Influence of Biological Preparations for Plant Protection on Plant Formation and Yeald of Sugar Corn

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Abstract

The article presents the results of the use of biological preparations BioNorma Pseudomonas and BioNorma Triomax produced (both produced by BioNorma LLC, Ukraine) in the technology of growing sugar corn (Zea mays convar. saccharata var. rugosa). The influence of biological preparations on the formation of biologized agroecosystems, increasing the productivity of agrophytocenoses, increasing the yield of sugar corn and obtaining environmentally friendly products is shown. Ecologically and economically grounded use of biological preparations in the cultivation of sugar corn.

Key words : *sugar corn, biological preparations, yield, cultivation technologies.*

Formulation of the problem. Currently, anthropogenic pressure on the environment leads to a violation of the integrity of natural complexes, loss of their ecological functions, deterioration of public health, loss of gross national product,

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etc. [1]. Reduction of these losses can be achieved only by increasing the environmental and economic efficiency of production and improving its technological systems. Therefore, the development of both individual economic systems and the economy as a whole should be based on the conditions of optimization of ecological and economic relations in the interaction of production and the environment.

In the economic literature, the concept has become widespread, according to which the improvement of product quality, as a rule, requires increased costs for its production, and the economic effect of improving product quality is obtained in the field of consumption [2]. The producer of environmentally environmentally friendly and biologically valuable agricultural products, deciding on the feasibility of using a particular tools of production is guided primarily by economic interest - whether this tool will be able to provide a higher level of economic efficiency compared to others. Widespread use of biological factors in the intensification of agricultural production has not only environmental but in most cases economic priority. Protecting plants from diseases caused by various pathogenic microorganisms is an economically and socially important issue; Losses in crop production account for 20% of the harvest in different parts of the world. The use of chemical pesticides is the main method of plant protection. However, chemicals have a number of serious drawbacks. Pesticides pose a serious threat to the soil environment and human health, as their derivatives remain in the soil system for a long period of time and have a negative impact on biological objects, their diversity and composition. This leads to a decrease in soil fertility and further crop failure.

The effectiveness of the effect of bacterization of seeds by microbial preparations on increasing crop yields has been proven and is beyond doubt. But the vegetation period of plants is long, and some factors (drought, pathogens, lack

of water and nutrients, etc.) disrupt the physiological balance of plants, which inevitably affects the yield and product quality [3]. A well-studied and stable alternative to improve plant growth and soil fertility is the use of plant growth-promoting bacteria (PGPB), which have functional characteristics that control the growth, development and yield of crops. These plant growth-promoting effects are due to improved availability and biosynthesis of several important macro- and micronutrients, as well as the protection of plants from stressful environmental conditions [4, 5]. In recent years, the positive effect of numerous strains of PGPB on plants has been confirmed by numerous studies, which has led to the commercialization of a large number of microbial inoculants [6, 7].

Plant growth-promoting bacteria (PGPM) is a term applied to all microorganisms (eg bacteria, actinomycetes, fungi and algae) that have a positive effect on plant growth through direct or indirect mechanisms (e.g. mineral nutrition, reduction ethylene, disease suppression) [8]. PGPM plays an important role in sustainable agriculture. They increase the yield of different crops, improve soil fertility, promote diversity and interaction with other beneficial microorganisms, inhibit the growth and infectious action of potential pathogens and generally maintain the stability of systems [9]. However, more stable positive results can be obtained by inoculating plants with microbial consortia containing two or more beneficial microorganisms [10, 11]. Bioinoculants based on microbial consortia may include bacteria of various species, beneficial bacteria and fungi. The use of different types of PGPM with different mechanisms of action provides a wide range of benefits for the plant, including direct stimulation of plant growth and health, as well as increased productivity. In addition, there is a decrease in the harmfulness of pathogens [12, 13]. Pesticides based on microorganisms and their products have proven their high efficiency, species specificity and environmental friendliness, which has led to their implementation in pest control strate-

gies around the world. It is also shown that the role of biologization in crop cultivation technologies becomes more important the more complicated becomes soil -climatic and weather conditions [14, 15].

The purpose of the research was to ground ecologically and economically the use of biological productions in the cultivation of sugar corn (*Zea mays* convar. *saccharata* var. *rugosa*).

Material and Methods. Experimental data were obtained on the basis of field experiments, which studied the technology of growing varieties and hybrids of sugar corn, their sowing and yielding properties depending on the factors of seed treatment with biological and chemical preparations. The experiments were conducted during 2016–2018 at the scientific experimental field of the Skvyrska Research Station of Organic Production of the Institute of Agroecology and Environmental Management of National Academy of Agrarian Sciences of Ukraine (IAP NAAS).

In the experiments there were used maize seeds of the variety of selection of the Skvyrska Research Station of Organic Production of the IAP NAAS and of hybrids of the selection of the LLC "All-Ukrainian Scientific Institute of Breeding (VNIS)". Maize of different maturity groups were represented by the medium-ripe variety Rusalka, the early-ripening hybrid Bagration F_1 and the early-ripening hybrid Barcelona F_1 (Daineris).

The following biological preparations (both from "BioNorma" LLC, Ukraine) were used: biofungicide BioNorma *Pseudomonas* (active substance: bacteria *Pseudomonas fluorescens, Pseudomonas aureofaciens, Pseudomonas putida*; consumption rate for seeds treatment – 0.5 l per 100 kg) and bioinsecticide BioNorma Triomax (active substance: *Beauveriabassianaeko/106, Metarhiziumanisopliae, Bacillusthuringiensiseko/212, Streptomycesavermitilis*; liquid form of the preparation; consumption rate for for seeds treatment – 0.05 l per 100 kg).

Chemicals (both from Syngenta AG) used: fungicide Maxim XL (active substance content: fludioxonil – 25 g/l , metalaxyl-M – 10 g/l; chemical group: phenylpyrroles, phnylamides; form: liquid suspension concentrate; consumption rate for seeds treatment – 0.1 l per 100 kg) and insecticide Cruiser (active substance content: Thiamethoxam – 350 g/l; chemical group: neonicotinoids; active group: thiamethoxam; consumption rate for seeds treatment – 6.0-9.0; 144 ml / 80 thousand of seeds).

The experimental plots were placed according to the generally accepted methods of field experiment (according to B. Dospekhov) [16]. Placement of repeats was carried out by a continuous method, arrangement of variants – by a method of randomized split blocks. The area of the accounting area was 25.2 m^2. Repeatability was threefold. Seed treatment was carried out on the day of sowing. In the experiments it was used a liquid form of biological and chemical preparations for seed treatment. Seeds were sown by manual plant seeder, in a dotted manner, to determine field germination of seeds in each variant. The sowing rate was 7 pieces per 1 meter running, 100,000 per 1 ha, the depth of earnings was 4 cm. During sowing, fertilization was carried out with fertilizer “Diamofoska”, $N_{10}P_{26}K_{26}$.

The scheme of the experiment:

Name of maize variety or hybrid	Variant	№ of experiment / № of repeata-bility
Rusalka	Control	1/1, 8/2, 22/3
	BioNorma Pseudomonas + BioNorma Triomax	2/1, 7/2, 24/3
	Maxim XL + Cruiser	3/1, 9/2, 23/3
Barselona F_1	Control	4/1, 14/2, 21/3
	BioNorma Pseudomonas + BioNorma Triomax	5/1, 12/1, 20/3
	Maxim XL + Cruiser	6/1, 13/2, 19/3
Bagration F_1	Контроль	10/1, 18/2, 26/3
	BioNorma Pseudomonas + BioNorma Triomax	12/1, 16/2, 27/3
	Maxim XL + Cruiser	11/1, 17/2, 25/3

The soil at the experimental plot is low-humus chernozem, coarse-pollen-medium loamy on carbonate loess, typical for the right-bank Forest-Steppe of Ukraine.

Yield and structure of yield of sugar corn were determined by the method of Bondarenko L. and Yakovenko K. (2001) [17]. The economic efficiency of the technology of growing sugar corn was determined by the calculation method on the basis of industry standards and the current tariff grid according to the standards of labor costs in the cultivation of crops according to generally accepted methods.

The obtained research results were processed by methods of descriptive (variational) statistics, variance and factor analysis using MS Excel 10.0 and Statistica 9.0.

Results and discussion. The analysis of quantitative indicators of the harvest,

The impact of the use of chemical and biological preparations on the yield of sugar corn for 2016-2018.

Name of maize variety or hybrid	Variant	Standing density, thousand pieces / ha	Number of cobs, thousand pieces / ha	Yield of cobs, t / ha	Increase to control	
					+/−	%
Rusalka	Control	47	71	0,80		
	BioNorma Pseudomonas + BioNorma Triomax	53	96	0,90	9	11
	Maxim XL + Cruiser	72	129	1,21	40	34
Barselona F_1	Control	50	94	0,84		
	BioNorma Pseudomonas + BioNorma Triomax	58	116	0,98	13	14
	Maxim XL + Cruiser	56	106	0,94	9	11
Bagration F_1	Control	55	111	0,93		
	BioNorma Pseudomonas + BioNorma Triomax	58	116	0,98	4	5
	Maxim XL + Cruiser	66	132	1,11	17	16
$LSD_{.05}$ for both factors		–	–	0,01	–	–

which was collected from the experimental plots, clearly indicates the differences in its formation, depending on the pre-sowing cultivation. The indicators of the minimum and maximum manifestation of these traits indicate their increased diversity.

Pre-sowing inoculation of sugar corn seeds with biological products BioNorma Pseudomonas ＋ BioNorma Triomax had a positive effect on yield increase, provided an increase for corn of Rusalka variety as well as for hybrids compared to the control. For the Rusalka variety the yield increased by 11%, for hybrids Barcelona F_1 and Bagration F_1 – by 14 and 5% respectively.

An important issue in the cultivation of crops is not only the level of their productivity, but also the economic aspects of cultivation technology. After all, the actual efficiency and payback of the applied technological measures, as evidenced by the increased crop yield allows to fully assess the break-even point of this cultivation technology as a whole and recommend it for implementation in production [18, 19]. The purpose of growing sugar corn, like any other crop, in market conditions is to obtain maximum profit from its sale [20]. Sugar corn belongs to the crops with high economic efficiency [21-24]. The selling price of sugar corn is much higher than the price of regular corn, although the cost of its production is not much higher. Thus, the production of this product in the presence of a market can be quite profitable, even in small areas.

Since the indicators of the cost of production and the level of costs for growing sugar corn in some years of research may vary in a certain range, the evaluation of data was carried out on the average of three years of research. Calculations were performed in the prices of 2016-2018.

The economic efficiency of different variants of the experiment with maize hybrids was determined by the actual costs, which are provided by the technologies of growing the studied crop in the North of Ukraine. To assess the economic ef-

ficiency, we used technological maps of crop rotation, taking into account the standards of costs for the implementation of relevant cultivation operations. This allowed to obtain and analyze the main economic indicators, namely the cost of production, net profit and profitability.

The analysis of economic indicators of the studied elements of the technology of growing sugar corn shows a significant impact of pre-sowing treatment on yield, cost, profit and profitability.

Economic efficiency of elements of sugar corn cultivation technology

Name of maize variety or hybrid	Variant	Yield, t / ha	Cost, UAH / ha	Profit, UAH / ha	Profitability, %
Rusalka	Control	0,80	14482	57517	497
	BioNorma Pseudomonas + BioNorma Triomax	0,90	14637	66362	553
	Maxim XL + Cruiser	1,21	15108	93791	721
Barselona F_1	Control	0,84	17534	66166	477
	BioNorma Pseudomonas + BioNorma Triomax	0,98	17622	70578	501
	Maxim XL + Cruiser	0,94	17865	82035	559
Bagration F_1	Control	0,93	17281	58319	437
	BioNorma Pseudomonas + BioNorma Triomax	0,98	17480	70720	505
	Maxim XL + Cruiser	1,11	17548	67052	482

Fluctuations in the level of crop yield from 0.84 to 1.11 t / ha caused a difference in the cost of production per hectare.

When using biological preparations for plant protection BioNorma Pseudomonas + BioNorma Triomax, the cost of growing products was less than the value of yield, resulting in a decrease in unit cost. Under the influence of these factors, profit and profitability have increased significantly. Conditionally net profit increased by 1–1.2 times. Profitability for options with seed treatment with biological preparations BioNorma Pseudomonas + BioNorma Triomax ranged

from 501 to 553%.

Hybrid Barcelona F_1, for the use of biological products provided a net profit of 1 ha at the level of 70,120 UAH.

The cost of 1 ton of product was highest in the hybrid Bagration F_1 with the treatment by chemicals for plant protection Maxim XL + Cruiser and was 17,865 hryvnias, while in the treatment of seeds with biological preparations BioNorma Pseudomonas + BioNorma Triomax – 17,622 hryvnias.

The profitability of the use of preparations for pre-sowing seed treatment is the criterion that determines the economic feasibility or disadvantage of using such technologies [25]. When using drugs for pre-sowing seed treatment, production costs increase slightly.

When calculating the profitability for all variants of the experiment, it was found that the use of biological preparations for plant protection had a higher profitability compared to control variants in 1-1.2 times, which makes their use promising from an economic point of view.

Conclusion. Treatment of sugar corn seeds with biological preparations BioNorma Pseudomonas + BioNorma Triomax, allows to obtain high quality products, increases yields to 0.9-0.98 t / ha. At the same time, the relatively net profit averaged UAH 69,220 / ha at a profitability level of 519.6%.

The use of the studied biological products demonstrates high efficiency in the technology of growing sugar corn, which is achieved by optimizing the cost of production, namely by reducing production costs, as well as by increasing the revenue side, because revenue per 1 ha increases due to higher yields.

Economic evaluation of the results obtained in field experiments using such economic indicators as the level of production costs, the level of profitability shows that even under adverse agricultural conditions, the cultivation of sugar corn is profitable.

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