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**BIOLOGICAL PREPARATIONS FOR PROTECTING PLANTS AND INCREASING  
YIELD OF AGRICULTURAL CROPS.  
BELARUSIAN STATE UNIVERSITY DEVELOPMENTS**

*Information on biological preparations based on living bacterial cells developed at the Research Laboratory of Molecular Genetics and Biotechnology of the Biological Faculty of the Belarusian State University is presented. Preparations Stimul and MaxImmun are made to stimulate plant growth and to protect them from pathogens of bacterial and fungal etiology. Aurin, Bactogen and Gulliver make up a group of biological preparations with a protective effect and ability to stimulate plant growth. At the moment, the only nematicide released for application on the territory of the Republic of Belarus is the biological preparation Nematicid. The microbial fertilizer Zhytsen, which is used to accelerate the decomposition of crop residues and increase the yield of subsequent crops, is also allocated to a separate group.*

*Представлена информация о разработанных в НИЛ молекулярной генетики и биотехнологии биологического факультета Белорусского государственного университета биологических препаратах на основе живых клеток бактерий. Препараты Стимул и МаксИммун предназначены для стимуляции роста растений и способны защищать их от возбудителей заболеваний бактериальной и грибной этиологии. Группу биопрепаратов защитного действия со способностью стимулировать рост растений составляют Аурин, Бактоген и Гулливер. В настоящий момент единственным разрешенным к применению на территории Республики Беларусь нематодицидом является биологический препарат Немацид. В отдельную группу также выделено микробное удобрение Жыцень, применяемое для ускорения разложения пожнивных остатков и повышения урожайности последующих культур.*

**Keywords:** antagonistic bacteria; rhizospheric bacteria; biological preparations; plant protection.

**Ключевые слова:** бактерии-антагонисты; ризосферные бактерии; биологические препараты; защита растений.

The United Nations has declared 2020 the International Year of Plant Health. The aim of the International Year of Plant Health is to invite world's attention to plant health, because it helps to eliminate hunger, reduce poverty, protect the environment, and promote economic development.

The Food and Agriculture Organization of the United Nations (FAO) estimates that up to 40 percent of food crops are lost annually to plant pests and diseases. Plant health is in great danger. Whole ecosystems are changing under the influence of such negative factors as climate change and human activity. Biodiversity is changing, pests are proliferating, the world is becoming more mobile: international transport, travel and trade have tripled in recent decades, facilitating the spread of diseases and pests.

This is the reason why plant health work under the International Plant Protection Convention (IPPC) is so important. The International Year of Plant Health is expected to bring plant health and protection to the forefront, raise public awareness of the importance of global plant health and prevent the spread of pests that cause huge economic losses and environmental damage that negatively impact the standard of living and even the fate of entire nations.

To successfully combat pests and plant diseases, a whole range of measures is required, including agrotechnical, physical and mechanical, biological and chemical means and techniques. Biopesticides are a key component of such comprehensive pathogen control programs, drawing the attention of organic producers as a viable alternative to synthetic crop protection chemicals.

Compared to chemical pesticides, preparations based on live bacterial cultures have a number of advantages: they are multifunctional (effective against a wide range of phytopathogens and nematodes, can stimulate plant growth and improve their mineral nutrition); they are environmentally safe, since the antagonist bacteria, that are part of the preparations, are natural inhabitants of the rhizosphere and phyllosphere of plants and do not change the composition of agrobiocenoses; harmless to humans, animals and plants; have a prolonged effect, since the microorganisms that make up the biological preparations are able to populate the rhizo- and phyllosphere of plants; do not cause addiction to phytopathogens; do not have a waiting period.

In modern agricultural practice, preference is given to biopreparations for multifunctional purposes, with protective effect and ability to stimulate plant growth, increase their immunity and productivity. Microbiological preparations developed at the Research Laboratory of Molecular Genetics and Biotechnology of the Biological Faculty of the Belarusian State University have all of the above requirements. The list of environmentally friendly preparations includes: Aurin, Nemacid, Zhytsen, Stimul, Baktogen, MaxImmun and Gulliver (Fig.). The producer of the first three of these bioproducts is LLC "Center of Innovative Technologies", the other four - JSC "Bobruisk Plant of Biotechnologies". All preparations have certificates of state registration and are included in the State Register of Plant Protection Products and Fertilizers Permitted for Use in the Republic of Belarus. Our developments are focused on both biological farming and chemical load reduction with integrated farming methods. Application of this products allows you to get a plentiful, high-quality and environmentally friendly harvest.

Aurin, Bactogen and Gulliver make up a group of biological products with protective and stimulating effects for plant growth. Preparations Stimul and MaxImmun are created to stimulate plant growth and to protect them from pathogens of bacterial and fungal etiology. At the moment, the only nematicide released for application on the territory of the Republic of Belarus is the biological preparation Nemacid, developed by specialists of the Belarusian State University in 2009. The microbial fertilizer Zhytsen, which is used to accelerate the decomposition of crop residues and increase the yield of subsequent crops, is also allocated to a separate group.

The biological product Aurin is based on the bacteria *Pseudomonas aurantiaca* B-162/498, the overproducers of phenazine antibiotics. Aurin made to combat pathogens (root rot of agricultural plants, leaf blight, powdery mildew, gray and white rot, leaf mould, downy mildew) and to stimulate crops growth. In addition, the application of Aurin can increase the yield of tomatoes and cucumbers by 26.6 %. Growing vegetables in greenhouses should be accompanied by a decrease in material costs with a guaranteed high and high-quality harvest. The low-volume technology system meets these requirements. Experiments to assess the effectiveness of the biological preparation Aurin in protecting cucumber plants from gray and main rot on mineral wool using low-volume hydroponics are held. It has been established that the new method of using the biopreparatoin Aurin provides high biological efficiency in relation to the surrounding rot (71 %), exceeding effect of biological preparation protecting cucumber plants cultivated in soil conditions (biological - 50.0 %).

Microbiological preparation Bactogen is a suspension of cells of the bacterium *Bacillus subtilis* and their metabolic products. Bactogen is registered for use on tomatoes against bacteriosis, black leg, gray mold, leaf mould, powdery mildew; on cucumbers against root rot, black stem, downy mildew, powdery mildew; on cabbage against vascular and mucous bacteriosis, leaf mould. It has been established that the treatment of vegetable crops during the growing season with the biological preparation Bactogen will increase the yield of cucumber by 20%, tomatoes - by 23.4 %, and cabbage - by 9.7 %.



Biological preparations - developments of the Research Laboratory of Molecular Genetics and Biotechnology of the Biological Faculty of the Belarusian State University

The complex preparation Gulliver is based on the bacteria *P. aureofaciens* A 8-6 and peat hydrohumate. This preparation is registered to treat on potatoes, cabbage, cucumber and tomato. It is shown that the biological preparation Gulliver has growth-regulating, fungistatic and economic efficiency. The application of Gulliver made it possible to increase the yield of potato by 6.5 %; cabbage by 12.4 %; tomato by 15.5 %, cucumber by 10.7 %.

Stimul based on the rhizosphere bacteria *Pseudomonas fluorescens* S-32 is intended to stimulate the growth and development of tomato and cucumber plants, as well as fiber flax. It has been established that biopreparation Stimul application on tomato plants provides an increase in yield of 27.4 %, and on cucumber plants - 16.1 %. Stimul is the only biological preparation released for use on the territory of the Republic of Belarus to stimulate fiber flax growth. Stimul application

contributes to an increase in the dryness (characteristic of the technological value of flax-straw) of fiber flax by 8 %, which increases the yield of long fiber; there was also a significant increase in the yield of flax straw +16.5 % and seeds +59.7 %. Analysis of the yield structure indicates that double spraying of fiber flax plants with Stimul with a consumption rate of 3 l / ha increased the quality of seed material: the weight of 1000 seeds increased by 18.2 % compared to the option without Stimul and by 10.6 % compared to the reference.

The active agents of the biopreparation MaxImmun are inactivated rhizosphere bacteria *Pseudomonas chlororaphis* subsp. *aurantiaca* 162 and *Bacillus subtilis* 494 and their secondary metabolites. The biological preparation MaxImmun is included in the State Register of Plant Protection Products and Fertilizers, released for use in the territory of the Republic of Belarus in plant growth regulators section, but it is an elicitor preparation by the mechanism of its action. The elicitor interacts with the receptors of plant cells, triggering a cascade of biochemical reactions, designed to prevent the entry of infection into the plant, slow down the spread of phytopathogens throughout the plant organism, and ensure the survival of plants in adverse conditions. Processing onion with MaxImmun, the yield increase reaches 55.5 %; in addition, the biological effectiveness of this preparation protecting onion against downy mildew is 56.0-71.4 %.

Leading producers of agricultural chemicals (such as BASF) see a growing market demand for nematode control, as the application of available chemicals is gradually being phased out for various reasons, including habituation of nematodes to active chemical compounds, as well as after expiration actions or their cancellation. BASF estimates annual losses from nematodes at \$ 10 billion globally. The unique preparation Nemacid, created at the Belarusian State University, based on the bacteria *P. putida* U and designed to suppress gall nematodes in tomatoes and cucumbers in protected ground. The results of the experiments showed a high biological and economic efficiency of the biological nematicide Nemacid: the consistent application of this preparation reduces the meloidjgynosis damages for tomatoes by 45.4 %, for cucumbers by 54.8 %, it makes it possible to obtain an additional 43.8 % production of tomato and 41.5 % of cucumbers. Nemacid application inhibited the development of meloidogynosis during the entire growing season of plants, and significantly increase the yield.

Zhytsen is a mixture of living cell cultures of natural cellulolytic strains *Pseudomonas* sp.-11 and *Bacillus* sp.-49 and is intended to accelerate the decomposition of crop residues in the fields, improve the soil and increase the yield of subsequent crops. It was found that application of complex microbial preparation Zhytsen (3 l / ha) made it possible to reduce the number of phytopathogenic strains in soil samples from 5 (titer  $2.0 \times 10^6$  CFU / g soil) to 1 pc. (titer  $3.50 \times 10^3$  CFU / g soil). In a field experiment, the effect of the complex microbial preparation Zhytsen on the decomposition of plant residues of sunflower was estimated indirectly through the yield of the subsequent agricultural crop (barley). Zhytsen treatment at a dose of 3 l / ha had a positive effect on the formation of the barley yield, providing a significant increase in grain (21 %). Application of Zhytsen made it possible to achieve the best indicators of grain quality: the collection of crude protein, fodder and fodder protein units reached the highest indicators - 356.7 kg / ha, 42.7 and 46.5 c / ha, respectively. In addition, 75.9 kg / ha of crude protein, 8.1 c / ha of feed units and 8.2 c / ha of feed protein units were obtained.

Currently, the Research Laboratory of Molecular Genetics and Biotechnology of the Biological Faculty of the Belarusian State University is studying the ability of bacteria and their metabolic products to stimulate root formation and root system growth in plants.