UDC 631.43:631.51:631.8:633.11«324»

AGROPHYSICAL CHARACTERISTICS OF TYPICAL BLACK SOIL IN AGROPHYTOCENOSES OF WINTER WHEAT DEPENDING ON CULTIVATION AND FERTILIZATION

Tsentylo L.V. *– Candidate of Agricultural Sciences,*
National University of Life and Environmental Sciences of Ukraine

The results of stationary research on the influence of long-term (2010-2017) application of four variants of the fertilizer system and three systems of basic tillage of deep-coarse-medium-loam black soil in the ten-field crop rotation in the right-bank forest-steppe on its agro-physical parameters in the last seven years of conducted observations are presented. It was determined that the variant of moldboard and boardless soil tillage in crop rotations creates the best agrophysical conditions of fertility of the typical black soil.
Key words: *density, porosity, soil cultivation, fertilizer system.*

Центило Л.В. Агрофізичні характеристики типових чорноземів при агрофітоценозах озимої пшениці залежно від культивування і добрива
Результати стаціонарних досліджень впливу довгострокового (2010–2017 рр.). Застосування чотирьох варіантів системи внесення добрив і трьох систем базового обробітку глибококристально-середньосуглинкових чорноземів у десятизерновій посівній сівозміні представлено правобережний лісостеп за його агрофізичними показниками за останні сім років проведених спостережень. Установлено, що варіант обробітку ґрунту полірованим та неполірованим у сівозміні створює кращі агрофізичні умови родючості типових чорноземів.
Ключові слова: *щільність, пористість, обробіток ґрунту, система добрив.*

Центило Л.В. Агрофизические характеристики типичных черных почв при агрофитоценозах озимой пшеницы в зависимости от культивирования и удобрения
Результаты стационарных исследований влияния многолетнего (2010–2017 гг.). Внесения четырех вариантов системы удобрений и трех систем основного возделывания глубокозернистых средне-суглинистых черноземов в десятизерновом пастбищном севообороте Правобережная лесостепь по ее агрофизическим показателям за последние семь лет проведенных наблюдений. Установлено, что вариант возделывания полированной и неполированной почвы в севообороте создает наилучшие агрофизические условия плодородия типичной черноземной почвы.
Ключевые слова: *плотность, пористость, обработка почвы, система удобрений.*

Introduction. Soil density along with its structural status is the main parameter that determines agrophysical characteristics and soil regimes, has a significant effect on the yield of cultivated crops.

The physical state of the arable layer, which is regulated by the work, is evaluated for the density of the soil and the hardness of the soil, which is closely related. Any measure of primary cultivation, aimed at changing the physical state of the soil, affects the water, heat and air, biological activity, and ultimately influences the productivity of crops [1, p. 244; 2, p. 31].

There are different vies to the optimal soil density and its impact on the growth and development of crops. But in general, researchers come to the conclusion that the optimum for most crops is the density of the soil within the limits of 1.1–1.3 g/cm^3 [3, p. 48; 4, p. 95; 5, p. 8] and life microorganisms that contribute to increased crop yields [6, p. 37]. The yield of crops is significantly reduced with increasing or decreasing by 0.1–0.2 g/cm^3 of the volumetric mass of the soil in relation to the optimum, and during compacting – sharply decreases.

The purpose of the study is to determine the impact of the application of systems of basic soil cultivation and fertilization of grain-cutting crop rotation on changes in soil density in agrophytocenoses of winter wheat.

Materials and methods. The experimental part of the work was performed on the research field of Ltd "AgrofirmaKolos" (2011–2017 gg.) In the Skvirsky district of Kyiv region in a stationary experiment based on a 10-field field crop rotation, expanded in time and space. Soil of the experimental field – is a typical deep-coarse-meadow-sand black soil. The content of humus in the processing layer of 4.6–4.8% (according to Tyurin), easily hydrolyzed nitrogen (according to Cornfield) – 14.4 mg/100 g of soil, mobile phosphorus (by Chirikov) – 15.2 mg/100 g of soil, exchangeable potassium – 15.2 mg/100 g soil (according to Chirikov). The volume of soil in equilibrium is 1.24 g/cm^3, the hydrolytic acidity is 1.14 mg ek/100 g soil, pH is 6.4 g/l.

Scheme of alternation of crops in field crop rotation: alfalfa, winter wheat, sugar beet, barley, soybean, corn silage, sunflower. In this crop rotation, three levels of fertilizer per hectare of crop rotation are used: for the mineral system – compost 4.5 tons+ $N_{80}P_{96}K_{108}$; organo-mineral – compost 4.5 tons+ $N_{80}P_{96}K_{108}$ + 3.5 tons by-products and seed weight and organic – compost 4.5 tons+ 3.0 tons by-products and seed weight. Winter wheat was the test crop in a chain with perennial herbs. In the experiment, the following fertilizers were used: compost, ammonium nitrate, superphosphate granulated and potassium chloride.

The second factor studied were systems of basic cultivation of the soil: 1) differentiated cultivation (control) recommended in the Forest-steppe and involves rotation of crop rotation five oranges, two surface cultivation for winter wheat after soybeans and corn for silage and one flat-cut barley treatment; 2) polished and unpolished soil cultivation predicts for rotation of crop rotation two plowing under sugar beet and sunflower for the rest of the cropless cultivations; 3) shallow, free-field cultivation for all crops of crop rotation. Area of sites – 240 m^2, four-time repetition of options in the experiment. Soil samples were taken to a depth of 25 cm. The density of the arable layer of soil at depths 0 – 10, 10 – 20, 20 – 30 cm was determined by the method of M. Kachynsky.

Results and discussion. At the beginning of the vegetation of winter wheat the density of the soil varied within 1.18-1.29 g/cm^3, which depended on the soil layer and cultivation. In the process of vegetation of plants, the density of the arable layer was increased, but in the case of polished and unpolished cultivation did not extend beyond the most optimal for this plant 1,1–1,3 g/cm^3.

The application of shallow non-field soil cultivation contributed to a higher density of 0–10 cm of the layer at 0.03 g/cm^3, and in layers 10–20 and 20–30 cm – at 0.04 and 0.02 g/cm^3. The soil density in different layers was higher to the corresponding horizons after differentiated cultivation at 0.03–0.02 g/cm^3 (Table 1).

Characteristic feature of typical black soil is good cultivation, but in connection with the growing anthropogenic loading, some undesirable physical processes are observed. Recently, many works have been published, which highlight the results of studying the change in agro-physical parameters of soils under the influence of fertilizers. Because the exclusive role of organicsubstances and organic fertilizers in their optimization is not in doubt, then on the impact of mineral fertilizers – data are very contradictory.

Some scientists conferm that the systematic use of mineral fertilizers (especially in elevated doses) in the case of an increase in physiologically acid forms or forms containing monovalent cations increases the aggregate composition, density of soil and permeability of black soil [7, p. 342; 8, p. 124] while [9, p. 56], proves that possible

insignificant changes in the physical characteristics of black soils during the applying of mineral fertilizers, especially in combination with organic, in small and medium doses.

Table 1

Soil density in the field of winter wheat under different fertilizers and soil tillage systems, g/cm³ (2011-2016 gg.)

Thesystemofferti-lization, A	Optionof soil cultivation, B	Layerofsoil, C cm	Definitionphase	
			startofvegetation	theendofthevegetation
Nofertilizers	Differentiated (control)	0–10	1,18	1,20
		10–20	1,20	1,22
		20–30	1,20	1,26
	Polished and unpolished (non-field ground) cultivation	0–10	1,16	1,19
		10–20	1,18	1,22
		20–30	1,21	1,25
	Shallow unpolished (non-field ground) cultivation	0–10	1,18	1,22
		10–20	1,20	1,27
		20–30	1,24	1,28
Organicandmineral	Differentiated (control)	0–10	1,18	1,21
		10–20	1,20	1,24
		20–30	1,22	1,27
	Polished and unpolished (non-field ground) cultivation	0–10	1,16	1,20
		10–20	1,20	1,24
		20–30	1,20	1,26
	Shallow unpolished (non-field ground) cultivation	0–10	1,20	1,23
		10–20	1,22	1,28
		20–30	1,24	1,29
Mineral	Differentiated (control)	0–10	1,18	1,22
		10–20	1,20	1,25
		20–30	1,25	1,27
	Polished and unpolished (non-field ground) cultivation	0–10	1,19	1,21
		10–20	1,20	1,25
		20–30	1,22	1,27
	Shallow unpolished (non-field ground) cultivation	0–10	1,21	1,23
		10–20	1,24	1,29
		20–30	1,26	1,28
HIP_{05} · A			$F_ф < F_{05}$	$F_ф < F_{05}$
HIP_{05} · B			0,02	$F_ф < F_{05}$
HIP_{05} · C			$F_ф < F_{05}$	$F_ф < F_{05}$

In the variant with the organic and mineral fertilizer system due to the use of the half rate of mineral fertilizers, we have established a decrease in the density in the upper and deeper layers of the soil compared with the mineral system. In particular, at the beginning of the vegetation, the decrease in winter wheat density is 2.5%.

The variant of the mineral fertilizer system led to an increase in the soil density in the upper 0–10 cm layer by 2.5% and in the layer 10–20 cm – by 3.3% compared to the option without fertilizer application.

At the time of harvesting, there was a certain increase in density, which occurred under the influence of soil tillage tools, precipitation, as well as due to the inherent soil of any self-compacting. The density of the arable layer during this period was within the range of 1.19–1.29 g/cm^3.

During the growing season of winter wheat, more densities of soil layers of 10-20 and 20-30 cm are observed in variants with unpolished treatments. For such cultivation of soil there is no mechanical turning and mixing of soil with soil tools. The highest soil density index is noted in variants with a systematic, shallow, unpolished treatment in a layer of 20–30 cm (1.29 g/cm^3) regardless of fertilizer system.

On the contrary, application in the crop rotation of polished and unpolished soil cultivation helps to optimize the density of the soil.

Consequently, in the field of soil cultivation, only unaltered, shallow, free-field cultivation leads to a significant increase in soil density (an average of 0.02–0.04 g/cm^3) compared to control.

Table 2

Total porosity of arable (0-30 cm) layer of soil for growing winter wheat, % (2011–2016 gg.)

The system offertilization, A	Optionof soil cultivation, B	Definitionphase	
		Start of vegetation	The end of the vegetation
Nofertilizers	Differentiated(control)	52,4	51,2
	Polished and unpolished (non-field ground) cultivation	52,8	51,2
	Shallow unpolished (non-field ground) cultivation	52,0	50,0
Organic and mineral	Differentiated (control)	52,0	50,4
	Polished and unpolished (non-field ground) cultivation	52,8	50,8
	Shallow unpolished (non-field ground) cultivation	51,2	49,6
Mineral	Differentiated (control)	51,6	50,4
	Polished and unpolished (non-field ground) cultivation	52,0	50,4
	Shallow unpolished (non-field ground) cultivation	50,8	49,6
Themiddleofthe-systemoffertilization	Nofertilizers	52,4	50,8
	Organic and mineral	52,0	50,3
	Mineral	51,5	50,1
Середнє за обробітком ґрунту	Differentiated (control)	52,0	50,7
	Polished and unpolished (non-field ground) cultivation	52,5	50,8
	Shallow unpolished (non-field ground) cultivation	51,3	49,7
HIP_{05} A		$F_ф<F_{05}$	$F_ф<F_{05}$
HIP_{05} B		$F_ф<F_{05}$	$F_ф<F_{05}$

For the application of the fertilizer system, the total porosity was at the same level: at the beginning of the winter wheat production it was 51.5–52.4%, at the end of the vegetation – 50.3-50.7%. The mineral fertilizer system tended to decrease by 0,9–1,7% of total porosity compared to the organic and mineral system and control.

The application of shallow non-field ground cultivation resulted in a significant decrease in the total porosity by 2.2% compared to the differentiated and polished and unpolished (non-field ground) treatment (table 2).

There are various considerations in the scientific literature regarding the optimization of certain indicators of soil porosity.

Heavy granulometric soils are mainly characterized by suction force and they are relatively poorly air and moisture-permeable. The natural drainage of these soils is slow. In order to improve the water and air modes of heavy soils, they must be loosened intensively, to increase the rates of organic fertilizers, to improve the structure. All this will contribute to increasing their total porosity due to an increase in the number of capillary and non-capillary pores [10].

The volume of capillary and non-capillary pores in the arable layer of typical black soil is within the optimum for this type of soil. According to the organic and mineral fertilizer system, the parameters of total porosity are more stable throughout the profile of the arable layer of the soil, which contributes to better growth and development of crop rotation crops.

Conclusion. The system of polished and unpolished soil cultivation in grain-cutting crop rotation of the right-bankof forest-steppe creates the best conditions for optimization of agro-physical indicators of fertility of typical black soil and provides the highest yield of winter wheat, located on the layer of perennial grasses.

REFERENCES:

1. Medvedev V.V, Lindina T.E., Laktionova T.N. Density of soil additions (genetic, ecological and agronomic aspects, Publishing house “13 printing house”, 2004. 244 p.

2. Tsylyuryk O.I. Influence of methods of basic cultivation on physical properties and water regime of soil. Agrochemistry and Soil Science: Interdistrict Themed Sciences Collection. Kharkiv: Agronomy and Agrochemistry, 2009. P. 31–36.

3. Kartamyshev N.I., Bardukova I.T, Doronchenko N.V., Vesingden N.V. Mechanical processing as a means of regulating agrophysical properties of soil, Agriculture, 1989. No. 9. P. 47–49.

4. Dmitriev EA, Makarov I.B. On the concept of “equilibrium density of soils”. Soil Science, 1993. No. 8. P. 94–98.

5. Tsyuk O.A. Agrophysical properties of soils in sugar beet crops for ecologization of agriculture.Sugar beet, 2006. No. 3. From P. 7–9.

6. Segin P.M, Begey S.V, Shuvar I.A. Intensification of crop rotation by intermediate crops: Recommendations for FPK. Lviv: SGI, 1990. 37 p.

7. Shykula M.K, Antonets S.S, Andrienko V.O. Reproduction of soil fertility in soil protection, Oranta, 1998. 680 p.

8. Tate R. Organic Soil: Biological and Environmental Aspects, World, 1991. 400 p.

9. Lykov A.M. Humus and soil fertility. Moscow Worker, 1983. 193 p.

10. Tsyuk O.A, Kirilyuk V.I. Influence of agricultural systems on changes in agrophysical parameters of soil. Scientific reports of NUBiP of Ukraine, 2016. № 4 (61). URL: http://journals.nubip.edu.ua/index.php/Dopovidi/article/view/6978.