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Performance of grain and leguminous crops under resource saving cultivation technology in the Southern Steppe of Ukraine

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Abstract. The study aimed to investigate the impact of conventional and no-till cultivation on crop productivity, particularly the efficiency of water and nutrient use, and to assess the impact on plant resistance to extreme weather conditions. The study presented the results of the impact of no-till technology on corn and soybean yields in the Southern Steppe of Ukraine, including a comparison of efficiency with the traditional method of tillage. The study included an analysis of agronomic indicators such as yield, plant height, plant density, survival rate and other physiological characteristics of crops. Two soybean varieties (Bettina and Fortress) and two corn hybrids (DCS 4795 and DCS 3730) were used to assess the impact of no-till technology and compare the results for the three years of the study, 2022-2024. The study determined that the use of no-till technology contributed to an increase in both corn and soybean yields. For corn, the yield increase in no-till plots was 13.9-15.1%, and for soybeans – 15.2-17.5% compared to conventional cultivation. These results indicate that the use of minimal tillage helped to retain moisture, improved structure and reduced the risk of erosion, which contributed to better plant growth and increased the ability to withstand stressful weather conditions such as drought. The analysis of the results demonstrated that the height of corn and soybean plants in the no-till plots was higher than in the control plots with conventional technology. However, this demonstrates the long-term benefits of no-till in maintaining soil sustainability and increasing productivity. The study established that no-till technology is an effective method for increasing yields and preserving soil fertility, which is important for the sustainable development of agricultural production in the southern regions of Ukraine

Keywords: soya; corn; no-till technology; plant height; plant density; survival; yield

INTRODUCTION

Minimum tillage technologies, such as no-till, are gaining popularity in modern agriculture due to their potential to preserve soil fertility, reduce erosion, improve soil water retention and reduce tillage costs. These technologies are especially important for the southern regions of Ukraine, where agricultural and climatic conditions

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are often characterised by droughts, high temperatures and water shortages. In such conditions, no-till can not only improve the environmental situation but also significantly increase the yield of crops such as corn and soybeans. The research relevance of no-till technology in southern Ukraine is determined by the need to adapt agricultural technologies to climate change, to increasing periods of drought, which is becoming one of the biggest challenges for agricultural producers. At the same time, traditional tillage methods, such as ploughing and cultivation, can lead to soil degradation, reduced water retention and increased risk of erosion. In this regard, no-till technology, which involves minimal tillage, can be an effective way to address these issues while also improving crop productivity.

The problem of the study is that traditional methods of soil cultivation, such as ploughing and cultivation, cause soil degradation and, a decrease in soil fertility and water retention properties, which in turn leads to lower yields of crops such as corn and soybeans in the southern regions of Ukraine. This is becoming particularly critical considering climate change, droughts and other extreme weather events that negatively impact agricultural production. The lack of scientific data on the impact of no-till on the productivity of major crops in these specific agricultural and climatic conditions creates a need for experiments to assess the feasibility and benefits in detail.

I. Honcharuk & H. Pantsyreva (2021) studied the efficiency of pulse cultivation in Ukraine, highlighting the integration of traditional and innovative methods to improve productivity and preserve soil fertility. The researchers emphasise the importance of modern agronomic approaches in ensuring sustainable production in the face of climate change. S. Sheoran *et al.* (2022) investigated the latest technologies to improve the productivity of pulses, focusing on innovations in water conservation and the use of technological inputs to increase yields. The researchers emphasise the importance of intensive use of modern methods, such as no-till, to optimise agricultural practices. Z.Z. Qodirov *et al.* (2022) studied water-saving irrigation technologies for soybeans, particularly the role of such technologies in increasing yields in arid regions. The researchers highlight the importance of proper water management for the sustainable development of crops. H. Tiwari *et al.* (2022) analysed the effectiveness of innovative technologies for increasing productivity in rice-wheat systems focusing on improving resource conservation and water retention. The authors of this paper also highlight the importance of using technologies such as no-till to improve the efficiency of agronomic systems, which reduces water consumption and increases crop resilience to drought.

S.S. Walia *et al.* (2022) considered the design of resource-efficient and environmentally sound crop rotations for sustainable energy use and economic benefits. They investigated how crop rotation optimisation can contribute to increased productivity and resource conservation. L.P. Amgain *et al.* (2022) analysed soil conservation technologies to improve the resilience of agricultural systems in Nepal. The researchers emphasise the importance of applying minimum tillage techniques to preserve fertility and improve structure, which is critical for food security. A. Nurbekov *et al.* (2024) studied the effectiveness of no-till technology for growing wheat in arid regions. The authors also noted that minimum tillage technologies help preserve soil moisture, reduce erosion risks, and improve the overall resilience of agricultural systems to climate change. X. Liu *et al.* (2024) assessed the efficiency of water use in agriculture, particularly in arid regions, focusing on no-till technologies to conserve water and increase use efficiency. They noted that these technologies can help reduce water consumption and reduce negative environmental impacts.

N. Suleimenova *et al.* (2021) studied soil conservation technologies for adapting agroecosystems to climate change in southeastern Kazakhstan. The scientists note that the use of the no-till system helps to preserve the natural structure of the soil, reduce erosion, and increase crop resilience to drought. T.K. Das *et al.* (2021) studied the impact of soil conservation technologies on productivity and resource use efficiency in agriculture. The authors note that no-till technology helps to increase water use efficiency, preserve soil fertility, and reduce negative environmental impact. The study aimed to evaluate the effectiveness of no-till technology for increasing corn and soybean yields in the southern regions of Ukraine, for preserving soil fertility, improving water retention properties and increasing crop resistance to stressful conditions. The objectives of the study were to compare the impact of no-till and conventional tillage on corn and soybean yields; assess growth characteristics; and determine the impact of no-till on soil ecological properties.

MATERIALS AND METHODS

The research was conducted in 2022-2024 in the conditions of Olena Farm, Voznesenskyi district, Mykolaiv region. Several agronomic approaches were used to evaluate the effectiveness of different technologies, including no-till technology for corn and soybean cultivation, as well as classical cultivation technology. Observations of plant development were conducted during the following phases of plant growth and development: during the germination phase (June), during the period

of active growth (July-August) and the ripening and harvesting phase (September-October). The weather conditions in 2022 were characterised by moderate rainfall at the beginning of the season, but a lack of rainfall in August, which affected plant development. In 2023, the spring was rainy, but August was dry, which also had an impact on the growth and development of crops. The year 2024 was defined as extremely dry, which affected the growth and development of plants and their productivity. During the growing season, plant height, plant density, and survival rate were measured, and the crops were harvested in late autumn. The study complied with the ethical standards set out in the Convention on the Trade in Endangered Species of Wild Fauna and Flora (1973) and the Convention on Biological Diversity (1992).

Plots with two soybean varieties were used to assess the impact of no-till technology on soybean yields: Bettina and Fortress. No-till sowing was carried out using a Sich-4.2 direct seed drill produced in Ukraine. This seed drill ensures precise seed placement without preliminary tillage and is equipped with disc elements that sow seeds to a depth of 3-5 cm with minimal soil mixing. Seeds were sown according to the recommended rates for each crop (Growing soybeans. Sowing..., 2024). Yields were measured by harvesting the entire crop in each plot after the crops were ripe. Yields were estimated in t/ha. The analysis of the impact of no-till on maize yields was conducted on hybrids DKS 4795 and DKS 3730. Yields were measured using the same standards as for soybeans, which made it possible to determine the yield increase with no-till. To measure the yield of corn using conventional and no-till technologies, the amount of grain harvested per 1 m^2 was calculated, after which these figures were converted into tonnes per hectare. Harvesting was conducted after the crop had reached full maturity, which accurately determined the amount and weight of grain.

To measure the density of plants and the degree of plant survival, the method of counting the number of plant sprouts per 1 m^2 was used. The assessment was conducted at each stage of the growing season: after germination, during the period of active growth and after maturation. The survival rate was defined as the ratio of the number of remaining plants to the number of seeds sown at the initial stages. This method accurately assessed the effectiveness of no-till and conventional cultivation technology in terms of plant survival and adaptation to stressful conditions. The dynamics of plant height were recorded by regular measurements at each study site. Plant height was determined using measuring rulers on standard 1 m^2 plots every 10-15 days during the growing season. The measurements were carried out during the main phases of plant growth and development, particularly the germination phase, active growth and before grain filling. Analysis of variance (ANOVA) was used to determine the statistical significance of the differences between the groups (conventional and no-till). This method was used to assess whether there are statistically significant differences between different crop cultivation technologies. The data were processed using Microsoft Excel statistical software for basic calculations and graphical presentation of the results.

RESULTS

To create a highly productive crop, it is necessary to determine an optimal plant density and ensure proper growth and development. At the same time, the initial period of plant development is crucial, as it determines the plant density, their growth in the future and the yield potential of the crop. To create a highly productive sowing, it is necessary to obtain the optimal number of plants per unit area, accounting for the variety, water supply, etc. The objective of this research was to study the plant density and survival rate of soybean and corn plants of different varieties and hybrids, depending on the technology of growing crops. The research demonstrated that, regardless of the year of soybean cultivation, the density of plants in the germination phase did not depend on varietal characteristics but was determined by the cultivation technology (Table 1).

Table 1. *Soybean plant density and survival depending on varietal characteristics and cultivation technology (average for 2022-2024)*

Technology	Variety	Plant density, thousand plants/ha		Survival rate, %
		Germination phase	Phase of full seed ripeness	
Classic	Bettina	383.9	339.8	88.5
	Fortetsia	375.9	328.7	87.4
No-till technology	Bettina	141.4	128.2	90.6
	Fortetsia	139.3	124.4	89.2

Source: *compiled by the authors*

The researchers determined that, regardless of the year of soybean cultivation, the plant density in the germination phase did not depend on varietal characteristics but was determined by the technology of growing the crop. Notably, soybean seeds were sown at a rate of 400 thousand units/ha under conventional cultivation technology and 150 thousand units/ha under no-till technology. On average, over the years of research, when Bettina was grown using classical technology, there were 383.9 thousand soybean plants per hectare in the germination phase and 375.9 thousand plants per 1 hectare of Fortetsia soybean. When growing soybeans using no-till technology, the number of soybean plants in the germination phase ranged from 139.3-141.4 thousand plants/ha. The calculation of the density of soybean plants in the phase of full seed maturity showed that the density of soybean plants of Bettina variety was 128.2-339.8 thousand units/ha, and Fortetsia variety – 124.4-328.7 thousand units/ha, depending on the cultivation technology. Notably, on average, Bettina plants had a slightly higher plant density in the phase of full seed maturity (234 thousand units/ha), which exceeded Fortetsia plants by 7.45 thousand units/ha or 3.2%. The study revealed that the survival of soybean plants during the growing season was influenced by the varietal characteristics of the crop and the cultivation technology. When growing soybeans using no-till technology, more plants survived than under the classical cultivation technology. On average, over the years of research, the majority of soybean plants survived for the period of full seed maturity under no-till technology 89.2-90.6%, which exceeded the indicators of the variant of the classical technology of growing the crop by 1.8-2.1%, depending on the variety under study. Notably, the survival rate of Bettina plants during the growing season was slightly higher than that of Fortetsia by 1.3% on average over the years of research and by the factor of cultivation technology. Plant density is one of the most important elements in regulating water consumption during the growing season of maize hybrids to ensure a high level of grain productivity under conditions of insufficient and unstable moisture. These studies showed that the density of maize plants depended on the characteristics of the hybrid under study (Table 2).

Table 2. *Influence of varietal characteristics and cultivation technology on the density of maize plants and their survival (average for 2022-2024)*

Technology	Variety	Plant density, thousand plants/ha		Survival rate, %
		Germination phase	The phase of full-grain ripeness	
Classic	DKC 4795	65.5	56.9	86.9
	DKC 3730	66.4	58.6	88.3
No-till technology	DKC 4795	65	59.5	91.5
	DKC 3730	65.5	60.4	92.2

Source: *compiled by the authors*

Thus, on average, during the years of research, when growing the hybrid DKS 3730, the density of plants in the germination phase, depending on the cultivation technology, was 65.5-66.4 thousand units/ha, which exceeded the figures for the hybrid DKS 4795 by 0.8-1.4%. The same trend was observed in the phase of full-grain ripeness. Notably, in the germination phase, a slightly higher density of maize plants was observed under conventional tillage, which may be due to the fact that no-till contributed to fewer germinations due to the preservation of a denser surface soil structure, which sometimes hinders seed germination. Due to better conditions for the growth and development of maize plants during the growing season, less damage and death of plants from pests when growing maize using no-till technology in the phase of full grain ripeness, the plant density under this technology was 59.5-60.4 thousand units/ha, depending on the hybrid, which exceeded the indicators of the classical cultivation technology by 3-4.4%.

The best results in the preservation of maize plants during the growing season, on average over the years of research, were provided by no-till technology 91.5-92.2%, depending on the hybrid under study, which exceeded the indicators of the classical technology variant by 3.9-4.6%. It should be noted that on average over the years of research and by the factor of cultivation technology, during the growing season, more plants of hybrid DKC 3730 were preserved at 90.3%, which exceeded the survival rate of plants of hybrid DKC 4795 by 1.1%. The obtained results demonstrate that the use of no-till technology compared to conventional sowing technology does not lead to significant losses in plant density or plant survival. At the same time, the degree of plant survival remains high and stable for both soybeans and corn, which confirms the effectiveness of no-till technology for maintaining plant viability (Tsyliuryk & Tyshchenko, 2024).

The formation of soybean productivity is influenced by plant height, so, depending on the dynamics of this

indicator during the growing season, it is possible to conclude the conditions of plant growth and development in ontogeny. The research data showed that the height of soybean plants depended on the weather conditions of the year of cultivation, varietal characteristics, as well as on the variant of the crop cultivation technology. In the dry years of 2022-2023, the height of plants of both studied soybean varieties in the budding phase reached 50.7-62.6 and 46.9-58.4 cm, depending on the variant of cultivation technology. In 2024, when a very severe drought was observed, similar indicators varied between 41.9-43 and 40.6-42.5 cm, respectively, depending on the factors studied.

In 2022, at the end of the flowering phase, the plants of the soybean variety Bettina were taller, reaching values of 61.7-63.2 cm, depending on the variant of crop cultivation technology, which is 4.7-5.6 cm or 8.2-9.1% higher than the height of the Fortetsia variety. In all subsequent years of research, plants of the Bettina variety were also determined to be slightly taller than the Fortetsia variety. Thus, depending on the variant of cultivation technology, in 2023 the excess was 2.8-4.3 cm (3.8-6.1%), and in 2024 – 2.1-2.4 cm (4.1-4.5%).

In the phase of seed filling, the linear height of plants of both studied varieties reached its maximum. At the same time, it was determined that the plants of the Bettina variety, as in the previous phases of plant growth and development, were slightly taller than the Fortetsia variety, regardless of the year of cultivation. On average, over the years of research, growing soybeans using no-till technology contributed to the formation of larger linear dimensions of plants of the studied varieties at all stages of plant growth and development (Fig. 1).

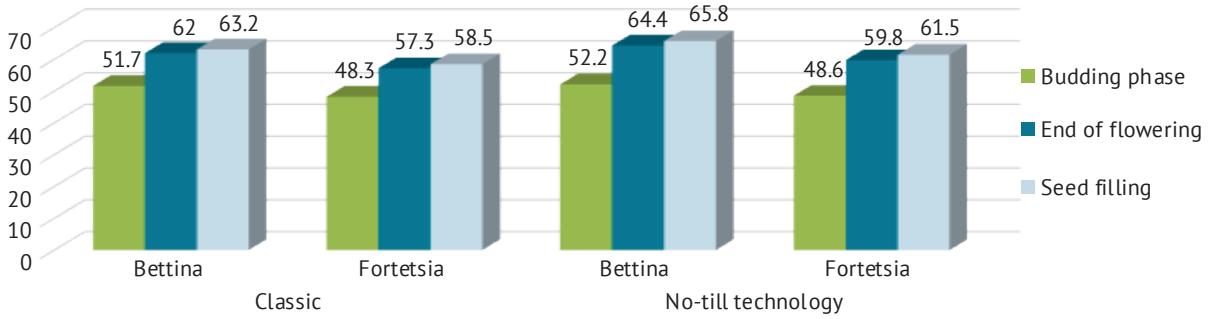

Figure 1. *Influence of varietal characteristics and cultivation technology on soybean plant height (average for 2022-2024), cm*

Source: *compiled by the authors*

Important manifestations of plant life are their growth processes, which are associated with quantitative changes (Vozhegova *et al.*, 2020; Mokrienko *et al.*, 2024). According to the results of research in 2022-2024 in the southern Steppe of Ukraine, the height of maize plants of the studied hybrids increased depending on the growing technology and weather conditions of the region. The best results were obtained in 2023. According to the results of the research, the highest height index for no-till cultivation technology was 240 cm (2023) in the full ripeness phase for the DKC 3730 hybrid, and 235 cm (2022) for the classic technology. On average, over the years of research, the highest plant height was determined in the variant of growing the studied hybrids using no-till technology (Fig. 2).

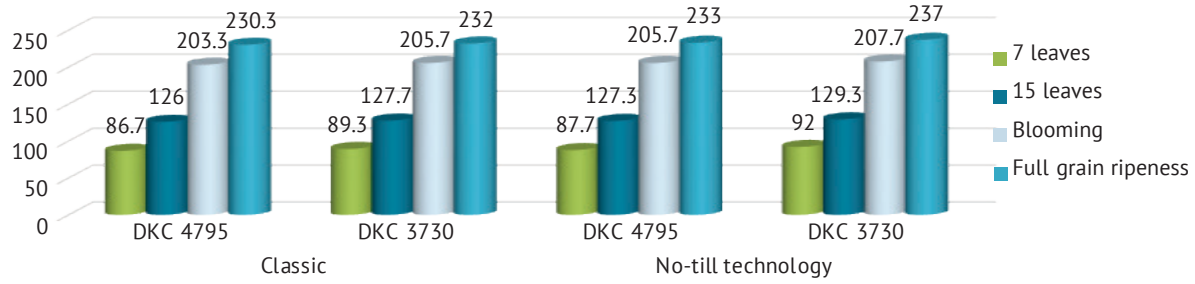

Figure 2. *IInfluence of cultivation technology on the height of maize hybrids (average for 2022-2024), cm*

Source: *compiled by the authors*

Thus, on average, according to the hybrid factor, the height of maize plants under the classical cultivation technology ranged from 88-231.2 cm, depending on the phase of growth and development, which was 1.4-3.8 cm or 1.1-1.6% less than the no-till technology variant. At the same time, regardless of the studied technology of crop cultivation, plants of hybrid DKC 3730 had slightly higher linear dimensions at all stages of growth and development. The use of no-till technology for growing soybeans in the Southern Steppe of Ukraine has shown a significant increase in yields compared to conventional cultivation. According to the study, on average, in 2022-2024, soybean yields were 15.2-17.5% higher in areas where no-till technology was used, depending on the variety under study, compared to conventional technology.

One of the main factors that contributed to the increase in yields is the preservation of moisture in the soil. No-till technology has significantly reduced moisture losses compared to conventional cultivation, as minimal tillage prevents soil loosening, which reduces water evaporation from the surface. This is crucial in the southern regions of Ukraine, where rainfall deficits are a common concern, especially during periods of active plant growth. No-till helps to retain moisture in the upper layers of the soil, which is crucial for plant growth during dry periods (Zabolotnyi *et al*., 2020). In areas where no-till technology was used, moisture was retained 20% longer than in conventionally cultivated areas.

Another important aspect of no-till technology is the improvement of soil structure. This method helps to preserve organic matter on the soil surface, which is key to improving physical properties. The presence of organic matter forms a natural protective layer that not only reduces erosion but also contributes to better soil moisture retention. This, in turn, allows for more stable conditions for plant development, especially during periods of drought, when moisture is a limited resource (Tsyryulyk, 2020). The study noted that the root system of soybeans in plots with no-till technology was more developed, which contributed to increasing plant resistance to stress factors.

Another important aspect of no-till technology was the improvement of soil biological activity. Minimal tillage does not disturb the natural environment for beneficial microorganisms, such as nodule bacteria, which play an important role in stimulating nitrogen fixation in the roots of plants, including soybeans. Nitrogen fixation provides the plants with the necessary nitrogen, which reduces the need for chemical nitrogen fertilisers. This, in turn, reduced fertiliser costs and contributed to a more sustainable use of natural resources. Preserving the natural microflora of the soil is critical to maintaining the ecological balance in the agroecosystem. Since no-till does not disturb the soil structure, it promotes the development of beneficial microorganisms that maintain soil health and improve fertility. In addition, the activity of these microorganisms contributes to better absorption of other important nutrients, such as phosphorus and potassium, which also reduces the need for mineral fertilisers. Preserving the biological activity of the soil helps to create a sustainable and productive farming system, which is an important factor for achieving long-term results in agriculture (Draganchuk, 2023). No-till technology has helped to preserve the top fertile layer of soil, which results in more sustainable plant development and improved product quality. Reduced erosion also has a long-term positive effect on soil fertility (Tereshchenko, 2024).

The cultivation of pulses, including soybeans, in Ukraine and high grain yields are key for agriculture and the economy, as they are strategic crops for food security, export potential and sustainable development of the agricultural sector (Drobitko *et al*., 2024; Mokrienko *et al*., 2024). The dynamics of yields of pulses, including soybeans, over the period 2015-2023 are marked by fluctuations. Soybean yields increased from 18.4 c/ha in 2015 to 25.8 c/ha in 2023. The choice of soybean variety and cultivation technology plays an important role in increasing soybean yields. Increasing soybean yields by 0.22-0.35 t/ha or 15.2-17.5% on average over the years of research using no-till technology is an important economic and environmental result that allows farms to reduce tillage costs, improve soil fertility and obtain consistently high soybean yields (Table 3).

Table 3. *Soybean yields using conventional and no-till technology, t/ha*

Variety	Technology		Yield increase from no-till technology	
	Classic	No-till	t/ha	%
		2022		
Bettina	1.81	2.17	0.36	16.6
Fortetsia	1.4	1.63	0.23	14.1
		2023		
Bettina	2.05	2.5	0.45	18
Fortetsia	1.58	1.89	0.31	16.4

Table 3, Continued

Variety	Technology		Yield increase from no-till technology	
	Classic	No-till	t/ha	%
		2024		
Bettina	1.09	1.32	0.23	17.4
Fortetsia	0.71	0.83	0.12	14.5
		Average for 2022-2024		
Bettina	1.65	2	0.35	17.5
Fortetsia	1.23	1.45	0.22	15.2

Source: *compiled by the authors*

The next task of the research was to study the impact of classical and no-till technology on the yield of maize hybrids DKC 4795 and DKC 3730 in the Southern Steppe of Ukraine (Table 4).

Table 4. *Influence of cultivation technology on corn yield, t/ha*

Hybrid	Technology		Yield increase from no-till technology	
	Classic	No-till	t/ha	%
		2022		
DKC 4795	3.73	4.32	0.59	13.6
DKC 3730	3.99	4.71	0.72	15.3
		2023		
DKC 4795	3.87	4.51	0.64	14.2
DKC 3730	4.21	4.98	0.77	15.5
		2024		
DKC 4795	2.89	3.28	0.39	13.8
DKC 3730	3.26	3.82	0.56	14.9
		Average for 2022-2024		
DKC 4795	3.73	4.03	0.3	13.9
DKC 3730	3.82	4.5	0.68	15.1

Source: *compiled by the authors*

In 2022, in areas where no-till technology was used, a yield increase of 0.59 t/ha or 13.6% was recorded for the hybrid DKC 4795 compared to the classical technology of growing the crop. In 2023, the increase was 0.64 t/ha or 14.2%, and in 2024, 0.39 t/ha or 13.8%. This demonstrates the significant advantage of no-till technology for increasing corn yields in the Southern Steppe of Ukraine, where soil moisture is an important factor in high crop productivity. No-till technology reduces water evaporation from the soil surface, which allows moisture to be retained 20% longer compared to conventional cultivation. This has become a crucial factor in the growth and development of corn plants, which is a water-dependent crop. Minimal tillage also improves the development of the root system, which allows plants to obtain nutrients from deeper soil layers.

The hybrid DKC 3730, which is highly resistant to stressful conditions such as drought and high temperatures, showed an even greater increase in yields when using no-till technology. In 2022, the increase in grain yield of the hybrid under study was 0.72 t/ha or 15.3%, in 2023 0.77 t/ha or 15.5%, and in 2024 0.56 t/ha or 14.9%. This data confirms that no-till technology is effective not only for high-yielding hybrids but also for crops that are highly resistant to adverse conditions. By preserving moisture in the soil, no-till contributes to the stable development of plants even in drought conditions, which is an important aspect for southern regions where precipitation can be irregular (Tereshchenko, 2024). A comparison of the yield increase between the two hybrids showed that for the hybrid DKC 4795, the average increase over the years of research was slightly lower than for DKC 3730, but still significant at 13.9%. DKS 3730 showed a greater increase due to its high resistance to stressful conditions, which once again confirms the effectiveness of no-till technology in ensuring stable growth and development of plants even in extreme conditions. In addition to increasing yields, no-till technology has helped to reduce tillage costs. Scientists have determined that the absence of ploughing and cultivation has reduced fuel and time costs, making this technology economically viable for farmers (Demydenko, 2024). Minimal intervention in the soil also reduces the probability of degradation,

which has a positive effect on soil structure and helps to preserve biological activity.

In general, no-till technology has a positive impact on preserving soil structure, reducing erosion and preserving moisture, which is an important aspect for southern regions where a lack of precipitation can significantly affect crop development. No-till technology allows for the preservation of organic matter on the soil surface, which improves physical properties such as aeration and water retention (Tsyliuryk & Tyshchenko, 2024). This is important for maintaining stable plant development even in dry conditions. The cultivation of the studied crops using no-till technology provided better conditions for plant growth and development in all years of research, while the plants had better conditions for the formation of linear dimensions and survival during the growing season, including due to the preservation and accumulation of moisture in the soil.

DISCUSSION

The study evaluated the effectiveness of no-till technology for growing corn and soybeans in the Southern Steppe of Ukraine. This study showed a significant increase in yields compared to conventional tillage methods, which confirms the effectiveness of no-till in ensuring stable plant development and increasing productivity in the southern regions. O.O. Fostachenko (2022) optimised the placement of crops in the field crop rotation on the example of the private enterprise "Lyon" in the Kamianskyi district of the Dnipro region. The researcher notes that the right choice of tillage method and optimal use is an important factor in increasing crop yields. This study is in line with the findings of the present study, where no-till technology also showed a significant increase in corn and soybean yields. However, unlike this study, the researcher also focuses on the role of proper crop placement in crop rotation and agronomic practices to increase land use efficiency and improve fertility. This experiment focuses more specifically on no-till, which demonstrates greater yield gains for specific crops, regardless of placement in the rotation.

O.O. Tsokalo & D.V. Tkachenko (2022) studied the adaptation of crop production to climate change, emphasising the importance of using conservation tillage, in particular no-till, to preserve soil moisture and adapt crops to stressful conditions such as drought. This study showed similar results to the current one, where no-till technology also showed increased plant resistance to drought conditions. However, the scientist focuses more on the general principles of plant adaptation to climate change, while this study focuses on the specific results of no-till to increase corn and soybean yields. This experiment also showed significantly higher yield gains, highlighting the more specific approach to no-till technology.

M.V. Veremiev (2023) evaluated the effect of Quantum micro fertiliser on the growth and development of grain sorghum plants. The author emphasised the importance of microfertilisers for stimulating plant growth, increasing resistance to stressful conditions and improving the general condition of plants. The research of the scientist does not fully coincide with the results of the current study, as it focuses on the use of biological products and microfertilisers, while this work focuses on no-till technology. Nevertheless, both studies confirm the significant impact of agricultural technologies on improving plant growth and stress tolerance. This experiment differs in that it analyses the impact of tillage without the use of additional fertilisers, which compared the effectiveness of the methods in the context of natural soil conservation.

O.M. Vuyko & Y.M. Shkatula (2020) substantiated the technological methods of spring wheat cultivation in the conditions of Promin Limited Liability Company (LLC) in the village of Suslivtsi village, Letychiv district, Khmelnytskyi region. The main focus of the study was on the selection of optimal agronomic measures to improve wheat yields, in particular, the correct placement of crops in crop rotation and the selection of effective tillage methods. This study has certain parallels with the present study, as it also deals with optimising crop cultivation technologies to increase productivity. However, in contrast to these results, which focused on comparing no-till and conventional tillage, the researchers' studies focus more on wheat practices, such as variety selection and seeding methods, without a focus on no-till technology. These results showed that no-till technology yielded higher yields, particularly for soybeans and corn, compared to the O.M. Vuyko & Y.M. Shkatula (2020) study on conventional planting methods.

O.Yu. Mokoychuk (2021) conducted a comparative assessment of soybean varieties by grain productivity in the conditions of AgroFirm "Khliborob" LLC in the village of Nalyvaika, Kirovohrad region. The scientist focused on the study of different soybean varieties and their ability to use resources efficiently with different sowing methods. The researcher determined that the choice of variety is an important factor that directly affects yields and that the right choice of variety can significantly increase the efficiency of growing the crop. This coincides with the present study, which also determined that no-till technology can increase yields, but in this case, the study examined sowing technology on the same varieties, which allows for more accurate comparisons of yields for each tillage method. The

results of a study by O.Y. Mokoychuk (2021) demonstrated a significant role for the variety, but in this study, the effect on yields was more due to tillage methods than to varieties.

O.V. Averchev & T.S. Kovshakova (2022) studied the effect of biostimulants and trace elements on the phenological characteristics of pea varieties in the South of Ukraine. The researchers determined that the use of biostimulants and micronutrients improves plant development and increases resistance to stress factors such as drought and low temperatures. This study partially coincides with these results, as each study examines the effectiveness of different agronomic practices to increase crop productivity. However, this study focuses on comparing no-till and conventional seeding methods without the additional use of biostimulants, which is an important distinguishing factor. In this case, the yield increase was achieved through no-till technology, while O.V. Averchev & T.S. Kovshakova (2022) focused on the improvement of phenological parameters using biostimulants, which may be an additional factor for increasing efficiency in future studies.

M.P. Kovalchuk (2020) studied and analysed the impact of agronomic practices on spring barley productivity in the experimental field of Vinnytsia National Agrarian University. The researcher studied different methods of tillage, fertilisation and sowing to determine the optimal conditions for increasing spring barley yields. This study is in some ways similar to the present results, as both studies examine the impact of agronomic practices on crop yields. However, in contrast to this study, which compared no-till and conventional tillage, the researcher focuses more on an integrated approach to agronomic practices. The results showed a greater increase in yields due to no-till. O.V. Kozak (2023) studied the impact of basic tillage on pea productivity in the conditions of Agrosvit LLC in the Synelnykivskyi district of the Dnipro region. The study focused on different methods of tillage, in particular, on the comparison of traditional and modern technologies. The author's conclusions partially coincide with the data, as the studies examined the impact of tillage on legume yields. However, this study focuses on comparing no-till and conventional tillage, while O.V. Kozak (2023) work examines different types of basic tillage. These results showed a greater yield increase with no-till.

A.I. Kibziy & I.I. Palamarchuk (2020) studied the influence of sowing dates on the yield of vegetable pea grain in the conditions of the Podillia Botanical Garden of Vinnytsia National Agrarian University. The researchers emphasise that sowing dates are one of the key factors affecting yields, especially when using minimum tillage technologies. This study also focuses on the impact of agronomic factors on yields. However, unlike current research that focuses on no-till as a tillage method, the researchers focus more on the optimal sowing time to increase yields. These results showed a greater yield increase with no-till technology, indicating the specificity of tillage methods compared to sowing dates. R.O. Shylo & Y.M. Shkatula (2020) studied the influence of mineral fertilisers and precursors on the formation of winter wheat productivity in the conditions of Podillya Agroproduct LLC in Brailiv village, Zhmerynka district. The researchers found that the right choice of predecessors and the use of mineral fertilisers significantly improved wheat productivity. This study has some similarities with the present study, as it also focuses on increasing crop yields. However, contrary to the work of the authors mentioned above, which addresses the optimisation of fertiliser application and choosing predecessors, this study focuses on comparing tillage technologies, including no-till. These results demonstrated a greater yield increase with no-till, without the use of additional mineral fertilisers, which confirms the effectiveness of minimal tillage in increasing productivity.

Y.O. Alexandrov (2021) studied the peculiarities of winter wheat grain yield formation depending on cultivation methods in the conditions of the Eldorado farm in the Pavlohrad district of the Dnipro region. The researcher highlighted the importance of choosing the right agronomic practices, particularly the importance of tillage technology for optimising yields. This study is similar to the current one, as it also examines the impact of tillage methods on wheat productivity. However, the study by Y.O. Alexandrov (2021) addressed the combination of tillage and fertiliser, while this study is more focused on comparing no-till and conventional no-till seeding technology. These results showed significantly higher yield increases with no-till, which demonstrates the greater efficiency of minimum tillage technology compared to other agronomic practices.

Comparing the results of this study with other studies shows that no-till technology is an effective strategy for increasing corn and soybean yields and for maintaining ecological balance in agriculture. Most studies confirm the importance of proper tillage for high yields, but these results demonstrate significantly higher yield increases with no-till, making this study an important contribution to the development of efficient and sustainable agricultural technologies. Differences in research methods and results could be determined by different experimental conditions, soil types and crops, but the overall conclusion shows the advantage of no-till for increasing crop productivity in the southern regions of Ukraine.

CONCLUSIONS

The study assessed the impact of no-till technology on corn and soybean yields in the Southern Steppe of Ukraine, in comparison with the classical technology of growing the crops under study. The use of no-till showed a significant increase in yields for both crops: for corn by 13.9-15.1% and for soybeans by 15.2-17.5%. These results confirm that no-till technology contributes to better water retention in the soil, which is especially important for the southern regions where water shortages are a pressing issue. In addition, this cultivation technology reduces soil erosion and improves soil structure, which creates optimal conditions for the development of the plant root system. The formation of linear plant dimensions in all phases of growth and development was better with no-till technology compared to conventional technology, which subsequently affected crop yields. This indicates that although the root system of plants develops somewhat slower in the initial stages, no-till technology contributes to an increase in overall crop productivity due to better conservation of soil resources in the long term. One of the most important aspects of the study was the finding that no-till technology increases crop resilience to stressful weather conditions such as drought. Preserving organic matter on the soil surface and improving its water-holding properties enables plants to better withstand periods of moisture deficit. This is an important factor for agricultural production in the context of climate change and extreme weather events typical for the southern regions of Ukraine. Thus, the results of this study show that no-till technology is an effective method for increasing corn and soybean yields, improving soil sustainability and conserving resources. The use of this technology can reduce tillage costs, improve soil structure and ensure stable productivity in difficult agroclimatic conditions. Based on the results obtained, no-till can be recommended for widespread adoption in agricultural enterprises of the Southern Steppe of Ukraine. For further research, it is recommended to expand the range of crops and investigate the long-term impact of no-till technology on other agronomic indicators and soil types in different climatic zones.

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CONFLICT OF INTEREST

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Продуктивність зернових та зернобобових культур за ресурсозберігаючої технології вирощування в умовах Південного Степу України

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Анотація. Метою дослідження було вивчення впливу класичної технології вирощування та технології no-till на продуктивність сільськогосподарських культур, зокрема на ефективність використання водних та поживних ресурсів, а також оцінка впливу на стійкість рослин до екстремальних погодних умов. У статті було наведено результати впливу технології no-till на врожайність кукурудзи та сої в умовах Південного Степу України, зокрема порівняння ефективності з традиційним методом обробітку ґрунту. Дослідження включало аналіз таких агрономічних показників, як врожайність, висота рослин, густота стояння, ступінь виживання та інші фізіологічні характеристики культур. Для оцінки впливу технології no-till було використано два сорти сої (Беттіна та Фортеця) та два гібриди кукурудзи (ДКС 4795 та ДКС 3730), а також порівняння результатів за три роки дослідження 2022-2024 рр. В результаті дослідження було виявлено, що застосування технології no-till сприяло підвищенню врожайності як кукурудзи, так і сої. Для кукурудзи приріст врожайності на ділянках за no-till становив 13,9-15,1 %, а для сої – 15,2-17,5 % порівняно з традиційною технологією вирощування. Ці результати свідчать, що застосування мінімального обробітку ґрунту сприяло збереження вологи, покращило структуру та знизило ризик ерозії, що сприяло кращому росту рослин і підвищенню здатності протистояти стресовим погодним умовам, таким як посуха. Аналіз результатів показав, що на ділянках за no-till висота рослин кукурудзи та сої була більшою, ніж на контрольних ділянках з класичною технологією. Однак це свідчить про довгострокові переваги no-till у збереженні екологічної стійкості ґрунтів та підвищенні продуктивності. Встановлено, що технологія no-till є ефективним методом для підвищення врожайності та збереження родючості ґрунтів, що має важливе значення для сталого розвитку сільськогосподарського виробництва в південних регіонах України

Ключові слова: соя; кукурудза; технологія no-till; висота рослин; густота стояння; виживаність; урожайність