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CHANGE IN AGROCHEMICAL INDICATORS OF LEACHED CHERNOZEM IN NO-TILL TECHNOLOGIES

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Abstract

The article presents the results of studies on the study the No-till technology influence depending on mineral fertilizers on the change in the agrochemical parameters of leached chernozem. Studies have shown that the seven-year use of No-till technology without fertilizers led to a decrease in the content of alkaline hydrolyzable nitrogen in leached chernozem by 10.1-13.7 mg/kg of soil, mobile phosphorus by 10.3-16.0 mg/kg, mobile potassium by 9.5-13.1 mg/kg of soil. The application of mineral fertilizers in the form of ammonium nitrate, sulfoammophos and ammophoska increased the content of alkaline hydrolysable nitrogen in the 0-30 cm layer by 12.1-13.6 mg/kg. The content of mobile phosphorus increased only in the 0-30 cm layer in the variants with the use of phosphorus-containing fertilizers by 17.7-19.9 mg/kg, and the content of mobile potassium in the variant with the potassium-containing fertilizer by 3.7-12.3 mg/kg of soil. The use of complex fertilizers such as sulfoammophos and ammofoska did not lead to a sharp decrease in pH. An increase in acidity was observed only in the variant with the use of ammonium nitrate.

***Key words**: No-till, mineral fertilizers, alkaline hydrolyzable nitrogen, mobile phosphorus, mobile potassium, pH.*

INTRODUCTION

Over the past 50-60 years, in countries developing intensive technologies for the cultivation of agricultural crops, the soil fertility of agricultural land has deteriorated more than twice. Traditional methods of intensive tillage sooner or later lead to a decrease in the stock of soil humus, a decrease in soil biological activity and (or) erosion up to soil degradation, as well as a decrease in productivity (Chekaev et al., 2015; Derpsch et al., 2010).

According to a number of authors, resource-saving technologies help preserve the level of humus content and reserves, mainly by reducing the loss of organic matter by slowing down the mineralization processes and increasing its labile part from the remaining plant residues (straw, chaff) (Huang et al., 1999; Vogeler et al., 2009; Martínez et al., 2016).

At present, the No-till technology is recognized as the highest level of minimization of soil tillage and sowing in the world. No-till farming can no longer be seen as a temporary fad or fad. This system has established itself as an agricultural practice and a distinct way of thinking about the sustainable management of an agroecosystem. With the No-till system, the influence of nature and climate is reduced to 20%. The remaining 80% is accounted for by technology and management in agriculture (Derpsch et al., 2010).

In increasing yields with direct sowing, the decisive role is played by mineral fertilizers, of which nitrogen fertilizers are of paramount importance (Liang et al., 2016). The use of No-till technology preserves soil nutrients and promotes better absorption of nitrogen, phosphorus and potassium by plants, which leads to an increase in the economic efficiency of fertilizer use. (Yang et al., 2020; Borges et al., 2000; Medvedeva et al., 2020).

No-till technology assumes that no fertilizer is applied during the period from the end of harvesting of the precrop to sowing. The key to obtaining a high yield using this technology is the application of fertilizers during sowing and feeding during the growing season of the crop (Chekaev N. et al., 2015).

MATERIALS AND METHODS

Studies to assess changes in agrochemical parameters of leached chernozem in No-till technologies with the use of mineral fertilizers were carried out in 2013-2019. at the experimental sites in LLC Kameshkirsky feed mill, Kameshkirsky district, Penza region, according to the following scheme:

1. Without fertilizers (control);
2. N_{20} in the form of ammonium nitrate (60 kg/ha);
3. $N_{20}P_{20}S_{14}$ in the form of sulfoammophos (100 kg/ha);

four. $N_{20}P_{25}K_{25}S_{23}$ in the form of ammophoska (166 kg/ha);

The research was carried out in a crop rotation with alternating crops: peas (*Pisum sativum* L.) - winter wheat (*Triticum aestivum* L.) - sunflower (*Helianthus annuus* L.) - spring wheat (*Triticum aestivum* L.) - buckwheat (*Fagopyrum esculentum*). The soil of the experimental plots is represented by leached chernozem, low-humus, medium-thick, light clayey. The upper thirty-centimeter soil layer before sowing peas in 2013 was characterized by the following indicators: humus content 5.2 ... 5.6% (average content), pH (KCL) 4.9 ... 5.2 (weakly acidic), alkaline hydrolysable nitrogen 95.3 ... 106.7 mg/kg (low content), mobile phosphorus 67.3 ... 70.3 mg/kg (average content), mobile potassium 120.0 ... 136.0 mg/kg soil (increased content). The area of the accounting plot is 42 m^2.

Fertilizers were applied during sowing with seeding machines for No-till technology.

Laboratory analyzes of soil samples were carried out by the following methods:

- mobile compounds of phosphorus and potassium - according to the method of F.V. Chirikov (GOST 26204-91);
- alkaline hydrolysable nitrogen - according to the Kornfield method (modified by CINAO);
- pH of the salt extract on a pH meter (GOST 26483-85);

Yield accounting - by the gravimetric method according to the variants of the experiment in 3-fold repetition from 1 m^2.

RESULTS AND DISCUSSIONS

Among the agrochemical parameters of the agroecological state of soils, traditionally, the greatest attention is paid to the content, reserves and quality of humus, available forms of basic nutrients (NPK) with assessment scales, pH values adapted to the conditions of a particular region.

Long-term application of no-till technology leads to differentiation of nutrient content in the upper and lower layers of the soil profile (Martínez et al., 2016; Messiga et al., 2012).

Mobile alkaline hydrolysable nitrogen characterizes the content of nitrogen potentially available for plants.

The content of alkaline hydrolyzable nitrogen in the 0-30 cm layer in the first year of the introduction of the No-till technology was in the range of 95.3-106.7 mg/kg soil, which was characterized by both very low and low content.

In the soil layer of 30-50 cm, the content of alkaline-hydrolyzed nitrogen was lower than in the upper 30-centimeter soil layer, and amounted to 84.5-99.2 mg/kg of soil (Table 1).

Table 1. Change in the content of alkaline hydrolyzable nitrogen in leached chernozem in No-till technology

Option	Soil layer, cm	Alkaline hydrolysable nitrogen, mg/kg soil		
		2013 (first year of implementation)	December 2019	Deviations from the original data
1. Without fertilizers (control)	0-30	106.7	93.0	-13.7
	30-50	99.2	89.1	-10.1
2. N20	0-30	95.3	107.4	12.1
	30-50	86.0	80.3	-5.7
3. N20P20S13	0-30	98.0	111.8	13.8
	30-50	84.5	77.0	-7.5
4. N20P25K25S23	0-30	99.6	113.2	13.6
	30-50	97.6	90.7	-6.9
NSR05	0-30			3.2
NSR05	30-50			2.7

Seven years after the introduction of the No-till technology (2019), the content of alkaline hydrolysable nitrogen was 93.0-113.2 mg/kg in the 0-30 cm layer and 77.0-90.7 mg/kg in the 30-50 layer cm. On the option without fertilizers, the content of alkaline hydrolyzable nitrogen decreased by 13.7 mg/kg in the 0-30 cm layer and by 10.1 mg/kg in the 30-50 cm layer. On the options with the introduction of mineral fertilizers, the nitrogen content in the 0-30 cm increased by 12.1-13.8 mg/kg. A decrease was observed in the 30-50 cm layer in all variants.

Thus, the use of nitrogen-containing fertilizers leads to the accumulation of alkaline hydrolyzable nitrogen in the upper 30-cm soil layer and to a decrease in its content in the 30-50 cm layer. At the same time, the dynamics of a clear differentiation of its content in the soil profile begins to appear.

Phosphate regime of soils means their ability to supply plants with phosphorus, which is characterized by: 1 - capacity factor, meaning the amount of phosphorus available to plants; 2 - an intensity factor characterizing the degree of mobility of the stock of soluble phosphates available in the soil (or the possibility of using mobile phosphates by plants).

The content of mobile phosphorus in the first year of the introduction of the No-till technology was 67.3-70.3 mg/kg of soil, which was characterized as an average content for grain crops and low for fodder crops, root crops and potatoes. In the layer of 30-50 cm, the phosphorus content was lower compared to the 0-30 cm layer by 4.3-17.7 mg/kg (Table 2).

Table 2. Change in the content of mobile phosphorus in leached chernozem in No-till technology

Option	Soil layer, cm	Mobile phosphorus, mg/kg soil		
		2013 (first year of implementation)	December 2019	Deviations from the original data
1. Without fertilizers (control)	0-30	67.3	57.0	-10.3
	30-50	59.6	43.6	-16.0
2. N20	0-30	69.7	56.8	-12.9
	30-50	57.3	41.5	-15.8
3. N20P20S13	0-30	70.3	85.0	17.7
	30-50	68.0	59.9	-8.1
4. N20P25K25S23	0-30	68.0	87.9	19.9
	30-50	63.7	53.0	-10.7
NSR05	0-30			3.1
NSR05	30-50			2.9

The data obtained in 2019 confirm the decrease in the content of mobile phosphorus in the variant without fertilizers both in the 0-30 cm layer and in the 30-50 cm layer. In the variant with ammonium nitrate, the decrease in mobile phosphorus was 12.9 mg/kg in layer 0 -30 cm and 15.8 mg/kg in a layer of 30-50 cm. The use of phosphorus-containing fertilizers sulfoammophos and ammophos increased its content in the layer 0-30 cm by 17.7-19.9 mg/kg, and in the layer 30-50 cm, a decrease of 8.1-10.7 mg/kg was observed, which can be explained by the low mobility of phosphorus compounds and weak migration along the soil profile. An increase in the phosphorus content was observed only in the variant with the use of phosphorus-containing fertilizers in the 0-30 cm layer. In the 30-50 cm layer, its decrease is observed in all variants, which will further lead to a clear differentiation of its content along the soil profile.

The content of mobile potassium in the soil after a seven-year period of introduction of No-till technology has decreased in almost all variants, with the exception of the variant with the use of potassium-containing fertilizer ammophoska. In these variants, the decrease was from 9.5 without fertilizers to 17.8 mg/kg in the layer of 0-30 cm and from 13.1 to 18.0 mg/kg in the layer of 30-50 cm. On the variant with the use of ammophos in the layer 0-30 cm, an increase in mobile potassium was observed by 12.3 mg/kg, and in the layer 30-50 cm by 3.7 mg/kg of soil (Table 3). On options without the use of potassium-containing fertilizers, seven years after the introduction of no-till technology, a decrease in its content is observed both in the 0-30 cm layer and in the 30-50 cm layer, while no clear differentiation was observed.

Table 3. Change in the content of mobile potassium in leached chernozem in No-till technology

Option	Layer soil, cm	Mobile potassium, mg/kg soil		
		2013 (first year of implementation)	December 2019	Deviations from the original data
1. Without fertilizers (control)	0-30	136.0	126.5	-9.5
	30-50	127.1	114.0	-13.1
2. N20	0-30	128.3	110.5	-17.8
	30-50	125.3	109.0	-16.3
3. N20P20S13	0-30	120.0	107.0	-13.0
	30-50	120.0	102.0	-18.0
4. N20P25K25S23	0-30	133.8	146.1	12.3
	30-50	108.8	112.5	3.7
NSR05	0-30			2.2
NSR05	30-50			1.4

Table 4. Changes in pH(KCl) of leached chernozem in No-till technology

Option	Soil layer, cm	pH(KCl), units		
		2013 (first year of implementation)	December 2019	Deviations from the original data
1. Without fertilizers (control)	0-30	5.09	5.01	-0.09
	30-50	5.13	5.10	-0.03
2. N20	0-30	5.06	4.75	-0.31
	30-50	5.17	5.15	-0.02
3. N20P20S13	0-30	4.93	4.81	-0.12
	30-50	5.10	5.03	-0.07
4. N20P25K25S23	0-30	5.05	4.95	-0.10
	30-50	5.04	5.06	0.02
NSR05	0-30			0.07
NSR05	30-50			0.03

Determination of soil acidity is one of the most common analyzes, both in theoretical and applied research.

Plants show varying sensitivity to acidic and alkaline environments. The negative effect of acidity is especially dangerous in the initial growing season.

Studies have shown that the use of No-till technology reduces the processes associated with soil acidification.

The use of the soil without fertilization practically did not lower the pH level.

The use of complex fertilizers such as sulfoammophos and ammofoska reduced the pH by 0.10-0.12 units. in the 0-30 cm layer.

In the variant with the use of ammonium nitrate, an increase in acidity is observed in the 0-30 cm layer by 0.31 units. pH. In a layer of 30-50 cm, changes in pH values were within the experimental error.

CONCLUSIONS

Studies have shown that the use of No-till technology without fertilizers for seven years led to a decrease in the content of alkaline hydrolyzable nitrogen in the leached chernozem in the upper thirty centimeter layer by 13.7 mg / kg of soil, mobile phosphorus by 10.3 mg / kg, and mobile phosphorus by 10.3 mg / kg. potassium per 9.5 mg / kg of soil. The introduction of mineral fertilizers in the form of ammonium nitrate, sulfoammophos and ammophoska increased the content of alkaline hydrolyzable nitrogen in the 0-30 cm layer by 12.1-13.8 mg / kg. The content of mobile phosphorus increased only in the 0-30 cm layer in the variants with the use of phosphorus-containing fertilizers by 17.7-19.9 mg / kg, and the content of mobile potassium in the variant with the potassium-containing fertilizer by 12.3

mg / kg of soil. Over the seven years of using fertilizers in No-till technology, there has been a tendency for a clear differentiation of the content of alkaline hydrolyzable nitrogen in soil layers of 0-30 and 30-50 cm when using nitrogen-containing fertilizers. According to the phosphorus content, differentiation according to the studied layers is manifested when using phosphorus-containing fertilizers. In terms of potassium content, no clear differentiation was observed in layers of 0-30 and 30-50 cm over the seven years of research.

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