УДК 633.152(470.630)

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

ВЛИЯНИЕ ПРИЕМОВ ОСНОВНОЙ ОБРАБОТКИ ПОЧВЫ И НОРМЫ УДОБРЕНИЙ НА ПРОДУКТИВНЫЕ И ЭКОНОМИЧЕСКИЕ ПОКАЗАТЕЛИ СОИ

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В статье показаны результаты полевых опытов по изучению продуктивных и экономических показателей сои сорта СК Веда. В рамках эксперимента, проведенного в 11-польном зерно-пропашном севообороте, были изучены два фактора: прием основной обработки почвы (вспашка и чизелевание) и норма удобрения (без удобрений, рекомендуемая норма удобрений ($N_{45}P_{60}$) и интенсивная норма удобрения ($N_{90}P_{120}$)). Исследованиями установлено, что Обобщающим показателем приведенных исследований является полученная урожайность. Прием основной обработки почвы и различные нормы удобрений оказывали значительное влияние на данный показатель. Применение безотвальной обработки приводило к снижению урожайности на 7,7 %, по сравнению со вспашкой. Использование удобрений в рекомендуемой дозе позволило получить прибавку урожайности 2,2 ц/га, относительно контроля. А при внесении повышенной дозы удобрений, прибавка составила 3,9 ц/га или 16,7 %, относительно контроля. Расчёт экономической эффективности показал, что наиболее выгодным был вариант со вспашкой с рекомендуемой дозой минеральных удобрений. Чистый доход на этом варианте составил 28410 руб./га, что на 9,8%

UDC 633.152(470.630)

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

INFLUENCE OF BASIC SOIL TILLAGE METHODS AND FERTILIZER RATES ON PRODUCTIVE AND ECONOMIC INDICATORS OF SOYBEAN

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The article presents data from field experiments to study of the productive and economic indicators of soybean variety SK Veda. As part of an experiment conducted in an 11-field grain-row crop rotation, two factors were studied: the use of basic tillage and the fertilizer rate. For the first factor, two options were used: 1) moldboard cultivation (plowing); 2) non-moldboard tillage (chiselling). For the second factor, mineral fertilizers were taken: 1) without fertilizers; 2) recommended fertilizer rate ($N_{45}P_{60}$). 3) intensive fertilizer rate ($N_{90}P_{120}$). Research has established that the general indicator of the above studies is the resulting yield. The use of no-moldboard cultivation led to a decrease in yield by 7.7% compared to plowing. The use of fertilizers in the recommended dose made it possible to obtain an increase in yield of 2.2 c/ha, relative to the control. And when applying an increased dose of fertilizers, the increase was 3.9 c/ha or 16.7%, relative to the control. Calculation of economic efficiency showed that the most profitable option was plowing with the recommended dose of mineral fertilizers. The net income for this option was 28,410 rubles/ha, which is 9.8% more than the control. And the profitability level was 38.4%, which is 0.2% more than control. The use of high doses of fertilizers for plowing increases yields, but also increases

больше контроля. А уровень рентабельности составил 38,4 %, что больше контроля на 0,2%. Использование высоких доз удобрений под вспашку, повышает урожайность, но также увеличивает производственные затраты. Это приводит к тому, что рентабельность данного варианта ниже контрольной на 0,3 % и составляет 37,9 %. Все варианты с чизелеванием показали меньшую рентабельность и чистый доход. Лучший результат был на варианте без удобрений. Его отставание от контроля составило 2,2 % и 2982 руб./га соответственно. Применение удобрений при таком способе обработки почвы немного повышает урожайность и существенно увеличивает производственные затраты. Применение рекомендованной дозы увеличивало затраты на 9,8 %, а двойной на 19,4 %.

Ключевые слова: СОЯ, СК ВЕДА, УРОЖАЙНОСТЬ, РЕНТАБЕЛЬНОСТЬ, СЕБЕСТОИМОСТЬ

production costs. This leads to the fact that the profitability of this option is lower than the control one by 0.3% and amounts to 37.9%. All chiseled options showed lower profitability and lower net income. The best result was with the option without fertilizers. Its lag from the control was 2.2% and 2982 rubles/ha, respectively. The use of fertilizers with this method of tillage slightly increases yields and significantly increases production costs. The use of the recommended dose increased costs by 9.8%, and the double dose by 19.4%

Keywords: SOY, SK VEDA, DENSITY, PRODUCTIVITY, PROFITABILITY, COST

http://dx.doi.org/10.21515/1990-4665-198-014

Introduction

In Russia, the government pays great attention to the cultivation of soybeans to meet the population's needs for soybean oil. Over the past 10 years in Russia, the average annual growth in soybean sown area was 13.4%, yield - 2.8%, and gross yield - 17.3%. In 2021, Russia recorded record levels of gross harvest (3.08 million tons, 3.5 times more than in 2011), yield (15.7 centners per hectare, 32% more). In Russia, the area under soybeans is 30% greater than the total area of all European countries. Soybean is a plant that can respond positively to the use of fertilizers, especially on leached black soils. Phosphorus and potassium fertilizers added to the soil along with basic tillage can significantly increase yields. However, nitrogen fertilizers can suppress the process of nitrogen fixation, so they are not used under optimal conditions for the symbiosis of nitrogen with soybeans. To obtain high and stable soybean yields, it is necessary to carry out timely and high-quality tillage, including deep moldboard fall plowing, but the constant use of moldboard tillage negatively affects the condition of the soil. So it is necessary to consider other methods [3-7].

The effect of mineral fertilizers on soybean yields varied depending on their amount. The recommended fertilizer rate (N20P80) contributed to an increase in yield by 3.37 centners/ha, and the intensive rate (N40P80) did not lead to an additional increase in yield [10-12].

It was found that the control option with moldboard plowing provides the most optimal agro-physical indicators of the soil, while the worst values of these indicators were recorded in areas with no-tillage. Optimal soil structure parameters were formed by plowing; by chiseling they were worse by 6.1%, by disk plowing by 17.6% and by no-tillage by 25.0% [1, 2, 7, 8].

Material and object of research

The experiment was carried out in 2021-2022 on an experimental field located of the KubGAU. The experimental plot is represented predominantly by leached chernozem. In general, both years of the experiment were favorable in terms of weather conditions for growing soybeans.

As part of an experiment conducted in an 11-field grain-row crop rotation, two factors were studied: the use of basic tillage and the fertilizer rate. Factor A (soil cultivation): plowing and chiselling. Treatment depth is 25-27 cm. Factor B: 1) without fertilizers; 2) recommended fertilizer rate (N45P60). 3) intensive fertilizer rate (N90P120).

The object of research is soybeans, early ripening variety SK Veda. For ripening, it requires 2300-2400 °C of the sum of active temperatures. High-tech, and also highly resistant to various diseases. Weight of 1000 seeds is 150-170 g, protein content is 39-41%, oil content is 21-23%. The SK VEDA variety has a potential yield of 4.4 t/ha in primary and 2.6 t/ha in repeated crops. At the Zolotaya Niva exhibition in the Krasnodar Territory, at the IPA “Otbor” agricultural farm in the Kabardino-Balkarian Republic, and at the farms of the Republic of Kazakhstan, the variety showed high yields from 37.4 to 42.4 c/ha. In 2019, SK VEDA was included in the State Register of Breeding

Achievements of the Russian Federation. This variety has been developed to withstand abiotic stresses and is recommended for cultivation in dry conditions, without the use of irrigation, due to its high drought tolerance. SK VEDA has a tall stem (122 cm) and a powerful root system, which allows it to extend deeper into the soil and extract moisture from lower layers.

Research results

A general indicator of the action and effectiveness of various methods of soil cultivation and fertilizer rates is yield. For plowing on an unfertilized background, a yield of 21.7 c/ha was recorded (Table 1).

Table 1 – Influence of soil tillage and fertilizer rates on soybean yield, c/ha, 2021

Option		Productivity	Deviation from control	
tillage	fertilizer rate		c/ha	%
Plowing at 25-27 cm (k)	no fertilizers (k)	21.7	-	-
	N45P60	23.1	1.4	6.5
	N90P120	24.6	2.9	13.4
Chiseling at 25-27 cm	no fertilizers	17.3	-4.4	-20.3
	N45P60	19.1	-2.6	-12.0
	N90P120	20.7	-1.0	-4.6

Application of fertilizers at the recommended rate ensures a soybean yield of 23.1 c/ha, which is 6.5% higher than the unfertilized background, and application of fertilizers at an intensive rate ensures an increase in yield by 13.4% to 24.6 c/ha.

Carrying out chiselization on an unfertilized background ensured the formation of a yield at the level of 17.3 c/ha. The recommended fertilizer rate resulted in a yield that was 10.4% higher (19.1 c/ha), but lower than the control

by 12.0%. The intensive rate led to an increase in yield by 19.7% (20.7 c/ha), which is already at the control level.

From Table 2 it follows that the average yield for plowing was at the level of 23.133 c/ha, for chisel cultivation - 19.033 c/ha. Without applying fertilizer, the average yield obtained in the experiment was 19.5 c/ha, when applying fertilizers at the recommended rate - 21.1 c/ha, and at the intensive rate - 22.65 c/ha. NSR05 for the variants was 2.125, for factor A – 0.950, for factor B – 1.344, and for the interaction of factors AB – 2.125.

Table 2 – Statistical processing by correlation and variance analysis, 2021

Tillage factor A	Fertilizer rate factor B	Average by			
		options	factor A	factor B	AB interaction
Plowing 25-27 cm	no fertilizers	21,700	23.133	19,500	0.1500
	N45P60	23,100		21,100	-0.0500
	N90P120	24,600		22,650	-0.1000
Chiseling 25-27 cm	no fertilizers	17,300	19,033		-0.1500
	N45P60	19,100			0.0500
	N90P120	20,700			0.1000
NSR05 for options		2.125			
Factor A			0.950		
Factor B				1,344	
AB interactions					2.125

In 2022, the maximum yield among all options was obtained by plowing against the background of N90P120; it amounted to 24.6 c/ha. The highest yield in the variant with chisel cultivation and the use of intensive fertilizer rates was obtained 20.7 c/ha, which is 3.9 c/ha less than with plowing (Table 3).

Table 3 – Influence of the method of main soil cultivation and mineral fertilizers on soybean yield, c/ha, 2022.

Option		Productivity	Deviation from control	
tillage	fertilizer rate		c/ha	%
Plowing at 25-27 cm (k)	no fertilizers (k)	23.4	-	-
	N45P60	25.6	2.2	9.0
	N90P120	27.3	3.9	16.7
Chiseling at 25-27 cm	no fertilizers	21.6	-1.8	-7.7
	N45P60	23.0	-0.4	-1.7
	N90P120	24.3	0.9	3.8

Plowing on an unfertilized background resulted in a yield of 23.4 c/ha. Application of fertilizers at the recommended rate ensured a yield of 25.6 c/ha, which is 9.0% more than the unfertilized background, and application of fertilizers at an intensive rate ensured a yield of 27.3 c/ha with an increase of 16.7%.

According to chiseling on an unfertilized background, a yield of 21.6 c/ha was formed. The application of fertilizers at the recommended rate ensured the formation of a yield of 23.0 c/ha, which is 1.7% less than the control indicators. The highest yield in the option with chiselling was achieved when applying fertilizers at an intensive rate - 24.3 c/ha, which is 3.8% more than the control.

From Table 4 it follows that NSR05 for variants was 2.244, for factor A - 1.004, for factor B - 1.419, and for the interaction of factors AB - 2.244.

Table 4 – Statistical processing by correlation and variance analysis, 2022

Varipant		Average by			
tillage, factor A	fertilizer rate, factor B	options	factor A	factor B	interaction A B
Plowing at 25-27 cm	no fertilizers	23,400	25,433	22,467	-0.3111
	N45P60	25,600		24,300	0.0556
	N90P120	27,300		25,800	0.2556
Chiseling by 25-27 cm	no fertilizers	21,533	22,944		0.3111
	N45P60	23,000			-0.0556
	N90P120	24,300			-0.2556
NSR05 for options		2,244			
Factor A			1.004		
Factor B				1.419	
Interactions A B					2,244

Having studied the data obtained, we can say that the main tillage and doses of fertilizers had a noticeable effect on the resulting yield. Overall, higher fertilizer treatments resulted in higher yields, and plowing had higher yields than chiselling.

The key basis of agricultural production is obtaining the maximum amount of high-quality products with the least amount of labor and money. In this regard, it is necessary to take into account that new methods of cultivating crops allow not only to obtain a good harvest, but also to reduce the costs associated with its production. In this regard, an important factor is the economic and organizational assessment of the results of the experience. An experiment conducted in 2021-2022, studying various methods of basic soil cultivation and rates of mineral fertilizers, showed that the highest yield was obtained in the option using plowing and high rates of fertilizers. This is a plus

of 3.9 c/ha to the control, and the recommended norm gave a plus of 2.2 c/ha. The lack of fertilizers for chisel cultivation led to a decrease in yield by 1.8 c/ha. The recommended fertilizer rate ensured that the yield remained at the control level. The option with chisel cultivation and a high dose of fertilizers showed an increase in grain yield by 0.9 c/ha (Table 5).

Table 5 – Economic efficiency of basic tillage methods and mineral fertilizer rates for soybean crops, 2021-2022.

Index	Option					
	plowing at 25-27 cm (k)			chiseling by 25-27 cm		
	no fertilizers (k)	N45P60	N90P120	no fertilizers	N45P60	N90P120
Productivity, c/ha	23.4	25.6	27.3	21.6	23.0	24.3
Cost of gross production, rub./ha	93600	102400	109200	86400	92000	97200
Production costs, rub./ha	67728	73990	79196	63510	69678	75834
incl. additional costs, rub./ha	-	6262	11468	-4218	1950	8106
Of these, the cost of work, rub.	-	5998	11000	-4002	1998	7998
Of which for harvesting, rub.	-	264	468	-216	-48	108
Cost of 1 centner of products, rub.	2894.4	2890.2	2901	2940.2	3029.5	3120.7
Net income from 1 hectare, rub.	25872	28410	30004	22890	22322	21366
Profitability, %	38.2	38.4	37.9	36.0	32.0	28.2

Despite the highest production costs (79,196 rubles/ha), the highest net income was obtained in the variant with plowing and a high dose of fertilizers; it

amounted to 30,004 rubles/ha, which is 4,132 rubles/ha more than in the control. The lowest production costs were when using no-moldboard tillage without fertilizers; they amounted to 86,400 rubles/ha. The lowest net income was in the variant with chisel cultivation and a high dose of fertilizers; it amounted to 21,366 rubles/ha, which is 4,506 rubles/ha less than in the control.

Thus, for the introduction into production of soybean crops using the predecessor winter wheat, we can recommend a moldboard tillage system and the use of fertilizers at a rate of N45P60. In this option, the net income was 28,410 rubles/ha, which is 2,538 rubles/ha more than in the control. And the profitability level was 38.4%, which is 0.2% more than the control option.

The use of plowing with a high rate of fertilizer shows a noticeable increase in yield. Despite the fact that this option has the highest net income, the level of profitability here is lower than in the control, by 0.3%. This was due to a significant increase in production costs; they amounted to 109,200 rubles/ha, which is 19% more than in the control.

The lowest profitability rate (28.2%) was in the option with chisel cultivation and a high rate of fertilizers. This option showed an increase in yield of 0.9 c/ha compared to the control, however, the use of a large dose of fertilizers significantly increased production costs.

The results were somewhat better in the variant with chisel cultivation and the recommended fertilizer rate. Here the profitability was 32%, which is 6.2% less than in the control option. Net income amounted to 22,322 rubles/ha, which was less than the control by 3,550 rubles/ha.

Among the options with chiselization, the best result was found in the option without fertilizers. The gap from the control level in terms of profitability was only 2.2%. Comparing the net income, you can see that in this option it is lower than in the control by 2982 rubles/ha.

Conclusion

The general indicator of the above studies is the resulting yield. The method of primary tillage and various fertilizer rates had a significant impact on this indicator. The use of no-moldboard cultivation led to a decrease in yield by 7.7% compared to plowing. The use of fertilizers in the recommended dose made it possible to obtain an increase in yield of 2.2 c/ha, relative to the control. And when applying an increased dose of fertilizers, the increase was 3.9 c/ha or 16.7%, relative to the control. Calculation of economic efficiency showed that the most profitable in terms of net income (28,410 rubles/ha) and level of profitability (38.4%) was the option with the recommended rate of fertilizer for plowing, which exceeded the control by 9.8 and 0.2%, respectively. Intensive application of fertilizer for plowing increases yields, but also increases production costs. This leads to the fact that the profitability of this option is lower than the control one by 0.3% and amounts to 37.9%. All chiseled options showed lower profitability and lower net income. The best result was with the option without fertilizers. Its lag from the control was 2.2% and 2982 rubles/ha, respectively. The use of fertilizers with this method of tillage slightly increases yields and significantly increases production costs. The use of the recommended dose increased costs by 9.8%, and the double dose by 19.4%.

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