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ECONOMIC EFFICIENCY OF SOYBEAN SEED PRODUCTION IN TERMS OF PRODUCTION COSTS

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The purpose of the study is to analyze all components of production costs using the example of soybean seed cultivation and outline possible areas for reducing costs to increase the economic efficiency of production. Experimental field studies were conducted in the conditions of the scientific research farm «Agronomichne» of Vinnytsia National Agrarian University. Studies conducted in the conditions of the Right-Bank Forest-Steppe on gray forest soils showed that the level of soybean seed yield largely depended on the hydrothermal conditions of the years of research and the factors studied, in particular pre-sowing seed treatment and foliar feeding. The relevance of the research is supported by the implementation of state-level tasks, financed by the state budget on the topic: «Development of environmentally friendly technologies for growing bioenergy crops to ensure energy independence and soil conservation for the formation of climate neutrality». The theoretical and methodological basis of the calculations was a systematic approach and individual aspects of biologized cultivation technology were studied to reduce production costs and increase the level of economic efficiency of soybean seed production in the conditions of the Right-Bank Forest-Steppe. The results of the calculations indicate that pre-sowing seed treatment and foliar feeding significantly affected the level of economic efficiency of soybean seed cultivation. On average, over the years of research, total production costs, depending on the experiment variant, fluctuated within 14836-16253 UAH/ha, which is due to the degree of saturation of the technological model with the relevant elements (at 2024 prices). Economic analysis of the obtained data confirmed the feasibility of introducing biologized elements into the soybean nutrition system. The highest economic efficiency was demonstrated by the cultivation technology model, which included pre-sowing seed treatment with the preparation «Bioinoculant BTU» (2 l/t) in combination with two foliar top dressings with the organo-mineral fertilizer «Helprost Soya» (2.5 l/ha) in the development phases: the third tripartite leaf and budding. The use of this option provided the maximum conditional net profit, at the level of 20216 UAH/ha and the highest level of profitability – 124.8%. The most effective from an economic point of view is the soybean growing technology model, which involves the application of mineral fertilizers at a dose of $N_{45}P_{45}K_{45}$, the application of the biological fertilizer Graunfix 5 l/ha in pre-sowing cultivation and seed treatment with the drug Mycofriend (1.5 l/ha), which provides a maximum level of profitability of 125%.

Key words: economic efficiency, soybeans, cost calculation, cost price, profit, profitability level.
Tab. 1. Fig. 2. Lit. 11.

Problem statement. The introduction of biologized elements into the technology of soybean cultivation and its individual agrotechnical techniques is an important measure that can slow down the process of soil degradation and contribute to the stabilization of agricultural production by reducing dependence on external technological factors [1-2]. Among the entire complex of agrochemical measures for soybean biofertilization, pre-sowing seed treatment with biological preparations and

foliar feeding with microelements require the least material and labor costs [3]. The use of biological preparations in the biologized technology of soybean cultivation contributes to increasing the seed productivity of the crop, improving the quality of seeds and, ultimately, helps to reduce economic costs and increase the level of profitability [4].

Analysis of recent research and publications. When analyzing the literature on the economic efficiency of biologized technological methods for growing soybean seeds, it is important to note the works of a number of domestic scientists, in particular, such as Vasyl Petrychenko, Volodymyr Lykhochvor, Mykola Bakhmat, Hanna Pantsyreva and others. They studied in detail various aspects of the impact of biological preparations on the productivity and economic indicators of soybean cultivation, and also analyzed the effectiveness of the use of inoculants and foliar feeding. In particular, the works of these authors contribute to a deeper understanding of the role of biological methods in increasing seed yield and quality, as well as optimizing production costs. Their studies identify key factors affecting economic efficiency, such as the choice of seed treatment technology, the use of various types of fertilizers and feeding, as well as innovative approaches to agronomy that help reduce production costs and increase profitability [1-3].

According to V. Petrichenko: the main quantitative indicator that determines the level of economic efficiency of soybean seed production is the level of yield. An increase in the gross harvest of seeds and the economic efficiency of its production directly depends on an increase in yield. An increase in yield also leads to a decrease in the labor intensity of production and a decrease in cost [1].

Practical experience of the results of the production verification of the dissertation research of Pantsyreva H.V. indicates that the yield of soybean seeds is largely determined by the quality of the seed material [4]. Practical experience shows that errors in the selection of varieties and low quality of seeds inevitably lead to losses for producers of commercial seeds. At the same time, the research of Mazur O.V. established that the key to high seed productivity of soybeans is high-quality varietal resources [5]. Thus, Tkachuk O.P. established that by using high-quality seed material it is possible to increase the yield level by 20-30% [6].

The presented information and analytical data allow us to conclude that soybean can serve as a criterion for identifying the biologization of agricultural systems, therefore we consider it appropriate to scientifically substantiate the technological methods of its cultivation with the simultaneous economic efficiency of its cultivation.

Conditions and methods of conducting research. Experimental field research was conducted in the conditions of the scientific research farm «Agronomichne» of Vinnytsia National Agrarian University. Research conducted in the conditions of the Right-Bank Forest-Steppe on gray forest soils showed that the level of soybean seed yield depended to a large extent on the hydrothermal conditions of the years of research and the factors under study, in particular pre-sowing seed treatment and

foliar top dressing. The purpose of the research is to analyze all components of the production cost using the example of soybean seed cultivation and to outline possible directions for reducing costs in order to increase the economic efficiency of production. The theoretical and methodological basis of the calculations was a systematic approach and individual aspects of biologized cultivation technology were studied in order to reduce production costs and increase the level of economic efficiency of soybean seed production in the conditions of the Right-Bank Forest-Steppe. The relevance of the research is reinforced by the implementation of state-level tasks financed from the state budget on the topic: «Development of environmentally friendly technologies for growing bioenergy crops to ensure energy independence and soil conservation for the formation of climate neutrality».

The calculation of economic efficiency indicators for soybeans in the conditions of the Right-Bank Forest-Steppe on gray forest soils, taking into account the biologization of the nutrition system using pre-sowing treatment and foliar feeding, was carried out on the basis of compiled technological cultivation maps (fig.1).

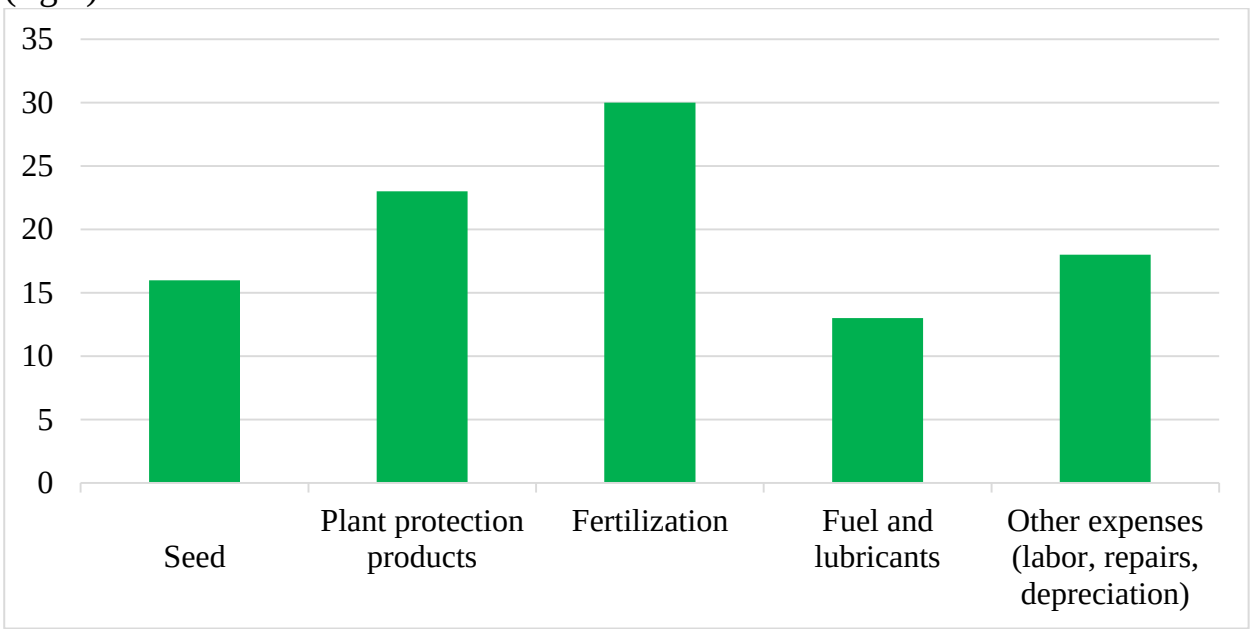

Fig. 1. Structure of production costs in soybean cultivation, %

At the same time, modern prices for material and technical resources (technological operations, seeds, plant protection products, mineral and biological fertilizers, fuel) and work performed as of 2024 were taken into account.

Research results. The combined use of mineral fertilizers and biological preparations, which act by different mechanisms, has a positive effect on the soil, helps to preserve its fertility, improves the release of phosphorus and potassium from the soil and mineral fertilizers, which, in turn, increases the coefficient of their assimilation by plants. It also increases the resistance of plants to stress factors, which, as a result, contributes to increasing productivity, yield and improving the quality indicators of agricultural crops [7-11]. Experimental field studies carried out

in the conditions of the Right-Bank Forest-Steppe on gray forest soils indicate that the yield of soybean seeds largely depended on the hydrothermal conditions of the years of research and the factors studied, namely pre-sowing seed treatment and foliar feeding, which ultimately affects economic efficiency (Table 1).

Table 1

Economic efficiency of soybean cultivation depending on pre-sowing seed treatment and foliar fertilization

Seed treatment	Foliar feeding	Production costs, UAH/ha.	Cost of grown products, UAH	Conditional net profit, UAH	Cost of 1 ton of seeds, UAH	Profitability level, %
Without processing	Without top dressing (c)	14836	27170	12334	6006	83,1
	BTU Biocomplex	15601	30140	14539	5694	93,2
	Gumifriend	15486	29260	13774	5822	88,9
	Helpprost soy	16098	30800	14702	5749	91,3
Bio-inoculant BTU	Without top dressing	14931	30910	15979	5314	107,0
	BTU Biocomplex	15696	35090	19394	4920	123,6
	Gumifriend	15579	33770	18191	5075	116,8
	Helpprost soy	16194	36410	20216	4892	124,8
Rizoline + Rizosave	Without top dressing	14989	29480	14491	5593	96,7
	BTU Biocomplex	15755	32670	16915	5305	107,4
	Gumifriend	15639	30910	15271	5565	97,6
	Helpprost soy	16253	33770	17517	5294	107,8
Anderiz	Without top dressing	14982	29700	14718	5549	98,2
	BTU Biocomplex	15747	33440	17693	5180	112,4
	Gumifriend	15631	32340	16709	5317	106,9
	Helpprost soy	16245	34760	18515	5141	114,0

Source: based on own research

The results of the comparative analysis show that the greatest economic efficiency among the studied preparations for foliar feeding in comparison with the control variant was provided by the organo-mineral fertilizer «Helprost Soya» (2.5 l/ha). For these variants, depending on the pre-sowing seed treatment, production costs varied from 16098 to 16253 UAH/ha, net profit was from 14702 to 20216 UAH/ha, the cost price of 1 ton of seeds ranged from 5749-4892 UAH, and the level of profitability – from 91.31 to 124.8%. Thus, the economic analysis of the obtained results confirmed the validity of the conclusions regarding the feasibility of biologization of the soybean nutrition system. The most cost-effective model of soybean cultivation technology was the one that included pre-sowing seed treatment with the preparation «Bioinoculant BTU» (2 l/t) in combination with two foliar top dressings with the organo-mineral fertilizer «Helprost Soya» (2.5 l/ha) in the phase of the third trifoliate leaf and budding. This model provided the maximum conditional net profit of 20,216 UAH/ha and the highest level of profitability – 124.8%.

According to the results of the calculations, it was found that the factors studied, namely (fertilizer level and pre-sowing treatment of seeds with a mycorrhizal preparation) had a significant impact on the economic efficiency of soybean cultivation. On average, over the years of research, total production costs for soybean cultivation ranged from 13,163 to 16,393 UAH/ha, depending on the intensification of the cultivation technology model by the studied elements (Table 2).

Table 2

Economic efficiency of soybean cultivation depending on seed treatment and fertilization system

Seed treatment	Fertilizer rates	Production costs, UAH/ha.	Cost of grown products, UAH	Conditional net profit, UAH	Cost of 1 ton of seeds, UAH	Profitability level, %
Without processing	$N_{60}P_{60}K_{60}$ (st)	15068	27480	12412	6580	82,4
	$N_{60}P_{60}K_{60}$ + Groundfix 3 л/га	15741	30120	14379	6271	91,3
	$N_{60}P_{60}K_{60}$ + Groundfix 5 l/ha	16158	31680	15522	6120	96,1
	$N_{45}P_{45}K_{45}$ + Groundfix 3 л/га	13163	25560	12397	6180	94,2
	$N_{45}P_{45}K_{45}$ + Groundfix 5 l/ha	13580	27000	13420	6036	98,8
Micofrend	$N_{60}P_{60}K_{60}$ (st)	15303	30720	15417	5978	100,7
	$N_{60}P_{60}K_{60}$ + Groundfix 3 л/га	15976	33960	17984	5645	112,6
	$N_{60}P_{60}K_{60}$ + Groundfix 5 l/ha	16393	35640	19247	5520	117,4
	$N_{45}P_{45}K_{45}$ + Groundfix 3 л/га	13399	29400	16001	5469	119,4
	$N_{45}P_{45}K_{45}$ + Groundfix 5 l/ha	13815	31080	17265	5334	125,0

Source: based on own research

Thus, the conducted economic analysis of the obtained research results confirmed the previously formed conclusions regarding the positive impact of biologization of the soybean fertilization system. Thus, the most effective from an economic point of view is the soybean cultivation technology model, which involves the application of mineral fertilizers at a dose of N45P45K45, the application of the biological fertilizer Graunfix 5 l/ha in pre-sowing cultivation and seed treatment with the drug Mycofriend (1.5 l/ha), which provides a maximum level of profitability of 125%.

Conclusions. The calculation of the costs of soybean seed production allowed us to determine the production cost, which amounted to UAH 4892 per 1 ton of seed. It is worth noting that the indicated prices were relevant for the beginning of the harvest in 2024. The highest economic efficiency among the studied preparations for foliar feeding compared to the control option was provided by the organo-mineral fertilizer «Helprost Soya» (2.5 l/ha). This model provided the maximum conditional net profit of UAH 20216/ha and the highest level of profitability – 124.8%. The most effective from an economic point of view is the model of soybean cultivation technology, which involves the application of mineral fertilizers at a dose of N45P45K45, the introduction of the biological fertilizer Graunfix 5 l/ha in pre-sowing cultivation and seed treatment with the drug Mycofriend (1.5 l/ha), which provides the maximum level of profitability of 125%.

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АНОТАЦІЯ

ЕКОНОМІЧНА ЕФЕКТИВНІСТЬ ВИРОБНИЦТВА НАСІННЯ СОЇ У РОЗРІЗІ ВИРОБНИЧИХ ВИТРАТ

Метою проведеного дослідження є аналіз усіх складових виробничої собівартості на прикладі вирощування насіння сої та окреслення можливих напрямів зниження витрат задля підвищення економічної ефективності виробництва. Експериментально-польові дослідження проведено в умовах науково-дослідного господарства «Агрономічне» Вінницького національного аграрного університету. Дослідження, здійснені в умовах Лісостепу правобережного на сірих лісових ґрунтах, засвідчили, що рівень врожайності насіння сої значною мірою залежав від гідротермічних умов років досліджень та досліджуваних факторів, зокрема передпосівної обробки насіння і позакореневих підживлень. Актуальність проведених досліджень підкріплюється виконанням завдань державної тематики, що фінансується за рахунок коштів державного бюджету за темою: «Розробка екологоорієнтованих технологій вирощування біоенергетичних культур для забезпечення енергонезалежності та ґрунтозбереження задля формування кліматичної нейтральності». За теоретично-методологічну основу проведених розрахунків використано системний підхід та вивчено окремі аспекти біологізованої технології вирощування задля зменшення виробничих витрат та підвищення рівня економічної ефективності виробництва насіння сої в умовах Лісостепу правобережного. Результати розрахунків свідчать про те, що передпосівна обробка насіння та позакореневі підживлення суттєво впливали на рівень економічної ефективності вирощування насіння сої. У середньому за роки досліджень загальні виробничі витрати залежно від варіанту досліду коливалися в межах 14836-16253 грн/га, що обумовлено ступенем насичення технологічної моделі відповідними елементами (за цінами 2024 року). Економічний аналіз отриманих даних підтвердив доцільність упровадження біологізованих елементів у систему живлення сої. Найвищу економічну ефективність продемонструвала модель технології вирощування, що включала передпосівну обробку насіння препаратом «Біоінокулянт БТУ» (2 л/т) у поєднанні з двома позакореневими підживленнями органо-мінеральним добривом «Хелпрост Соя» (2,5 л/га) у фази розвитку: третій трійчастий листок і бутонізація. Застосування даного варіанту забезпечило максимальний умовно чистий прибуток, на рівні 20216 грн/га та найвищий рівень рентабельності – 124,8%. Найбільш ефективною з економічної точки зору є модель технології вирощування сої, яка передбачає внесення мінеральних добрив у дозі $N_{45}P_{45}K_{45}$, внесення у передпосівну культивацію біологічного добрива Граунфікс 5 л/га та обробки насіння препаратом Мікофренд (1,5 л/га), що забезпечує максимальний рівень рентабельності 125 %

Ключові слова: *економічна ефективність, соя, розрахунок витрат, собівартість, прибуток, рівень рентабельності.*

Табл. 2. Рис. 1. Літ 11.

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