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BALAEV A.D., Doctor of Agricultural Sciences, Professor
BORYSENKO Y.A., PhD Student
National University of Life and Environmental Sciences of Ukraine
e-mail: yura.nybip@gmail.com

THE EFFECT OF DIFFERENT SOIL TILLING SYSTEMS ON WATER-PHYSICAL PROPERTIES OF GREYZEM HAPLIC SOIL AND SPRING WHEAT YIELD UNDER THE CONDITIONS OF THE FOREST-STEPPE OF THE LEFT BANK OF THE DNIPRO RIVER OF UKRAINE

The experiment about the effect of different soil tilling systems of Greyzem haplic soil on its water-physical properties and spring wheat yield was made. It was found, that the usage of minimal tillage of soil for wheat, compare to traditional plowing, positively affects the moisture level of soil, improves its agro-physical properties that in the eventual result significantly increases the crop yield.
Keywords: *spring wheat, density of soil, moisture level, tilling system*

Introduction. During lots of decades, the most widely-used soil tillage in Ukraine is plowing. Along with this, many researchers point on high power consumption of such tillage and negative impact of long-term usage of plowing on water-physical and physical-chemical properties of soils. Its systematic usage causes the creation of furrow pan that prevents penetration of air, moisture and roots of plants into the deeper layers of soil. Furthermore, excessive aeration of upper layer of soil supports intense mineralization of organic matter of soil that causes a significant decrease of humus level and degradation of soil properties that are connected with it [1].

Modern agriculture involves more economic, soil defense technologies of cultivation of crops that are based on the minimization of soil tillage and even refusal it by using No-till technology. Nowadays, widely-used are the technologies with subsoiling techniques that minimize the mineralization of humus and the increase its level in the upper layer of soil [3, 4].

Along with this, the minimization of tillage on poorly aggregated soils can cause an increase of soil density, a decrease of its porosity and permeability. These particular showings will be limiting factors in adoption of technology with minimal tillage on Greyzem haplic soils. Especially significant importance has soil density which is an integrated index of soil physical condition [5, 6].

Consequently, it needs to be mentioned, that the minimization of soil tillage has its positive side, as well as negative.

So, the goal of our experiment was to research changes of water-physical properties of soil and features of formation of spring wheat yield under the influence of different tillage systems under the conditions of the forest-steppe of the left bank of the Dnipro river of Ukraine.

Materials and methods. Researches were conducted under the conditions of LLC "Biotech", Boryspil district, Kyiv region (the zone of the forest-steppe of the left bank of the Dnipro river of Ukraine) during 2012-2013. The soil of researched fields – Greyzem haplic, humus level in plowing layer - 1,94-2,49%; pHH_2O – 5,65-6,48; pH_{KCl} – 4,74-5,30. A sector of short-term crop rotation: soybean seed – spring wheat – corn seed. Fertilizing system –- $N_{100}P_{80}K_{80}$.

The program of researches on spring wheat sowing stated layer (0-10, 10-20 and 20-30 cm) determination of soil density and its moisture level before sowing, on the phase of shoots and before harvesting at a time when using three systems of soil tillage (plowing – 25-27 cm deep; disking – minimal subsoiling technique 12-14 cm deep and direct seeding – without soil tillage).

Soil samples for the research were chosen by current standard State Standards of Ukraine 4287:2004 [7] and were prepared for the analysis according to State Standards of Ukraine ISO 11464-2007 [8]. Soil density was determined according to State Standards of Ukraine ISO 11272-2001 [9];

moisture level in soil – State Standards of Ukraine ISO 11465-2001 [10]. Biologic crop yield was determined by the method of direct combine harvesting.

Results of the researches. Experimentation showed that the soil tillage systems affected the indicators of water-physical properties of Greyzem haplic soil. Soil density was changing according to layers during vegetation period and depended on the features of the effect of different tillage systems on soil. Before sowing, upper 0-10 cm layer was carried to a friable condition by before-sowing tillage and had approximate indicators on all variants of experiment 1,01-1,05 g/cm^3. Lower layers were denser that corresponded to the optimal content of sowing layer [2]. In the phase of shoots, soil was getting denser in all variants and its density differentiation in the layers was moderate. By plowing, the layer 20-30 cm became slightly denser (to 1,29 g/cm^3) and by minimal tillage the layer 10-20 cm (1,25-1,29 g/cm^3) and this tendency saved till the end of vegetation (table 1).

Table 1

Soil Density by Cultivation of Spring Wheat, Accordingly to Soil Tilling System, g/cm^3 (average in 2012-2013)

Soil tilling system	Soil layer, cm	Stages		
		Before sowing	Phase of shoots	Before harvesting
Plowing	0-10	1,01±0,04	1,14±0,02	1,35±0,03
	10-20	1,27±0,01	1,35±0,01	1,38±0,02
	20-30	1,29±0,06	1,39±0,07	1,39±0,04
Disking	0-10	1,03±0,01	1,26±0,02	1,31±0,06
	10-20	1,25±0,01	1,39±0,06	1,41±0,03
	20-30	1,29±0,03	1,26±0,05	1,38±0,07
Direct seeding	0-10	1,05±0,04	1,26±0,07	1,30±0,07
	10-20	1,27±0,02	1,35±0,03	1,33±0,05
	20-30	1,28±0,05	1,31±0,04	1,37±0,04

It stands to mention the variants with using of direct seeding. On this variant the soil density in the plowing layer was lower compare to plowing and disking. This can be explained by the fact that by using direct seeding, after-harvesting leftovers stay on the field. These leftovers decrease the pressure on soil from tractors and also decrease the density of the upper layer from atmospheric precipitation.

Soil density affects soil's permeability and moisture level which we determined on the upper layers during vegetation period of spring wheat (table 2). The highest moisture level is noticed at the beginning of vegetation and its quantity was decreasing gradually till the end of the vegetation period. Before sowing, the most moist was soil in the variant of direct seeding, where the moisture level was 22,8-24,7% and was the highest in comparison to plowing by 2,7-4,7%. Variant with disking also had an advantage of plowing. This pattern stayed till the end of the vegetation period and it was connected with the fact that while using disking and direct seeding, there is a mulching layer on the soil surface that does not let the moist to evaporate from the soil.

Table 2

The Content of Moisture in Soil, in Accordance with the Tilling System, % (average in 2012-2013)

Soil tilling system	Soil layer, cm	Stages		
		Before sowing	Phase of shoots	Before harvesting
Plowing	0-10	20,1±0,39	16,3±0,54	9,1±0,11
	10-20	20,2±0,27	16,5±0,39	9,7±0,24
	20-30	20,3±0,21	16,5±0,54	10,3±0,28
Disking	0-10	22,7±0,78	18,6±0,57	9,3±0,32
	10-20	22,9±0,77	18,9±0,37	10,1±0,30
	20-30	23,2±0,99	19,6±0,21	10,4±0,35
Direct seeding	0-10	22,8±0,89	18,7±0,09	9,3±0,32
	10-20	24,4±0,83	20,0±0,48	10,3±0,54
	20-30	24,7±0,27	20,4±0,55	10,6±0,27

The improvement of separate indicators of water-physical properties of Greyzem haplic soil affected the spring wheat yield in the variant with minimization of tillage (table 3).

Table 3

Spring Wheat Yield by Different Tillage Systems of Greyzem Haplic Soil (average in 2012-2013)

Soil tilling system	Yield, t/ha
Plowing	3,91
Disking	3,76
Direct Seeding	4,55
$HIP_{0,5}$	0,39

The average yield of spring wheat in 2012 and 2013 was significantly higher in the variants with direct seeding. An increase of yield, compare to plowing, was 0,64 t/ha. Yield in the variant with disking did not differ from plowing drastically.

Conclusion.

1. Minimization of soil tillage improves the indicators of water-physical properties of soil and guarantees moisture preservation during whole vegetation period.

2. During vegetation period, significant soil density is observed, independently of soil tillage system. Along with this, on the variant with using direct seeding technology, compare to plowing and disking, there is a tendency of decrease of the indicators of soil density.

3. The usage of direct seeding technology has considerable effect on the formation of spring wheat yield. In particular, in this variant, the cultivation yield was 4,55 t/ha, which is accordingly 0,64-0,79 t/ha more than the indicators of plowing and disking.

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Анотація

Балаєв А.Д., Борисенко Ю.А.

Вплив різних систем обробітку ґрунту на водно-фізичні властивості темно-сірого опідзоленого ґрунту та врожайність пшениці ярої в умовах Лівобережного Лісостепу України

Досліджено вплив різних систем обробітку темно-сірого опідзоленого ґрунту на його водно-фізичні властивості та врожайність пшениці ярої. Встановлено, що застосування під пшеницю мінімального обробітку ґрунту, порівняно із традиційною полицевою оранкою, позитивно впливає на рівень вологозабезпеченості ґрунту, сприяє покращенню його агрофізичних властивостей, що, у кінцевому результаті, забезпечує суттєвий приріст урожайності культури.

Ключові слова: *пшениця яра, щільність ґрунту, вміст вологи, система обробітку*

Аннотация

Балаев А.Д., Борисенко Ю.А.

Влияние различных систем обработки почвы на водно-физические свойства темно-серой подзолистой почвы и урожайность пшеницы яровой в условиях Левобережной Лесостепи Украины

Исследовано влияние различных систем обработки темно-серой подзолистой почвы на его водно-физические свойства и урожайность пшеницы яровой. Установлено, что применение минимальной обработки почвы под пшеницу, по сравнению с традиционной вспашкой, положительно влияет на уровень влагообеспеченности почвы, способствует улучшению его агрофизических свойств, что в конечном итоге обеспечивает существенный прирост урожайности культуры.

Ключевые слова: *пшеница яровая, плотность почвы, содержание влаги, система обработки*