ECONOMIC AND ENERGY EFFICIENCY OF BACTOPASLON APPLICATION IN THE TECHNOLOGY OF POTATO CULTIVATION

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The paper describes the investigation results of economic and energy efficiency of microbial preparation Bactopaslon application in the technology of potato cultivation. The high efficiency of the studied biological product due to the advanced yield increase rates as compared to the increased costs was established.

Keywords: *potato, Bactopaslon, economic efficiency, energy efficiency.*

Application of microbial preparations into the modern crop production technologies is an effective mean for environmentally friendly crops yield enhancement. As the results of our previous research an experimental microbial preparation Bactopaslon, with *Azotobacter* bacteria activated with the potato lectin as bio-agents, was created. The high efficiency of this preparation was proven on potato [1]. It should be noted, that economic efficiency is one of the most important criteria for product evaluation, especially in case of such innovative product as Bactopaslon. For developers of microbial preparations such information is necessary to evaluate product competitiveness on the market of innovative research for agriculture in order to identify the most promising product, while for the consumer (agricultural management) – to determine the appropriateness of its application.

To this end, we investigated the economic effects of pre-planting potato bacterization with Bactopaslon.

Materials and methods. Evaluations were made using the average values of potato yields of Fantasia variety obtained during three-year field experiments on the meadow black leached light loam soils in Institute of Agricultural Microbiology and Agricultural Production NAAS. Experimental conditions were described in our previous research work [1]. Estimation of economic efficiency of potato bacterization was performed according to the recommendations based on the method of results comparison of certain agricultural technique and the cost of its introduction, using such indicators of economic efficiency as cost per unit of output, profits per 1.0 tons of product and per 1.0 ha of cultivation area, its production and additional costs profitability [2, 3].

Technological operations, resource consumption and prices are taken from the standards of National Scientific Centre “Institute of Agricultural Economics NAAS” (Kyiv) with the exception of additional direct and overhead costs associated with the use of the studied microbial preparation [4, 5].

Estimation of yield and cost changes impact per 1 hectare on the deviation of cost of 1 ton of potatoes in the experiment was compared to the control values using the following two-factor deterministic model:

$$C = \frac{B}{Y}, \quad (1.1)$$

where C – cost of 1 ton of potatoes, UAH
 B – expenditures per 1 ha of planting UAH
 Y – potato yield, t/ha.

The quantitative effect of changes of potatoes yield and costs per 1 ha of planting on the deviation of the profit per 1 ton of potatoes was determined by the following three-factor deterministic model:

$$\Pi_T = \Pi - \frac{B}{Y}, \quad (1.2)$$

where Π_T – profit per 1 ton of product, UAH
 Π – sale price of 1 ton of potatoes, UAH

To determine the quantitative impact of changes in yield and size of the monetary costs per 1 ha of cultivated crops on profit deviation per 1 ha of planting three-factor deterministic model was used:

$$\Pi_{ra} = \Pi \times Y - B, \quad (1.3)$$

where Π_{ra} – profit per 1 ha of planting, UAH

The quantitative effect of changes of studied factors on the deflection of profitability of potato production was determined by the following deterministic model:

$$P = \left(\frac{\Pi \times Y}{B} - 1 \right) \times 100, \quad (1.4)$$

where P – profitability of potato production, %.

This model is obtained from the traditional economic profitability model in order to isolate the effect of studied factors:

$$P = \frac{\Pi}{B} \times 100 \% = \frac{(\Pi \times Y) - B}{B} \times 100 \% = \left(\frac{\Pi \times Y}{B} - 1 \right) \times 100 \% \quad (1.5)$$

Results and discussions. Parameters directly related to bacterization (direct costs: cost of preparation, treatment, transportation and sorting of additional yield) together with the changes in overhead expenses, that at calculation of production costs are allocated proportionally to direct ones were taking into the account in order to determine the costs associated with the use of biological preparations.

For this purpose, the full production cost was calculated, since the income, which is primarily of the main interest to the product consumer is the difference

between the price and the full cost of production. Such methodological and methodical approach in cost estimation slightly increase the cost of biological preparation, but at the same time, it promotes precise assessment of its cost-effectiveness. The calculation results of economic efficiency of Bactopaslon application on potatoes of Fantasia variety are shown in Table 1.

TABLE 1. The economic efficiency of Bactopaslon application on potatoes (Fantasia variety)

Index	Control	Bactopaslon	Control deviation ($\pm$)	
			Absolute	%
Yield, t/ha	20,35	24,55	+ 4,20	+ 20,6
The cost of 1 ha (total cost), UAH	10892,0	11314,0	+ 422,0	+ 3,9
including additional costs for bacterization UAH/ha	—	+ 422,0	—	—
Total cost per 1 t, UAH	535,2	460,9	- 74,3	- 13,9
Sale price per 1 t, UAH	850,0	850,0	—	—
Sale proceeds per 1 ha, UAH	17298,0	20868,0	+ 3570,0	+ 20,6
Profit per 1 ha, UAH	6406,0	9554,0	+ 3148,0	+ 49,1
Profit per 1 t, UAH	314,8	389,1	+ 74,3	+ 23,6
Profitability, %	58,8	84,4	+ 25,6 в.п.	—
Additional expenses profitability, %	—	746,0	—	—

Data depicted in the table indicate that the pre-planting potato bacterization promotes a significant increase of economic efficiency. Thus, in variants with Bactopaslon potato yield has increased on 4.20 t/ha or 20.6 %, while the costs have increased on only 422.0 UAH/ha or 3.9 %. As a result, the cost has decreased on 74.3 UAH/t or 13.9 %, while the amount of revenue per hectare has increased on 3 570.0 UAH/ha or 20.6 %.

The combined effects of these factors contributes to a significant increase of production profitability. Thus, application of Bactopaslon has promoted profitability increase to even greater extent: the amount of profit per hectare has increased on 3 148.0 UAH/ha or 49.1 % while profitability has increased on 25.6 %.

The data obtained shows that bacterization of planting material with given microbial preparation significantly increase economic efficiency of potato production.

It should be emphasized that the increase in productivity and improvement of economic efficiency was obtained without the use of fertilizers and substantial additional costs on resources, which is especially important today, at growing costs of resources and crisis conditions when commodity producer is not capable to introduce innovations requiring significant capital investment.

Based on the performed studies of the economic effectiveness of Bactopaslon for growing potatoes, two main factors with a direct influence (first order factors) on the entire chain of economic indicators can be distinguished: the productivity level and the amount of the costs associated with bacterization of planting material per 1.0 ha. In this connection, it is useful to determine the quantitative impact of these factors on main indices of economic efficiency of potato production: cost of 1 ton of product, the amount of profit per 1 ton of product and 1,0 ha of planting and production profitability. For this purpose deterministic factor analysis was used.

It was established that increase of direct and overhead costs associated with the use of microbial preparation per 1 ha of planting has a slight effect on cost of 1 ton of potatoes – 20.8 UAH/t (Table 2), but due to the yield increase the production cost has significantly dropped – on 95.1 UAH/t, ensuring its total decrease on 74.3 UAH/t.

The quantitative effect of the studied factors (yield and costs per 1 ha of planting) on profit deviation per 1 ton of potatoes will be the same as on cost deviation of 1 ton of potatoes (but with the opposite sign): +95.1 UAH/t and – 20.8 UAH/t, correspondingly, resulting in total +74.3 UAH/t.

TABLE 2. Effect of the cost per 1 hectare and yield on the cost of 1 ton of potato (Fantasia variety) at Bactopaslon application

Index	Legend and formulas	Values
Yield (control), t/ha	Y_K	20,35
Yield (experiment), t/ha	Y_D	24,55
Costs per 1 ha (control), UAH	B_K	10 892,0
Costs per 1 ha (experiment), UAH	B_D	11 314,0
Full costs of 1 t (control), UAH	$C_K = \frac{B_K}{Y_K}$	535,20
Full costs per 1 t (experiment), UAH	$C_D = \frac{B_D}{Y_D}$	460,90
Estimated (conditional) cost per 1 t, UAH	$C_y = \frac{B_D}{Y_K}$	556,00
Total cost deviation, UAH/t	$\Delta C_{\text{заг.}} = C_D - C_K$	–74,30
Cost deviation due to the cost changes per 1 ha, UAH/t	$\Delta C_B = C_y - C_K$	+20,80
Cost deviation due to the yield changes, UAH/t	$\Delta C_y = C_D - C_y$	–95,10

According to Table 3, it can be concluded that increase of potato yield profits per 1 ha of planting make 3570.0 UAH

At the same time, due to the associated increase of monetary costs per 1 ha of planting area profitability has decreased on 422.0 UAH/ha. Thus, productivity

increase has played an essential role, not only increasing the costs but ensuring the overall profit growth on 3148.0 UAH/ha.

TABLE 3. Effect of the cost per 1 hectare and yield on the profit deviation per 1 ha of potato planting (Fantasy variety) at Bactopaslon application

Index	Legend and formulas	Values
Yield (control), t/ha	Y_k	20,35
Yield (experiment), t/ha	Y_d	24,55
Costs per 1 ha (control), UAH	B_k	10892,0
Costs per 1 ha (experiment), UAH	B_d	11314,0
Sale price per 1 t of potatoes, UAH	Π	850,0
Profit per 1 ha (control), UAH	$\Pi_{\text{га к}} = \Pi \times Y_k - B_k$	6406,0
Profit per 1 ha (experiment), UAH	$\Pi_{\text{га д}} = \Pi \times Y_d - B_d$	9554,0
Estimated profit per 1 ha, UAH	$\Pi_{\text{га у}} = \Pi \times Y_d - B_k$	9976,0
Total profit deviation, UAH/ha	$\Delta \Pi_{\text{га заг}} = \Pi_{\text{га д}} - \Pi_{\text{га к}}$	+ 3148,0
Profit deviations due to the yield changes, UAH / ha	$\Delta \Pi_{\text{га у}} = \Pi_{\text{га у}} - \Pi_{\text{га к}}$	+ 3570,0
Cost deviation due to the cost changes per 1 ha, UAH/t	$\Delta \Pi_{\text{га в}} = \Pi_{\text{га д}} - \Pi_{\text{га у}}$	- 422,0

Influence estimation of studied factors on the increase of overall profitability of potato production is shown in Table 4.

The results obtained by factor data analysis have shown that improvement of economic efficiency of potato bacterization with Bactopaslon, observed in all quality parameters is achieved due to a strong positive impact on productivity in comparison with the growth of direct and overhead costs related to the use of given microbial preparation. Therefore, the effects of its use tenfold compensate additional costs associated with Bactopaslon application.

Special attention should be given to the efficiency of microbial preparation as specified innovative method unlike many other innovations, does not require large capital investments which is particularly important in the current economic conditions in Ukraine.

TABLE 4. Effect of yield and expenditures changes per 1 ha on deviation of profitability of potato (Fantasia variety) at application of Bactopaslon

Index	Legend and formulas	Values
Yield (control), t/ha	Y_K	20,35
Yield (experiment), t/ha	Y_D	24,55
Costs per 1 ha (control), UAH	B_K	10 892,0
Costs per 1 ha (experiment), UAH	B_D	11 314,0
Sale price per 1 t of potatoes, UAH	Π	850,0
Profitability per 1 ha (control), UAH	$P_K = \left(\frac{\Pi \times Y_K}{B_K} - 1 \right) \times 100\%$	58,8
Profitability per 1 ha (experiment), UAH	$P_D = \left(\frac{\Pi \times Y_D}{B_D} - 1 \right) \times 100\%$	84,4
Expected profitability level, %	$P_p = \left(\frac{\Pi \times Y_D}{B_K} - 1 \right) \times 100\%$	91,6
General deviation of profitability level, r.i.	$\Delta P_{\text{заг}} = P_D - P_K$	+ 25,6
Deviation of profitability due to the yield changes, r. i.	$\Delta P_y = P_p - P_K$	+ 32,8
Deviation of profitability due to the costs changes per 1 ha, r. i.	$\Delta P_B = P_D - P_p$	- 7,2

In this regard, the assessment of energy efficiency of microbial preparation use looks reasonable, including yield cost recovery of human energy. In contrast to the economic evaluation undertaken in value terms, subject to the influence of market conditions, prices disparity and inflationary process, etc., energy evaluation provides an objective overview of the effectiveness and appropriateness of studied agricultural technique as well as effectiveness of corresponding agro-ecosystem as a whole.

For this purpose, the calculations of energy assessment under the use of Bactopaslon for potatoes growing were performed. At this, production operations and resources costs (used for the economic evaluation) were converted in the relevant energy equivalents [6, 7].

The analysis of main energy efficiency indices of potato of Fantasia variety in control and experimental variants (Table 5) have shown the high energy efficiency of bacterization of planting material for growing potatoes.

Thus, the energy efficiency ratio (the ratio of total energy of major and minor products to the cost of human energy) in control was 3.98, while at application of Bactopaslon – 4.39. At this, the energy efficiency ratio for additional costs (the ratio of additional energy yield obtained with bacterization means, to extra cost of human energy associated with its use) was 9.38.

TABLE 5. Energy efficiency of Bactopaslon in growing potato
(Fantasia variety)

Index	Energy efficiency, MJ	
	Control	Bactopaslon
Energy-output ratio – total	28 698,0	31 058,0
Including: – labor inputs	421,0	484,0
– tractor and motor vehicles	1 478,0	1 655,0
– agricultural tools	4 532,0	5 478,0
– diesel fuel	2 214,0	2 214,0
– gasoline	4 528,0	5 412,0
– electricity	84,0	170,0
– manufacture costs of microbial preparation	–	205,0
– protection means	520,0	520,0
– planting material	14 921,0	14 921,0
Additional energy costs (to control)	–	2 360,0
Yield energy content – total	11 4216,0	136 342,0
Including: – major product	70 614,0	85 189,0
– minor product	43 602,0	51 153,0
Energy content of additional yield (to control)	–	22 126,0
Energy efficiency ratio	3,98	4,39
Energy efficiency ratio for additional energy expenditures	–	9,38

Summing up the analysis results of the economic and energy efficiency technologies at Bactopaslon application on potato of Fantasia variety it can be concluded that given preparation is highly effective both in economic and in energy terms.