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S.P. Tanchyk*
Doctor of Agricultural Sciences, Professor, Head of the Department
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine

N.I. Babilia
Postgraduate Student
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine

A.I. Babenko
PhD in Agricultural Sciences, Senior Lecturer
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine

Agrophysical indicators of soil for growing winter barley in the Transcarpathia of Ukraine

Abstract. The study presents the values, tasks, and results of various methods of basic tillage for different predecessors on its agrophysical properties for growing winter barley in the Transcarpathia of Ukraine. The soil of the experimental field is sod-podzolic gumbo, which contains an average of 2.6% humus in the humus horizon. With depth, the amount of humus decreases gradually and at a depth of 100-130 cm it reaches 1.0-1.7%. The soil is typical for the area where the study was conducted and is moderately provided with mobile forms of phosphorus, potassium, and nitrogen. A qualitative assessment of the examined soils showed that the soil requires constant use of organic and mineral fertilisers, liming, and the introduction of crop rotations. The soil density is an important indicator of the physical properties of the soil, which affects not only the soil regimes but also the quality of its cultivation, which ultimately affects the yield of the crop and its quality. For the period of sowing winter barley, the most favourable indicators of the volume mass of 0-10 cm of the soil layer were provided by all systems of basic cultivation. The average soil density for the main cultivation options ranged between 1.09-1.17 g/cm^3, at $HIP_{0.5}$ = 0.01 g/cm^3. At a depth of 10-20 cm, the average volume mass of soil during ploughing was 1.14 g/cm^3, for chiselling, it was without substantial differences – 1.15 g cm^3. Conducting shallow (12-14 cm) and surface (6-8 cm) cultivation was accompanied by an increase in volume mass indicators to 1.16 and 1.19 g/cm^3, respectively. In the soil layer of 20-30 cm, it was similar: with shallow chisel cultivation, the average density was at the level of 1.24 g/cm^3, and on the surface – 1.25 g/cm^3. The precursors did not substantially affect the change in the

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*Corresponding author

density of the tillage layer of the soil. However, after corn for grain and sunflower, there is a tendency to increase the volume mass of the soil after chisel shallow and surface cultivation, especially in the lower layers of the soil. This soil density was at the level of 1.24-1.26 g/cm^3, which is within the optimal limit. The soil, loosened by mechanical cultivation, self-compacts during the growing season to an equilibrium density under the influence of its own mass, moisture, and drying. Therefore, during the period of earing and harvesting of winter barley, the soil gradually compacted to natural values. In a 0-10 cm layer of soil, the volume mass varied in the range of 1.20-1.27 g/cm^3, in the soil layer of 10-20 cm – from 1.25 to 1.30 g/cm^3, and in 20-30 cm – from 1.34 to 1.37 g/cm^3. For the effective activity of microorganisms, the growth and development of the root system of plants, and the accumulation of moisture in the soil, density (porosity) is important. It was identified that long-term use of the deep and chisel tillage did not reduce the overall porosity below 50% of the structure of the cultivated layer, which ensured the high productivity of cultivated plants. For the surface and shallow chisel tillage, the total porosity in the lower layers was up to 50% of the structure of the cultivation layer, and in some cases less than 47%. This structure of the cultivation layer negatively affected the water and air regimes of the soil, the growth and development of the root system, and, ultimately, the yield of winter barley. The highest yield of winter barley was obtained after buckwheat, winter rapeseed and soybeans (6.0-6.3 t/ha) during chisel tillage to the depth of 20-22 cm. After corn for grain and sunflower, the yield was 5.1-5.7 t/ha

Keywords: ploughing; chiselling; soil density; porosity

RELEVANCE

Soil fertility is determined by a complex of biological, chemical, and agrophysical properties. In the process of production activity, the farmer modifies these properties and achieves the most favourable conditions for the growth and development of agricultural crops. Human intervention in soil processes should be based on the use of agricultural laws. (Demyatnik *et al.* 2021; Tsyuk & Kirilyuk, 2016; Burtan & Cioroianu, 2020; Shuvar & Grynyk, 2019).

The agrophysical properties of the soil determine the complex of vital conditions for the growth of cultivated plants. Density and porosity are the most important indicators of physical condition that characterise water, nutrient, air, and heat regimes, conditions for the development of root systems, soil microflora, and the formation of agricultural crops. (Shevchenko, 2013; Odachenko & Tanchyk, 2016; Ovsyannikov, 2020; Degodyuk *et al.*, 2020; Kramaryov *et al.*, 2021; Pikovska, 2013).

Thus, the examination of the specific features of growth, development, and formation of productivity of winter barley in the Transcarpathia of Ukraine is still relevant and led to the choice of the algorithm of the study.

ANALYSIS OF RECENT STUDIES AND PAPERS

The soil, loosened by mechanical cultivation, self-compacts during the growing season to an equilibrium density characteristic of a certain soil cover under the influence of its own mass, moisture, and drying. Thus, for chernozems of medium loamy mechanical composition, it is 1.0-1.3 g/cm^3 (Tanchyk & Salnikov, 2014; Uvarenko, 2018), for sod-podzolic gumbo – 1.5-1.6 g/cm^3 (Chumbey *et al.*, 2019), for grey forest heavy-loamy – 1.2-1.45 g/cm^3 (Korchagin *et al.*, 2015). In most cases, the equilibrium soil density exceeds the optimal one for cultivated plants, and therefore mechanical cultivation is mandatory (Sinchenko *et al.*, 2019).

In the introduction of chisel tillage into production, considerable attention is paid to its theoretical justification and, above all, to its

impact on the agrophysical properties of the soil. Studies in various soil and climatic zones of Ukraine established that the density of the tillage layer of soils with chisel cultivations is higher compared to ploughing to the same depth (Nakloka & Yeshchenko, 2005; Markovska *et al.*, 2020; Chumbey *et al.*, 2018), and reducing the depth of chisel cultivation to 10-12 cm leads to an increase in the density of the entire cultivating (arable) soil layer (Medvedev *et al.*, 2002; Tsylyuryk *et al.*, 2020; Shevchenko *et al.*, 2012; Karpenko & Panchenko, 2014; Tkalich *et al.*, 2011; Reznichenko, 2015; Huang at al., 2015; Weber, Kunz, 2017; Ryken *et al*., 2018).

In recent years, many studies have been conducted to examine the reaction of agricultural crops to the density of the tillage layer of soil. Now in different soil and climatic zones, soil density parameters for grain crops are established (Berezhnyak, 2015). Regarding winter barley in the Transcarpathia of Ukraine, there are discrepancies in the literature sources, which are explained by soil differences, cultivated varieties of this crop, conditions and methods of scientific research, and many other factors.

The optimal density of the cultivated soil for growing winter barley in conditions of average moisture content of the year on sod-podzolic soils of heavy- and medium-loamy mechanical composition is 1.15 g/cm^3, on sod-podzolic light- and sandy-loamy mechanical composition – 1.22 g/cm^3, on chernozems of typical and grey forest soils of heavy- and medium-loamy composition – 1.17 g/cm^3, on chernozems of typical, southern, and brown soils of heavy-loamy mechanical composition – 1.19 g/cm^3 (Gavrilyuk, 2016; Litvinov, 2015).

The purpose of the study consists in establishing effective mechanical tillage, depending on the predecessor, for growing winter barley in the Transcarpathia of Ukraine. It was planned to solve the following tasks to achieve this goal: establish the influence of different methods of tillage and its depth for different predecessors on changes in the density of the structure, the porosity of the cultivated soil layer, and the productivity of winter barley; provide an economic and energy assessment of crop cultivation under different predecessors.

MATERIALS AND METHODS

Experimental studies on the influence of different methods of tillage with different predecessors on the productivity of winter barley were conducted during 2018-2020 in the experimental crop rotation of the SSU "Mukachevo Applied College of the National University of Life and Environmental Sciences of Ukraine" in the Transcarpathian region.

The soil of the experimental field is sod-podzolic gumbo, which contains an average of 2.6% humus in the humus horizon. With depth, the amount of humus decreases gradually and at a depth of 100-130 cm it reaches 1.0-1.7%. Formation on carbonate-free parent material and the influence of the podzolic process of soil formation caused a high active and potential acidity of soils, the pH of salt extract ranges between 5.0-6.0.

The soil under study, according to the agrochemical analysis of the initial samples, contains available forms of nitrogen – 35-45 mg/kg, mobile phosphorus (by Kirsanov method) – 130-160 mg/kg, mobile potassium (by Kirsanov method) – 120-170 mg/kg. The soil is typical for the area where the studies were conducted and is moderately provided with mobile forms of phosphorus, potassium, and nitrogen. A qualitative assessment of the examined soils showed that the soil requires constant use of organic and mineral fertilisers, liming, and the introduction of crop rotations.

The scheme of the experiment included the analysis of the influence of five predecessors and four tillage types for the cultivation of winter barley:

Predecessor: (A)

1. Soy (control);
2. Winter rapeseed;
3. Buckwheat;
4. Corn for grain;
5. Sunflower.

Tillage: (B) (control)

1. Deep tillage (ploughing) to a depth of 20-22 cm;

2. Chiseling (deep chisel) to a depth of 20-22 cm;
3. Chiseling (discing) to a depth of 12-14 cm;
4. Chiseling (discing) for 6-8 cm.

The climate of the area is moderate with unstable humidity. The average perennial precipitation rate for the year is 618.0 mm. Over the years of the experiment, the amount of precipitation for the year was: 2018 – 568.3 mm, 2019 – 558.1, and 2020 – 513.1 mm, which is 10-13% less than normal.

The following precursors were examined for the cultivation of winter barley: soy (control), winter rapeseed, buckwheat, corn for grain, and sunflower.

The repetition rate of the experiment is fourfold, the total area of one plot is 240 m^2, accounting plot – 150 m^2. Land plot placement is randomised. The technology of growing winter barley in the experiment is generally accepted for the zone. In soil samples, the folding density was determined by the Kaczynski cylinder method, and the solid phase density was determined by the Dolgov method. The total porosity was determined by the calculation method.

RESULTS AND DISCUSSION

The soil density is an important indicator of the physical properties of the soil, which affects not only the soil regimes but also the technological properties and quality of tillage, which ultimately affects the yield of the crop and its quality.

It is established that the optimal density of the cultivated soil layer during the growing season of winter barley should be in the range of 1.1-1.3 g/cm^3. In experiments, this indicator changed substantially depending on the soil layer, the sampling period, and the factors under study. Thus, during the period of sowing winter barley, the most favourable indicators of the volume mass of 0-10 cm of the soil layer were provided by all systems of basic tillage without a substantial difference. The average soil density for the main cultivation options ranged between 1.09-1.17 g/cm^3, at $HIP_{0.5}$ = 0.01 g/cm^3 (Table 1). The differences between the main tillage options were more pronounced with increasing sampling depth. At a depth of 10-20 and 20-30 cm, the difference between the main cultivation options was statistically substantial and was manifested in an increase in volume mass in the options with a decrease in the depth of the main cultivation and the predecessor. At a depth of 10-20 cm, the average volume mass of soil during ploughing was 1.14 g/cm^3, for chiselling it was not substantially different – 1.15 g/cm^3. Conducting shallow (12-14 cm) and surface (6-8 cm) cultivation was accompanied by an increase in volume mass indicators to 1.16 and 1.19 g/cm^3, respectively. In the soil layer of 20-30 cm, it was similar: with shallow chisel cultivation, the average density was at the level of 1.24 g/cm^3, and on the surface, respectively – 1.25 g/cm^3.

Table 1. Influence of the main cultivation and predecessors on the total density of the cultivated soil layer during the cultivation of winter barley, g/cm^3 (sowing period, average for of 2018-2020)

Predecessor	Soil layer, cm	Basic tillage			
		Deep tillage (ploughing) to a depth of 20-22 cm (control)	Chiselling (deep chisel) to a depth of 20-22 cm	Chiselling (discing) to a depth of 12-14 cm	Chiselling (discing) to a depth of 6-8 cm
Soy (control)	0-10	1.12	1.14	1.09	1.11
	10-20	1.14	1.15	1.13	1.18
	20-30	1.23	1.21	1.24	1.25
	0-30	1.16	1.17	1.15	1.18
Winter rapeseed	0-10	1.09	1.11	1.10	1.12
	10-20	1.15	1.14	1.14	1.17

Table 1. Continued

Predecessor	Soil layer, cm	Basic tillage			
		Deep tillage (ploughing) to a depth of 20-22 cm (control)	Chiselling (deep chisel) to a depth of 20-22 cm	Chiselling (discing) to a depth of 12-14 cm	Chiselling (discing) to a depth of 6-8 cm
Winter rapeseed	20-30	1.21	1.23	1.24	1.24
	0-30	1.15	1.16	1.16	1.18
Buckwheat	0-10	1.11	1.12	1.10	1.10
	10-20	1.14	1.13	1.13	1.16
	20-30	1.22	1.20	1.22	1.23
Buckwheat	0-30	1.16	1.15	1.15	1.16
Corn for grain	0-10	1.13	1.15	1.17	1.16
	10-20	1.15	1.17	1.19	1.21
	20-30	1.25	1.21	1.26	1.24
	0-30	1.18	1.18	1.21	1.20
Sunflower	0-10	1.12	1.13	1.15	1.14
	10-20	1.14	1.15	1.17	1.23
	20-30	1.23	1.23	1.25	1.26
	0-30	1.16	1.17	1.19	1.21
HIP_{05} (A)		0.013	0.014	0.013	0.016
HIP_{05} (B)		0.014	0.01	0.01	0.015
HIP_{05} (AB)		0.15	0.18	0.7	0.14

Therefore, it can be argued that chisel cultivation leads to some compaction of the soil, which does not exceed the deviation standards for winter barley.

The precursors did not substantially affect the change in the density of the cultivated soil layer. However, after corn for grain and sunflower, there is a tendency to increase the volume mass of the soil after chisel shallow and surface cultivation, especially in the lower layers of the soil. This soil density was at the level of 1.24-1.26 g/cm^3, which is within the optimal limit.

Volume mass is a dynamic value during the growing season. It varies depending on the level of soil fertility, the degree of moisture, the conditions for the development of the root system, and soil microflora. The soil, loosened by mechanical cultivation, self-compacts during the growing season to an equilibrium density characteristic of a certain soil cover under the influence of its own mass, moisture, and drying. Therefore, during the period of winter barley earing, there was a gradual compaction of the soil to natural values. The effect of tillage on its density was substantial, starting from a depth of 10 cm. In the 0-10 cm layer, there was no substantial difference between the main tillage options. The volume mass varied in the range of 1.20-1.27 g/cm^3. In the soil depth of 10-20 cm, the average soil density was from 1.25 g/cm^3 in the version with ploughing up to 1.30 on areas with surface tillage. Chiselling and shallow cultivation tended to slightly compact the soil to indicators of 1.23 and 1.26 g/cm^3, respectively. In the soil layer of 20-30 cm during surface tillage, compaction occurred at the level of 1.30 g/cm^3.

During the winter barley harvest period, soil compaction trends continued. The volume mass

in layers of 10-20 and 20-30 cm substantially exceeded the optimal values for all tillage and was maximum for surface chiselling after corn for grain and sunflower and amounted to 1.34-1.37 g/cm^3. That is, for the period of harvesting winter barley, the indicators of soil volume mass acquired natural values inherent in this type of soil (Table 2).

Table 2. Influence of the main cultivation and predecessors on the total density of the cultivated soil layer during the cultivation of winter barley, g/cm^3 (harvest period, average for 2018-2020)

Predecessor	Soil layer, cm	Basic tillage			
		Deep tillage (ploughing) to a depth of 20-22 cm (control)	Chiselling (deep chisel) to a depth of 20-22 cm	Chiselling (discing) to a depth of 12-14 cm	Chiselling (discing) to a depth of 6-8 cm
Soy (control)	0-10	1.26	1.25	1.24	1.25
	10-20	1.32	1.31	1.35	1.36
	20-30	1.35	1.34	1.32	1.37
	0-30	1.31	1.30	1.30	1.33
Winter rapeseed	0-10	1.25	1.24	1.25	1.24
	10-20	1.30	1.31	1.33	1.35
	20-30	1.33	1.34	1.35	1.37
	0-30	1.29	1.30	1.31	1.32
Buckwheat	0-10	1.24	1.24	1.23	1.24
	10-20	1.30	1.30	1.34	1.33
	20-30	1.32	1.33	1.36	1.36
	0-30	1.29	1.29	1.31	1.31
Corn for grain	0-10	1.26	1.25	1.27	1.26
	10-20	1.34	1.33	1.35	1.36
	20-30	1.35	1.34	1.36	1.37
	0-30	1.32	1.31	1.33	1.33
Sunflower	0-10	1.25	1.23	1.24	1.25
	10-20	1.33	1.32	1.34	1.35
	20-30	1.36	1.33	1.37	1.36
	0-30	1.31	1.29	1.32	1.32
HIP_{05} (A)		0.016	0.018	0.02	0.019
HIP_{05} (B)		0.017	0.01	0.019	0.022
HIP_{05} (AB)		0.03	0.027	0.025	0.033

The density of the soil does not provide complete information about the structure of the cultivation layer by itself. For the effective activity of microorganisms, the growth and development of the root system of plants, and the accumulation of moisture in the soil, such an indicator of the physical condition of the cultivation layer as density (porosity) is important.

Doyarenko A.G. identified that when the total porosity decreases below 50%, the conditions

for the growth and development of agricultural plants worsen and their yield decreases, while for 55% the latter was the highest.

This study established that long-term use of deep and chisel tillage did not reduce the overall porosity below 50% of the structure of the cultivated layer, which ensured the high productivity of cultivated plants. For the surface and shallow chisel tillage, the total porosity in the lower layers was up to 50% of the structure of the cultivated layer, and in some cases less than 47% (Table 3, 4). This structure of the cultivated layer negatively affected the water and air regimes of the soil, the growth and development of the root system, and, ultimately, the yield of winter barley.

Table 3. Influence of the main cultivation and predecessors on the total duty cycle of the tillage layer for growing winter barley, % (sowing period, average for of 2018-2020)

Predecessor	Soil layer, cm	Basic tillage			
		Deep tillage (ploughing) to a depth of 20-22 cm (control)	Chiselling (deep chisel) to a depth of 20-22 cm	Chiselling (discing) to a depth of 12-14 cm	Chiselling (discing) to a depth of 6-8 cm
Soy (control)	0-10	57.0	56.2	58.1	57.3
	10-20	56.2	55.8	56.5	54.6
	20-30	53.1	53.5	52.5	52.0
	0-30	55.4	55.0	55.8	54.6
Winter rapeseed	0-10	58.1	57.3	57.7	57.0
	10-20	55.8	56.2	52.5	55.0
	20-30	53.5	53.1	52.5	52.5
	0-30	55.8	55.4	55.4	54.6
Buckwheat	0-10	57.3	57.0	57.7	57.7
	10-20	56.2	56.5	56.5	55.4
	20-30	53.1	53.9	53.1	53.1
	0-30	55.4	55.8	55.8	55.4
Corn for grain	0-10	56.5	55.8	55.0	55.4
	10-20	55.8	55.0	54.2	53.5
Corn for grain	20-30	52.0	53.5	51.5	52.5
	0-30	54.6	54.6	53.5	53.9
Sunflower	0-10	57.0	56.5	55.8	56.2
	10-20	56.2	55.8	55.0	53.1
	20-30	53.1	53.1	52.0	51.5
	0-30	55.4	55.0	54.2	53.5
HIP_{05}(A)		0.014	0.014	0.015	0.018
HIP_{05}(B)		0.013	0.015	0.017	0.016
HIP_{05}(AB)		0.021	0.019	0.025	0.019

Table 4. Influence of the main cultivation and predecessors on the total duty cycle of the tillage layer for growing winter barley, % (harvest period, average for 2018–2020)

Predecessor	Soil layer, cm	Basic tillage			
		Deep tillage (ploughing) to a depth of 20-22 cm (control)	Chiselling (deep chisel) to a depth of 20-22 cm	Chiselling (discing) to a depth of 12-14 cm	Chiselling (discing) to a depth of 6-8 cm
Soy (control)	0-10	51.5	52.0	52.5	52.0
	10-20	49.2	49.6	48.2	47.8
	20-30	48.2	48.5	49.2	47.3
	0-30	49.6	50.0	50.0	48.9
Winter rapeseed	0-10	52.0	52.5	52.0	52.5
Winter rapeseed	10-20	50.0	49.6	48.9	48.2
	20-30	48.9	48.5	48.2	47.3
	0-30	50.4	50.0	49.6	49.2
Buckwheat	0-10	52.5	52.4	53.1	52.5
	10-20	50.0	50.0	48.5	48.9
	20-30	49.2	48.9	47.8	47.8
	0-30	50.4	50.4	49.6	49.6
Corn for grain	0-10	51.5	52.0	51.2	51.5
	10-20	48.5	48.9	48.2	47.8
	20-30	48.2	48.5	47.8	47.3
	0-30	49.2	49.6	48.9	48.9
Sunflower	0-10	52.0	53.1	52.5	52.0
Sunflower	10-20	48.9	49.2	48.5	48.2
	20-30	47.8	48.9	47.3	47.8
	0-30	49.6	50.4	49.2	49.2
HIP_{05} (A)		0.016	0.017	0.013	0.018
HIP_{05} (B)		0.013	0.015	0.016	0.02
HIP_{05} (AB)		0.015	0.018	0.017	0.019

The productivity of winter barley is an integral indicator of the effectiveness of using various predecessors and tillage.

Among the predecessors under study, the highest level of crop yield was obtained for planting it after buckwheat, winter rapeseed, and soybeans for conducting chisel tillage to a depth of 20-22 cm. On average, for three years in these variants, the yield was from 6.0 to 6.3 t/ha (Table 5).

Table 5. Yield of winter barley depending on its predecessors and main tillage, t/ha

Predecessor (A)	Main tillage (B)	Years			Average for 2018-2020
		2018	2019	2020	
Soy (control)	Deep tillage (ploughing) to a depth of 20-22 cm (control)	6.2	5.7	5.3	5.7
	Chiselling (deep chisel) to a depth of 20-22 cm	6.2	6.1	5.8	6.0
	Chiselling (discing) to a depth of 12-14 cm	5.5	5.3	5.1	5.3
	Chiselling (discing) to a depth of 6-8 cm	5.3	5.2	5.0	5.2
Winter rapeseed	Deep tillage (ploughing) to a depth of 20-22 cm (control)	6.0	5.8	5.4	5.7
	Chiselling (deep chisel) to a depth of 20-22 cm	6.4	5.9	5.8	6.0
	Chiselling (discing) to a depth of 12-14 cm	5.8	5.6	5.5	5.6
	Chiselling (discing) to a depth of 6-8 cm	5.7	5.1	5.3	5.4
Buckwheat	Deep tillage (ploughing) to a depth of 20-22 cm (control)	6.3	5.8	5.7	5.9
	Chiselling (deep chisel) to a depth of 20-22 cm	6.5	6.1	6.2	6.3
	Chiselling (discing) to a depth of 12-14 cm	6.2	5.8	5.5	5.8
	Chiselling (discing) to a depth of 6-8 cm	5.9	5.9	5.3	5.7
Corn for grain	Deep tillage (ploughing) to a depth of 20-22 cm (control)	5.0	4.9	4.8	4.9
	Chiselling (deep chisel) to a depth of 20-22 cm	5.4	5.2	4.8	5.1
	Chiselling (discing) to a depth of 12-14 cm	4.7	4.5	4.6	4.6
	Chiselling (discing) to a depth of 6-8 cm	4.6	4.6	4.3	4.5
Sunflower	Deep tillage (ploughing) to a depth of 20-22 cm (control)	5.4	5.2	5.0	5.2
	Chiselling (deep chisel) to a depth of 20-22 cm	5.9	5.6	5.7	5.7
	Chiselling (discing) to a depth of 12-14 cm	5.0	4.7	4.8	4.8
	Chiselling (discing) to a depth of 6-8 cm	5.1	4.6	4.6	4.8
HIP_{05}	A	0.248769	0.198605	0.158627	0.248769
	B	0.222506	0.177638	0.14188	0.222506
	AB	0.497538	0.39721	0.317254	0.497538

The lowest yield of winter barley was obtained after corn for grain during shallow and surface tillage. The decrease in yield was from 25 to 29%. The difference between winter barley and sunflower reduced the yield of the crop by 18-20% compared to the reference predecessors.

CONCLUSIONS

In the Transcarpathia of Ukraine, on sod-podzolic soils, minimising tillage leads to an increase in the density of the cultivation layer and a decrease in overall porosity. The soil density increased from sowing to full ripeness of grain, which did not exceed the optimal one for most agricultural crops, including winter barley (1.30 g/cm^3) for ploughing and chiselling to the depth of 20-22 cm. With shallow and surface chisel tillage, the density formed in the range of 1.35-1.37 g/cm^3, which exceeded the optimal one for the culture.

The highest yield (6.0-6.3 t/ha) of winter barley was formed when placed after buckwheat, winter rapeseed, and soybeans with chiselling to the depth of 20-22 cm.

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С.П. Танчик
Доктор сільськогосподарських наук, професор, завідувач кафедри
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
Н.І. Бабіля
Аспірант
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
А.І. Бабенко
Кандидат сільськогосподарських наук, старший викладач
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна

Агрофізичні показники ґрунту за вирощування ячменю озимового в Закарпатті України

Анотація. У статі подані значення, завдання та результати різних способів основного обробітку ґрунту за різних попередників на агрофізичні його властивості за вирощування ячменю озимого в Закарпатті України. Ґрунти дослідного поля – дернові опідзолені оглеєні, які містять у гумусовому горизонті в середньому 2,6 % гумусу. З глибиною кількість перегною зменшується дуже поступово й на глибині 100-130 см він досягає ще 1,0-1,7 %. Ґрунт є типовим для зони проведення досліджень, середньо забезпечений рухомими формами азоту, фосфору та калію. Якісна оцінка обстежених ґрунтів показала, що ґрунти потребують постійного застосування органічних і мінеральних добрив, проведення вапнування та впровадження сівозмін. Щільність ґрунту є важливим показником фізичних властивостей ґрунту, який впливає не лише на ґрунтові режими, а й на його якість обробітку, що в підсумку впливає на урожайність культури та її якість. На період сівби ячменю озимого найбільше сприятливі показники об'ємної маси 0-10 см шару ґрунту забезпечували всі системи основного обробітку. Щільність ґрунту в середньому по варіантах основного обробітку коливалася в межах 1,09-1,17 г/см^3, за НІР0,5

0,01 г/см^3. На глибині 10-20 см середня об'ємна маса ґрунту за оранки становила 1,14 г/см^3, за чизельного обробітку вона була без істотних відмінностей – 1,15 г/ см3. Проведення мілкого на 12-14 см та поверхневого на 6-8 см супроводжувалося підвищенням показників об'ємної маси до, відповідно, 1,16 і 1,19 г/см^3. У шарі ґрунту 20-30 см була аналогічною: за мілкого безполицевого обробітку середня щільність була на рівні 1,24 г/см^3, а за поверхневого – 1,25 г/см^3. Попередники суттєво не впливали на зміну щільності оброблювального шару ґрунту. Проте, після кукурудзи на зерно та соняшника спостерігається тенденція до підвищення об'ємної маси ґрунту після безполицевого мілкого та поверхневого обробітку, особливо в нижніх шарах ґрунту. Ця щільність ґрунту була на рівні 1,24-1,26 г/см^3 , що не виходила за межі оптимальної. Розпушений у процесі механічного обробітку ґрунт упродовж вегетаційного періоду під впливом сили власної маси, зволоження і висихання самоущільнюється до рівноважної щільності. Тому на період колосіння і збирання врожаю ячменю озимого відбулося поступове ущільнення ґрунту до природних значень. У 0-10 см шарі ґрунту об'ємна маса варіювала в межах 1,20-1,27 г/см^3 у шарі ґрунту 10-20 см – 1,25-1,30 г/см^3 і 20-30 см – 1,34-1,37 г/см^3 . Для ефективної діяльності мікроорганізмів, росту й розвитку кореневої системи рослин та нагромадження вологи в ґрунті важливе значення має щільність (пористість). Встановлено, що тривале застосування полицевих і безполицевих обробітків ґрунту не знижувало загальної щілинності нижче 50 % будови оброблюваного шару, що забезпечило високу продуктивність культурних рослин. За безполицевих поверхневого та мілкого обробітку ґрунту загальна щілинність у нижніх шарах становила до 50 % будови оброблювального шару, а в деяких випадках менш як 47 %. Така будова оброблювального шару негативно впливала на водний та повітряний режими ґрунту, на ріст і розвиток кореневої системи і, у кінцевому результаті на урожайність ячменю озимого. Найвища урожайність ячменю озимого отримана після гречки, ріпаку озимого та сої (6,0-6,3 т/га) за проведення безполицевого чизельного обробітку ґрунту на 20-22 см. Після кукурудзи на зерно і соняшнику урожайність становила 5,1-5,7 т/га

Ключові слова: часник; сорт; Любаша; Дюшес; Угорський; урожайність; поліморфізм