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4.1.1. Общее земледелие и растениеводство (биологические науки, сельскохозяйственные науки)

ПРОДУКЦИОННЫЕ ПОКАЗАТЕЛИ ОЗИМОЙ ПШЕНИЦЫ, ВОЗДЕЛЫВАЕМОЙ ПО ПРЕДШЕСТВЕННИКУ СОЯ В УСЛОВИЯХ ЗАПАДНОГО ПРЕДКАВКАЗЬЯ

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В статье описаны итоги научных исследований вариабельности агробиологических показателей озимой пшеницы, возделываемой по предшественнику, соя в условиях Западного Предкавказья. Опытное поле, где выполняли исследования в 2022-23 с.-х. годах, размещено в УОХ «Кубань» Кубгау. В опыте изучались агробиологические показатели озимой пшеницы, возделываемой по предшественнику соя, в стационарном опыте на черноземе выщелоченном. Сорт – Тимирязевка 150. Среднепоздний сорт с посевом в конце оптимальных сроков для зон, имеет массу 1000 семян 36-42 грамм и высоту растения 73-95см. Высокоурожайный сорт, имеет потенциальную урожайность 120 ц/га, с качеством зерна хорошим и отличным на уровне «сильных» пшениц. Данный сорт рекомендован для выращивания по всем предшественникам на высоком агрофоне. Опыт двухфакторный. Первый фактор – прием основной обработки почвы (вспашка на 20-22 см и no-till). Второй фактор – норма минудобрения (контроль без внесения удобрений, рекомендованная норма минерального удобрения (под основную обработку почвы $N_{20}P_{80}$ + ранневесенняя подкормка N_{20}), интенсивная норма минерального удобрения (под основную обработку почвы $N_{40}P_{160}$ + ранневесенняя подкормка N_{40}). Предшественник – соя. Выявлено, что как прием основной обработки почвы, так и норма удобрения оказывают влияние на структуру урожая. Лучшие ее параметры отмечены на варианте со вспашкой на фоне интенсивной нормы минерального удобрения ($N_{40}P_{160}$ + N_{40}), где отмечен их рост по сравнению с контролем на 6,5–38,9 %. Переход на систему no-till влечет за собой снижение параметров структуры

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4.1.1. General agriculture and crop production (biological sciences, agricultural sciences)

PRODUCTION INDICATORS OF WINTER WHEAT CULTIVATED AFTER SOYBEAN AS A PRECURSOOR IN THE WESTERN CAUCAUSIA

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The article describes the results of scientific studies of the variability of agrobiological parameters of winter wheat grown after soybean as a predecessor in the conditions of the Western Ciscaucasia. The experimental field, where the studies were carried out in 2022-23 agricultural years, is located in the Kuban UOH of KubGAU. The experiment studied the agrobiological parameters of winter wheat grown after soybean as a predecessor in a stationary experiment on leached chernozem. Variety - Timiryazevka 150. Mid-late variety with sowing at the end of the optimal terms for the zones, has a 1000 seed weight of 36-42 grams and a plant height of 73-95 cm. High-yielding variety, has a potential yield of 120 c/ha, with good and excellent grain quality at the level of "strong" wheat. This variety is recommended for growing after all predecessors on a high agricultural background. The experiment is two-factorial. The first factor is the method of primary soil cultivation (plowing to 20-22 cm and no-till). The second factor is the rate of mineral fertilizer (control without fertilizer application, recommended rate of mineral fertilizer (under primary tillage N20P80 + early spring top dressing N20), intensive rate of mineral fertilizer (under primary tillage N40P160 + early spring top dressing N40). Predecessor - soybean. It was found that both the method of primary tillage and the fertilizer rate affect the crop structure. Its best parameters were noted in the variant with plowing against the background of an intensive rate of mineral fertilizer (N40P160 + N40), where their increase in comparison with the control by 6.5-38.9% was noted. The transition to the no-till system entails a decrease in the parameters of the crop structure by 7.2-42.5% and biological yield by 19.9-64.1% depending on the fertilization background.

урожая на 7,2–42,5 % и биологической урожайности на 19,9–64,1 % в зависимости от фона удобренности. Параметры таких показателей, как длина колоса, число колосков и зерен в колосе были вне влияния изучаемых факторов. И прием основной обработки почвы, и норма удобрения оказывают влияние на урожайность озимой пшеницы сорта Тимирязевка 150. Максимум их параметров достиг на варианте со вспашкой на фоне интенсивной нормы минерального удобрения ($N_{40}P_{160}$ + N_{40}), где отмечен их рост по сравнению с контролем на 11,3–13,0 ц/га или на 25,2–35,1 %. Переход на систему no-till при выращивании озимой пшеницы влечет за собой снижение урожайности на 5,2–21,3 ц/га или на 11,6–43,7 %. На такие показатели, как натура зерна и ИДК клейковины изучаемые факторы влияния не оказали. На остальные показатели положительно влияли как минеральные удобрения, так и прямой посев культуры

Ключевые слова: ПШЕНИЦА ОЗИМАЯ, ТИМИРЯЗЕНВКА 150, СТРУКТУРА, УРОЖАЙНОСТЬ, КАЧЕСТВО

Parameters of such indicators as spike length, number of spikelets and grains per ear were not affected by the factors studied. Both the method of primary tillage and the fertilization rate affect the yield of winter wheat of the Timiryazevka 150 variety. Their parameters reached their maximum in the variant with plowing against the background of an intensive rate of mineral fertilizer (N40P160 + N40), where their growth was noted compared to the control by 11.3–13.0 c/ha or 25.2–35.1%. The transition to the no-till system in growing winter wheat entails a decrease in yield by 5.2–21.3 c/ha or 11.6–43.7%. The factors studied did not affect such indicators as grain nature and gluten content. The remaining indicators were positively affected by both mineral fertilizers and direct sowing of the crop

Keywords: WINTER WHEAT, TIMIRYAZENKA 150, STRUCTURE, YIELD, QUALITY

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Introduction

Winter wheat is the most essential crop for humans in Russia. It is one of the main sources of food products and is also used in the production of bread, pasta and cereals. Thanks to modern selection, winter wheat has high resistance to adverse weather conditions, which allows for a stable harvest. In addition, it is a model of productivity and grain quality, which makes this crop very profitable for cultivation. In Russia, winter wheat is grown on vast territories in various regions of the country, including foothills, steppes, forest-steppes and other areas. It can be grown on various soils: clay, sandy loam and loamy soils, gray forest and chestnut soils. Provided that they are sufficiently fertile and have an optimal level of water and nutrients. It has great development prospects, including through the use of modern technologies and scientific achievements in the field of selection and agronomy. As of 2021, the total area under winter wheat in the world is about 220 million hectares. In Russia, according to Rosstat data for 2020, the area under winter wheat is 16.1 million hectares. This makes

Russia the second largest producer of winter wheat in the world, after China [1-5].

Of particular importance is the study of the effect of mineral fertilizers on wheat productivity in the context of climate change. In unfavorable weather conditions, growing wheat can become problematic, so the use of the correct dosage of mineral fertilizers can significantly increase the yield and, accordingly, ensure food security of the Russian Federation. [10].

Cereals occupy the main share of arable land in field crop rotations, so they are critically important for our food security and forage base for livestock. Winter wheat is a key crop, nitrogen fertilizers contribute to its growth and development, improving the quality of grain and protein content in it. The main regulated factor that can affect the growth and yield of winter wheat is mineral nutrition. Providing nitrogen to grown crops is the main condition for increasing yields in different periods of time. In order to maximize the yield of wheat, a combination of different types of mineral fertilizers is usually used. Fertilizer dosage should be determined based on soil fertility analysis and recommendations for the wheat variety [6-9, 11].

Thus, correct agricultural technology at each stage of winter wheat development is important for obtaining a highly productive harvest when growing soybeans as a predecessor in a stationary experiment on leached chernozem.

Material and object of research

The experimental field, where the research was carried out in 2022-23 agricultural years, is located in the UOH "Kuban" Kubgau. The experiment studied the agrobiological parameters of winter wheat grown after soybean as a predecessor, in a stationary experiment on leached chernozem. Variety - Timiryazevka 150. Mid-late variety with sowing at the end of the optimal terms for the zones, has a 1000 seed weight of 36-42 grams and a plant height of 73-95

cm. High-yielding variety, has a potential yield of 120 c / ha, with good and excellent grain quality at the level of "strong" wheat. This variety is recommended for growing after all predecessors on a high agricultural background. The experiment is two-factor. The first factor is the method of primary soil cultivation (plowing to 20-22 cm and no-till). The second factor is the rate of mineral fertilizer (control without fertilizer application, recommended rate of mineral fertilizer (under primary soil tillage N20P80 + early spring top dressing N20), intensive rate of mineral fertilizer (under primary soil tillage N40P160 + early spring top dressing N40). Predecessor – soybean.

Research results

The structure of the crop is a set of elements that make up the productivity of plants. In order to determine the share of influence in the formation of the crop and its main components, it is necessary to measure the main elements of the crop structure of the field crop. The results of the measurements are presented in the 1st table.

Table 1 – Structure of the grain yield of winter wheat variety “Timiryazevskaya 150”

Option		Number of productive stems, pcs/m^2	Number of grains in an ear, pcs.	Number of spikelets in an ear, pcs.		Weight of 1000 grains	Grain weight from 1 ear, g	Biological yield, g/m^2
soil cultivation	fertilizer rate			total	including productive ones			
Plowing	b/fertilizer (k)	475	38	19	17	27.4	1.04	494
	$N_{20}P_{80} + N_{20}$	508	40	19	17	29.3	1.17	592
	$N_{40}P_{160} + N_{40}$	512	40	19	18	33.5	1.34	686
Zero tillage	b/fertilizer	414	37	17	16	19.7	0.73	301
	$N_{20}P_{80} + N_{20}$	430	37	19	17	23.0	0.85	364
	$N_{40}P_{160} + N_{40}$	443	37	19	17	25.1	0.93	412

The transition to the no-till system resulted in a decrease in the number of productive stems compared to the control (plowing without fertilizers) from 475 to 414 pcs/m2 (or by 14.7%) against an unfertilized background, to 430 pcs/m2 (or by 10.5%) against the background of the recommended rate of mineral fertilizer (N20P80 + N20) and to 443 pcs/m2 (or by 7.2%) against the background of an intensive rate of mineral fertilizer (N40P160 + N40). Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in the number of productive stems by 16 pcs/m2 was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 29 pcs/m2, which is lower than the control by 45 and 32 pcs/m2 (or by 9.5 and 6.7%), respectively.

When plowing, the use of the recommended rate of mineral fertilizer (N20P80 + N20) brought this figure to 508 pcs/m2 (an increase of 6.5%), and the intensive rate (N40P160 + N40) – to 512 pcs/m2 (an increase of 7.2%).

The parameters of such indicators as spike length, number of spikelets and grains in the spike were not influenced by the studied factors.

The transition to the no-till system resulted in a decrease in the 1000-grain weight compared to the control (plowing without fertilizers) from 27.4 to 19.7 g (or 39.1%) against an unfertilized background, to 23 g (or 19.1%) against the recommended rate of mineral fertilizer (N20P80 + N20) and to 25.1 g (or 9.2%) against the intensive rate of mineral fertilizer (N40P160 + N40). Against the recommended rate of mineral fertilizer (N20P80 + N20), an increase in the 1000-grain weight of 3.3 g was noted, and against the intensive rate of mineral fertilizer (N40P160 + N40) – by 5.4 g.

When plowing, the use of the recommended rate of mineral fertilizer (N20P80 + N20) brought this figure to 29.3 g (an increase of 4.0%), and the intensive rate (N40P160 + N40) – to 33.5 g (an increase of 7.2%).

The transition to the no-till system resulted in a decrease in the grain weight per ear compared to the control (plowing without fertilizers) from 1.04 to

0.73 g (or by 42.5%) against an unfertilized background, to 0.85 g (or by 22.4%) against the background of the recommended rate of mineral fertilizer (N20P80 + N20) and to 0.93 g (or by 11.8%) against the background of the intensive rate of mineral fertilizer (N40P160 + N40). Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in the grain weight per ear by 0.12 g was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 0.20 g, which is already comparable with the control.

When plowing, the use of the recommended rate of mineral fertilizer (N20P80 + N20) brought this figure to 1.17 g (an increase of 11.1%), and the intensive rate (N40P160 + N40) – to 1.34 g (an increase of 22.4%).

The transition to the no-till system resulted in a decrease in biological yield compared to the control (plowing without fertilizers) from 494 to 301 g/m2 (or 64.1%) against an unfertilized background, to 364 g/m2 (or 35.7%) against the background of the recommended rate of mineral fertilizer (N20P80 + N20) and to 412 g/m2 (or 19.9%) against the background of an intensive rate of mineral fertilizer (N40P160 + N40). Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in biological yield by 63 g/cm2 was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 111 g/cm2, which is lower than the control by 130 and 82 g/cm2 (or 26.3 and 16.0%), respectively.

When plowing, the use of the recommended rate of mineral fertilizer (N20P80 + N20) brought this indicator to 592 g/m2 (an increase of 16.6%), and the intensive rate (N40P160 + N40) – to 686 g/m2 (an increase of 28.0%).

Let us summarize that both the method of primary tillage and the fertilization rate affect the yield structure. Its best parameters were noted in the variant with plowing against the background of an intensive rate of mineral fertilizer (N40P160 + N40), where their growth was noted compared to the control by 6.5–38.9%. The transition to the no-till system entails a decrease in

the parameters of the yield structure by 7.2–42.5% and biological yield by 19.9–64.1% depending on the fertilization background. The parameters of such indicators as the length of the spikelet, the number of spikelets and grains in the spikelet were not influenced by the studied factors.

The formation of the yield of field crops is influenced by a large number of factors, not only of a biotic or abiotic nature, but also of an anthropogenic nature, caused by both the direct action of man and the aftereffects of his activities.

The results of crop data measurements in 2022 are presented in the 2nd table.

Table 2 – Grain yield of winter wheat depending on the method of primary soil cultivation and the rate of mineral fertilizer, c/ha (2022)

Option		Productivity	Deviation from control		By factor	
soil cultivation	fertilizer rate		c/ha	%	A	IN
Plowing	Without fertilizers (k)	44.9	-	-	51.0	38.6
	$N_{20}P_{80} + N_{20}$	51.8	+6.9	+15.4		44.1
	$N_{40}P_{160} + N_{40}$	56.2	+11.3	+25.2		48.0
Zero tillage (direct seeding)	without fertilizers	32.3	-12.6	-28.1	36.1	-
	$N_{20}P_{80} + N_{20}$	36.4	-8.5	-18.9		-
	$N_{40}P_{160} + N_{40}$	39.7	-5.2	-11.6		-
HSR05 for options		2.5	-		-	-
HSR05 for factor A		-	-		2.0	-
HSR05 for factor B		-	-		-	2,2

The yield of winter wheat under control (plowing without applying fertilizers) was 44.9 c/ha. Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in yield of 6.9 c/ha (or 15.4%)

was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 11.3 c/ha (or 25.2%).

Studying the table on the yield under zero tillage with direct sowing of the crop, we note that in the variant without applying fertilizers it was 32.3 c/ha, which is 12.6 c/ha (or 28.1%) lower than the control. Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in yield of 3.3 c/ha was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 7.4 c/ha, which is lower than the control by 8.5 and 5.2 c/ha (or 18.9 and 11.6%), respectively.

On average, in the experiment, replacing plowing with direct seeding under zero tillage led to a decrease in yield by 14.9 c/ha. The application of mineral fertilizers according to the recommended rate (N20P80 + N20) contributed to an increase in yield by 5.5 c/ha, and according to the intensive rate (N40P160 + N40) - by 9.4 c/ha, which is higher than the control by 14.2 and 24.4%, respectively.

The reliability of differences in the experiment is confirmed by the least significant difference (LSD05) for the variants at the level of 2.5 c/ha, for factor A – 2.0 c/ha, and for factor B – 2.2 c/ha.

The results of crop data measurements in 2023 are presented in Table 3.

The yield of winter wheat under control (plowing without applying fertilizers) was 48.7 c/ha. Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in yield of 8.4 c/ha (or 17.2%) was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 17.1 c/ha (or 35.1%).

Studying the table of yields for zero tillage with direct sowing of crops, we note that in the variant without applying fertilizers it was 27.4 c/ha, which is lower than the control by 21.3 c/ha (or 43.7%).

Table 3 – Grain yield of winter wheat depending on the method of primary soil cultivation and the rate of mineral fertilizer, c/ha (2023)

Option		Productivity	Deviation from control		By factor	
soil cultivation	fertilizer rate		c/ha	%	A	IN
Plowing	Without fertilizers (k)	48.7	-	-	57.2	38.1
	$N_{20}P_{80} + N_{20}$	57.1	+8.4	+17.2		42.2
	$N_{40}P_{160} + N_{40}$	65.8	+17.1	+35.1		51.6
Zero tillage (direct seeding)	without fertilizers	27.4	-21.3	-43.7	32.7	-
	$N_{20}P_{80} + N_{20}$	33.2	-15.5	-31.8		-
	$N_{40}P_{160} + N_{40}$	37.4	-11.3	-23.2		-
HSR05 for options		5.2	-		-	-
HSR05 for factor A		-	-		3.6	-
HSR05 for factor B		-	-		-	1.6

Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in yield by 5.8 c/ha was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 10.0 c/ha, which is lower than the control by 15.5 and 11.3 c/ha (or 31.8 and 23.2%), respectively.

On average, in the experiment, replacing plowing with direct seeding under zero tillage led to a decrease in yield by 24.5 c/ha (or 42.8%). The application of mineral fertilizers according to the recommended rate (N20P80 + N20) contributed to an increase in yield by 4.1 c/ha, and according to the intensive rate (N140P140K100 + N60) - by 13.5 c/ha, which is higher than the control by 10.8 and 35.4%, respectively.

The reliability of differences in the experiment is confirmed by the least significant difference (LSD05) for the variants at the level of 5.2 c/ha, for factor A – 3.6 c/ha, and for factor B – 1.6 c/ha.

To summarize, both the method of primary tillage and the fertilization rate affect crop yields. The best indicators were noted in the variant with plowing against the background of an intensive rate of mineral fertilizer (N40P160 + N40), where their growth was noted compared to the control by 17.1 c/ha or 35.1%. Cultivation of winter wheat by zero tillage with direct sowing of the crop leads to a decrease in yield by 11.3–21.3 c/ha or 23.2–43.7%.

Grain quality is a series of characteristics and various properties such as biological, physiological, physical and chemical. Depending on the purpose, it can be used for seed, food or feed purposes.

The results of measurements of quality indicators of winter wheat grain are presented in Table 4.

Table 4 – Quality of winter wheat grain depending on the method of primary soil cultivation and the rate of mineral fertilizer

Option		Grain nature, g/l	Protein, %	Gluten		Vitreousness, %
soil cultivation	fertilizer rate			%	IDK	
Plowing	without fertilizers (k)	802	12.3	23.0	67.40	55.93
	$N_{20}P_{80} + N_{20}$	815	13.6	24.7	69.23	57,58
	$N_{40}P_{160} + N_{40}$	817	14.1	25.3	68.28	58,69
Zero tillage (direct seeding)	without fertilizers	806	13.1	25.1	68.99	58.43
	$N_{20}P_{80} + N_{20}$	816	13.3	25.5	69.43	58,58
	$N_{40}P_{160} + N_{40}$	817	13.4	25.6	68.48	58,69
HSR05		27	0.6	0.9	3.36	1.75

The studied factors did not influence such indicators as grain nature and gluten content.

The protein in the control (plowing without fertilizing) was 12.3%. Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in the grain protein parameters by 1.3% was noted, and

against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 1.8%. In the variant with zero tillage with direct sowing of the crop, an increase in the grain protein parameters was noted, regardless of the fertilization background, by 0.8-1.1%.

Gluten in the control (plowing without fertilizing) was 23.0%. Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in grain gluten parameters by 1.3% was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 2.3%.

In the variant with zero tillage and direct sowing of the crop, an increase in the parameters of grain gluten was noted, regardless of the fertilization background, by 2.1–2.6%.

The vitreousness of winter wheat grain in the control (plowing without fertilizing) was 55.93%. Against the background of the recommended rate of mineral fertilizer (N20P80 + N20), an increase in the vitreousness parameters of grain by 1.64% was noted, and against the background of the intensive rate of mineral fertilizer (N40P160 + N40) - by 2.76%). In the variant with zero tillage with direct sowing of the crop, an increase in the gluten parameters of grain was noted, regardless of the fertilization background by 2.60-2.76%.

In conclusion, it is worth noting that the studied factors did not affect such indicators as grain nature and gluten IDK. The remaining indicators were positively affected by both mineral fertilizers and direct sowing of the crop.

Conclusion

Let us summarize that both the method of primary tillage and the fertilization rate affect the yield structure. Its best parameters were noted in the variant with plowing against the background of an intensive rate of mineral fertilizer (N40P160 + N40), where their growth was noted compared to the control by 6.5–38.9%. The transition to the no-till system entails a decrease in

the parameters of the yield structure by 7.2–42.5% and biological yield by 19.9–64.1% depending on the fertilization background. The parameters of such indicators as the length of the spikelet, the number of spikelets and grains in the spikelet were not influenced by the studied factors. Both the primary tillage method and the fertilization rate affect the yield of winter wheat of the Timiryazevka 150 variety. Their parameters reached their maximum in the variant with plowing against the background of an intensive mineral fertilization rate (N40P160 + N40), where their growth was noted compared to the control by 11.3–13.0 c/ha or 25.2–35.1%. The transition to the no-till system in growing winter wheat entails a decrease in yield by 5.2–21.3 c/ha or 11.6–43.7%. The studied factors did not affect such indicators as grain nature and gluten IDK. The remaining indicators were positively affected by both mineral fertilizers and direct sowing of the crop.

Bibliographic list

1. Arkhipenko, A. A. The role of mineral fertilizers and primary tillage for winter wheat crops in the formation of its productivity / A. A. Arkhipenko, R. V. Kravchenko // Scientific journal of KubSAU, 2021. - No. 171. - P. 335-347. - DOI 10.21515/1990-4665-171-023.

2. Kravchenko, R. V. Realization of the productive potential of corn hybrids using technologies of different intensity / R. V. Kravchenko // Bulletin of the BSHA, 2009. - No. 2. - P. 56-60.

3. Kravchenko, R. V. Optimization of mineral nutrition with minimization of primary soil cultivation in winter wheat cultivation technology / R. V. Kravchenko, A. A. Arkhipenko // Proceedings of KubSAU, 2019. - No. 80. - P.150-155. - DOI 10.21515/1999-1703-80-150-155.

4. Kravchenko, R. V. The influence of primary tillage for winter wheat on the formation of its productivity elements / R. V. Kravchenko, S. I. Luchinsky, A. A. Arkhipenko, A. E. Semenov // Proceedings of KubSAU, 2021. - No. 90. - P. 64-70. - DOI 10.21515/1999-1703-90-64-70.

5. Kravchenko, R. V. Influence of primary tillage for winter wheat on the formation of its productivity / R. V. Kravchenko, V. I. Prokhoda, S. I. Luchinsky, A. A. Arkhipenko // Scientific journal of KubSAU, 2021. - No. 169. - P. 124-132. - DOI 10.21515/1990-4665-169-011.

6. Kravchenko, R. V. Dynamics of agro-physical parameters of soil depending on its cultivation and mineral fertilizers in winter wheat technology / R. V. Kravchenko, A. A. Arkhipenko / Scientific journal of KubSAU, 2022. - No. 178. - P.283-292. - DOI 10.21515/1990-4665-178-024.

7. Kravchenko, R. V. Efficiency of mineral fertilizers against the background of no-till soil cultivation in the technology of winter wheat cultivation / R. V. Kravchenko, V. I. Prokhoda, U. B. Asrorov / Scientific journal of KubSAU, 2022. - No. 182. - P. 99-111. - DOI 10.21515/1990-4665-182-009.

8. Bardak, N. I. Influence of the method of processing leached chernozem and its agrophytic parameters and agrobiological indicators of winter wheat / N. I. Bardak, R. V. Kravchenko, S. A. Dmitriev / Scientific journal of KubSAU, 2023. - No. 188. - P. 56-66. - DOI 10.21515/1990-4665-188-006.

9. Kravchenko, R. V. Formation of agrobiological indicators of winter wheat depending on mineral fertilizers against the background of minimization of primary tillage / R. V. Kravchenko, S. I. Luchinsky, A. E. Semenov / Proceedings of KubSAU, 2023. - No. 108. - P. 71-76. - DOI 10.21515/1999-1703-108-71-76.

10. Kravchenko, RV Dynamics of agrophysical indicators of the soil under winter wheat crops while minimizing the main tillage / Kravchenko RV, Luchinskiy SI, Amzaeva Ya.B. // Polythematic Online Scientific Journal of Kuban State Agrarian University. 2024. No. 199. pp. 61-68. – DOI 10.21515/1990-4665-199-007.

11. Kravchenko, R. V. Formation of production indicators of winter wheat depending on mineral fertilizers against the background of minimization of primary tillage / R. V. Kravchenko, S. I. Luchinsky, A. E. Semenov / Proceedings of KubSAU, 2024. - No. 112. - P. 125-131. - DOI 10.21515/1999-1703-112-125-131.