

Climatologically, the studied territory is characterized by a temperate climate, with the manifestation of the phenomenon of drought.

Through the interaction of soil genesis factors, the following soil types were formed on the researched territory of Vrancea locality: reddish preluvosoil on carbonate deposits, reddish mollic preluvosoil on carbonate deposits and mollic psamosoil on aeolian deposits.

In relation to the pedogenetic factors and environmental conditions, bonitation marks were calculated and quality classes were established. For arable use, the surface of Vrancea town, Mehedinti County, was classified into two quality classes: class III, for preluvosoils and class IV, for psamosoil.

The crops cultivated in the area are in the Vth class of favorability (wheat and barley) and the VIth and VIIth classes (sunflower and corn), on preluvosolis, the VIIIth class (wheat, barley and sunflower) and class IXth (maize), on psamosoil.

Depending on the intensity of the restrictive factors for agricultural production, the lands were grouped into two suitability classes for arable use. In class II, lands with reduced limitations, where the two preluvosoil units were placed, and class III, lands with moderate limitations, for psamosoil.

From the consideration of the restrictive factors, the ameliorative requirements and the necessary measures to optimize exploitation result.

The way of carrying out soil tillage is the main means of preventing or mitigating the physical degradation of the soil. Poor structuration and compaction of the soil, the most common forms of physical degradation, can be greatly reduced if the following measures are made: performing soil tillage only in optimal humidity conditions; the reduction to the minimum, to the strictly necessary, of seedbed, crop maintenance, etc.; preservation and incorporation of vegetable debris into the soil; the inclusion of some improving plants in the crop rotation. The physical degradation of the soil takes place through the phenomenon of soil displacement known as soil erosion, a complex phenomenon in which soil material is removed by moving water and drift wind. Wind erosion affects psamosoil arable land. The establishment of protective forest strips in the perimeters affected by wind erosion is very effective in preventing deflation.

Chemical degradation refers to unwanted changes in some important chemical or physical -chemical properties of the soil. The most important chemical degradation process is soil acidification. The correction of the acid reaction of the soil is done by lime as amendment, in order to change the acid reaction and the low level of bases saturation in the soil.

Fertilization by organic and mineral fertilizers has a particularly important role for increasing the humus content and replenishing the nutrient pool.

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