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The Influence of Cultivation Technologies and Fertilizer Systems on The Productivity of Winter Wheat on Leached Chernozem.

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ABSTRACT

The article describes the influence of basic tillage and sowing methods on the content of basic nutrients in the soil and the results of the winter wheat productivity studies carried out on the predecessor of winter rapeseed (2015-2017). During the period of research before sowing winter wheat, the content of nitrate nitrogen and mobile phosphorus in the control without fertilizers for both cultivation technologies was very low, against the background of fertilization, this indicator in the upper soil layer increased. The technology of cultivation and the fertilizers applied did not significantly affect the content of potassium. The introduction of mineral fertilizers for winter wheat on leached chernozems is more effective with the traditional technology of its cultivation.

Keywords:soil cultivation, winter wheat, calculated fertilizer system, yield.

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INTRODUCTION

Rational soil cultivation is an important link in the system of measures to ensure a high crop culture, increase soil fertility and crop yields. The tasks that it must perform: improving the air, water, heat and nutrient regimes of the soil, regulating the biological processes and rates of mineralization of organic substances in the desired direction, reducing the number of weeds, diseases and pests of agricultural plants, creating conditions for protecting the soil from erosion and carrying out high-quality sowing [1].

Currently, adapted soil treatment systems share a common drawback - their energy intensity. For this reason, farmers and scientists are engaged in the development and research of energy-saving and environmentally sound techniques, including the widespread introduction of No-till technology, which has been widely applied to 150 million hectares in Brazil, Argentina, the USA, Canada, Australia, France and other countries. countries. Now this technology is being actively tested in Ukraine, Russia and Kazakhstan [2]. The use of zero tillage should be considered a modern conceptual approach to the technology of crop cultivation with the use of new generation agricultural machinery.

For chernozems, the use of direct sowing is expedient in that these soils contain humus 4% or more, have a favorable density, porosity and structure. Plant residues on the surface reduce the evaporation of moisture and protect the soil from overheating [8]. When switching to direct seeding technology in the soil, the mineralization process is significantly reduced, which contributes to an increase in soil fertility.

It is proved that when switching to zero technology labor and energy costs are significantly reduced, but the negative aspects of this method should be taken into account. Reducing the biological activity of the soil leads to a low supply of plants with nitrogen and phosphorus. Therefore, using direct seeding technologies, it is necessary to increase the doses of nitrogen and phosphorus fertilizers [5], and also take into account soil-climatic factors, biological characteristics of crops and other conditions.

There is an increase in the efficiency of mineral fertilizers by 8-10% in the crop rotation with minimal soil cultivation in comparison with the technology of dump processing. Following the recommendations of scientists and practitioners [7], during the spring renewal of the growing season of winter wheat, it is necessary to add up to 150 kg of ammonium nitrate, while adding the second internode, another 150 kg should be added.

Thus, higher yields of cultivated crops with zero technology, while lowering production costs, also ensure a higher economic efficiency of this technology compared to the conventional one on the basis of dump cultivation [4], which in modern conditions is decisive for mastering this technology.

MATERIALS AND METHODS

In order to study the possibility and effectiveness of the zero technology of crop cultivation in the crop rotation, the studies were conducted in the period from 2012 to 2017. in the conditions of a zone of moderate moistening on chernozem leached. In many years of in-patient experience, field experiments have been conducted to study the effect of no-till technology and traditional technology on soil fertility and crop yields. The experience is two-factorial: on the basis of grain-fallow crop rotation, the influence of soil tillage and sowing systems is studied using traditional technology and technology using direct sowing, as well as fertilizer doses.

The fertilizers used are ammophos - together with sowing, in top dressing - ammonium nitrate - surface method, carbamide-ammonium mixture, urea (carbamide) with a sprayer.

Analyzes of soil and plant samples were carried out according to generally accepted methods:

- Humus content according to Tyurin in the modification of CINAO (Central research Institute of agrochemical service) GOST 26213-91;
- mobile forms of phosphorus and exchangeable potassium according to Machigin in the modification of CINAO, GOST 26205-91;
- Nitrate nitrogen - colorimetrically with disulfophenolic acid by the Grandval-Liazhu method, GOST 26488-91;

- Ammonium nitrogen - by colorimetry with Nessler reagent, GOST 26489-91;
- taking into account the harvest of cultivated crops by the method of mechanized harvesting with subsequent recalculation to standard moisture and purity according to the method of state testing (1983);
- statistical processing of experimental data by dispersion and regression-correlation analysis (B.A. Dospekhov, 1985).

RESULTS AND DISCUSSION

Removing plant residues on the soil surface using zero technology without tillage provides greater accumulation and better conservation of productive moisture in the soil throughout the growing season that the crop plants can use to form the crop.

The technologies of winter rapeseed cultivation and the dose of fertilizers applied had a significant effect on the content of available nutrient elements and their distribution over the soil horizons. Before sowing, the content of nitrate nitrogen without fertilization on both cultivation technologies was very low - 5.3-6.9 mg / kg soil. The introduction of nitrogen fertilizers increased this index in the upper soil layer to 20-25 mg / kg. Also, without the application of fertilizers, the content of mobile phosphorus in the arable layer of the soil was at a low level of 10.4-14.4 mg / kg soil. The introduction of phosphoric fertilizers increased its content to an average of 20.7-28.0 mg / kg, and when a calculated dose of phosphorus by zero technology and up to 0.10 cm in the upper soil layer was 38.1 mg / kg soil. On the content of exchangeable potassium, cultivation technologies and introduced fertilizers did not have a significant effect.

When plowing, when the soil horizon is wrapped and mixed, according to traditional cultivation technology, nitrate nitrogen and, especially, available phosphorus are uniformly distributed in the soil layer of 0-20 cm. At the same time, plowing and fertilization were carried out under the previous crop rotation culture - winter wheat.

With zero cultivation technology, neither under the previous crop, nor under canola cultivation, was carried out. All fertilizers were introduced with sowing to the depth of the seeding, which explains the greater content of these elements, especially the slightly mobile phosphorus, in the upper soil layer. A slightly higher content of phosphorus in the 10-20 cm layer as compared to the 20-30 cm layer is due to its penetration due to migration and the assimilation by the preceding winter rape of plants, after which the phosphorus is mineralized and penetrated into the underlying soil layer.

Prior to harvesting, the content of plant nutrients available for plants was reduced in all variants of the experiment (Table 1), especially strongly nitrate nitrogen and mobile potassium.

Table 1: Effect of technologies and fertilizers on the content of available nutrients in the soil during harvest, mg / kg soil (average for 2015-2017)

Fertilizer	Layer of soil, cm	$N\text{-}NO_3$		P_2O_5		K_2O	
		common	zero	common	zero	common	zero
Without fertilizer	0-10	3,4	3,6	13,3	12,6	180	140
	10-20	3,8	4,3	12,5	9,1	181	153
	20-30	3,3	5,7	8,6	7,9	192	164
Recommended	0-10	11,1	12,0	19,4	26,2	195	193
	10-20	10,6	7,2	17,7	12,4	190	186
	20-30	7,8	6,1	9,3	7,8	191	203
Calculated	0-10	12,5	11,7	22,4	36,4	213	207
	10-20	9,0	8,5	19,2	13,0	204	213
	20-30	8,7	6,7	10,7	7,8	208	216

Therefore, when cultivating winter rapeseed using traditional technology, available phosphorus in the 0-10 cm layer is smaller, and in the layer 10-20 cm larger than with zero technology without tillage.

Before sowing winter wheat, the content of nitrate nitrogen without fertilization for both cultivation technologies was very low - 5.3-6.9 mg / kg soil. The introduction of nitrogen fertilizers increased this index in

the upper soil layer to 20-25 mg / kg. A similar situation was observed in mobile phosphorus: without fertilization, its content in the arable layer of the soil was low at 10.4-14.4 mg / kg soil. The introduction of phosphoric fertilizers increased its content to an average of 20.7-28.0 mg / kg, and when a calculated dose of phosphorus by zero technology and up to 0.10 cm in the upper soil layer was 38.1 mg / kg soil.

Prior to harvesting, the contents of plant food items available for plants decreased in all variants of the experiment, especially strongly nitrate nitrogen and mobile phosphorus. On the content of potassium, cultivation technologies and applied fertilizers did not have a significant effect.

The cultivation technologies did not have a significant effect on the content of available nutrients for plants in the soil, but resulted in a greater accumulation of mobile phosphorus in the 0-10 cm soil layer with zero cultivation technology, whereas with traditional technology this element is more evenly distributed in the plow layer of the soil. The introduced fertilizers provided an increase in the content of nitrate nitrogen and mobile phosphorus in the soil.

Field germination on both technologies was high 91.1 - 93.6%, but the difference between them was 2.5% in favor of traditional technology, where in the sowing layer there was a sufficient supply of moisture, the soil density was within the optimal range.

The highest yield of winter wheat was obtained when grown according to traditional technology. On average, for three years (2015-2017), 3.83 tons of grain per hectare was obtained, which is 1.17 tons per hectare or 30.5 percent more than in direct seeding.

Reducing yields in the cultivation of winter wheat, cultivated according to the predecessor of winter rapeseed, on the technology of direct sowing is mathematically demonstrable, it is also reliable for an average of 3 years of research. This suggests that on winter chernozem leached winter wheat yields higher yields when cultivating according to traditional technology with the application of soil cultivation [3].

The introduction of mineral fertilizers for both technologies also ensured a reliable increase in yield, both in individual years of research and in average yield data. Thus, the introduction of the recommended dose of fertilizers ensured an increase in yield of 0.48 t / ha (16.9%) on average over three years with an index of the smallest significant difference of 0.14 t / ha. For years of research, the increment varied from 0.19 t / ha in 2015 to 0.80 t / ha in 2017, but it is mathematically demonstrable and reliable (Table 2).

From the application of the calculated fertilizer dose, the yield of winter wheat relative to the control, where fertilizers did not contribute, increased by 0.75 t / ha (26.4%) with fluctuations in years from 0.65 to 0.93 t / ha.

A reliable increase in the grain yield of winter wheat was ensured by the application of a calculated dose of fertilizers in relation to the recommended dose, since during all the years of research the yield increase is higher than the smallest significant difference. It is higher than the average for 3 years - 0.27, while the smallest significant difference is 0.14 t / ha.

Table 2: Influence of the technology of tillage and sowing and fertilization on the yield of winter wheat on the predecessor of winter rapeseed, t / ha

Technology	Fertilizer	Year			Average	Addition, t / ha
		2015	2016	2017		
Traditional	without fertilizer	2,76	3,28	3,60	3,21	-
	recommended	3,40	3,82	4,66	3,96	+0,75
	calculated	3,54	4,40	5,03	4,32	+1,02
Direct seeding	without fertilizer	2,38	1,98	3,02	2,46	-
	recommended	2,66	2,12	3,26	2,68	+0,22
	calculated	2,94	2,16	3,45	2,85	+0,39
$HCP_{0,95}$		0,16	0,18	0,20	0,17	

However, the introduction of the recommended dose of fertilizers according to the traditional technology on the average ensured a yield increase in comparison with the control of 0.75 t / ha or 23.4%, whereas in direct seeding technology - 0.22 t / ha (8.9%), when applying a calculated dose of fertilizers, respectively - 1.11 (34.6%) and 0.39 t / ha (15.8%). The increase in yields from the application of a calculated dose of fertilizers in relation to the recommended dose according to traditional technology was 0.36 t / ha (9.1%), and by direct sowing technology, the increment was only 0.17 t / ha or 6.3%. That is, the application of mineral fertilizers for winter wheat on leached chernozems is more effective with the traditional technology of its cultivation. The poor agrophysical properties of these soils not only lead to a decrease in yields with respect to direct seeding technology, but also a significant decrease in the efficiency of mineral fertilizer use, which is for the same reason - excessive compaction and deterioration of the food and air regime [6].

The productivity of winter wheat planned at the calculated fertilizer dose of 5.0 t / ha when cultivated using direct sowing technology was not achieved in one year. The planned yield was obtained only once in the most favorable weather conditions in 2017 when growing winter wheat using traditional technology. This means that the effectiveness of mineral fertilizers depends largely on weather conditions, especially on the amount of precipitation and their distribution during the vegetation period. The arid conditions of the growing season with high temperatures did not allow the plants of winter wheat to form the planned yield level when applying calculated doses of fertilizers for both technologies.

CONCLUSION

The data showed that the applied No-till technology is inferior to the accepted cropping technology. All the same, the traditional technology with a wide range of fertilizer options has its advantages, which few are ready to give up. But in the long term, a more efficient and profitable way of exploiting land is a zero system of tillage and sowing.

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