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SOIL-SAVING TECHNOLOGIES AND THEIR INFLUENCE ON AGROPHYSICAL AND COLLOID-CHEMICAL PARAMETERS OF CHERNOZEM

Olga ZHERNOVA[1], Yurii DEHTIAROV[1], Oleksandr KUTS[2]

[1]State Biotechnological University, Alchevskyh, 44, Kharkiv, Ukraine
[2]Institute of Vegetable and Melon Growing of National Agrarian Academy of Science, Institutska, 1, Kharkiv, Ukraine

Corresponding author email: degt7@ukr.net

Abstract

According to the criteria of destructuring and compaction of agricultural soils, it is possible to establish and improve a set of agricultural measures that will increase their productivity and reduce the cost of growing crops to producers in agricultural enterprises. The structure helps to inhibit the mineralization of organic matter, which is better stored in agronomically valuable units with limited air supply. The more agronomically valuable of structure units, the higher the manifestation of physical factors of soil fertility. Physical condition is one of the most important factors for determining the conditions of growth and development of plants and the value of their productivity, as it determines the formation of water-air and thermal regime of the soil. We offer method of expert assessment of soils according to the criteria of destructuring and compaction of soils in which are in agricultural use.

Key words: *soil-saving technologies, agrophysical parameters, colloid-chemical parameters, chernozem.*

INTRODUCTION

All over the world there is an increasing attention to ensuring the proper state of ecosystems, soil fertility, agriculture on the basis of maximum recycling of all farm waste. At the same time, soil conservation technologies play a leading role, combining traditions, innovations and science to improve the environment, prevent soil degradation, develop and implement environmentally friendly farming systems, which together determine the relevance of our research.

Soil-saving technologies help to improve the nutritional conditions of cultivated plants, soil fertility, product quality, increase arable land productivity, have a positive impact on the environment. Implementing ways to produce quality and safe agricultural products in agricultural practice ensures stable production of high quality and safe food and reduces the risk of life and health hazards of food consumers (Makarenko, 2010).

Fertile soil must correspond in its properties to the ecological characteristics of cultivated crops; have in an accessible form the necessary nutrients for plants; have an optimal and stable supply of moisture; be sufficiently loose and structural, ensure free and deep development of the root system of plants, as well as be air and water permeable; to have optimal heat capacity and thermal conductivity, to be warm enough to ensure the viability of relevant plants; to perceive, accumulate, store and simultaneously and evenly provide plants with water, nutrients, provide plants with conditions of air-thermal and redox regimes (Medvedev, 2017).

The introduction of chernozems in agricultural use has led to dramatic changes and the ratio of almost all soil processes and properties: the entry of organic matter into the soil and its mineralization, physical performance (deterioration of structure) and water regime, acidification and decalcification. Physical indicators as well as humus condition of the soil significantly affect a number of agrophysical properties of the soil, including moisture capacity, heat regime, etc. Therefore, they are the most important factors in soil fertility. In turn, organic farming helps to increase the flow of organic matter into the soil, thus forming favorable indicators in the soil (Zhernova, 2017; Dehtyarov, 2017).

Studying the influence of different phytocenoses on the physical characteristics of typical chernozems, it was found that typical chernozems of the virgin steppe have the most favorable physical characteristics for plants. Plowing of soils leads to deterioration of almost all studied indicators. In particular, in comparison with the absolute virgin land, the density of composition increases by 15-20% and the density of the solid phase of the soil by 2-5%. The ability of soils to withstand the destructive effects of water is also declining (especially in the arable horizon) (Miroshnychenko, 2013).
Typical chernozems of absolute virgin land and fallow land are characterized by the highest content of agronomically valuable water-resistant units. Agricultural use of chernozems for 77 years leads to the dispersal of structural aggregates. Agrogenic chernozems contain four times less agronomically valuable (3-1 mm) water-resistant units and twice as many aggregates <0.25 mm in size in 0-20 cm layer compared to virgin soil (Panasenko, 2015).
Thus, during the long-term agricultural use of chernozems, their agrophysical properties deteriorate, there is a weak degree of compaction in the subsoil horizons, there is a decrease in the number of agronomically valuable aggregates against the background of accumulation of big aggregates. Intensification of agricultural production leads to changes in the particle size distribution of chernozems. The number of silty particles in a number of soils increases. This indicates that the growth of anthropogenic load and high doses of mineral fertilizers lead to increased gleying processes and increase the sludge content by reducing the share of fine and medium dust fractions (Bezuhlova, 2006).
Shikula (2004) and other scientists have scientifically substantiated ways to abandon chemicalization, but with the use of organic farming, which can not only keep yields at the previous level, but also significantly increase it. Organic farming system, on the other hand, helps to improve agrophysical and agrochemical indicators of soil fertility, reduce weeds by 25-40% and the number of pests, increase soil biological activity by 6.5-7.5%, reduce reduction of nitrate content in agricultural products by 10-12% compared to products grown by traditional technology (Antonets′, 2010).
The aim of the work was to study some physical characteristics, the content of humus and its colloidal forms in chernozems typical of soil-saving technologies.

MATERIALS AND METHODS

The farm "Agroecology" is located in the village Mikhailiki of the Poltava region (49°29'52.2"N 34°18'50.6"E). The total land use area is 8026 ha. Of these, agricultural land - 3290 hectares, including: arable land - 2909 hectares, hayfields - 50.1 hectares, pastures - 201 hectares. Plowing of agricultural land is about 92%.
At the heart of the unique technology of private enterprise (PE) "Agroecology" - shelf less tillage, which does not disturb the soil structure, retains moisture, maintains temperature, creates conditions for the life of soil biota. The farm is working on the creation of tillage units that would best meet the needs of such agriculture. In "Agroecology" introduced a unique system of organic farming, the foundation of which was laid in the 70-s of the twentieth century. Thus, for more than 40 years it has been managed in cooperation and harmony with nature, using only organic technologies. Due to this, the company has clean, healthy, fertile soils and produces organic products.
The soil cover of the farm is represented by typical medium-loam chernozem. 5 variants were selected for the study: fallow land, control (without fertilizers), organic fertilizer system, green manure system and mineral fertilizer system. Individual samples were taken every 10 cm to a depth of 50 cm.
Variant 1 - fallow - 30 years without tillage.
Variant 2 - control (without fertilizers). Culture: winter wheat crops ("Vidrada" 250 kg/ha). Predecessor: sainfoin of the third year of cultivation, yield 10 t/ha. Tillage: the predecessor was harvested for haylage, stubble peeling with 3-4 cm disc harrows, cultivation 4 cm, moisture closure 5 cm, winter wheat sowing 250 kg/ha.
Variant 3 - mineral fertilizer system. Culture: sugar beet. Predecessor: winter wheat, yield 3.2 t/ha. Tillage: plowing to a depth of 30 cm.

Variant 4 - organic fertilizer system. Culture: corn MIA. Predecessor: radish and oats for fodder, yield 15 t/ha. Tillage: moisture closure 5 cm, pre-sowing cultivation by 8 cm, sowing - 7 cm.

Variant 5 - green manure system. Culture: winter wheat crops ("Vidrada" 250 kg/ha). Predecessor: vetch on green manure, yield 15 t/ha. Tillage: closing of moisture by 4 cm, sowing of winter wheat without tillage (Tarasen complex seeder 8 m).

The study was conducted by the following methods:

- the density of the composition of the intact soil by the method of the cutting cylinder according to N.A. Kaczynski;
- density of the solid phase of the soil by pycnometric method;
- porosity - calculated (according to the density of the composition and the density of the solid phase of the soil);
- structural-aggregate composition and water resistance of structural aggregates by the method of fractionation on sieves according to M.I. Savvinov;
- coefficients of structure and water resistance - calculated;
- the content of general humus according to I.V. Tyurin in the modification of V.M. Simakova;
- content of colloidal forms of humus (active and passive) by the method of O.N. Sokolovskyy.

RESULTS AND DISCUSSIONS

Soil density. The results of the study of soil density (Table 1) showed that fallow as a natural ecosystem has optimal performance.

Table 1. Soil density, g/cm^3

Depth of soil, cm	Variant				
	without fertilizers		fertilizer system		
	fallow (30 years)	control	mineral	organic	green manure
0-10	1.03	1.01	1.18	1.00	1.09
10-20	1.11	1.18	1.19	1.08	1.14
20-30	1.18	1.22	1.18	1.11	1.17
30-40	1.23	1.25	1.24	1.21	1.21
40-50	1.23	1.25	1.25	1.23	1.24

Thus, in the layer of 0-10 centimeters, the density is 1.03 g/cm^3, and with depth this figure increases to 1.23 g/cm^3. This is due to the loosening effect of the root systems of natural grass vegetation in the conditions of fallow.

The use of organic fertilizer system helps to reduce the density of 0.01-0.11 g/cm^3 of chernozem typical of this variant compared to the control soil. Chernozem in the organic system of fertilizer in terms of density is close to the variant of fallow throughout the study thickness.

When applying the sidereal fertilizer system, there is an increase in the density of chernozem from a depth of only 30 centimeters to 1.21 g/cm^3. Thus, the use of green manures has a positive effect on the soil density of typical chernozem and brings the value closer to the soil in natural conditions (fallow).

Under the conditions of the mineral fertilizer system, the arable layer is compacted in comparison with the organic and green manure systems, but the greatest compaction is undermined by the subsoil horizon (1.24-1.25 g/cm^3). This is due to the formation of the plow sole.

Density of the solid phase of the soil. Examining the density of the solid phase of the soil of typical chernozem (Table 2), it was found that the fallow land as a natural ecosystem has the lowest values for the entire soil thickness (2.45-2.58 g/cm^3). This is due to the greater humus content of the soil of the fallow area.

Table 2. Density of the solid phase of the soil, g/cm^3

Depth of soil, cm	Variant				
	without fertilizers		fertilizer system		
	fallow (30 years)	control	mineral	organic	green manure
0-10	2.45	2.48	2.48	2.46	2.48
10-20	2.45	2.52	2.48	2.46	2.48
20-30	2.45	2.52	2.48	2.46	2.50
30-40	2.53	2.56	2.56	2.53	2.53
40-50	2.58	2.60	2.60	2.58	2.60

In the organic and green manure fertilization system, the density values are close to the values of the fallow area, but they are slightly higher, especially in the green manure fertilization system (2.46-2.58 and 2.48-2.60 g/cm^3). Thus, the action of organic fertilizers and green manures has a positive effect on the density of the solid phase of the soil. The control variant has the highest values (2.48-2.60 g/cm^3) in comparison with all studied variants. This is due to the low humus content in this study.

Porosity. Porosity depends on the particle size distribution, structure, content of organic matter. In arable soils porosity is due to cultivation and cultivation techniques. As a result of any loosening of the soil, the porosity increases, and in the case of compaction decreases. The more structured the soil, the greater the overall porosity (Hakansson, 2000; Makarenko, 2010).

Studies show that on a scale of Kaczynski's duty cycle in all variants of the study is assessed as "satisfactory" and ranges from 51-60% (Table 3).

Table 3. Porosity, %

Depth of soil, cm	Variant				
	without fertilizers		fertilizer system		
	fallow (30 years)	control	mineral	organic	green manure
0-10	58	59	52	59	56
10-20	55	53	52	56	54
20-30	52	52	52	55	53
30-40	51	51	52	51	52
40-50	52	52	52	52	52

In the layer of 0-10 centimeters of all studied variants (except for the mineral fertilizer system, which has a porosity index of 52%), the highest soil porosity index, which is in the range of 56-59% and is assessed as more satisfactory.

Variant control does not have a high rate of porosity, except for 0-10 cm layer, where the porosity is 59%. This value is close to the variant of the mineral fertilizer system, which is due to the root system of cultivated crops (sowing of winter wheat).

Fallow and organic fertilizer system have the highest rate of soil porosity to other studied variants, and with depth the indicator tends to decrease insignificantly.

Sidereal fertilizer system in terms of porosity is almost not inferior to organic fertilizer system (52-56%).

When using the mineral fertilizer system, the porosity index is low and the value of 52% of the entire studied thickness is 52%, which is a less satisfactory estimate compared to all the studied variants.

Soil structure. Analysis of the obtained data on the aggregate composition of typical medium loam chernozems for different fertilization systems showed that the content of agronomically valuable aggregates (0.25-10 mm) is maximum in the soil of the fallow compared to control and fertilizer variants and is 93.3-91.0%. This is due to the high content of humus, the presence of a high proportion of detritus in its composition, as well as the structure-forming effect of the root system of plants in the natural ecosystem. At the same time, structural aggregates >10 mm in size make up a very small share, which is the lowest figure of all the studied variants. The reason for this is the dense, very branched root system of herbaceous vegetation, which mechanically prevents the formation of aggregates >10 mm. With a depth (20-50 cm) the number of units >7 mm increases almost twice.

Agricultural use of chernozems causes an increase in the content of structural units in the soil >7 mm and a decrease in the content of aggregates 1-5 mm. This is especially evident in the upper part of the soil control profile (0-20 cm), in the part that is most exposed to plowing. It should also be noted that the upper part of the profile of the control variant is characterized by a higher content of structural units <0.25 mm in the upper part of the profile (0-20 cm).

The application of organic and green manure systems brings typical chernozem of the structural condition of the soil of the natural ecosystem (fallow). This contributes to an increase in the number of agronomically valuable aggregates (10-0.25 mm) compared to chernozem control to 89.20 and 88.61%, respectively (layer 0-10 cm).

In chernozem under the mineral fertilizer system there is a decrease in trends in improving soil structure. The number of structural units with a size of 1-5 mm has not increased significantly, especially for the upper (0-20 cm) part of the soil profile. The content of agronomically valuable aggregates (0.25-10 mm) here is 77.94%. This is due to the method of fertilization and tillage technology.

Thus, with soil-saving agricultural technologies (variants with organic and green manure systems) plowed chernozems of PE "Agroecology" have a content of agronomically valuable aggregates (0.25-10 mm) almost 10% more than chernozem with mineral fertilizer system compared to the variant of control - without application of fertilizers (Figure 1).

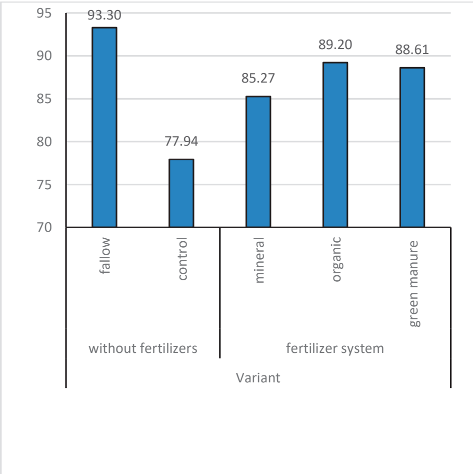

Figure 1. Content of agronomically valuable aggregates (depth 0-20 cm), %

Having studied the soils of the Kharkiv region Medvedev V.V. (2015), based on many years of research, notes that the structural-aggregate composition of typical and common chernozem under the action of high doses of mineral fertilizers becomes stable, despite its deterioration in the first years. Moreover, after 6 years there was even a tendency to improve the structural-aggregate composition of chernozems.

Plowing and agricultural use of typical chernozems causes a sharp decrease in the structural factor, especially in the upper part of the studied soil thickness. Thus, in the 0-20 cm layer of soil control, compared to the soil of the natural ecosystem, the coefficient of structural is 3.5, which is ten times lower than in the soil under fallow (Figure 2).

The use of organic and green manure systems significantly increase the structural factor of typical chernozem. Here the coefficient of structural is 8.20 and 7.77, respectively. This contributes to an increase in the number of agronomically valuable aggregates (10-0.25 mm) compared to chernozem control, where in the layer of 0-20 cm the structural factors 5.78.

The degree of structure in agrogenic phytocenoses varies considerably, the physical properties of the soil change.

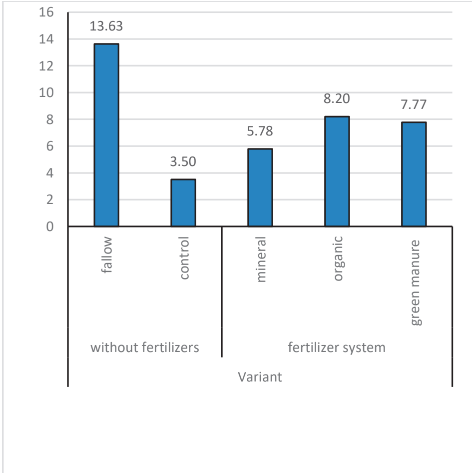

Figure 2. Structural coefficient (depth 0-20 cm)

The quality of the soil structure is determined by its size, porosity, mechanical strength and water permeability. The most agronomical valuable are macroaggregates 0.25-10 mm in size, which have high porosity (over 45%), mechanical strength and water permeability. The formation of a water-resistant structure of chernozem requires a relatively small amount of organic matter, but the differences in the composition of humus in macro and microaggregates are quite significant (Medvedev, 2008).

Content of water-resistant aggregates of chernozems typical of different fertilizer systems shows that the use of organic and green manure systems increases the number of water-resistant structural units compared to the variant without fertilizers.

The 0-10 cm layer of the control variant is dominated by structural units with a size of 1-0.25 mm and <0.25 mm. The smallest number of structural units >3 mm in size, in a layer of 20-30 cm is only 2.3.

In the variant with a mineral fertilizer system in the soil layer 0-10 cm, the largest number of structural units with a size of <1 mm is available. With depth, their number decreases,

and the number of units with a size >1 mm increases.
With an organic fertilizer system, the largest number of structural units with a size of <2 mm in a layer of 0-10 cm. Structural units with a size of >3 mm quantitatively predominate at a depth of 0-20 cm.
In the variant with sidereal fertilization system, the number of structural units of 1-0.25 and <0.25 mm is the largest in the entire studied soil thickness. The smallest number of structural units measuring >3 mm at a depth of 30-40 cm and 40-50 cm.
The highest water resistance is characterized by structural aggregates in the variant of fallow (0-10 cm). In the variant of the mineral fertilizer system, in comparison with all the others variants, the smallest number of aggregates is >3 mm in size (2 times less than in the fallow area).
With an organic fertilizer system, the largest number of structural aggregates with a size of <2 mm in a layer of 0-10 cm. Structural aggregates with a size of >3 mm quantitatively predominate at a depth of 0-20 cm.
In the variant with sidereal fertilization system, the number of structural aggregates of 1-0.25 and <0.25 mm is the largest in the entire studied soil thickness. The smallest indicators are of structural aggregates of size >3 mm at a depth of 30-40 cm and 40-50 cm.
The highest water resistance is characterized by aggregates in the variant of fallow in 0-10 cm soil thickness. In the variant with the mineral fertilizer system, in comparison with all the others, the smallest number of aggregates is >3 mm in size (2 times less than in the fallow area).
The highest coefficient of water resistance is observed in fallow chernozem. In the control variant, the indicators are sharply reduced, especially in the lower part of the soil. A similar decrease in water resistance is observed in the variant with a mineral fertilizer system. Sidereal and organic fertilizer system in the 0-20 cm layer helps to improve the soil structure in contrast to the mineral fertilizer system and compared to the control.
On the cultivated lands the intensity of soil processes intensifies and the soil structure is destroyed. Therefore, the content of agronomically valuable aggregates in agrocenoses is lower than in the fallow. Thus, under the influence of soil-saving technologies, the physical condition of arable land is significantly improved and becomes more favorable for growing field crops.
The destruction of the soil structure on the control is accompanied by a decrease in the number of units 0.25-10 mm. On annually cultivated lands with mineral fertilization system there is less significant improvement of agronomically valuable structure, fewer structural water-resistant units compared to organic and green manure systems.
Humus content. One of the most important diagnostic signs of soil degradation is the reduction of organic matter and its main component - humus. This is due to many reasons, the main of which is the lack of constant compensation of plant residues and organic fertilizers for current costs of organic matter, mainly due to their biological mineralization and changes in the relationship between mineralization of fresh organic matter, formation and stabilization of new humus in soil.
Studies of the content of total humus in typical medium loam chernozems showed that the highest rate on the variant of fallow compared to the control, as well as with all other studied variants. In the 0-10 cm layer it is 6.70%, with depth the humus content decreases, and already at a depth of 40-50 cm the humus content is 4.23%, which is 25% less (Table 4).

Table 4. Content of total humus, %

Depth of soil, cm	Variant				
	without fertilizers		fertilizer system		
	fallow (30 years)	control	mineral	organic	green manure
0-10	6.70	4.20	4.60	5.59	5.41
10-20	5.54	4.14	4.60	5.50	5.25
20-30	5.04	4.10	4.12	4.86	4.45
30-40	4.97	3.90	3.80	3.86	3.84
40-50	4.23	3.61	3.57	3.59	3.55

In the variant without the use of fertilizers (control) there is a tendency to reduce the content of total humus compared to all studied variants.
The results of our research show that the application of organic fertilizers in typical

chernozem increases the content of total humus in the 0-10 cm layer of soil to 5.59%, and with depth its content decreases and is 3.59%.

When applying the mineral fertilizer there is an intensive mineralization, so humus in 0-10 cm 4.60%. This applies to the entire soil profile studied, compared to the control.

The use of sidereal fertilizer system helps to increase the content of total humus, relative to chernozem control. But compared to the organic fertilizer system, the values of total humus content are lower.

Thus, sidereal crops not only increase soil fertility and crop yields, but also reliably protect the soil from erosion. The main advantage of green manures is the high content of organic substances, and they should be considered as a biological catalyst for soil transformations that improve the mineral nutrition of plants (Korzhov, 2011).

The content of colloidal forms of humus. The conducted research showed (Table 5) that in typical chernozems under fallow the share of passive forms of humus in the total humus is the highest 2.6%, which is 1.6% more than the control and with depth it decreases to 1.4%.

Table 5. Content of passive forms of humus, %

Depth of soil, cm	Variant				
	without fertilizers		fertilizer system		
	fallow (30 years)	control	mineral	organic	green manure
0-10	2.6	1.0	1.1	1.4	1.3
10-20	2.0	1.0	1.0	0.9	1.1
20-30	1.8	0.9	0.9	1.6	0.8
30-40	1.5	0.7	1.0	0.8	0.9
40-50	1.4	0.6	1.0	1.2	0.9

This is due to the constant influx and accumulation of organic residues that are not alienated from year to year compared to the agrochernozems of the four other studied variants and the accumulation of detritus as one of the most stable components of the organic in soil.

The chernozem of control over the content of passive humus in the studied agrophytocenoses has the lowest values of all variants. Thus, in the 0-10 cm layer of chernozem of this variant, the passive humus index is 1.0% and decreases with depth to 0.6%.

The application of an organic fertilizer system helps to increase the content of passive humus in typical chernozem compared to the control soil. This is especially true for the upper 0-10 and 20-30 centimeter part of the studied soil thickness where the content of passive humus is 1.4% and 1.6%, which is 0.4% and 0.7% more, respectively, compared to the variant of control. In general, chernozem with the organic fertilizer system is almost close in terms of passive humus to the soil of the fallow area.

When applying the sidereal fertilizer system, there is also an increase in the content of passive humus compared to the chernozem control area, because green manure, like manure is one of the main measures to increase the passive form of humus in the soil. In the 0-10 cm layer of soil, the passive humus index is 1.3%, which is 0.3% more than in the control variant. With the depth of the studied variant tends to decrease the passive humus and at a depth of 40-50 centimeters the content is 0.9%.

The application of the mineral fertilizer system of typical chernozem leads to the depletion of the soil of the content of passive humus, where the indicators are close to the control variant (without fertilizers).

According to the results of the study, we can say that variant of fallow and variant of organic fertilizer system the share of passive form of humus in the total humus is the highest. This is due to the constant influx and accumulation of organic residues and the formation of detritus, as one of the most stable components of the organic part of the soil. Sidereal fertilizer system is almost not inferior to the organic system. In variant of mineral fertilizer system, we have the lowest rate of passive humus compared to other fertilizer variants.

Examining the active form of humus (Table 6), we can conclude that in the typical chernozem under fallow, which is a natural ecosystem, the share of active form of humus in the total humus is the lowest.

Variant of control at a depth of 0-10 centimeters has an indicator of active humus 3.20%, and with depth the share decreases and already at a depth of 40-50 centimeters of soil thickness is 3.01%.

Table 6. Content of active forms of humus, %

Depth of soil, cm	Variant				
	without fertilizers		fertilizer system		
	fallow (30 years)	control	mineral	organic	green manure
0-10	4.10	3.20	4.19	3.50	4.11
10-20	3.54	3.14	4.60	3.60	4.15
20-30	3.24	3.20	3.26	3.22	3.65
30-40	3.47	3.20	3.06	2.80	2.97
40-50	2.83	3.01	2.39	2.57	2.65

The mineral fertilizer system in the 0-10 cm layer has active humus - 4.19%, which is 1% more than the control variant. The use of mineral fertilizer system causes less of passive humus and including increases the active form of humus.

During the application of organic and green manure fertilizer system increases the content of active humus chernozem typical, especially in the upper horizons, compared with the control variant. In depth of 30-40 cm, there is a tendency to reduce the active humus compared to the control area.

Influence of soil-saving technologies on agrophysical and colloid-chemical indicators of chernozem. Adverse conditions for the preservation and reproduction of humus are the traditional system of agriculture, which is designed to use large amounts of manure and industrial fertilizers. Recently, as a soil protection alternative, a system of sustainable agriculture has been implemented, which provides for the minimization of technical and chemical loads on the soil, with an emphasis on perennial sources and means of managing soil regimes. The latter circumstance determines the restoration of research interest in the involvement of fresh plant material in the renewal of soil organic matter (Tarariko, 2007; Miroshnichenko, 2016).

The results of studies of the qualitative composition of humus in the process of humus formation in virgin and arable soils are contradictory.

Thus, some researchers (Arbyzov, 2001) point to the fundamental preservation of the nature of humus formation and the quality of humus in arable lands in accordance with the original zonal type of soil formation. At the same time, other scientists note a clear dependence of the quality of humus on the intensity of the impact on the soil of agricultural crops, in particular there are significant changes in the organic part of the soil, namely the formation of more valuable in agronomic terms humus (Dehtyar′ov, 2011; Medvedev, 2017).

Preventing soil degradation and reducing the risk of environmental disturbances in the process of growing crops, comprehensive biologization of agricultural technologies and the priority of organic means of optimizing soil fertility - the hallmarks of modern farming systems. Great importance in solving these problems is given to the use of crop residues, by-products of crops, increasing the share of intermediate and green manure crops, as well as perennial grasses in the structure of crop rotations. Plant residues contribute to the comprehensive - both direct and indirect effects on the physical, chemical and biological properties of the soil, its air, temperature and nutrient regimes (Mukha, 2004). The entry of plant residues into the soil and their transformation into humic substances and organo-mineral complexes is a way of sequestering carbon and reducing the concentration of CO_2 in the atmosphere (Medvedev, 2017). Plant residues are a source of organic matter in the soil, a means of forming aggregates and improving the structure, a factor in regulating the mobility of mineral nutrients, nutrient and energy substrate for microorganisms, producer of low molecular weight soluble organic compounds that are essential for soil metabolism (Demydenko, 2021).

This is confirmed by our research results based on the study of some physical and colloid-chemical parameters of typical chernozem, when using variants of soil-saving technologies compared to other studied variants.

Thus, the density of chernozem typical of the mineral fertilizer system deteriorates compared to the control, there is a compaction of the arable layer, but the greatest compaction is the subsoil horizon, as a result of the formation of the plow sole. The use of organic and green manure systems on agrochernozems in organic farming, helps to improve density of soil.

The most optimal indicators of the solid phase of the soil belong to chernozem under natural vegetation (fallow). Variants of agrochernozems are characterized approximately equally by the density of the solid phase of the soil, throughout the studied soil thickness. Some differences are noticeable only on the variants of chernozem under fallow and chernozem with organic fertilizer system. This is due to the increase in humus in these variants.

Indicators of porosity on the studied variants vary within optimal limits. With depth, the porosity decreases. In the 0-10 cm layer, the variant with an organic fertilizer system is slightly higher due to the application of organic fertilizers, in contrast to the variant with a mineral fertilizer system. The upper layer of chernozem control also has a high porosity, which is associated with the cultivation (winter wheat).

The maximum content of agronomically valuable units (0.25-1 mm) is characterized by a 0-20 cm layer of the fallow area, as a variant of natural phytocenosis, due to the high content of humus and the presence of roots of natural vegetation. Plowing virgin chernozems leads to an increase in the content of fine units (<0.25 mm) and a decrease in the content of agronomically valuable units - a control variant.

This is especially true of the upper part of the soil profile, which is subject to the action of tillage implements. Fertilization certainly improves the structural condition of agricultural chernozems, but not equally. The application of organic fertilizers and green manure crops brings the studied soil closer to the soil of natural phytocenosis in terms of structural condition. And intensive use of mineral fertilizers has less impact on the reproduction of the structural state of typical chernozem. Plowing and agricultural use of typical chernozems is accompanied by a sharp decrease in the coefficient of structure, especially in the upper soil layers. The introduction of the fallow regime contributes to the growth of the structural factor.

Water resistance of chernozem structure, depending on agricultural technologies, has significant differences. Compared to the control in agricultural chernozems, the best indicators of water resistance of the structure are characterized by variants with sidereal and organic fertilizer systems. Chernozem with a mineral fertilizer system has the lowest water resistance coefficient of all the studied variants. The structure of chernozem typical under fallow (natural phytocenosis) has the greatest water resistance.

The formation of the structure of typical medium loam chernozem depending on different fertilizer systems has some differences. On the cultivated lands the intensity of soil processes intensifies and the soil structure is destroyed. Therefore, the content of agronomically valuable aggregates in agrocenoses is less than in the fallow. Thus, under the influence of soil-saving technologies, the structural condition of arable land is significantly improved and becomes more favorable for growing crops.

The highest humus content in the farm is in chernozem of the fallow area, in the 0-10 cm layer - 6.70%. The use of an organic fertilizer system helps to increase the content of total humus in typical chernozem. Sidereal fertilizer system also increases the content of total humus, but compared to the organic fertilizer system values are it slightly lower. When applying the mineral fertilizer, the humus in the soil decreases compared to all variants.

Studies of colloidal forms of humus have shown that the variant of chernozem under the natural phytocenosis in the total humus has a higher percentage of passive form of humus in contrast to the variants under the influence of agricultural use. Among agrochernozems more passive form in chernozem humus by organic and sidereal fertilizer system, especially for the upper 0-10 cm layer of soil. At the same time, having studied the active form of humus, we can say that in agricultural chernozems the content of the active form of humus in the total humus is almost 2 times higher than the share of passive humus.

CONCLUSIONS

The variant with mineral fertilizer system showed an increase in the density of composition, the density of the solid phase of the soil, and as a result of reduced porosity, deterioration of the structural condition (number of agronomically valuable units) and water resistance of structural aggregates. In contrast to the previous variant, the physical indicators under fallow, as a natural phytocenosis and variants for organic and green manure are more optimal.

The use of an organic fertilizer system helps to increase the content of total humus in typical chernozem. The use of sidereal fertilization system leads to an increase in the content of total humus, but compared to the organic fertilization system, the values of the content of total humus are slightly lower. Sidereal crops not only increase soil fertility and crop yields, but also reliably protect the soil from erosion. The largest amount of passive humus is contained in the variants of fallow, and among the variants of agricultural use in sidereal and organic fertilizer systems.

Thus, soil-saving technologies, namely variants with the use of organic and green manure fertilizers contribute to some improvement of physical and colloid-chemical parameters of the soil compared to the variant of mineral fertilization and variant control - without the use of fertilizers.

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