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Influence of primary tillage on some soil fertility indicators and corn yield

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Abstract. Cultivated soils are constantly under stress, in particular, from anthropogenic pressure due to their tillage. At the same time, climate change, moisture deficit, trends in crop rotation and improved crop tillage technologies encourage farmers to pay more attention to tillage systems. In addition, this element of technology plays a significant role in ensuring the sustainability of the entire agrophytocenosis. The aim of the study was to determine the effectiveness of different tillage practices on certain soil fertility indicators and corn yield. The research was carried out in 2021-2023 at the Dokuchaevske Experimental Field of the State Biotechnological University, which is located in the Left-Bank Forest-Steppe zone of Ukraine. The experimental design includes the study of different tillage methods: ploughing with PLN-4-35 at 25-27 cm (control); chisel local tillage with PC-2.5 at 33-35 cm; moldboardless tillage with PRN-31000 at 33-35 cm and discing with BDM-2.5 at 10-12 cm. The reaction of the soil to the main tillage in corn crops was determined through its main water and agrophysical parameters: moisture content, density and hardness. The results of the research showed that the condition of typical chernozem is almost the same after ploughing and moldboardless tillage with the PRN-31000 ("paraplough"). A slight increase in the density of the arable soil layer was found after the application of chisel and discing tillage. All tillage options created favourable conditions in the soil, as its hardness in the 0-20 cm soil layer was in the range of 13.3-15.1 kg/cm^2. In corn crops, moisture reserves in the one-metre layer did not differ by tillage options. However, there was a tendency for its decrease in the variants with chisel and discing tillage compared to ploughing. For all variants of soil tillage, compared to ploughing, there was a significant decrease in corn grain yield. The practical significance of the results obtained is to optimise the regulation of water and physical properties of typical chernozem with the achievement of soil protection technologies and stabilisation of corn grain yields in the context of climate change and variability of modern production

Keywords: soil texture density; moisture reserves; soil hardness; yield; row crops; ploughing; moldboardless tillage

INTRODUCTION

The study of the effectiveness of basic tillage methods in corn tillage is a topical issue due to the ambiguous reaction of the crop to the replacement of ploughing and minimisation of tillage. Climate change and the modernisation of the current state of technology with the use of high-performance hybrids, new forms of

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fertilisers and plant protection products have prompted research in this area. In particular, a comparative analysis of the intensive use of traditional tillage methods with current technologies aimed at resource conservation and adaptation used in agriculture should be carried out. At the same time, their impact on soil fertility should be taken into account. The structural condition of the soil, moisture reserves, soil density, nutrient regime, etc. are critical for maintaining crop sustainability and ensuring the productivity of technologies.

Corn is one of the world's major food crops, but it is highly susceptible to high temperatures and drought, with yield losses ranging from 17 to 60% (Tandzi *et al.*, 2019). In order to ensure high productivity of this crop, it is necessary to comply with the growing conditions it requires (Dehtiarova, 2022). In this regard, the agrophysical characteristics of the soil (hardness, density of the soil), weediness of crops, and water regime, which depend on tillage and weather conditions, are of great importance. Soil tillage is an important agricultural practice that affects soil properties and leads to the creation of a complex ecosystem in the soil. At the same time, tillage methods can cause soil stress, which manifests itself through the deterioration of water and agrophysical parameters, etc.

The degree of influence of tillage on the agrophysical properties of the soil is determined by the type, depth and methods of tillage. K. Acquah & Y. Chen (2022) noted that in order to create optimal conditions for growing crops, it is necessary to adhere to traditional tillage methods: harrowing, ploughing and loosening. The basic concept is to create favourable conditions for growing crops, including corn. It also takes into account soil and climatic conditions, the predecessor, biological characteristics of the crop, the level and nature of weed infestation, terrain, etc. As of 2024, differentiated tillage, with a depth of 6-8 to 40-45 cm, using ploughing, discing, flat-cutting and chiselling, is the dominant method.

Developed countries are intensively searching for ways to reduce the energy intensity of basic tillage. B. Rosser (2021) noted that an evenly levelled field after ploughing makes it possible to reduce the cost of subsequent tillage. At the same time, due to the rotation of the layer and the absence of stubble residues, the risk of erosion on the soil surface increases (Shaheb *et al.*, 2021; Ledermüller *et al.*, 2021). In Ukraine, the latest tillage technologies are increasingly used: no-till, surface tillage, minimum tillage, etc. The significance of these tillages lies in the combination of a certain number of agrotechnical operations in one technological process, the absence of turning the chop and deep loosening of the soil. Such technologies increase the economic and energy efficiency, as well as provide less stress on the soil. At the same time, they reduce the risk of "plough tread", which manifests itself in excessive soil compaction due to the passage of heavy agricultural machinery. Ye. Yurkevych *et al.* (2020) point out the importance of monitoring the density of the 0-30 cm soil layer, its dynamics during the growing season under different tillage systems, given that the main development of the root system occurs in this layer. Also, porosity, water permeability, moisture accumulation in the soil, growth and development of plants in general depend on this indicator.

The most energy-intensive method of soil tillage is loosening the top layer. In order to reduce energy consumption, a number of researchers propose to use strip tillage and a paraplane-type soil deepener to a two-tier plough (Gilandeh *et al.*, 2022). M. Furmanets & Yu. Furmanets (2023) found that the density of compaction in the case of moldboardless tillage was in the range of 0.86-1.17 g/cm^3 of soil, and with the use of basic surface tillage it increased to 0.9-1.26 g/cm^3. According to the research of P. Pisarenko & V. Piliarsky (2020) also found that the use of deep shelf ploughing at 28-30 cm contributed to the formation of optimal physical and mechanical properties of the soil. The most compacted soil was due to the use of discing tillage at a depth of 12-14 cm. Scientists say that yields can be reduced by 20-40% due to excessive compaction of the topsoil.

The purpose of the research was to study the impact of current tillage practices in modern agriculture when growing corn for grain.

MATERIALS AND METHODS

The study complies with ethical standards and adheres to the Convention on Biological Diversity (Secretariat of the..., 2011). The research was conducted in 2021-2023 at the Dokuchaevske Experimental Field of the State Biotechnological University of Ukraine. The soil cover of the experimental field is represented by typical heavy loamy chernozem on loess loam. In terms of agrophysical and agrochemical properties, it is one of the most favourable soils for growing field crops. It is characterised by high reserves of nutrients available to plants, high humus content and intense biological activity. The 0-30 cm soil layer contains 4.9-5.1% humus, 81 mg/kg of easily hydrolysable nitrogen (according to Kornfield), 100 and 200 mg/kg of mobile phosphorus and exchangeable potassium (according to Chirikov). The content of exchangeable cations: calcium – 37.8%, magnesium – 6.6%, sodium – 0.49% and potassium – 0.5%. Soil reaction: pH_{water} – 7.0, pH_{salt} – 5.2-5.6. Groundwater is located at a depth of about 18 m (Tykhonenko & Degtiarov, 2016).

According to the weather station in Dokuchaevske, the weather conditions in 2021 were not favourable for corn growing. Low precipitation in March (23.5 mm) was partially compensated in April-June (177.1 mm). However, insufficient rainfall in the second half of the summer significantly worsened growth conditions during flowering and grain harvest formation. In 2022, the temperature regime was more favourable and differed from the trends of recent years. In September, there was an increased amount of precipitation – 79 mm, which is almost 2 times more than in previous years. In 2023, the highest amplitudes of air temperature deviations from the long-term average were recorded in February (+5.2°C), March (+5.9°C) and June (+4.3°C). March and June saw the highest rainfall: 79.3 and 104.5 mm, respectively. The deviations from the average long-term norm were the largest in April, exceeding the norm by 33.4 mm, and in August, decreasing the norm by 23.4 mm.

For the experiment, a specially modified mid-early corn hybrid – DB Khotyn (FAO 280) – was used, which was developed by the Institute of Grain Farming of the National Academy of Agrarian Sciences of Ukraine. This hybrid was included in the Register of Varieties of Ukraine in 2013 and is recommended for tillage in all soil and climatic zones. The study was conducted in the third field of a five-field crop rotation with the following crop rotation: 1. Black fallow; 2. Winter wheat; 3. Safflower, corn; 4. Winter rye; 5. Sunflower. The content of corn tillage technology did not differ by experimental variants, except for the main tillage.

The experiment included the following variants of basic tillage methods:

1. Ploughing with PLN-4-35 at 25-27 cm (control).
2. Chisel local tillage by PC-2.5 at 33-35 cm.
3. Non-moldboard tillage with PRN-31000 at 33-35 cm.
4. Discing by BDM-2.5 at 10-12 cm.

Replication of the experiment – three times, placement of variants – sequential. The size of the sowing plot was 150 m^2 and the accounting plot was 50 m^2. The available moisture reserves were determined by the thermostat-weight method in the soil layer 0-100 cm, the density of the soil was determined by the cutting cylinder method according to N.A. Kachinsky every 10 cm (DSTU ISO 11272-2001, 2003), and the hardness was determined by the Revyakin hardness tester (DSTU 5096:2008, 2009). The corn grain yield was determined from the area under study by manually removing the cobs, followed by threshing and recalculation per hectare.

RESULTS AND DISCUSSION

The most significant soil stress is excess or deficit moisture. Most of Ukraine's territory is in the risky farming zone. The reasons for this are irregular precipitation, limited soil penetration and moisture accumulation, and high evaporation losses. The accumulation and preservation of moisture is an important factor in obtaining stable yields in the Forest-Steppe zone of Ukraine. At the same time, basic soil tillage plays a key role in regulating its agrophysical and water-physical properties, and monitoring of soil-water stress is a prerequisite for effective management of its mechanisms (Kharchenko *et al.*, 2019). In view of this, it is necessary to carry out high-quality tillage in a timely manner, taking into account modern technologies and using equipment that can be easily adapted to soil preparation processes with frequent changes in production conditions. Figure 1 shows the data on soil moisture reserves in 2021-2023. In some years, this indicator depended more on precipitation and air temperature than on the impact of tillage methods.

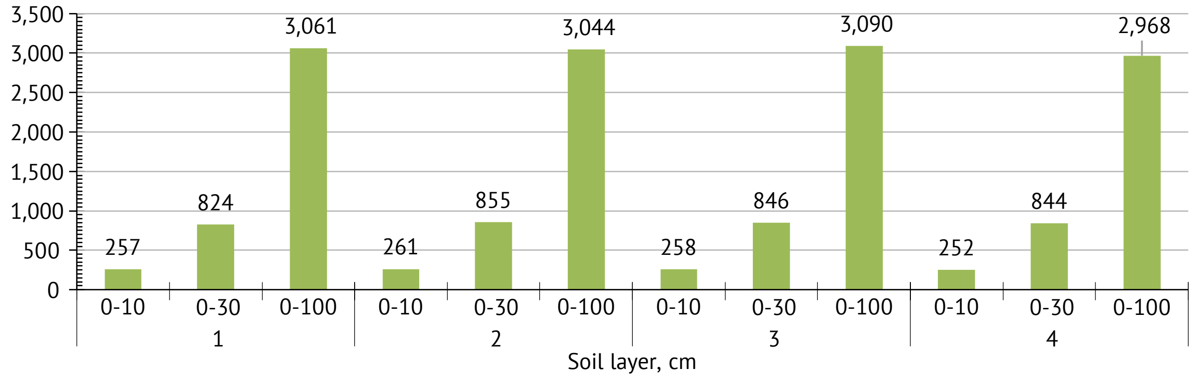

Figure 1. *Moisture reserves in the one-metre soil layer, m^3/ha (average for 2021-2023)*
Notes: *1. Ploughing PLN-4-35 by 25-27 cm (control); 2. Chisel local tillage PC-2.5 by 33-35 cm; 3. No-field tillage PRN-31000 by 33-35 cm; 4. Discing BDM-2.5 at 10-12 cm*
Source: *authors' development*

There was a slight difference between the variants of soil tillage in terms of the impact on moisture reserves in corn tillage. In the 0-30 cm tilth layer of soil, the amount of available moisture was 33-35 cm higher when using chisel tillage with the PC-2.5 compared to the control by 31 m³/ha. Studies show that discing and moldboardless tillage had an advantage over ploughing. These variants increased the moisture reserves in the arable layer by 20 and 22 m³/ha, which is a consequence of the increase in the density and hardness of the arable layer. These results are confirmed by the research of R. Vozhehova *et al.* (2019), where the soil moisture reserves were higher in the variant with discing to a depth of 8-10 cm.

In corn crops, moisture reserves in the one-metre layer did not actually differ by tillage options, but they were found to be reduced with chisel and discing tillage compared to ploughing by 17 and 93 m³/ha. The moisture reserves under the moldboardless tillage of PRN-31000 at 33-35 cm "paraplough" exceeded the values obtained under ploughing PLN-4-35 at 25-27 cm (control) by 29 m³/ha. This can be explained by the fact that this technology does not change the macrorelief of the soil surface and creates a dense network of cracks, the so-called "dense slotting effect", which, in general, contributed to a significant accumulation of moisture. In the research of S. Petrenko (2020) also did not find a clear dependence of moisture reserves on tillage methods. In the 0-100 cm soil layer, they were in the range of 58.1-51.5 mm. The scientist emphasised that this water-physical state of the soil depended more on the amount of precipitation.

Much attention is paid to the need for soil tillage as the main indicator of soil agrophysical properties. The results of scientists' research indicate a close dependence of the decrease in crop yields on the increase in soil density, especially after surface and flat-cut tillage (Stošić *et al.*, 2020). In fact, all studies related to tillage are considered in terms of the impact on this indicator. If there is no clear trend in soil texture between tillage systems, it is worth paying attention to the type of crops grown and the duration of the experiment. Sometimes, short-term studies do not show appropriately noticeable or significant changes in the physical and mechanical properties of the soil (Akinola *et al.*, 2023).

The application of a certain method and depth of basic tillage largely depends on the soil's natural condition. For example, chernozem soils in the Forest-Steppe zone have favourable agrophysical properties and, as a rule, do not require special loosening with layer turnover. Ploughing on such soils in dry conditions leads to excessive looseness of the topsoil and rapid evaporation of moisture (Pysarenko & Chaika, 2016). Chisel tillage, especially to a depth of 33-35 cm, provides similar parameters to ploughing. In addition, its use for local loosening, as well as shallow discing tillage, worsen the physical condition of the topsoil.

Studies conducted in 2021-2023 showed that the density of the 0-30 cm soil layer after corn harvesting ranged from 1.18 to 1.24 g/cm³ (Fig. 2). This value, according to the generally accepted scale (DSTU 4362:2004, 2006), was within the range of optimal values for corn tillage and did not exceed the optimal limit. A looser soil condition was provided by ploughing – 1.18 g/cm³. In the areas where the PRN-31000 was used for 33-35 cm moldboardless tillage, the density of the tilth layer of soil was higher than in the control by 0.03 g/cm. An increase in the density of topsoil was found after the use of chisel PC-2.5 at 33-35 cm and discing BDM-2.5 at 10-12 cm of tillage. The difference compared to the control in these variants was 0.05 and 0.06 g/cm³. Such differentiation of the topsoil by the studied indicator is associated with the mechanism of action of the working tools on the soil surface, which resulted in more compaction of the lower soil layers of 10-20 and 20-30 cm. These results are confirmed by the data of R. Vozhegova *et al.* (2021), which indicate that when ploughing to a depth of 28-30 cm, the soil density is lower (1.35 g/cm³) than in the shallow discing tillage system to a depth of 12-14 cm – 1.39 g/cm³.

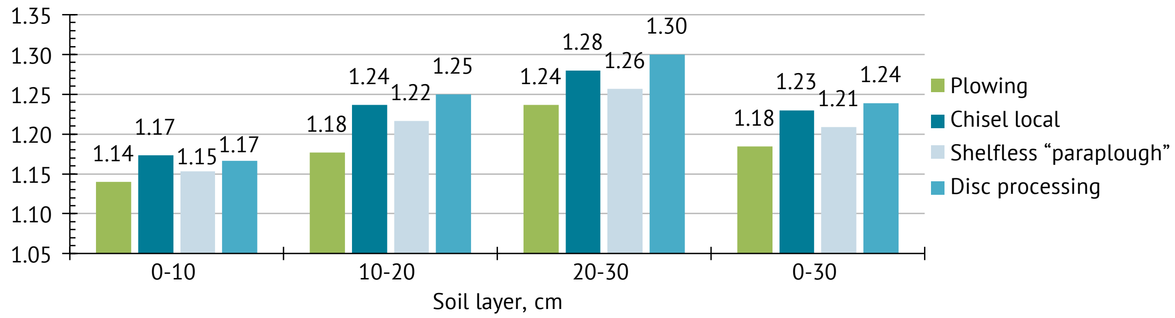

Figure 2. *Topsoil tilth density, g/cm³ (average for 2021-2023)*

Source: *authors' development*

The 0-10 cm soil layer had relatively low values of the density of compaction in all variants, especially when using ploughing and "paraplough" tillage. A slight increase in the density of soil compaction compared to the control occurred under the influence of chisel and discing tillage. On these variants in the soil layer 0-10 cm, the studied indicator was at the same level – 1.17 g/cm^3). However, the research of R.K. Afshar *et al.* (2022) showed that after the application of chisel tillage in corn crops, there was no significant change in soil density compared to ploughing.

With depth, the compaction of the arable layer increased, especially in the variants of chisel and discing tillage. Ploughing and "paraplough" are characterised by compaction of the layer in the lower part of the tilth layer (20-30 cm) to an average of 1.24-2.16 g/cm^3. The increase in density in the lower soil layers (10-20 and 20-30 cm) in these tillage options was due to a lower supply of corn residues than in PLN-4-35 ploughing at 25-27 cm. I. Garo & V. Gamayunova (2021) argue that the long-term use of moldboardless tillage and, especially, discing contributes to the differentiation of the arable layer by density. As a rule, these indicators decrease in the 0-10 cm soil layer, and increase in the 10-20 and 20-30 cm layers compared to ploughing. In order to create a level of soil density close to ploughing, it is necessary to carry out any other tillage to a depth of at least 20-22 cm. However, replacing ploughing with moldboardless tillage does not always provide the same effect as traditional tillage. Tillage with a moldboardless plough with PRN-31000 risers to a depth of 20-22 cm causes a tendency to increase the density of the arable layer compared to ploughing by 0.03-0.04 g/cm^3. The nature of the action of this tool on the soil leaves the density of the cultivated layer virtually unchanged. The study by Ye. Yurkevych *et al.* (2020) indicate an increase in the density of compaction in the soil layer of 10-20 cm by 0.06-0.08 g/cm^3, and in the layer of 20-30 cm by 0.07-0.08 g/cm^3 under flat-cutting and discing compared to ploughing.

Soil hardness reflected the same trends as the density of the tilth layer. The results of the research indicate that all tillage options created favourable conditions in the soil, as its hardness in the 0-20 cm soil layer was in the range of 13.3-15.1 kg/cm^2 (Fig. 3). The values of this indicator increased significantly in the upper soil layer (0-10 cm) after tillage with PC-2.5 at 33-35 cm, where it exceeded the control by 1.1 g/cm^2. In the lower soil layers, there was an increase in the resistance force after the moldboardless tillage with PRN-31000 by 33-35 cm compared to the control. In general, in the arable layer, the hardness value increased by 1.2 kg/cm^2 after deep continuous loosening with the PRN-31000, by 2.3 kg/cm^2 after local tillage with the PC-2.5, and by 3.3 kg/cm^2 after shallow discing tillage compared to ploughing.

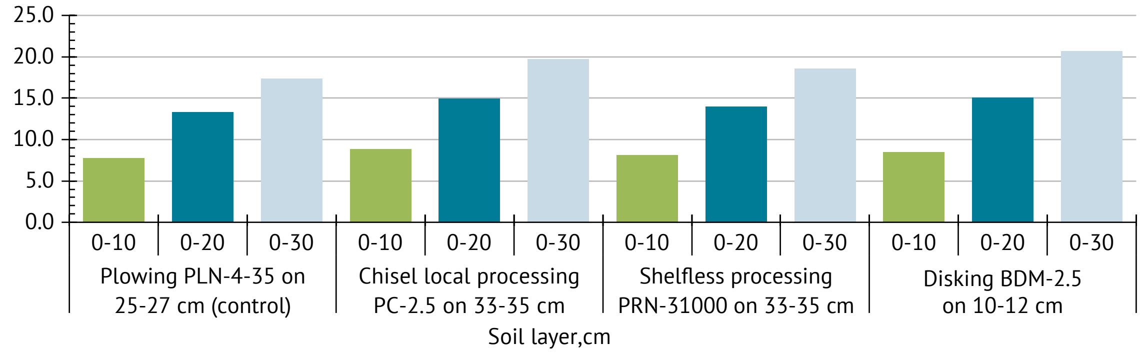

Figure 3. *Topsoil hardness, kg/cm^2 (average for 2021-2023)*
Source: *authors' development*

In almost all variants of the experiment, there was no dense layer in the arable layer. After deep moldboardless tillage, only a steady increase in soil hardness was recorded in all layers compared to ploughing. After applying shallow discing tillage with BDM-2.5, a significant increase in the resistance force was recorded at a depth of 8 to 13 cm, depending on the surface microrelief and the impact of the working bodies of the tool. However, in the conditions of 2022, the presence of this layer was felt to a lesser extent compared to other years of research. Moisture conditions after the winter period, late field work and the absence of additional surface treatments contributed to the mitigation of this problem. M. Shevchenko *et al.* (2020) found that the soil hardness when ploughing in the 0-30 cm layer was 31.7 kg/^{2}, and the use of shallow discing led to an increase of 4.7 kg/cm^2.

Crop yields can indirectly indicate the level of soil protection efficiency. On the one hand, higher crop yields can be the result of better plant development and more effective surface protection during the growing season. On the other hand, with higher yields, the weight of by-products that traditionally remain in the field and can create a protective screen increases accordingly. S. Shevchenko *et al.* (2024) found that ploughing led to faster soil warming and seed germination, which subsequently affected all stages of corn growth and development. The scientists emphasise that lower plant height, leaf area, number of ears per 100 plants and lower weight of 1,000 grains were associated with minimal tillage, which in turn led to a yield loss of 0.37-0.88 t/ha on average compared to ploughing. V. Hanhur *et al.* (2023) determined the highest corn yield after ploughing to a depth of 25-27 cm – 7.91 t/ha, while minimum tillage of 8-10 cm led to a significant decrease.

There was a significant decrease in yields for all tillage treatments compared to ploughing in the control (Table 1). The corn grain yield in 2021 was quite high considering the growing conditions. The main factors behind this result were a good predecessor, high-quality sowing, crop care and a small experimental area (3 ha).

Table 1. *Corn yields depending on the main tillage methods, t/ha (2021-2023)*

Methods of soil tillage	Years			
	2021	2022	2023	2021-2023
Ploughing PLN-4-35 by 25-27 cm (control)	6.92	6.25	6.93	6.70
Chisel local tillage of PC-2.5 at 33-35 cm	6.58	5.62	6.39	6.20
Shelfless processing PRN-31000 at 33-35 cm	6.67	5.96	6.62	6.42
Discing BDM-2.5 by 10-12 cm	6.51	5.59	6.11	6.07
$LSD_{0.05}$	0.10	0.22	0.12	

Source: *authors' development*

The yield of corn grain after replacing ploughing with any tillage was significantly lower. In particular, after applying the PRN-31000 tillage, it was 0.25 t/ha (3.6%) lower than the control, after local tillage with the PC-2.5 – by 0.34 t/ha (4.9%), and after discing shallow tillage – by 0.41 t/ha or 5.9%. Under the conditions of 2022, all the studied tillage methods were inferior to ploughing in terms of their impact on corn grain yield. After tillage with the PRN-31000, this decrease was 0.29 t/ha, after local tillage – by 0.63 t/ha and after discing tillage – by 0.66 t/ha. Discing tillage in 2023 reduced corn yields by 0.82 t/ha compared to ploughing, continuous chisel tillage by 25-27 cm – by 0.71 t/ha, and local tillage with a chisel plough – by 0.54 t/ha. The reason for this decline was the deterioration of the physical condition of the soil, which traditionally occurs after conservation tillage. The smallest decrease in corn grain yield in the experiment was obtained after deep loosening of PRN-31000 by 0.31 t/ha compared to ploughing, which indicates the advantage of this tillage among other soil-protective tillage. However, the use of deep moldboardless tillage of continuous and local impact contributed to an increase in the soil-protective efficiency of the surface and good moisture accumulation in the soil.

According to DSTU 4362:2004 (2006), the range of optimal density of typical heavy loamy chernozem for most crops, including corn, is 1.05-1.20 g/cm^3. A. Cerdà *et al.* (2021) note that conventional tillage practices have a more intense impact on soil density than natural processes. Thus, under the influence of moisture and temperature, the change in this indicator varies within ±0.05 g/cm^3, and depending on tillage methods, this range increases to ±0.20-0.30 g/cm^3. Conducting basic tillage to the same depth involves multiple passes of tractors and other agricultural machinery across the field, and as a result, the density of the soil can reach 1.4-1.6 g/cm^3. F.M. Mamatov *et al.* (2020) emphasise that the most effective way to eliminate the harmful effects of compaction is to carry out deep tillage. V. Hanhur *et al.* (2022) also believe that no-till tillage reduces the effects of machine passes, increases the organic matter content of the soil, improves its structure, regulates soil temperature and allows the soil to store more moisture.

A significant number of researchers prefer ploughing as the main method. According to T. Keller *et al.* (2019), this method provides soil loosening, incorporation of plant residues, organic and mineral fertilisers, and weed control. P.B. Obour *et al.* (2019) also proved that ploughing has an impact on the formation of high productivity of crops, in particular corn. I. Masyk *et al.* (2020), in turn, determined that ploughing instead of discing with a minimum depth ensures a corn grain yield of 10.5 t/ha.

Thus, according to the results of the study, the impact of tillage on corn grain yield varies depending on the methods used. Although some tillage practices show significantly lower results compared to conventional ploughing, and some studies point to the benefits of this technique, there are also arguments in favour of no-till as a means of reducing negative impacts on the soil and improving soil quality, as presented in this study.

CONCLUSIONS

According to the results of the research, it was found that tillage had a minimal impact on the accumulation of moisture in the one-metre soil layer. However, ploughing with PLN-4-35 to a depth of 25-27 cm and moldboardless tillage with PRN-31000 to 33-35 cm provided the highest moisture reserves: 3,061 and 3,090 m^3/ha, and in the variant with discing BDM-2.5 to a depth of 10-12 cm, its accumulation was the lowest – 2,968 m^3/ha. There was also no significant difference in the tilth of the soil in the variants. On average, the density of the topsoil in the experiment was within the optimal range for all tillage options – 1.17-1.30 g/cm^3. In corn crops, the maximum density of soil compaction was observed when using a chisel PC-2.5 at a depth of 33-35 cm and a discing BDM-2.5 at 10-12 cm. The use of chisel local tillage with the PC-2.5 at a depth of 33-35 cm and discing with the BDM-2.5 at 10-12 cm resulted in an increase in the hardness of the tilth layer of soil compared to the control. Under the dry conditions of the second half of summer and moisture deficit in early spring, hybrid DB Khotyn responded positively to the use of ploughing to a depth of 25-27 cm. Shallow discing caused a deterioration in the physical condition of the arable layer. In this regard, in 2021-2023, a decrease in grain yield was obtained compared to ploughing by 0.63 t/ha. The positive impact and prospects of using no-till tillage, which contributes to high yields with a slight decrease compared to ploughing, have also been identified. This method, similarly to local tillage, helps to improve soil protection from erosion and preserve soil moisture. The results presented in this paper are the basis for further research on the impact of different tillage methods on the sustainability of agrophytocenosis in general, taking into account abiotic and biotic stress factors.

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CONFLICT OF INTEREST

None.

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Вплив основного обробітку на деякі показники родючості ґрунту та врожайність кукурудзи

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Анотація. Ґрунти, що обробляються, постійно перебувають у стресовому стані, зокрема, від антропогенного навантаження внаслідок їх обробітку. Разом з цим, зміни клімату, дефіцит вологи, тенденції в організації сівозмін та удосконалення технологій вирощування сільськогосподарських культур спонукає аграріїв приділяти більшу увагу системам обробітку ґрунту. Крім того, цей елемент технології відіграє вагому роль задля забезпечення сталості всього агрофітоценозу. Мета дослідження – визначити ефективність проведення різних прийомів основного обробітку ґрунту на окремі показники родючості ґрунту та врожайність кукурудзи. Дослідження проводились у 2021-2023 рр. на базі навчально-науково-виробничого центру «Дослідне поле Докучаєвське» Державного біотехнологічного університету, який розташований у зоні Лівобережного Лісостепу України. Схемою досліду передбачено вивчення різних способів обробітку ґрунту: оранки ПЛН-4-35 на 25-27 см (контроль); чизельного локального обробітку ПЧ-2,5 на 33-35 см; безполицевого обробітку ПРН-31000 на 33-35 см та дискування БДМ-2,5 на 10-12 см. Було визначено реакцію ґрунту на проведення основного обробітку у посівах кукурудзи через його основні водно- та агрофізичні показники: вологість, щільність складення та твердість. Результати досліджень засвідчили, що стан чорнозему типового є майже однаковим після проведення оранки та безполицевого обробітку ПРН-31000 («параплау»). Незначне підвищення щільності складення орного шару ґрунту виявлено після застосування чизельного та дискового обробітків. Всі варіанти обробітків створили сприятливі умови у ґрунті, оскільки його твердість в 0-20 см шарі ґрунту знаходилася у межах 13,3-15,1 кг/см^2. У посівах кукурудзи запаси вологи в метровому шарі фактично не відрізнялися за варіантами обробітку ґрунту. Однак виявлено тенденцію до її зниження у варіантах з чизельними та дисковими обробітками порівняно з оранкою. За всіма варіантами обробітків ґрунту порівняно з оранкою відбулося істотне зниження урожайності зерна кукурудзи. Практичне значення отриманих результатів полягає в оптимізації регулювання водно-фізичних властивостей чорнозему типового з досягненням ґрунтозахисної спрямованості технологій і стабілізації врожайності зерна кукурудзи в умовах зміни клімату та мінливості сучасного виробництва

Ключові слова: щільність складення ґрунту; запаси вологи; твердість ґрунту; урожайність; просапні культури; оранка; безполицевий обробіток