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Soybean Cultivation Cost-effectiveness Depending on Bacterial Preparations and Growth Stimulants Use

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Abstract

Researches and analysis of the data obtained on the basis of the Armavir Experimental Station of the All-Russian Scientific Research Institute of Oilseeds establish the most effective bacterial preparations, growth stimulants and their combination for soybean cultivation under conditions of unstable moisture on ordinary chernozem. The soybeans yield during the seed treatment with the rhizobial preparation Nitrofix P (2 kg/t) in combination with the film former was the highest and amounted to 1.83 t/ha, which is 0.23 t/ha higher than in the control. It also obtained the maximum collection of plant protein -- 0,69 t/ha. The highest yields (1.72--1.83 t/ha) and relatively low production costs allows getting quite high profits (19,472--22,191 rub/ha) with complex soybeans seed treatment with rusobial preparations containing a film former. The maximum profitability in the study of seed treatment with rhizobial preparations was obtained in the variants with the use of the preparations Nitrofiks P and Nitrofiks Zh in combination with the film-forming agent -- 95--107 %, which is higher in comparison with the use of bacterial preparations by 2--15 %, and with the control by 12--24 %. The most cost-effective (107 %) was the use of rhizobial Nitrofix preparation in its powder form (2 kg/t) combining with a film former. The obtaining soybeans yield -- 1.73 t/ha in the treatment of seeds combining with a rhizobial preparation in combination with a growth stimulator Nagro bioenergetic made it possible to get the highest profit -- 19 668 rubles/ha. Given the cost of production and profit per hectare rate, the highest level of profitability was obtained when applying seed treatment with the rhizobial preparation Nitrofiks Zh in combination with Albit and Nagro bioenergetic growth stimulants: 91--94 %. Hence it has been established that the bacterial preparations for treating seeds in combination with a film former and growth stimulants use provides high profits and increases the soybean cultivation profitability level.

Keywords: soybean, cost-effectiveness, yield, profitability, profit

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1. Introduction

Soy -- the most valuable proteinaceous and oilseeds culture. Due to its unique chemical composition, it is widely used as food, feed and industrial crops. Its prevalence in various sectors of the national economy surpasses all other agricultural crops [1]. There are two

complementary ways to solve so problem increasing protein production. The first is to restore a competitive meat and dairy sector, the second is to develop the production and use of vegetable protein products for nutritional purposes system. Soybean processing products are getting greater attention as an additional sources of food proteins. It is caused by the high biological qualities of soy protein [11].

Nowadays, in Russia the soybean market gets an active development, so the acreage under soybeans has increased by more than 20 % over the past few years. In 2017, the soybeans gross harvest in Russia amounted to 3.6 million tons, compared to 3.1 million tons in 2016. The crop of agriculture in the country has more than tripled compared to 2010. Half of the acreage of soybeans is owed by the Far Eastern Federal District, 31 % -- by the Central, 8 % -- Southern, 5 % -- Siberian, 3.5 % -- Privolzhsky, 1.3 % -- North Caucasus. [5].

Due to numerous stress factors, the activity of local symbiotic nitrogen-fixing soils forms decreases. Annual depositing of an active forms of specially directed nitrogen-fixing microorganisms is necessary to enhance nitrogen fixation (nodule-forming bacteria-Bradirhizobium japonicum Kirchner) [2]. Inoculation of soybean seeds with rhizobia is obligatory not only when planting this crop into new soils where there are no these microorganisms resident forms, but also in old arable areas where soybean has been cultivated, since the use of cultivated, more virulent and active strains of nodule-forming bacteria is an effective technique to increase the this crop yield [6].

Another way to stimulate plant growth and development, to increase yields, soybean seed quality, and plant resistance to pests and diseases is to use growth regulators (Nagro is a bioenergetic for seed treatment, liquid organic fertilizer Nagro is universal for non-root plants extra nutrition, albite for seed and plant treatments). Growth regulators, having anti-stress properties, increase plant resistance to low and high temperatures, excess and lack of water, drought and frost, and contribute to an increase in soybean yield [10].

2. Problem Statement

Today the domestic industry's need for the soybean grain production is satisfied by only 20 %. According to the Ministry of Agriculture of Russia data, it is planned to increase the capacity for processing soybeans to 6.7 million tons/year and the area under crops is up to 3.0--3.5 million hectares by 2020 [9]. Domestic need for soybeans is driven by the need to expand the feed base for livestock -- green mass, haylage, hay, seed meal, oil cake, feed-stuff additives (more than 80 % of the produced soybean volumes), as

well as an increase in raw materials consumption for the processing industry, including food [3].

The increase in gross soybean grain yield is possible due to the expansion of this crop planting, but the main pool for increasing grain yield is to increase its yield due to scientifically based cultivation technologies and rational use of bioclimatic potential based on adapted highly productive varieties and modern research and development [7].

The development of modern crop production involves the widespread use of bacterial fertilizer that increases the productivity of soybean [12]. Many scientists in their studies mention the high effectiveness of bacterial fertilizer and plant growth stimulants, their ability to increase the plants adaptability to such stress factors as extremely high temperatures and drought [9]. The modern market of agrochemicals and bacterial fertilizer for presowing seed treatments and non-root plant dressings is very diverse. The examination of promising preparation in certain soil and climatic conditions will help to identify the most effective among them [4].

3. Research Questions

Presented yield, protein collection and calculation of indicators of soybean grain production cost-effectiveness, depending on bacterial preparations and growth stimulants use in the conditions of unstable moisture on the ordinary chernozem.

4. Purpose of the Study

The main goal of the research is to determine the yield, protein collection from the soybean planting area, depending on use of domestic and foreign bacterial preparations and growth stimulants, and to establish the economic efficiency of these techniques.

5. Research Methods

Studies determining the cost-effectiveness of rhizobial preparations and growth stimulants were conducted during 2013--2015 on the experimental base of Armavir Experimental Station of the All-Russian Scientific Research Institute of Oilseeds.

Following preparations were tested during the experiments: Nitrofix P (2.0 kg/t), Nitrofix Zh (2.5 L/t), Nitrofix P (2.0 L/t) + film former, Nitrofix Zh (2.5 L/t) + film former, and complex use of a bacterial preparation and growth stimulants: Nitrofix F (2.5 L/t)

+ Albit (50 ml/t), Nitrofix Zh (2.5 L/t) + Nagro bioenergetic (0.7 L/t) Nitrofix Zh (2.5 L/t); Bio-organic fertilizer Nagro universal (0.7 L/ha), Nitrofix Zh (2.5 L/t) + Nagro bioenergetic (0.7 L/t); Bio-organic fertilizer Nagro universal (0.7 L/ha) -- foliar fertilizing with bio-organic fertilizer was carried out in phases: 2--3 true leaves, branching and seed filling.

Agricultural technician, used in the experiments, are generally accepted for the soil and climatic conditions of the research area. The forerunner in the experience is winter wheat. The main tillage was carried out as a semi-pair. Sowing was mechanized, took place in optimal time. Conducting research and calculating the economic efficiency of soybean grain production, depending on the methods being studied, was carried out according to the generally accepted methodology, using technological charts and current regulatory costs and prices.

6. Findings

The increase in the production of high-grade food and feed protein is one of the key problems in the field of agricultural production intensification in the current situation [9]. In this regard, the study of techniques that increase the protein content in soybean seeds is of great significance.

Yield is the main indicator in evaluating the studied preparations for the soybean seeds and plants treatment.

Incrustation of seeds is a highly efficient and low-cost agricultural practice, retrievable with a cost of only 20--30 kg of marketable soybean seeds. But it allows increasing the yield of seeds by 20--45 % and their protein content by 2--4 %. Moreover, the lower the soil fertility, the higher the agricultural practice efficiency.

The cost of the inoculation is 5--10 times paid off by the cost of yield increase. In this connection, seed incrustation is currently widely used.

Averaging over the years of research, the yield increase in comparison with the control was significant in all variants of the experiment. The highest soybean yield was noted when treating seeds with Nitrofix P (2 kg/t) in combination with a film former -- 1.83 t/ha, the yield increase to the control was 0.23 t/ha. (table 1).

Yield quality is a complex indicator, which is formed during the cultivation of the crop. The increase in this protein collecting index was stable for three years with the application of seed treatment with Nitrofix in various forms both in pure form and when combined with a film former. On average, the maximum protein collection was observed with the complex use of bacterial preparations with a film former, compared with the control in these variants, on average for three years it was higher by 14--21 %.

Table 1: Soybean yield and protein collection depending on seed treatment with rhizobial preparations, 2013--2015, t/ha.

Preparation	Yield	Collecting Protein	Increase control	
			Seed yield	Collecting Protein
Control (without processing)	1,60	0,57	--	--
Nitrofix P (2 kg/t)	1,70	0,64	0,10	0,07
Nitrofix Zh (2.5 L/t)	1,72	0,64	0,12	0,07
Nitrofix P (2 kg/t) + film former	1,83	0,69	0,23	0,12
Nitrofix Zh (2.5 L/t) + film cob.	1,74	0,65	0,14	0,08
HCP05	0,08	0,03	--	--

Cost-effectiveness is the ratio between the results of production and the total costs of its implementation (table 2).

When calculating the cost-effectiveness indicators of the value of output and production costs are taken at 2015 prices. The highest profit (19,472--22,191 rub/ha) was obtained with the complex treatment of seeds with organic preparations in combination with a film former.

Table 2: Cost-effectiveness of rhizobial preparations for treating soybean seeds, 2013--2015.

Indicators	Bio preparations				
	control	Nitrofiks P	Nitrofiks Zh	Nitrofiks P + film former	Nitrofiks Zh + film former
Productivity from 1 ha, t	1,60	1,70	1,72	1,83	1,74
Money proceeds from 1 ha, rub.	37 600	39 950	40 420	43 005	40 890
Labor costs per 1 ha, man-h	12,4	12,5	12,5	12,5	12,5
Labor costs per 1 t, man-h	7,8	7,4	7,3	6,8	7,2
Production costs per 1 ha, rub.	20 528	20 788	20 948	20 814	20 974
The cost price of 1 tons of products, rub.	12 830	12 228	12 179	11 374	12 054
Profit per 1 ha, rub.	17 072	19 162	19 472	22 191	19 916
Profitability level, %	83	92	93	107	95

The maximum profitability of seed treatment with rhizobial preparations was 95--107 % in variants with the use of the preparations Nitrofix P and Nitrofix Zh in combination with the film former, which is higher than the use of bacterial preparations in its pure form by 2--15 % and 12--24 %. The most cost-effective (107 %) was the use of rhizobial Nitrofix preparation in its powder form (2 kg/t) combining with a film former.

The soybean yield and the protein collection from the sowing area, depending on the bacterial preparation Nitrofiks Zh and growth stimulants use are presented in the table (table 3).

Table 3: Soybean yield and protein collection depending on seed treatment with bacterial preparation and growth stimulants, 2013-2015, t/ha.

Preparation	Yield	Collecting Protein	Increase control	
			Seed yield	Collecting Protein
Control (without processing)	1,55	0,56	--	--
Nitrofix Zh (2.5 L/t)	1,65	0,61	0,10	0,05
Nitrofix Zh (2.5 L/t)+Albit (50 ml/t)	1,70	0,62	0,15	0,06
Nitrofix Zh (2.5 L/t)+ Nagro bioenergetic (0.7 L/t)	1,73	0,63	0,18	0,07
Nitrofix Zh (2.5 L/t); Nagro universal -- 3-fold foliar nutrition (0,7 L/ha)	1,73	0,64	0,18	0,08
Nitrofix Zh (2.5 L/t)+ Nagro bioenergetic (0.7 L/t); Nagro universal -- 3-fold foliar nutrition (0,7 L/ha)	1,75	0,64	0,20	0,08
HCP05	0,06	0,01	--	--

On average for 2013--2015 the research has shown that the combination of a bacterial preparation with Albit growth stimulant allows obtaining a yield increase of 0.15 t/ha, and with Nagro bioenergetic -- 0.18 t/ha.

The greatest yield increase was noted in the variant with seed treatment with the bacterial preparation Nitrofiks Zh in combination with Nagro bioenergetic, as well as 3-fold foliar feeding of vegetative plants with bioorganic fertilizer Nagro universal -- the gain was 0.20 t/ha, the maximum protein collection compared to control was found in these variants on average over three years was about 14.3 % higher.

The calculation of the cost-effectiveness of the rhizobial preparation with growth stimulants complex use suggests that on average over 2013--2015 production costs, depending on the preparation use, totalled 20 948--22 625 rub/ha (Table 4).

Seed treatment with Nitrofix in combination with bioenergetic and foliar fertilizing with bioorganic fertilizer Nagro universal with wide-row sowing provided the highest money proceeds -- 41 125 rubles per hectare. The resulting yield of soybeans -- 1.73 t/ha, and relatively low production costs for seed treatment with a rhizobial preparation in combination with the growth stimulator Nagro bioenergetic allowed to get the highest profit -- 19 668 rub/ha. Taking into account the production cost and profit per hectare indicators, the highest level of profitability was obtained when applying seed

treatment with the rhizobial preparation Nitrofiks Zh in combination with Albit and Nagro bioenergetic growth stimulants: 91--94 %.

Table 4: Cost-effectiveness of the bacterial preparation and growth stimulants use, 2013--2015.

Indicators	Bio preparations					
	control	Nitrofix Zh	Nitrofix Zh +Albit	Nitrofix Zh + Nagro bioenergetic	Nitrofix Zh + Nagro universal	Nitrofix Zh + Nagro bioener-getic; Nagro universal
Productivity from 1 ha, t	1,55	1,65	1,70	1,73	1,73	1,75
Money proceeds from 1 ha, rub.	36 425	38 775	39 950	40 655	40 655	41 125
Labor costs per 1 ha, man-h	12,4	12,5	12,5	12,5	12,8	12,8
Labor costs per 1 t, man-h	8,0	7,6	7,4	7,2	7,4	7,3
Production costs per 1 ha, rub.	20 528	20 948	20 961	20 987	22 586	22 625
The cost price of 1 tons of products, rub.	13 244	12 696	12 330	2 131	13 056	12 929
Profit per 1 ha, rub.	15 897	17 827	18 989	19 668	18 069	18 500
	77	85	91	94	80	82

7. Conclusion

The conducted research allows establishing that the symbiotic activity that is provided by the treatment of seeds with rhizobial preparations in combination with the film former and growth stimulators has a great influence on the soybean seeds yield and quality. Therefore, we can draw following conclusions: the treatment of seeds with bacterial preparations, especially in combination with film formers, as well as the use of growth stimulants in the treatment of seeds and vegetative plants are important technological methods, which provide not only an increase in yield and protein collection from the sown area, but also provides high profits and increases the soybean cultivation profitability level.

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References

[1] Dudka, N.Z., Zaitsev, N.I., Mazola, N.A. (2010). Breeding and seed production of soybean in the Armavirskaya experimental station. *Agriculture*, no. 3, pp. 47--48.

[2] Ishkov, I.V., Komaritskaya, E.I. (2012). The effect of seed treatment and planting with biological products on the productivity of soybean in dark gray forest soils of the Kursk region. *Bulletin of the Kursk State Agricultural Academy*, no. 2, pp. 52--54.

[3] Rakhimova, Yu.M., Naumov, A.Yu., Dozorov, A.V. (2014). Productivity and quality of soybean seeds depending on the methods of basic tillage and herbicides. *Bulletin of the Ulyanovsk State Agricultural Academy*, no. 3(27), pp. 11--15.

[4] Hanieva, I.M., Bosiev, A.L., Kardanova, M.M., Tlostanov, I.H. (2017). Influence of growth regulators and inoculation on yield and quality of soybean seeds. *Advances in modern science*, vol. 2, no. 4, pp. 127--130.

[5] Shabaldas, O.G., Golub, A.S., Zelenskaya, T.G., Donets, I.A., Mukhina, O.V. (2018). Symbiotic activity and productivity of soybean, depending on the methods of presowing treatment of soybean seeds in the conditions of central ciscaucasia. *Research Journal of Pharmaceutical. Biological and Chemical Sciences*, vol. 9, no. 4, pp. 688--691.

[6] Shabaldas, O.G., Golub, A.S., Mukhina, O.V., Donets, I.A. (2016). Nitrogen-fixing activity of soybean plants in the application of complex inlays seeds. *Research Journal of Pharmaceutical. Biological and Chemical Sciences*, vol. 7, no. 3, pp. 2348--2350.

[7] Shabaldas, O.G., Troop, A.I., Dove, A.S. (2013). The effect of different methods and techniques of primary tillage on aggregate composition and yield of soybeans. *Vestnik APK Stavropol*, no. 4(12), pp. 31--35.

[8] Shulaev, G.M., Milushev, R.K., Votanovskaya, N.A., Saranchina, E.F. (2014). The feed value of seeds of lupine and full-fat soybean by methods of technological processing. *Bulletin of the University of Tambov. Series: Natural and Technical Sciences*, vol. 19, no. 2, pp. 777--779.

[9] Shuvalov, A.M., Shulaev, G.M., Votanovskaya, N.A., Chernov D.S. (2015). The influence of the method of heat supply on the controllability of the process of hydrothermal treatment of soybean seeds. *Bulletin of the University of Tambov. Series: Natural and Technical Sciences*, vol. 20, no. 2, pp. 443--445.

[10] Tilba, V.A., Shabaldas, O.G. (2015). The use of biological nitrogen as a means of biological system of agriculture. *Bulletin of agriculture Stavropol*, no. S2, pp. 96--100.

[11] Ustyuzhanin, A.P. (2010). Strategy of development of soybean complex of Russia. *Agriculture*, no. 3, p. 3.

[12] Zaitsev, N.I., Rogozin, R.N. (2011). Agricultural techniques affecting the quality of soybean seeds. *Agriculture*, no. 7, pp. 45--48.