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EVALUATION OF SOIL STRUCTURE UNDER THE INFLUENCE OF PEDOCLIMATIC CONDITIONS AND SOIL TILLAGE SYSTEMS

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Abstract: Soil is the one of the basic elements of the environment. The agroecosystems created by humans exert a negative influence on its physical properties as the structure is an inherent characteristic on which the fertility of soils depends. Correct maintenance of soil used under agricultural land can reduce this problem. The structure of the soil carried out by wet and dry sieving by the sieve method shows us that in the agrocenoses with winter wheat (No-till) the best structure was highlighted at a depth of 0-30 cm. The quality of the structure also depends on some physical properties of the soil, as well as the cultivated plant. To improve the structure and quality of the soil, you can use coarse organic material, which should make (dig) in the soil or just spread on the surface 10 cm layer as a mulch at least twice a year.

Keywords: agrocenoses, soil structure, soil moisture, soil tillage system, pedoclimatic conditions.

EVALUAREA STRUCTURII SOLULUI SUB INFLUENȚA CONDIȚIILOR PEDOCLIMATICE ȘI A SISTEMELOR DE PRELUCRARE A SOLULUI

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Rezumat: solul este unul dintre elementele de bază ale mediului. Agroecosistemele create de om exercită o influență negativă asupra proprietăților sale fizice, întrucât structura este o caracteristică inerentă de care depinde fertilitatea solurilor. Utilizarea corectă poate reduce impactul negativ asupra solului din terenurile agricole. Structura solului obţinută prin prelucrarea umedă și uscată a solului prin metoda utilizării sitelor ne arată că în agrocenozele cu grâu de iarnă (fără a ara solul) cea mai bună structură a fost evidenţiată la o adâncime de 0-30 cm. Calitatea structurii depinde, de asemenea, și de unele proprietăți fizice ale solului, precum și de plantele cultivate. Pentru a îmbunătăți structura și calitatea solului, se poate utiliza material organic brut, care ar trebui incorporat în sol sau doar împrăştiat pe suprafața solului un strat de 10 cm sub formă de mulci, cel puțin de două ori pe an.

Cuvinte cheie: agrocenoze, structura solului, umiditatea solului, sistemul de prelucrare a solului, condiții pedoclimatice.

INTRODUCTION

The agriculture currently practiced in the Republic of Moldova faces a big number of major problems that seriously affect the rural development. As a result of the extension of soil degradation processes due to conventional agriculture and technological errors, over the years, the so-called conservative agricultural technologies have been studied and implemented (Guş, 1997, Andriuca V. et. al., 2017). The conservative system was used at the beginning of the 20th century, its concept was formulated in the 90's of the last century, and the implementation has grown in the last 20-25 years.

Soil tillage are interventions, most often mechanical, in order to model it according to the optimal living conditions corresponding to the crop plants. The necessity of carrying out the works is determined by the fact that the crop plants, unlike the spontaneous flora that is adapted to the conditions of the landscape, have a lower capacity to adapt to them. At the same time, they have higher demands on soil characteristics (lower compactness, higher amounts of water etc.). This is the intervention of the human beings through various works, differently, depending on the agricultural area, type / subtype of soil and genus and species of the cultivated crop.

Even the simplest soil work leads to disturbance of trophic chains and ecological balances established over the millennia. As a result, even in the incipient phases of framing, in the soil in the agricultural circuit, there was a reduction of the intensity of the processes of formation and accumulation of humus in the soil, the shredding of the structure, the compacting of the arable layer in some periods of vegetation and so on (Guide, 2018).

Soil structure is a characteristic of the soil, of great importance for the physical processes as well as for the chemical and biological processes that occur in the soil and the soil-plant-atmosphere system. The structure is a distinct feature of the soil, depending on the type of pedogenesis and a number of intrinsic factors: climatic conditions, particle size, humus content and composition, mineralogical composition of the finely dispersed fraction, composition of the adsorbed cations, humidity, soil work (Canarache A , 1990; Jigău Gh., 2009; Ursu A., 2000).

Structure represents an important feature of the soil, and in modern conceptions, "soil structure" represents one of the essential characteristics with direct influence on all physical, mechanical and biological processes that take place in the soil (Răus L., Jitareanu G., 2007). One of the most important criteria for agronomic evaluation of soil structure is the water stability of the aggregates. The arable layer has a stable position if it contains not less than 40-45% hidrostabile aggregates with a diameter> 0.25 mm, otherwise the soil is easily subjected to contamination which leads to worsening physical properties, in particular water and air permeability. (Nagacevschi T., 2013; Dexter A., Czyz E., Gate O., 2007).

Research realized in the Republic of Moldova revealed that the soil fertilized with stable manure and manure + siderate recorded a higher content of valuable agronomic aggregates (10-0.25 mm), which implies the idea that the application of organic fertilizers diminishes the mechanical effects of modification of the structure within the anthropized pedogenesis. The arable soils under the field crops with different maintenance regimes undergo changes of structure in the layer 10-20 cm by significantly increasing the content of aggregates> 10 mm, as a result of its compacting (Nagacevschi T., 2013). Soil structure and aggregate stability are key factors in soil functioning and its ability to ensure crop growth (Martens D., 2000).

One of the main factors in the dynamics of soil structure is the quantity and composition of soil organic matter. It has been found that the annual dynamics of soil organic matter is quite close to the dynamics of the structure. This is the result of a large correlation between organic matter and soil structure. The main factors in the dynamics of the structure are the quantity and the qualitative composition of the humus, especially the content of its active colloidal forms (Калиновский А. идр.; Халилова С., 1987). Organic matter, which stabilizes the aggregates, increases the water retention capacity of the soil and the ratio of changes of macropores to micropores, which causes a change in structure. In the dynamics of soil structure, plants are an important factor. The review (Ростовцева О., Аваева М., 1935) on the dynamics and origin of soil structure underlines the special role of the biological factor. It was found that the growth of maize roots, dense plants, reduces the resistance of soil aggregates compared to the soil without plants. (Плотников А., 1960).

The soil structure exerts a direct influence on the aero hydric and thermal regime of the soils, ensuring optimum conditions for seed germination, plant emergence and root system development, as well as mechanical properties that can condition the necessity and efficiency of future technological works (Canarache A , 1990). In order to ensure a favorable structural state for optimal growth of plants, certain processes and factors that influence its formation are needed.

MATERIALS AND METHODS

Determination of soil structure is done at a suitable humidity, because if the soil is too dry or too wet, it is difficult to detach the structural aggregates from the soil mass, an operation that is done either by gently squeezing a soil ball in one's hand (for small aggregates) or leaving to fall on a level surface, from a height of 1-1.5 m, a considerable volume of material cut from the ground. The structural composition was determined on the 0-60 cm depth of soil according to the dry site screening method (Вадюнина А., Корчагина З., 1986; Модина С., Долгов С., Бахтин П., 1966) and evaluated according to the classes of quality values of soil structure according to the content of 0.25-10 mm agronomically valuable aggregates, % represented in Table 1. Soil moisture determined by drying in the oven at $t^{\circ} = 105^{\circ}$ and weighing soil samples, and pedoclimatic conditions – using information data from Bureau of Statistics (www.statistica.md).

Table 1. Classes of quality values of soil structure according to the content of aggregates 0.25-10 mm agronomically valuable, %

Dry sieve	Wet sieve, structural hidrostability
> 80 – very good	> 70 – very high
80-60 – good	70-55 – good
60-40 – medium	55-40 – medium
40-20 – unsatisfactory	40-20 – small
< 20 – very unsatisfactory	< 20 – very small

RESULTS AND DISCUSSIONS

As the agricultural civilization developed, agricultural technologies were also improved. Highlights in their improvement are intensive mechanization and chemization, irrigation, drainage-drying etc. They imposed an accelerated rate of intensification of agricultural production in order to obtain more and more profits, a fact that has been reported since the 30s of the last century, leading to the rapid degradation of the soil and the intensification of these processes over time. This involved identifying alternative methods of tillage, fertilization and soil management, materialized in the concept of a conservative soil tillage system (Ghid, 2018).

Currently, in the agriculture practiced in the Republic of Moldova, two systems of agricultural preparation of the soil have been outlined: - the classical system, also called conventional, which consists of the plowing with the cormorous plow and the subsequent preparation of a germinal bed, and the management of the nutrition regime by applying mineral fertilizers, in recent years uncontrolled; - the conservative system, based on the minimal disturbance and mobilization of the soil, the reduction of the crossings on the ground and alternative methods of fertilization of the soil.

The research was carried out in the vilagw Plop, Donduseni district, located on the Plateau of Northern Moldova, which is characterized by inhomogeneous fragmented relief of valleys with a moderate continental climate with a short and comparatively warm winter, with a long and hot summer.

The researches were carried out on the chernozem leached clay-loamy, which is characterized by an intense accumulation of humus, altered and pronounced leaching of the carbonates to the BC horizon with a low differentiation, with very good fertility, where it was determined the soil moisture to the depth 0-60 cm of soil (Table 2 and Figure 1).

Table 2. Soil moisture depending on the tillage system and agrocenoses, 2019

Depth, cm	Humidity,%
Sugar beet, autumn wheat predecessor, No-till (P-1)	
0-10	21,18
10-20	16,11
20-30	15,80
30-40	15,16
40-50	14,86
50-60	14,43
Soybean, corn predecessor, Ploughing (P-2)	
0-10	18,84
10-20	15,45
20-30	16,43
30-40	15,70
40-50	15,46
50-60	14,86
Autumn wheat, predecessor autumn wheat, No-till (P-3)	
0-10	21,77
10-20	18,07
20-30	18,65
30-40	18,66
40-50	18,65
50-60	18,28

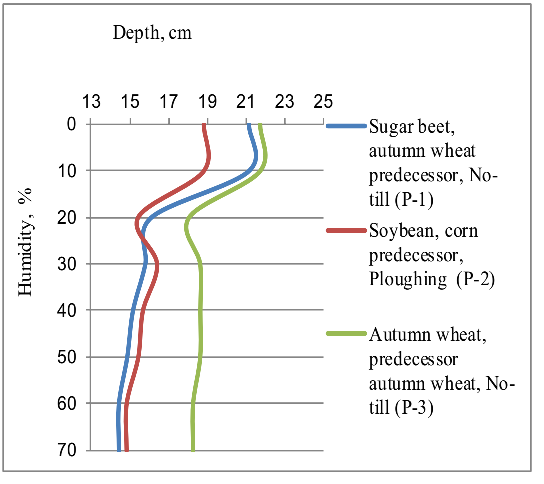

Figure 1. Humidity (%) depending on the soil tillage system and agrocenoses (Plop, Donduşeni, 2019)

From the obtained data, it is observed that in agrocenoses with sugar beet, autumn wheat precursor and especially autumn wheat, wheat precursor with conservative soil tillage, No-till soil moisture is higher, compared to soybean agrocenoses, precursor corn, with conventional tillage of soil, plows, which proves that the No-till technique conserves water in the soil.

Soil moisture is influenced not only by the system of tillage of the soil practiced, but also by climatic conditions (temperature, amount of precipitation), data collected for the agricultural year 2018-2019 are shown in Figures 2 and 3.

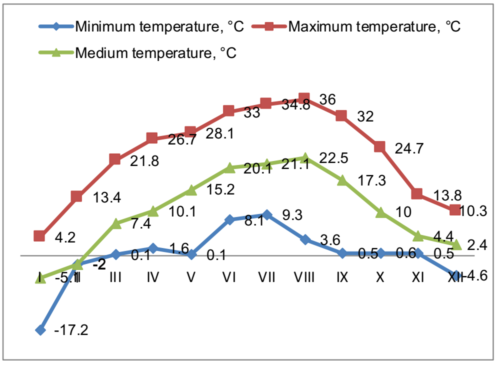

Figure 2. Average air temperature (° C) per month and multiannual average, 2019

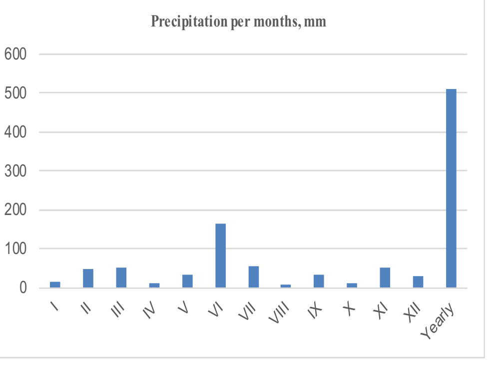

Figure 3. Monthly and annual precipitation quantity (mm), Donduseni, 2019

In the year 2019, a large amount of rainfall was recorded at the beginning of the vegetation period, and the months of June-August were arid and only in September, there were precipitations of approx. 150 mm. The research location is characterized by the annual amount of precipitation constituting 490-510 mm, during the vegetation period it constitutes 285-335 mm, the one that constitutes only 60-70%. The sum of the active temperatures during the vegetation period is 2750 ° C - 2850 ° C. The duration of the active vegetation period is 165-176 days. The hydrothermal coefficient ranges from 1.1 to 1.2. In the years with sufficient humidity the annual amount of precipitation in the vegetation period constitutes 40%, compared with the arid years - only 10%. In the last decade, the effects of climate change, manifested by periods of drought and floods, which have become more frequent, have been manifested on agriculture, leading to a decline in agricultural production and influencing soil properties, including its structure.

The soil structure assessment was performed on agrocenoses with autumn wheat, predecessor autumn wheat, sugar beet, predecessor autumn wheat with conservative soil work, No-till with the application of organic fertilizers, and the third soil type was agrocenoses with soybean, predecessor maize with the conventional soil work, with plowing (Table 3).

From the obtained data, it is observed that agrocenoses with autumn wheat with the No-till technique has the best soil structure, compared to the other agrocenoses studied. From the research carried out, it is observed that on the 0-30 cm depth the soil structure is the best.

It is now considered that the main determinant of the physical conditions of soil fertility is the structural state of the soils. The structural composition of the soil, the content

Table 3. Structural composition of the clay-leached chernozem in various agroecosystems with plowing and No-till systems, 2019

Depth, cm	Content of structural elements determined by dry screening (numerator) and hydro stable aggregates (denominator),%											Structure quality coefficient K=a/b	Structure quality (dry screening)	Structural hydro-stability (wet screening)
	>10	10-7	7-5	5-3	3-2	2-1	1 – 0,5	0,5 -0,25	< 0,25	Σ 10-0,25 (a)	Σ >10+< 0,25 (b)			
Sugar beet, autumn wheat predecessor, No-till (P-1)														
0-10	14,1 -	11,3 -	15,1 2,2	10,7 2,9	20,4 3,7	19,8 2,9	3,8 6,0	3,1 12,4	1,7 69,9	84,2 30,1	15,8 69,9	5,3 0,4	very good	little
10-20	23,4 -	11,0 -	14,8 2,1	10,6 2,6	18,4 5,2	15,9 2,4	2,5 9,3	2,7 11,9	1,5 66,5	75,4 33,5	24,9 66,5	3,0 0,5	good	little
20-30	27,9 -	10,4 -	14,6 2,0	10,3 2,2	18,2 5,1	13,2 2,3	2,7 13,7	1,7 11,6	1,0 63,1	71,4 36,9	28,9 63,1	2,5 0,6	good	little
30-40	33,1 -	10,2 -	12,4 1,8	10,0 2,0	15,2 4,9	12,9 2,1	3,0 16,3	2,1 10,2	1,1 62,7	65,8 37,3	34,2 62,7	1,9 0,6	good	little
40-50	37,4 -	10,0 -	11,9 1,6	9,6 1,8	13,5 3,2	12,5 2,0	2,5 20,9	1,7 10,0	0,9 60,5	61,7 39,5	38,3 60,5	1,6 0,7	good	little
50-60	42,5 -	9,6 -	13,7 1,5	9,7 1,7	12,0 3,0	8,4 1,9	1,9 22,4	1,1 9,6	1,1 59,9	56,4 40,1	43,6 59,9	1,3 0,7	middle	middle
Soybean, Corn Predecessor, Ploughing (P-2)														
0-10	16,1 -	12,4 -	9,9 2,0	6,9 2,4	24,8 5,8	17,1 4,4	5,3 6,1	5,2 11,2	2,3 68,1	81,6 31,9	18,4 68,1	4,4 0,5	very good	little
10-20	19,6 -	21,8 -	15,6 1,6	11,2 2,2	16,5 8,2	10,4 2,5	2,2 8,2	1,6 12,8	1,1 66,5	79,3 33,5	20,7 66,5	3,8 0,5	good	little
20-30	28,9 -	18,7 -	14,8 1,5	10,9 1,2	14,1 6,7	9,1 2,0	1,5 16,7	1,1 8,2	0,9 63,1	70,2 36,3	29,8 63,7	2,4 0,6	good	little
30-40	38,1 -	17,8 -	10,7 1,2	8,2 0,8	13,9 5,1	8,1 1,8	1,1 22,2	0,6 7,4	0,8 61,5	60,4 38,5	38,9 61,5	1,6 0,6	good	little
40-50	37,4 -	10,0 -	11,5 1,4	9,6 1,8	13,9 3,4	12,5 2,0	2,5 20,9	1,7 10,0	0,9 60,5	61,7 39,5	38,3 60,5	1,6 0,7	good	little
50-60	42,5 -	9,6 -	13,7 1,6	9,7 1,6	12,0 3,0	8,4 1,9	1,9 22,3	1,1 9,7	1,1 59,9	56,4 40,1	43,6 59,9	1,3 0,7	middle	little
Autumn wheat, predecessor autumn wheat, No-till (P-3)														
0-10	7,9 -	7,6 -	6,4 1,4	4,4 2,1	18,9 4,9	27,9 5,6	6,4 8,7	10,8 42,4	9,7 34,9	82,4 65,1	17,6 34,8	4,7 1,9	very good	good
10-20	8,4 -	8,6 -	7,2 1,4	4,9 2,3	19,2 4,8	26,3 5,2	7,2 8,6	7,9 33,9	10,3 43,8	81,3 56,2	18,7 43,8	4,3 1,3	very good	good
20-30	14,7 -	10,9 -	10,5 1,2	4,9 2,0	20,4 2,6	17,5 3,0	6,2 4,1	7,0 29,5	7,9 57,6	77,4 42,4	22,6 57,6	3,4 0,7	good	middle
30-40	17,8 -	9,1 -	9,2 1,0	5,2 1,5	23,0 2,4	16,9 2,9	5,5 3,6	5,9 27,1	7,4 61,5	74,8 38,5	25,2 61,5	3,4 0,6	good	little
40-50	23,4 -	7,6 -	6,3 0,9	3,9 1,8	29,4 2,1	15,7 2,2	3,1 2,9	3,6 25,7	7,0 64,4	69,6 35,6	30,4 64,4	2,3 0,6	good	little
50-60	27,9 -	7,0 -	5,9 0,6	3,4 1,2	30,6 1,9	14,3 2,2	2,7 2,3	2,9 21,1	5,3 70,7	66,8 29,3	33,2 70,7	2,0 0,4	good	little

of water-resistant aggregates from particles larger than 0.25 mm is considered a criterion to predict the stability in time given by the processing of the addition, the justification of the different agricultural measures to support it. Soil degradation is an extremely complex process that determines or intensifies the action of one or more limiting factors. In conventional agriculture, the intensification of land degradation is largely determined by human activities and cannot be less than eliminated by some limiting factors, which are generally permanent in nature, so that agricultural technology must be adapted.

These conservative technologies have contributed substantially to improving the fertility and productivity status of the soil and, consequently, other environmental resources (Guş, 1997, Andriucă V. et al., 2017).

CONCLUSIONS

To determine the dynamics of soil structure, it is necessary to know the factors that determine it: the biological activity of soil microorganisms, plant roots, soil organic and inorganic components, soil water regime, treatment, composition and quantity of fertilizers applied to soil and other factors that cause changes in soil structure.

The structure of the soil carried out by wet and dry sieving by the sieve method shows us that in the agrocenoses with winter wheat (No-till) the best structure was highlighted at a depth of 0-30 cm. The quality of the structure also depends on some physical properties of the soil, as well as the cultivated plant.

Soils with about 80 % macro-aggregates (with a diameter greater than 0.25 mm), and they are at least 50 % hydro stable, provide the best conditions for growing plants. The best soil structure was in agrocenoses with autumn wheat, No-till.

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