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EVALUATION THROUGH NATURAL BONITATION WORK OF THE SOILS IN THE ZONE OF CONFLUENCE OF DOLJ AND MEHEDINTI COUNTIES, ROMANIA AND THE ESTIMATION OF CROP PLANT PRODUCTIONS SPECIFIC TO THE AREA

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Abstract

The technical bonitation work was carried out based on soil mapping in the reference area, identifying the typical preluvosoil, the typical luvosoil and the gleic alluviosoil as the main soil units. The soils identified and evaluated in these natural conditions are characterized by morphological, physical, hydro physical and chemical properties, specific to the hilly area. Based on the physical-chemical properties, the evaluation of the main identified soils was carried out, in terms of their favorability for different plants grown in the area, by establishing bonitation marks and favorability classes. It was found that the highest bonitation marks (over 50 points) and the lowest favorability classes (III, IV and V) were obtained by the gleic alluviosoil, followed by the typical preluvosoil, and the lowest bonitation marks and the highest favored classes are recorded for the typical luvosoil. The estimation of the productions that can be obtained by the specific crops in this area, are according to the value of the bonitation marks obtained in natural conditions, with the 3 researched soil types.

Key words**:** *soil mapping, soil bonitation, bonitation marks, favorability classes, yields*

INTRODUCTION

The soil, a naturally occurring body, ensures the entire process of growth and fruiting of plants and is of particular importance in the life of mankind, through the various functions it has - economic, ecological and social [13].

The soil, as a natural organism, through its functions, makes possible the existence of mankind on Earth, representing the guarantee of the provision of agricultural products and is the most important natural resource of the planet [17,10].

The soil, as a natural and complex system, is the natural resource that provides food and biomass, contributing to the transformation of substances such as water, carbon, nitrogen [12,15].

The main characteristic of the soil, which makes it the life support for plants and the main source of supply of agricultural made food products for mankind, is fertility. The soil, as a complex and natural system, through its fertility ensures the proper growth and development of plants in the phases of vegetation, through the favorable conditions it provides, depending on the physical, hydric - physical, chemical and biological properties, which it acquired in the soil genesis process [4].

In the last period of time, in many countries of the world, including in Romania, a series of soil degradation processes have been observed, which lead to the decrease of soil fertility, many of them due to soil genesis processes (acidity, salinity, erosion, etc.), which are amplified by the low level of precipitation, as a result of climate changes that are happening more and more obviously [1,11].

The low level of rainfall, combined with the high temperatures, has an immediate impact on the level of production, which it limits. In the southern part of Romania and especially in the Oltenia area, recently, drought has been present almost every year [3].

In addition to these negative aspects, determined by natural factors and formation conditions, the anthropic factor also intervenes in reducing the fertility of soils, through the agricultural activity they carry

out. Through the need to obtain large and immediate yields, farmers contributes to the destruction of the soil structure, to the decrease in humus content, to the reduction of the reserve of nutrients, to the reduction of permeability for water and air, etc. [26, 11].

In the current conditions, when climate changes are increasingly evident, it is necessary to obtain as much information as possible regarding the characteristics of the soils and related to the natural factors, which diminish or limit the fertility and quality of the soils and implicitly their productivity, the level of productions. All these data, once obtained, are very important in order to apply the most appropriate measures to improve, ameliorate or limit the negative aspects, in order to obtain high productions in terms of quantity and quality and for the sustainable use of soils in order to the practice of modern agriculture [16].

In the context of practicing sustainable agriculture, soil conservation and protection are supported and promoted by specialists and researchers in the field and this can only be achieved by knowing their physical, chemical and biological properties [5].

Through the relationships that are created between the characteristics of the soil and the plant, in their interdependence, farmers can thoughtfully intervene in the appropriate direction of the technologies that must be applied in order to obtain high and safe productions, to practice a sustainable, competitive agriculture [21].

The soil has its limits in producing yields, it cannot be multiplied, and if it is not used rationally, it wears out. Through their scientific and rational use, safe and quality productions, efficient from an economic point of view, are obtained; in this sense a profitable agriculture is practiced. The increase in production per surface unit satisfies the needs of food products and raw materials of mankind, thus supplementing the limited space, as a means of production by which the soil is generally characterized [6].

The intensive agriculture practiced in the last period, led to the decrease of soil fertility. This is a problem encountered in all areas of the country and is manifested in particular by the reduction of organic matter, which implicitly leads to the loss of soil biodiversity [14]. Maintaining the fertility of the soil and improving its quality is a primary concern of the specialists, of all those who have in their work this means of production, with the aim of ensuring, through the productions obtained, the food needs of the population, both for today's generations and for tomorrow [7, 8].

The studies carried out so far show that fertile soils are healthy soils, soils that determine the support for the development and development of biological activity, providing plants with everything they need to withstand thermal and water stress, climate changes [18,16].

Starting from all these aspects, it is topical and important to know the productive capacity of soils, in order to use them rationally, in a modern agriculture. This is the obligation of all those who work in this field. If it is used rationally, the soil maintains its productive capacity for a longer period of time, but it can be degraded quite quickly and difficult to recover [23].

The knowledge of the production capacity of the soils is achieved through the technical assessment work, with importance for agricultural practice, because it provides relevant indications regarding the agricultural crops and the uses that are best performed on certain soils and lands, by establishing the assessment grades in depending on the physical and chemical properties of the soil structural aggregates and the characteristic environmental factors [22]. It is also important for the application of appropriate technologies, but also for the investments that must be made and last but not least, for adequate earnings [20].

The topic under study, in this context, has a practical importance, but it also presents a theoretical importance, in light of the fact that the updating of research on the properties of Romanian soils enriches the specialized literature with new data about the soils and the productive potential of the area under study.

MATERIALS AND METHODS

The main purpose of the work is to establish the fertility of the soils in the confluence area

of Dolj and Mehedinti counties, to assess their suitability for the agricultural crops practiced in the area and to estimate the productions that can be obtained. In order to achieve the objective pursued, the natural factors in which the soils were formed and evolved in this area were studied, the main soil units and their properties were identified, and based on them, credit rating indices were established, grades of credit rating, favorability classes and production estimation. The natural setting of the area was studied from the specialized literature, supplemented with data from the weather station Craiova and through field observations. The natural factors that are taken into account in the assessment of soils through natural assessment are represented by relief (slope of the land and landslides), climatic conditions (temperature and average annual rainfall), and hydrological conditions (depth of groundwater).

Soils were identified through field research and laboratory analysis. Soil profiles were dug on the relief forms specific to the area, plateau, micro depressions, valley, the morphological properties were studied in the field (number and sequence of horizons, thickness of horizons, color, humidity, state of gleization, stagnogleization, salinization, alkalization), according to the Romanian Soil Taxonomy System 2012, soil samples were collected from the soil horizons both in natural structure, in metal cylinders and with modified structure, to be analyzed in the laboratory, according to IRPA (Institute of Research for Pedology and Agrochemistry) methodology - 1987 and 2012 [24, 25].

The properties analyzed in the laboratory, which are taken into account directly or indirectly when establishing bonitation marks, are represented by: density, bulk density, total porosity, particle size composition and texture, reaction (pH value), exchange capacity for hydrogen, capacity to exchange for bases, total cation exchange capacity, degree of saturation in bases.

Each natural factor or property of the soil, specific to the natural assessment work, was analyzed and received a score, according to the bonitation, between 0 and 1 point, depending on the intensity of the influence on soil fertility, according to the assessment methodology established in Romania.

Using the score value for natural factors and soil properties, the value of the bonitation marks is obtained by calculation, by multiplying the bonitation indices, and the result is multiplied by 100 [2, 27]. The favorability classes in natural conditions for agricultural crops practiced in the area are established according to the value of the bonitation marks in descending order, from the first class when they are between 100 - 91 points to the X th class, with 10 - 1 points. The estimation of the productions that can be obtained on the identified soils is also carried out with the help of the bonitation mark, by multiplying it by the amount of products per point of the bonitation mark, for each plant, established by the Romanian bonitation methodology.

RESULTS AND DISCUSSIONS

The area under study, the confluence of Dolj and Mehedinti counties, is located in southwest Romania, the North Western part of Dolj county.

Due to the reconstitution of the property law, after the application of Law 18/1991, the land fund in the area became very non cropped and approximately 30-35% of the surface (as in the whole Dolj county), remained a large period of time not plowed by the new owners. This aspect led to lower yields per unit area.

The method of reconstituting the right of ownership, on the former locations, in the form of strips (Photo 1), in the N-S or E-W directions and with small widths of 8-10-12 m and on different lengths, depending on the configuration of the relief, also contributed to the amplification of the decrease in yielding capacity per hectare [19].

Recently, through the establishment in the area of agricultural forms and associations of different sizes in terms of surface area, there are no more uncultivated lands and the need to obtain large and qualitative yields is increased.

Photo 1. Crops drilled on stripes.
Source: Original photo.

Therefore, estimating the productions that can be obtained on the soils in this area is beneficial both for farmers in the area and for small private producers, in order to be able to take the most appropriate measures to increase the fertility and implicitly the productivity of the soils.

The soils identified in the studied area are represented by the typical preluvosoil, the typical luvosoil and the gleic alluviosoil [9]. The typical preluvosoil was formed and is found in the area of the plateaus with altitudes around 200 m, the typical luvosoil is present in the micro - depressions areas on the flat lands and the gleic alluviosoil specific to the low areas, the valley micro - relief. The identified soils were formed and evolved under natural conditions specific to the area of low hills, with relief characteristic of the Getic Piedmont, with a thermal and rainfall regime, which determines a period of drought from mid-May to mid-July, with bedrock material as clay, with groundwater at over 10 m in the area of the plateaus and at 1 – 1.5 m in the low areas, in the valleys, with vegetation typical of oak forests.

Photo 2. Wheat crop
Source: Original photo.

The crops cropped, both by farmers and private agricultural producers, are: wheat, barley, sunflower, corn, alfalfa (Photos 1, 2, 3, 4, 5), potato, and fruit trees especially plum and apple.

Photo 3. Barley crop
Source: Original photo.

Photo 4. Maize crop
Source: Original photo.

Photo 5 Sunflower crop
Source: Original photo.

The suitability of soils for agricultural crops practiced in the area and for fruit trees

Table 1 shows the suitability of the soils in the reference area for wheat and barley cultivation. It can be seen that on the typical preluvosoil, the bonitation for wheat is 66

points and the favorability class IV and for barley a bonitation score of 57 points is recorded, which places the soil in class V - favorability.

Low bonitation ratings, of 30 points for wheat and 27 points for barley, respectively high favorability classes, VIIIth, were obtained on the typical luvosoil. Gleizated alluvial soil recorded for the two agricultural crops the values of the bonitation ratings specific to the IInd classes for wheat (80 points) and the IIIrd for barley (71 points).

The values of the bonitation scores in the medium-high range, for the two analyzed crops, can be explained by the medium reserve in humus, the high compaction, the fine texture, and the low values of the bonitation scores for the typical luvosoil are caused by the low content in humus, acidity, high compaction and clayey texture.

Table 1. Suitability of soils for wheat and barley

Soil type	Wheat		Barley	
	Bonitation marks	Fertility class	Bonitation marks	Fertility class
typical preluvosoil	66	IV	57	V
typical luvosoil	30	VIII	27	VIII
gleic alluviosoil	82	II	71	III

Source: Own calculation.

The high ratings and low favorability classes, in the case of the gleic alluviosoil, are due to the coarser texture of the soil in the low area, and implicitly the higher porosity and the higher degree of loosening, the phreatic supply and the higher content in humus.

Analyzing the favorability of the typical preluvosoil, the typical luvosoil and the gleic alluvisoil for corn and sunflower crops (Table 2), it is found that the preluvosoil has bonitation rating values for the 6th class of favorability (49 bonitation points), for corn and for the 5th class for sunflowers (51 bonitation points). The typical luvosoil, records for these crops, particularly low values of the bonitation scores, 19 points for corn and 23 points for sunflower, and the gleic alluviosoil falls into the IVth class for the corn crop, which corresponds to 68 points for bonitation rating and fourth class in sunflower, for 67 bonitation rating points.

Table 2. Soil suitability for maize and sunflower

Soil type	Maize		Sunflower	
	Bonitation marks	Fertility class	Bonitation marks	Fertility class
typical preluvosoil	49	VI	51	V
typical luvosoil	19	IX	23	VII
gleic alluviosoil	68	IV	67	IV

Source: Own calculation.

The potato and alfalfa crops analyzed in Table 3, in terms of bonitation scores and favorability classes, keep the same configuration as the crops analyzed previously.

On the typical preluvosoil, the potato gets 39 points in the bonitation rating grade and falls into the VIIth favorability class, and alfalfa has the bonitation rating grade with 41 points and the VIth favorability class.

Table 3. Soil suitability for potato and alpha-alpha

Soil type	Potato		Alpha-alpha	
	Bonitation marks	Fertility class	Bonitation marks	Fertility class
typical preluvosoil	39	VII	41	VI
typical luvosoil	6	X	16	IX
gleic alluviosoil	54	V	72	III

Source: Own calculation.

The typical Luvosoil also records the lowest values of bonitation scores for these crops, 16 points for alfalfa and 6 points for potato, and the gleic alluviosoil falls into IIIrd favorability class for alfalfa and Vth for potato, corresponding to bonitation scores of 72 and 54 points, respectively.

For corn, sunflower, potato and alfalfa crops, the limitations presented for wheat and barley crops and which explain the values of bonitation scores and the classification of favorability classes are kept.

It can also be stated that the wide-planted crops, maize and sunflower, obtained low bonitation scores and high favorability classes compared to wheat and barley, and potato obtained the lowest bonitation scores and the highest favorability classes on plateau soils and the lowest bonitation rating grade 6 and the Xth favorability class on the typical luvosoil, characterized by severe limitations such as high compactness, clayey texture, high acidity and low humus content.

Fruit trees, which are suitable in the studied area, apple tree and plum tree (Table 4), on the typical preluvosoil obtained ratings of 55 and 58 points respectively and the 5th class of favorability, on the gleic alluviosoil, the favorability is still in the 5th class with a score of 51, respectively 53 bonitation score, and on the typical luvosoil, these plants occupy classes IXth (apple tree) and VIIIth (plum tree) with 19 and 25 points, respectively.

Table 4. Soil suitability for apple tree and plum tree

Soil type	Apple tree		Plum tree	
	Bonitation marks	Fertility class	Bonitation marks	Fertility class
typical preluvosoil	55	V	58	V
typical luvosoil	19	IX	25	VIII
gleic alluviosoil	51	V	53	V

Source: Own calculation.

Based on the score obtained by each plant taken into the study, the productions that can be obtained on the analyzed soils were estimated (Tables 5, 6, 7).

It is found that in the confluence area of Dolj and Mehedinti counties, the highest productions of agricultural crops (Tables 5 and 6) were obtained on the gleic alluviosoil, followed by the typical preluvosoil, and the lowest productions are obtained on the typical luvosoil.

Table 5. Estimation of yields in wheat, barley and corn crops

Soil type	Estimated yields (Kg/ha)		
	wheat	barley	corn
typical preluvosoil	3,960	3,420	3,920
typical luvosoil	1,860	1,620	1,520
gleic alluviosoil	4,920	4,260	5,440

Source: Own calculation.

Table 6. Estimation of yields in sunflower, potato and lucerne

Soil type	Estimated yields (Kg/ha)		
	Sunflower	Potato	Lucerne
typical preluvosoil	1,632	17,550	3,280
typical luvosoil	736	2,700	1,280
gleic alluviosoil	2,144	24,300	5,760

Source: Own calculation.

Wheat crop can get 3,960 kg on typical preluvosoil, 1,860 kg on typical luvosoil and maximum production of 4,290 kg on gleic alluvisoil, barley crop estimates yields are about equal to those of wheat crop and maize can yield 3,920 kg on typical preluvosoil, 5,440 kg on gleic alluviosoil and only 1,520 kg on the typical luvosoil. And as far as the sunflower, potato and alfalfa crops are concerned, the situation of estimating the productions that can be obtained on the three units of soil taken into account is similar, the value of the bonitation marks, they reflect the level of expected productions. The largest ones can be obtained on the gleic alluviosoil, the middle ones on the typical preluvosoil and the smallest ones on the typical luvosoil.

In the case of fruit trees, good productions are also obtained on the soil on the plateaus, with good drainage (the typical preluvosoil) and on those on the edge of the valley (the gleic alluviosoil), and the lowest productions are recorded on the soils formed and developed in the micro depressions areas of plateaus with low drainage, the typical luvosoil.

For apple tree and plum tree (Table 7), maximum production is obtained on the typical preluvosoil with 16,500 kg/ha for apple tree and 17,400 kg/ha for plum tree and the lowest productions of 5,700 kg/ha for apple tree and 7,500 kg/ha for plum tree are obtained on the typical luvosoil.

Table 7. Estimation of yields in apple tree and plum tree

Soil type	Estimated yields (Kg/ha)	
	Apple tree	Plum tree
typical preluvosoil	16,500	17,400
typical luvosoil	5,700	7,500
gleic alluviosoil	15,300	15,900

Source: Own calculation.

One in all, the estimated productions of the cultivated plants that are practiced in the studied area, it can be stated that they are in perfect agreement with the value of the obtained natural bonitation ratings.

If we include the studied crops and the three types of soil analyzed in the favorability maps, the following aspects would result, for the assessment in natural conditions: wheat falls for the typical preluvosoil in class B, for the typical luvosoil in class D, and for the

gleic alluviosoil in class A. Barley, class C in typical preluvosoil, D in typical luvosoil, B in gleic alluviosoil. Maize, class C for typical preluvosoil, E – typical luvosoil and B – gleic alluviosoil. Sunflower, class C on the typical preluvosoil, class D on the typical luvosoil and class B on the gleic preluvosoil. The potato occupies class D in the typical preluvosoil, class E in the typical luvosoil and class C in the gleic alluviosoil. Alfalfa, class C for typical preluvosoil, class E for typical luvosoil and class B for gleic alluviosoil. Fruit trees are listed together in class C, on the typical preluvosoil and gleic alluviosoil, and in class E (apple tree) and class D (maize) for gleic alluviosoil.

The increase in the fertility of the soils in the studied area and implicitly the agro-productive potential is achieved by applying a complex of improvement measures, and the establishment of fertility, suitability and the estimation of productions, which can be obtained, is achieved through enhanced bonitation which will be the subject of the next study in the area of confluence of Dolj and Mehedinti counties.

CONCLUSIONS

The territory under study is part of the Getic Piedmont and is located in the southwest of Romania in the North Western part of Dolj county. The natural conditions of climate, relief, vegetation, bedrock, hydrology, determined the formation and evolution in the area of some soils with different profile development, namely, well-developed soils in the area of the plateaus represented by the typical preluvosoil and the typical luvosoil and short soils on valleys represented by the gleic alluviosoil.

The agricultural crops used in the area by both farmers and small producers are represented by wheat, barley, corn, sunflower on a large scale, alfalfa and potato on a small scale. The most productive fruit trees in this area are apple trees and plum trees.

By calculating bonitation marks and establishing favorability classes, factors that determined the limitation of bonitation ratings were highlighted.

It was emphasized that the highest bonitation marks, over 60 points and the lowest favorability classes Ist, IInd, IIIrd, IVth and Vth, were obtained by the gleic alluviosoil for all 6 crop. Preluvosoil obtained bonitation marks above 50 points for wheat, barley, sunflower and IVth and Vth favorability classes, bonitation marks above 40 points for corn and alfalfa with favorability VIth class and below 40 points for potatoes, with XIIth class of favorability.

The typical luvosoil obtained small bonitation scores, in all agricultural crops 30 points for wheat, 27 points for barley, 19 points for corn, 23 points for sunflower, 16 points for alfalfa and 6 points for potato, and the favorability classes are VIIth , VIIIth, IXth and Xth.

The apple tree and the plum tree fall into favorability Vth class both on the typical preluvosoil and the gleic alluviosol, with ratings of over 50 points and VIIIth class (plum tree) and IXth (apple tree), with 25 and 19 points respectively bonitation marks, on the typical luvosoil.

Estimated productions for both agricultural crops and fruit trees faithfully follow the value of bonitation marks.

The analysis of the limiting factors of credit scores and implicitly the estimated productions, can be grouped into factors with moderate limitation (low content in humus, compaction, clayey texture, low total porosity) and factors with severe limitation (low content in humus, acidity, low value of saturation in bases degree).

In order to increase the fertility of the soils in the confluence area of Dolj and Mehedinti counties, complex amelioration works must be applied which will reduce or eliminate the restrictive, limiting or diminishing effects on fertility.

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