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PRODUCTIVITY OF THE AUTUMN WHEAT IN DEPENDENCE OF THE PHYSICAL AND PHYSICO-CHEMICAL PROPERTIES OF THE SOIL

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Abstract: The problem of producing cereal crops was and will remain one of the most current in the country's agro-industrial complex. In order to have a rich harvest, it is essential to observe all the technological procedures for growing autumn crops.

The main link in Moldova's agricultural development is the production of cereals. In developed countries, there is produced 1 ton of cereals per head of inhabitant. This is enough to provide the population with all the necessary products. The Republic of Moldova is a developing country and currently produces about 1.3-1.5 million tons of cereals, which is about 500 kg / head of inhabitant. Autumn wheat is one of the most important crops, occupying annually in our country about 320-350 thousand hectares. But the harvest of this crop continues to remain quite small (about 2 - 2.5 t / ha).

Key words: carbonated chernozem, autumn wheat, physical and chemical ecopedological indices, agrophysical indices.

PRODUCTIVITATEA GRÂULUI DE TOAMNĂ ÎN DEPENDENȚĂ DE PROPRIETĂȚILE FIZICE ȘI FIZICO-CHIMICE ALE SOLULUI

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Rezumat: Problema producerii culturilor de cereale a fost şi va rămâne una dintre cele mai actuale din complexul agro-industrial al ţării. Pentru a avea o recoltă bogată, este esenţial de a respecta toate procedurile tehnologice pentru cultivarea culturilor de toamnă.

Principalul element în dezvoltarea agricolă a Moldovei este producţia de cereale. În ţările dezvoltate se produce în mediu 1 tonă de cereale pe cap de locuitor. Această cantitate este suficientă pentru a oferi populaţiei produsele necesare. Republica Moldova este o ţară în curs de dezvoltare şi produce în prezent aproximativ 1,3-1,5 milioane tone de cereale, adică aproximativ 500 kg/cap de locuitor. Grâul de toamnă este una dintre cele mai importante culturi, ocupând anual în ţara noastră aproximativ 320-350 de mii de hectare. Dar recolta acestei culturi continuă să rămână destul de mică (aproximativ 2 - 2,5 t/ha).

Cuvinte-cheie: cernoziom carbonat, grâu de toamnă, indici eco-pedologici, fizici şi chimici, indici agrofizici.

INTRODUCTION

Soil as an environmentally open system is related to the environment through a continuous flow of matter and energy. In its long evolution, under the influence of natural factors in the area of interaction of lithosphere, hydrosphere, atmosphere and biosphere - Soil is the geosphere in which many of the elements are accumulated and preserved in easily accessible forms, necessary for the existence and perpetuation of life on Earth. Therefore, among the material conditions necessary for the existence of mankind, the productive activity of the people, the soil (pedosphere), due mainly to its specific characteristic and fertility plays an essential role (Florea, 2009).

Soil fertility is one of the main issues for any farming system, including sustainable agriculture. The higher the fertility of the soil is, the higher is the productivity of the crops per unit area. The anthropogenic factor determines, to a great extent, the processes of decomposition and resistance of soil organic matter (Boincean, Stadnic, 2015).

One of the most important tasks of agriculture is the production of high quality cereals to satisfy the needs of the population and exports. In many countries of the world, wheat is the main crop. According to the National Bureau of Statistics in 2016, 24.4 % of the total area sown in Moldova was occupied by winter wheat. Winter wheat is one of the most frequent crops in the republic, and Moldova ranks second place for surfaces after maize. Potentially, the yield of modern sorts of wheat varies from 5 to 8 t/ha, however the yield of winter wheat is still low and varies from 1.32 t/ha (in dry years) to 5 tons and more in the high-moisture years.

Productivity of crop plants depends of multiple factors: natural, biological, technological, economic, managerial, etc. The main natural factors, which ensure high and stable yields in the conditions of the Republic of Moldova, are the atmospheric precipitation (the degree of moisture assurance of the plants) and the level of soil fertility. The soils of Moldova are characterized by high fertility. Growth, plant development, productivity, water and soil solutions are strongly related to the physical and physico-chemical properties of the soil.

Soil needs to be physically and chemically characterized to understand its global functioning. Soil quality is the capacity of the soil to function within ecosystem boundaries, to support biological productivity, to maintain the quality of the environment and to promote the health of plants and animals (Aon, et al., 2001). The physical properties of the soil have a major influence on how soil functions within an ecosystem (Rauş, 2010).

The scientific prognosis of changes in physical properties in the soil active layer is one of the most important tasks of the contemporary pedologists, since favorable soil properties and physical regimes are one of the basic factors determining its fertility, obtaining high and stable crops (Guş, Rusu, 2008).

MATERIALS AND METHODS

Soil researches: Morphological features were highlighted through a soil profile up to a depth of 150 cm. Munsel Atlas of Color was used to describe the color.

Soil properties: The physical properties of the soil were determined by the methods: texture- pipetting method with preliminary soil processing with sodium pyrophosphate; micro aggregate composition - Kacinski method. The chemical and physicochemical properties were determined by Tiurin's method, humus content in the modification of Simacov V., pH soil – potentiometric method, carbonates – gasoidimetric method, exchangeable cations – complexonometric method.

Winter wheat harvest was determined on 1 ha plots; the biometry was calculated from 1m^2 in rehearsals.

The experimental data were calculated and analyzed by statistical methods

(Dospehov, 1985) and the appreciation of the degree of manifestation of the properties was characterized by the classes of values (Cerbari, 1997; Florea, 1995).

RESULTS AND DISCUSSIONS

The research was carried out at the Chetrosu Didactic Experimental Station (DES Chetrosu). For the research was chosen non-eradicated carbonate chernozem, moderately humic with strong profound humic profile, arable, clayey.

The climatic conditions correspond to 5 agroclimatic districts with predominant heights of 150-300 m. The annual air temperature is 7.9-9.0 ° C, and the sum of temperatures > + 10 ° C is 2850-3100 ° C, annual rainfall 520-580 mm. The annual amount of precipitation during the research period was 480.2 mm (+ 31.2 mm from the multiannual average), and the annual medium temperature was + 10 ° C (+0.3 °C from the multiannual average).

Codri Plateau (Central) is a combination of narrow, crepuscular crests with broad and deep valleys, with altitudes of 200-300 m. Rough terrain and torrential rains condition the intense erosion of surface and linear erosion. The average monthly soil temperature at the depth of the arable layer is positive or close to 0 ° C, but in case of low temperatures and lack of snow cover, the soil can freeze up to a depth of 1 m. Thermal resources ensure the growth of a broad spectrum of agricultural crops.

The physico-mechanical properties record the short and long lasting effects of agroecosystems. Surveillance and assessment of their changes in time and space allows identification of agroecosystem-friendly agricultural management actions, highlighted by self-sustaining technological links for the creation of sustainable agroecosystems. The morphological characteristic of non-eroded carbonated chernozem is presented in Table 1.

Table 1. Morphological characteristic of non-eroded carbonated chernozem, moderately humic with strong profound humic profile, clayey

Horizon	Morphological description of the horizon
Aрк 0-30/30	Arable layer, humus accumulation horizon, dark gray, low compacted, damp, clayey, grainy-glomerular structure, porous, neoformation - roots, poor effervescence, gradual color transition.
Aк 30-46/16	Dark gray, low compacted, damp, clayey, grainy-glomerular structure, porous, neoformations, roots, effervescent, gradual color transition.
Bк1 4670/24	Dark gray, low compacted, damp, clayey, grainy-glomerular structure, porous, neoformations, roots, effervescent, gradual color transition.
Bк2 70-96/26	Brownish yellow, low compacted, damp, clayey, porous, neoformations, strong effervescent, slow color transition.
BCк 96-117/21	Dark-yellowish brown, low compacted, porous, bieloglasic neoformations.
Cк 117-140/23	Dark yellow, slightly compacted, porous structure.

Human intervention in the agricultural production process changes the natural variability of soil characteristics both vertically and horizontally. Soil structure has a great importance for physical, chemical and biological processes that occur in the soil and soil-plant-atmosphere system. Soil structure is a function of the pedogenesis type and a series of factors, as the granulometric composition, the humus content and composition, the mineralogical structure of the finely dispersed fraction, the composition of the adsorbed cations.

One of the most important criteria for agronomic evolution of the structure is the water stability of the aggregates. It is known that the arable layer of chernozems has a stable settlement if it contains not less than 40-45 % of hydrostatic aggregates with a diameter > 0.25 mm, otherwise the soil is easily subject to compaction and leads to the worsening of the physical features, especially permeability to water and air. This can serve as the basis for the theoretical argumentation and grounding of different soil tillage methods which in practice ensure that the aggregate's hydrostability is > 0.25mm at a level of 40-45 %.

Table 2 shows the granulometric and micro aggregative composition of the carbonated chernozem layer of 0-50 cm.

Table 2. Granulometric and micro aggregative composition of carbonated chernozem, DES Chetrosu

Horizon / Depth, cm	Traction diameter (mm), content %							
	Sand		Dust			Clay	Physical clay	The dispersion index, к
	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01	
Арк 0-10	3,11 / 24.07	10,23 / 29.30	44,64 / 36,90	5,11 / 3,80	12,20 / 5,55	24,71 / 1,38	42,02 / 6,0	5.6
Арк 10-20	2,8 / 25.21	11,35 / 28.03	46,37 / 36.50	5,43 / 4.13	11,75 / 4.33	22,3 / 1.8	39.48 / 10.3	8.1
Арк 20-30	2,0 / 27.65	8,94 / 28.26	48,01 / 35,14	5,85 / 4,14	11,75 / 3,55	23,53 / 1,26	41,05 / 9,0	5.3
Ак 30-46	2,3 / 25.24	9,95 / 30.0	47,44 / 33,20	6,03 / 4,66	11,33 / 5,10	22,95 / 1,8	40,31 / 11,6	7.8
Вк1 46-50	2,12 / 21.40	8,13 / 30.45	45,44 / 35,15	5,11 / 5,13	14,78 / 6,0	24,32 / 1,87	44,21 / 13,0	7.7

* at the numerator - the dry sifting, the denier - the wet sifting

The studied chernozem subtype remains stable in the 0-50 cm layer. It is known that the larger the dispersion is, the finer particle of the clay is formed, and the soil is therefore liable to crust formation and compaction after rain and irrigation.

Besides the size of the elementary particles, which define the texture and structure, the physical behavior of the soil depends of the tighter laying of the elementary particles and the structural elements. Settlement status is expressed by various indicators, including soil density and porosity of carbonated chernozem (Table 3).

Table 3. Density of the soil (g/cm^3), total porosity and aeration (%) of carbonatic chernozem, DES Chetrosu

Horizon	Depth, cm	Soil density, g/cm^3	Total porosity, %	Porosity of aeration, %
Aрк	0-10	2.58	58.3	28.7
Aрк	10-20	2.60	53.8	29.7
Aрк	20-30	2.65	54.6	29.5
Aрк	30-46	2.65	54.4	30.1
Bк1	46-50	2.60	50.1	26.5
Bк2	50-60	2.63	50.9	28.1
DL 0.95=0.18				

DL 0.95 = 0.18 laessoidal, which serves as the native rock of the studied carbonated chernozem

Apparent density is an integral indicator of the state of physical quality of the soil, a relatively independent attribute, whose knowledge provides elements of physical characterization of the soil. Mostly, a soil of a certain genetic type, with specific chemical properties, can have very different values of apparent density. On the contrary, many of the other physical properties of soil depend, in addition to texture or some chemical characteristics, also on bulk density (Canarache, 1990). Knowledge of this parameter has a particular importance in the calculation of water reserves, nutrients, salts, fertilizer requirements and amendments (Guş, Rusu, Stănila, 2003).

Another indicator of the physical quality of the soil is the total porosity, the values of which correlate with the bulk density. Optimal values of total porosity indicate good permeability of water and air, high soil ability to retain water. Large values of bulk density reduce total porosity (Chiriac, Jitareanu, 2012) and change the ability to retain between water and air in favor of the first (Husnjak, Filipović, Kosutić, 2002).

The bulk density and total soil porosity are functions of the organic matter content in the soil, the stability of the structural aggregates and their fractionation. Decreasing organic matter in soil increases apparent density, reduces total porosity, reduces infiltration and soil capacity to retain water and air (Chetan et al., 2017).

According to research on the total porosity scale (Canarache, 1990), the arable layer of carbonated chernozem is used as moderately loose, reaching average values of 55 %, and according to the porosity of aeration classes it is characterized in the arable layer with large aeration porosity, reaching 29-25 %. In addition to the physical properties of the soil, the chemical and agrochemical properties of the carbonated chernozem were investigated and performed (Table 4).

Table 4. The chemical and agrochemical properties of moderately humic carbonatic chernozem with humic profile, deeply profound, clayey, DES Chetrosu

Horizon	Depth, cm	Humus, %	pH	Changing cations, me / 100g soil		Carbonates,%
				Ca^{++}	Mg^{++}	
Aрк	0-30	3.43	7.6	30.9	3.3	2.5
Aк	30-46	3.00	7.7	29.1	3.1	4.1
Bк1	46-50	2.40	7.8	27.1	3.0	4.6
Bк1	50-70	2.26	8.1	27.0	3.1	6.3
Bк2	70-80	2.00	8.1	25.4	3.0	7.1

The more humid the soil profile is, the higher is the amount of humus. During 20-25 years, almost all the districts reduced soil surfaces with moderate humus content, on average by 5 % (Ecopedological monitoring bulletin 1996, and after Ursu, Sinkevich, 1988) with the change of the content humus, decreases and his reserve.

According to the classification (Cerbari, 1997) the humus content of 3.4 % in the arable layer can be called moderately humic. The total humus reserve calculated for the studied soil is characterized as very large and constitutes 214 t / ha. All these physical, chemical and agrochemical properties influence harvest crops, in our case of winter wheat, which is shown in Table 5.

Table 5. Harvest of winter wheat on moderate humic chernozem

Biological harvest t/ha	Harvest in grains, t/ha	Plant height, cm
10.4	3.18	99

Research results show that the organic harvest is 10.4 t/ha, harvest 3.18 t/ha and plant height 99 cm, autumn wheat harvest is small, compared to other years due to spring droughts.

CONCLUSIONS

There is a slight decrease in the humus content with the depth, at 30-40 cm the humus content being 3 %, but at 70-80 cm constituting only 2 %. The content of humus in the soil is recorded as having values indicating a degree of average supply to the experimental variant.

An increase in pH value of 0.5 units was observed, which resulted in the transition from alkaline to basic, leading to improved soil fertility. The content of carbonates increases with the depth up to 7.1 % at the depth of 50-60 cm.

The lack of fertilization in a period of 30-50 years conditioned the reduction of the humus in the arable layer from 2.5 to 2.0-2.2 %, the increase of the compaction and the decrease of the organic harvest and the grain harvest in the case of the variants with organic and mineral fertilization over time; in 30 years, the humus content of the arable layer has increased by 0.2-0.4%, which has led to the improvement of the agrophysical properties and the stabilization of the autumn wheat harvest at > 4400-5700 kg/ha. Autumn wheat can be cultivated successfully in conservative soil systems with fewer investments, with higher productivity and more efficient energetic.

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