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**ODESSA NATIONAL ACADEMY OF
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**BLACK SEA
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Odessa National Academy of Food Technologies

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2020

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5. ECOLOGY AND ENVIRONMENTAL PROTECTION

**ECOLOGICAL ASPECTS OF NO-TILL TECHNOLOGY IN THE
CONDITIONS OF SOUTHERN STEPPE OF UKRAINE**

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Abstract. *It was studied the effect of No-till technology on soil density, soil moisture reserves, soil microbiological activity, and crop yields. It was found that the soil density under winter wheat according to No-till technology did not exceed the optimal index of 1.30 g/cm³ and it was 1.14-1.25 g/cm³ for the sowing period and it was 1.18-1.29 g/cm³ for the harvesting period. The moisture content in the soil was significantly higher according to No-till technology and it was amounted to up to 21.3-27.6 mm during the winter wheat sowing period and it was 22.4-27.4 mm during the harvest period, where as with traditional technology this indicator was 16.8-20.2 mm and 17.3-23.9 mm, respectively. The average yield of winter wheat using No-till technology for two years was 4.54 t / ha, yield of soybean was 2.24 t / ha, yield of sunflower was 2.71 t / ha. The increase in crop yield up to 14.3-22.9 % by No-till technology allowed us to draw a conclusion about optimizing soil fertility indicators in the climatic conditions of the southern Steppe zone of Ukraine in comparison with traditional intensive technologies.*

It was shown that the introduction of No-till technology would improve environmental processes in the soil, reduce the anthropogenic load on agroecosystems and the manifestation of erosion processes, increase crop yields and reduce energy costs for their cultivation.

Keywords: soil, No-till technology, soil density, soil moisture, fertility, yield.

I. INTRODUCTION

The Earth's soil cover plays a key role in maintaining the complex functioning of the biosphere, ensuring ecological balance and preserving biodiversity, and it is the main natural resource for growing crops and food production.

In the modern world, soil degradation processes are rapidly developing due to excessive ploughing of the soils, non-compliance with science-based farming systems and agronomic and environmental land use standards, and the lack of an appropriate system for managing soil fertility processes. According to [1, 2], 33 % of global soil resources are degraded due to erosion, pollution, compaction, salinization, acidification, dehumidification, and other adverse processes associated with poor soil use.

At the same time, in the 21st century, the food shortage on the planet is rapidly increasing. The reasons for this are partly due to the rapid rate of population growth on Earth, according to scientists, by 2050 the world's population will exceed 9.2 billion [1]. The International Research Institute for food policy showed that in 2010, more than 1.0 billion people suffered from hunger, while more than 20,000 people died every day, most of them children under 3 years of age. The highest level of hunger is recorded in sub-Saharan Africa and South Asia [3]. Scientists predict that by 2030, more than

2.5 billion of the world's population will suffer from hunger, which is at least a third of the world. Therefore, in order for humanity to survive for the next 30 years, it is necessary to increase food production by about 70% [1]. According to the FAO definition, only a few countries in the world can accelerate food production and stop the rapid development of the global food crisis, including Ukraine [4].

Ukraine is one of the largest countries in Europe with a strong land and resource potential. About 42 million hectares of the state's 60.3 million hectares of land, are agricultural land (70%), 32.5 million (77.3%) of which are arable land. Ukraine is home to about a third of the world's and 70% of Europe's chernozem reserves, as well as favorable climatic conditions for growing the most important food crops [1]. However, now, the fertility of chernozems is reduced due to irrational use, and natural processes, in particular, climate changes.

In this regard, it is particularly important to research and develop energy-saving and resource-saving farming systems, in particular, the promising No-till technology for Ukraine. The No-till system is a modern farming system that provides for the abandonment of tillage, sowing on stubble, the use of cover crops and the use of crop rotation. No-till is based on soil protection: sowing is performed without mechanical impact on the soil. Crop residues form a mulching layer. It preserves moisture, protects the soil from water, wind erosion and dust storms, which is especially important in the arid conditions of the southern Steppe of Ukraine. The spread of No-till technology in countries with an intensive agricultural sector (the United States, Canada, Brazil, and other Latin American countries) indicates that it meets modern economic, environmental, and social conditions [5].

The goal of this work is to study the effect of No-till technology on the physical and biological properties of soil and crop yields in the southern Steppe of Ukraine.

To achieve this goal it was necessary to solve the following tasks:

- 1) to identify the effect of No-till technology on soil density in a layer of 0-30 cm;
- 2) to determine soil moisture using No-till technology;
- 3) to investigate the microbiological activity of the soil;
- 4) to determine the effect of No-till technology on soil fertility and crop yields.

II. ANALYTICAL REVIEW OF THE LITERATURE

Ecological and economic functions of soils. Soil cover, as the main component of land resources and as a macroecosystem, plays a very important role in the biosphere. In general, it acts as a regulatory mechanism for interaction between geospheres on the verge of interaction between biota, the lithosphere and the atmosphere. In the geosphere system, the soil is one of the earth's shells of the pedosphere and it performs important functions that are of direct ecological significance for plants, bacteria and other organisms, including humans [6]. Among the main functions of the soil cover, there are biospheric and ecological functions in relation to living organisms.

The most important biosphere function of the soil cover is to provide life on Earth. It consists in the concentration of biophilic elements necessary for organisms in the soil in the forms of chemical compounds available to them. The soil is also able to accumulate the necessary water supply for the primary producers of terrestrial ecosystems in the forms available to them [8].

The soil provides a constant interaction of large (geological) and small (biological) cycles of substance rotations. All biogeochemical cycles of elements, including such important biophiles as carbon, nitrogen, and oxygen, as well as flow-forming cycles of water occur only with the participation of soil [6].

The soil cover performs regulation of the composition of the atmosphere and hydrosphere, it does this due to its high borehole (40-60 % of the volume) and dense population of organisms (plant roots, animals, microorganisms and worms). At the same time, there is a constant gas exchange between the soil and the surface atmosphere [7, 8].

The soil regulates the intensity of biosphere processes by regulating the density and productivity of organisms on the earth's surface. The limiting factors of the soil include: high acidity or alkalinity, low water capacity, the presence of toxic substances, strong compaction, and the like [6].

In the biological cycles of synthesis and destruction of organic matter that constantly occur on the earth's surface, the soil acts as an accumulator of the residual products of these cycles. Organic matter, especially its specific part – humus, thanks to the fertility function provides stability of the process of production – destruction of biomass [6-8]. Another important ecological function of soil is that it is the main source of nutrition elements for plants and microorganisms [7].

Among the material conditions which are necessary for human life, a special place is occupied by the soil cover of the Earth. It is the first prerequisite and natural basis in many sectors of the national economy. In different industries which use land, different soil properties are taken into account.

Agriculture is a branch of the national economy that is completely based on the use of soils, their main property of fertility. In this area, the soil is the economic basis, the main means of production. In addition, the soil in agriculture performs two more functions: at the same time it is both an object of labor and a product of labor [9, 10].

No-till system in the world. According to the latest data the volumes of using No-till technology in the world are in the range of 105 million hectares including, in US the squares, with embedded new technologies, are of approximately 87 million hectares, in Australia they are 12 million hectares, in other countries they are 6 million hectares. Sum of the total area of six countries: such as Brazil, Argentina, USA, Canada, Australia and Paraguay have 95% of America area. The European continent, including the Eastern part of it, accounts for 2.5-3%. Each year, the area under No-till grows by about 1 million hectares [6].

Zero-tillage technology is now a fundamental and somewhat revolutionary approach to agricultural technology that can stop soil degradation and create the prerequisites for sustainable land use. After 10-15 years, the soil under permanent vegetation cover switches to the natural non-degradable mode of functioning of energy and substances and at the same time it does not lose its productive function [11].

In the world, this technology is considered primarily as a soil protection measure. Followers of zero-tillage claim that no-till technology is effective in all soil-climatic and economic conditions. There are positive examples from Equatorial countries (Kenya, Uganda), from countries which are located at 40° South latitude (Argentina, Chile) or 60° North latitude (Finland). Zero-tillage is effective at an altitude of 3000 m,

as noted in Bolivia and Colombia, if the soil contains 90 % of the sand fraction (Australia, Paraguay) or 85% of the clay (Brazil), if the precipitation level is 200 mm (Western Australia), 2000 mm (Brazil) and even 3000 mm (Chile) [12]. At the same time, permanent and necessarily significant vegetation cover (mulch) on the soil surface is considered as a new strategy for weed control. Tools for cutting annual weeds without breaking the mulch have been widely used [13].

The analysis of literature sources confirms that the main advantages of zero-tillage are in energy saving and soil protection. However, even these advantages do not contribute to the spread of zero-tillage in European countries, in particular progressive ones in the agricultural sector such as Great Britain, Germany, and France. At the same time, the experience of South American countries is very effective as in a short time, archaic backward agriculture was transferred to the level of modern high-tech and productive agriculture [13, 14].

The global trend towards the minimization of tillage is now determined not only by the attempt to reduce costs of material resources and labor of tillage, and how much control of soil-creating cultural processes and the expanded reproduction of soil fertility, which is unrealistic at a constant shelf processing [15].

Due to the growing problem of contamination and the development of diseases, even where the minimum-tillage and zero-tillage has already been successfully tested, farmers from different countries perform plow processing every 4-5 years to clean the fields [16]. On the other hand, a permanent and necessarily significant thickness of vegetation (mulch) on the soil surface is at the same time considered as a new strategy for weed control. Tools for cutting annual weeds without breaking the mulch have been widely used [13]. In some farms, at first, problems with sprouting the seeds of the forerunner crops can lead to certain crop losses due to little experience, inadequate mechanization, or unfavorable weather conditions [17].

In the US, the rationale for implementing No-till is to increase productivity and the soil protection value of zero-tillage. For Canada, where grain production is concentrated in the steppe regions, the main factor is the accumulation and preservation of moisture. The same factor applies to agriculture in the Western provinces of Australia. For the tropics of Brazil, the No-till technology is a government program that aims to preserve soil fertility and protect it from water erosion. Regarding the European continent, where the undisputed leader is the UK, the main argument for introducing zero-tillage is to increase productivity at the stages of preparing the soil and sowing grain crops [18].

This technology is also becoming widespread in other countries of the world, as every year the area under No-till technology in the world is growing by more than 1 million hectares [19]. Among the countries of Western Europe, Spain and France have the largest areas under No-till technology, although in Europe as a whole, the share of land under such technology does not exceed 3% in the structure of cultivated areas [20].

No-till system in Ukraine. The development of the agricultural sector of Ukraine in recent years has a stable and positive direction of growth, there is an increase in the rate of agricultural production [21].

Therefore, in Ukraine, which is an agricultural country and it has 33 million hectares of agricultural land (70 % of the total territory, 80 % of which is arable land), issues and measures on soil quality and fertility should be in the first place both at the state level and among agricultural producers and agricultural scientists [22].

Zero-tillage is a highly effective agromeliorative method of retaining and preserving soil moisture from precipitation. In summer, it has a typical effect of 30-50 mm, that's why it stabilizes agriculture, especially during severe droughts. Therefore, the most promising area for the introduction of minimum-tillage and "zero-tillage" is the steppe zone, a significant part of the Right-Bank Forest-Steppe. [15]

According to N. K. Shikula and G. V. Nazarenko, permanent minimum-tillage of the soil ensures the accumulation of organic substances, nutrients and accumulated energy in the upper part of the soil profile, which creates the basis for expanded reproduction of chernozem fertility [23]. It is established that as longer the systematic zero tillage is applied, as higher the yield of field crops is [24].

According to experts from the European continent, Ukrainian chernozem soils are ideal objects for the introduction of zero-tillage [25], which makes it possible to manage the cultural soil-making process and access to expanded reproduction of soil fertility, which is unrealistic due to constant cultivation [26].

The advantages of zero tillage are demonstrated by the experience of a number of Ukrainian agricultural enterprises which have successfully introduced the No-till system. Among them, we should highlight the company "Agromir", "Agrosoyuz", the agronomic experimental station NUBiPu of the Vasilkovsky district of the Kiev region [5]. According to the researchers of Uman NUS during the first years of its development water supply conditions of crops did not worsen [27], and the density of a 30-centimeter layer of podzol chernozem though somewhat increased, but it remained within the optimal parameters [28]. Progressive is the experience of using the No-till system in the FH "Arcadia" of the Mykolaiv region, where corn, winter wheat and legumes (peas, chickpeas, soy) are grown using this technology [29].

Summarizing the scientific data obtained both in foreign countries and in Ukraine, we can conclude that it is promising to conduct research on the environmental aspects of the No-till technology and its impact on soil fertility in the southern Steppe zone of Ukraine.

III. OBJECT, SUBJECT AND RESEARCH METHODS

The object of research is the southern Chernozem soil with winter wheat agrocenosis using the No-till technology.

The subject of research is the density, humidity and microbiological activity of the soil, the yield of winter wheat, soy, and sunflower.

The research was conducted in 2017-2019 yrs on the basis of the FH "Arcadia" of the Bratsk district of the Mykolaiv region, located in the southern Steppe zone of Ukraine. The average annual precipitation is 350 mm, the absolute maximum air temperature in July-August is 32-38⁰C. The area of cultivated land is 1600 ha. The structure of the farm's sown areas are: soy as 25-30%; winter wheat as 10-15 %; winter barley as 10-15 %; corn as 10-15 %; sunflower as 20-25 %; rapeseed as 7-10 %; peas as 5-7 %; mustard as 2%; chickpeas as 2%.

The soil of the experimental field is southern low-humus medium-loam chernozem. The humus content in the layer 0-30 cm was 2.4 %, the content of light-hydrolyzed nitrogen by Tyurin is 6.3 mg/100 g soil (low), mobile phosphorus by Machygin is 6.0 mg/100 g soil (medium), exchangeable potassium by Maslova is 24,0 mg/100 g of soil (high).

The research was carried out in the seventh and ninth years of the introduction of No-till technology. To determine the agrophysical and biological indicators of soil fertility, experimental plots of winter wheat, whose predecessor was soy, were used as a model system. For sowing of winter wheat using the No-till technology, it was used the JD 7000 stubble grain seeder, which allowed to apply mineral fertilizers simultaneously with sowing. As a control, wheat plots were grown using the traditional technology adopted for the southern Steppe zone with intensive soil cultivation, including plowing to a depth of 20 cm up to 22 cm. We also determined the yield of winter wheat, soy and sunflower, which were grown using No-till technology compared to the control.

We used the following research methods: empirical (field, laboratory-field, laboratory); theoretical (comparison, analysis, commensuration, synthesis); statistical (descriptive statistics); computational and comparative (justification of research results and dependencies of influence of factors). The soil density was determined using the Kaczynski method, and the moisture content was determined using the thermostatic-weight method [30]. Determination of the total microbiological activity of the soil was carried out according to the generally accepted method based on the intensity of decomposition of linen [31].

The area of experimental plots is 0.05 ha, their placement is randomized. Their repeatability is four times.

IV. RESULTS OF RESEARCH

The main principle of the No-till system is to use natural processes that occur in the soil. According to a number of researchers [5, 23, 24], an untilled field to a depth of 1 m - 2 m is permeated with billions of capillaries left after the roots of annual plants or these capillaries formed as a result of the life of earthworms and other organisms. Through these thin, but deep passages, the earth is saturated with moisture, and in winter it freezes and breaks the channels. This is how natural loosening occurs. Sowing is carried out with a special seeder which cuts off crop residues, it distributes them on the soil surface, it makes a furrow in the soil surface of the desired depth, it sows the seeds and it closes the seedbed. The No-till technology has a set of positive environmental consequences. Crop residues remain in the field, serve as mulch for the soil, they retain moisture, reduce soil temperature, protect the soil from erosion, they make it possible to manage soil carbon, which is the basis of humus, it improves the soil structure, and it is a substrate for energy production by microorganisms. Also, the No-till technology significantly reduces the cost of fuel for soil treatment, respectively, it reduces emissions of carbon dioxide into the atmosphere, and organic matter created by removing carbon dioxide from the atmosphere is fixed in plant residues.

The No-till technology is particularly relevant in the arid conditions of the southern Steppe zone of Ukraine, where the limiting factor for growing high yields of

strategic crops is moisture, the soils are subject to wind erosion, and there are dry winds in the spring.

Among the agrophysical indicators of soil fertility, the soil density and soil moisture reserves have the greatest impact on crop yields.

Soil density. Density is an important indicator of fertility. The optimal density for most crops is in the range of 1.0 up to 1.3 g / cm³. With these density values, the most favorable water, heat, air, and nutrient regimes are created in the fertile soil layer, as well as the most optimal conditions for the development of the root system. Under the influence of intensive load of agricultural machinery, the soil density can increase to the level of 1.4 up to 1.6 g / cm³ or more, at the same time, not only the arable layer, but also the subsurface layer is re-compacted [12].

As a result of the conducted research, it was found that the density increased with the depth of the soil layer and the time from sowing to harvesting of winter wheat using both traditional technology and No-till (Table. 3.1).

Table 3.1

Soil density under winter wheat according to No-till technology, g / cm³

Technology	Soil layer, cm	Period of sowing		Period of harvesting Harvest period	
		2017 yr	2018 yr	2018 yr	2019 yr
Traditional (control)	0-10	1,09	1,10	1,14	1,18
	10-20	1,12	1,12	1,20	1,24
	20-30	1,16	1,18	1,26	1,25
No-till	0-10	1,16	1,14	1,22	1,18
	10-20	1,20	1,17	1,27	1,22
	20-30	1,25	1,22	1,29	1,26

In the control, the soil density fluctuated between 1.09-1.18 g / cm³ for the sowing period and it increased from 1.14 up to 1.25 g / cm³ for the harvest period. In the absence of mechanical treatment of the soil, the density was significantly higher, it was 1.14 up to 1.25 g / cm³ for the sowing period and it grew from 1.18 up to 1.29 g / cm³ for the harvesting period. However, over the years of research, the soil density of the No-till technology in different periods was within the optimal limits and it did not exceed the equilibrium index, which was 1.30 g/cm³.

Increasing the density of the soil layer 0-10 cm in the no-till variant from 1.14 up to 1.16 g / cm³ compared to 1.09 up to 1.10 g/cm³ in the control did not have a negative impact on the emergence of winter wheat seedlings and their further development and overwintering (Fig. 3.1). This indicates that this density of the seedbed soil does not create a mechanical barrier to wheat seedlings and it provides a sufficient level of aeration.



Figure 3.1-Winter wheat in the tillering phase using No-till technology, December 10, 2018

Soil moisture. In the southern Steppe zone of Ukraine, the limiting factor for obtaining stable crop yields is moisture. Especially important factors are the reserves of available moisture in the soil for obtaining seedlings. Often in the fall or spring, there is not enough moisture in the soil, so technologies aimed at accumulating and preserving moisture in the soil are relevant.

The moisture content in the soil under winter wheat was determined during the sowing period and before harvesting (Table. 3.2).

Table 3.2

Moisture content in the soil under winter wheat according to No-till technology, mm

Technology	Soil layer, cm	Period of sowing		Period of harvesting	
		2017 p.	2018 p.	2018 p.	2019 p.
Traditional (control)	0-10	18,4	20,2	23,9	22,0
	10-20	17,4	19,5	20,1	19,2
	20-30	16,8	17,6	17,3	18,0
No-till	0-10	25,2	27,6	27,4	26,3
	10-20	23,7	24,8	25,3	25,3
	20-30	21,3	23,0	22,5	24,0

Analysis of the results shows that with the No-till technology, soil humidity was higher compared to the control in all layers, both during the sowing period and during the harvesting period of winter wheat. It is especially important that during the sowing period, the humidity in the experimental version in the upper layer significantly exceeded this indicator in the control, which was an important condition for the emergence of seedlings.

Thus, the moisture content in the soil was significantly higher according to No-till technology and it was amounted from 21.3 up to 27.6 mm during the winter wheat sowing period and it was from 22.4 up to 27.4 mm during the harvest period, whereas

with traditional technology this indicator was from 16.8 up to 20.2 mm and from 17.3 up to 23.9 mm, respectively.

Microbiological activity of the soil. Soil is an organo-mineral substrate with a characteristic zoning and individual composition of microorganisms of different levels of organization which completely populate it. Soil microorganisms play a key role in the formation of fertility, transforming organic residues and ensuring the synthesis of humus substances in the soil. Cellulose is the main component of plant matter, which accounts for 40-70 % of the annual organic matter produced on the planet. The decomposition of cellulose is the largest natural destructive process on the scale, soil microorganisms play the main role in which [31].

In our research, we determined the overall microbiological activity of the soil based on the decomposition of cellulose (linen fabric), depending on the technology of soil treatment. The experiment was laid in two terms – during the sowing period (October) and the harvest period (end of June - beginning of July), in the soil layer 10-20 cm, the exposure of samples in the soil for 20 days.

Analysis of the results of the study on the intensity of linen fabric decomposition showed that the overall microbiological activity of the soil depended on both the technology and the duration of the research (Table. 3.3, Fig. 3.2). When comparing the effect of soil treatment technology on the activity of soil microorganisms, it was found that in both periods of research, the highest percentage of decomposition was observed when using the No-till technology.

Table 3.3

The intensity of decomposition of linen fabric in the soil under winter wheat by No-till technology, %

Technology	Period of sowing		Period of harvesting	
	2017 yr	2018 yr	2018 yr	2019 yr
Traditional (control)	14,2±1,2	11,9±2,1	20,7±2,5	24,0±2,3
No-till	22,0±2,4	19,7±2,7	35,1±2,9	40,7±3,7

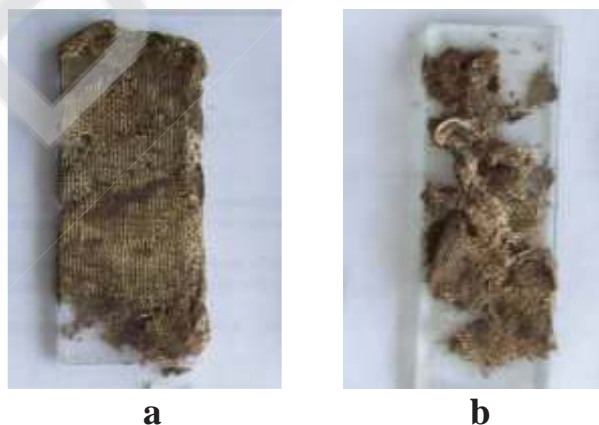


Figure 3.2- The rate of decomposition of linen fabric in the soil under winter wheat, depending on the application of the technology: a - traditional (control), b - No-till

In June-July, the loss of linen fabric weight was by 7.8% higher compared to the control, and in October it was by 14.4-16.7 %. Obviously, the revealed pattern is

associated with a large amount of substrate for microorganisms using the No-till technology and higher soil moisture compared to traditional technology, which contributes to the reproduction of microorganisms.

The greatest loss of fabric mass occurred during the harvest period (June-July), when the environmental conditions for cellulose-destroying microorganisms are more favorable. It is known that for cellulose-destroying bacteria, the optimal temperature of life is 20-25 C and the soil humidity is 60-70% of the total saturation of the soil with water. In October, the soil temperature decreased, which caused a decrease in microbiological activity. In the control, the rate of decomposition of linen fabric during the harvesting period was 20.7-24.0 %, which was by 6.5-12.1% more than during the harvest period. According to No-till technology, the loss of fabric mass during the harvest period was 35.1-40.7 %, which was by 13.1-21.0% more than during the sowing period.

Thus, the use of No-till technology in the cultivation of winter wheat contributed to an increase in the overall microbiological activity of the soil. When using this technology, the highest rate of decomposition of flax tissue in the soil was observed during the harvest period of 35.1 up to 40.7 %, which was by 14.4-16.7% more than in the control period.

Crop yield. Yield is the amount of crop production obtained from one hectare as a result of the vital activity of a certain set of plants, which consists in the absorption of nutrients and water from the ground and the synthesis of organic substances under the influence of solar energy. That is, yield is an integral indicator of soil fertility.

In our studies, we determined the yield of agricultural crops in the crop rotation with such an alternation of crops: soy, winter wheat, soy, and sunflower. The yield was determined separately using the Ag Leader Technology device (Fig. 3.3) and the weight method.



a



b

Figure 3.3 - Determination of soybean yield:
a - using the Ag Leader Technology device; b - test area before harvesting

Analysis of the data table. 3.4 shows that growing of all the crops included in the research program using No-till technology provided a significant increase in yield compared to the control.

Table 3.4

Crop yield using No-till technology, t / ha

Culture	Technology	Crop yield, t/ha			
		2018 yr	2019 yr	average for 2018-2019 yrs.	± to control
Winter wheat	Traditional (control)	3,21	4,12	3,67	-
	No-till	3,86	5,21	4,54	0,87
HIP ₀₅	-	0,42	0,48	-	-
Soya beans	Traditional (control)	2,03	1,89	1,96	-
	No-till	2,50	2,18	2,24	0,28
HIP ₀₅	-	0,42	0,27	-	-
Sunflower	Traditional (control)	1,98	2,19	2,09	-
	No-till	2,56	2,85	2,71	0,62
HIP ₀₅	-	0,32	0,45	-	-

The average yield of winter wheat for two years using No-till technology was 4.54 t/ha, which was by 0.87 t/ha (23.7 %) more than the control. The yield of soybeans was 2.24 t / ha, and the addition to the control was 0.28 t / ha (14.3 %). Sunflower formed a yield in the experimental version of 2.71 t/ha, which was by 0.62 t/ha (22.9 %) more than the control.

The increase in crop yield of 14.3-22.9 % by No-till technology allows us to draw a conclusion about optimizing soil fertility indicators in the climatic conditions of the southern Steppe zone of Ukraine in comparison with traditional intensive technologies.

Environmental aspects of No-till technology. The analysis of modern literature sources and scientific publications and the results of our own experimental studies allow us to make the following generalizations about the environmental advantages of the No-till technology:

1. The soil density in different periods of winter wheat cultivation did not exceed the equilibrium index, which was 1.30 g/cm³.

2. Soil moisture was higher compared to the control in all layers both during the sowing period and during the harvest period of winter wheat.

3. It was revealed an increase in the overall microbiological activity of the soil.

4. Increase of productivity of agricultural crops amounted from 14.3 up to 22.9%.

5. Thanks to the plant residues, a mulching layer is formed on the field surface, which helps to reduce the soil temperature, moisture losses and to make the manifestation of wind and water erosion.

6. Organic carbon losses are reduced due to a decrease in mineralization intensity and increased humification.

7. Fuel costs are reduced by about 50 % compared to traditional technology, which helps reduce greenhouse gas emissions.

The results of the research were implemented in the FH "Olena" of the Bratsk district of the Mykolaiv region and they were tested at the all-Ukrainian scientific and practical conference "Actual problems of the agricultural industry and ways to solve them" (Mykolaiv, 4-6 December 2019 yr) [32].

V. CONCLUSIONS

On the basis of the conducted scientific research, the ecological justification for the use of No-till technology in the southern Steppe zone of Ukraine is given. Based on the results obtained, the following conclusions are formulated:

1. The soil density under winter wheat according to No-till technology did not exceed the optimal index of 1.30 g/cm³ and was 1.14-1.25 g/cm³ for the sowing period and 1.18-1.29 g/cm³ for the harvesting period.

2. The moisture content in the soil was significantly higher according to No-till technology and amounted to 21.3-27.6 mm during the winter wheat sowing period and 22.4-27.4 mm during the harvest period, whereas with traditional technology this indicator was 16.8-20.2 mm and 17.3-23.9 mm, respectively.

3. The use of No-till technology helped to increase the overall microbiological activity of the soil – the intensity of decomposition of flax tissue in the soil during the harvest period was 35.1-40.7 %, which is 14.4-16.7% more than in the control.

4. The average yield of winter wheat using No-till technology for two years was 4.54 t / ha, soybean-2.24 t / ha, sunflower-2.71 t / ha. the Increase in crop yield of 14.3-22.9 % using No-till technology allows us to conclude that soil fertility indicators are optimized in the climatic conditions of the southern Steppe zone of Ukraine in comparison with traditional intensive technologies.

5. The positive environmental effects of No-till technology was noted, such as a reduction in moisture loss, organic carbon and water and wind erosion, as well as a reduction of about 50% compared to traditional technology, which contributes to a reduction in greenhouse gas emissions.

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