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**КОМПЛЕКСНЫЕ БИОПРЕПАРАТЫ В СЕЛЬСКОМ ХОЗЯЙСТВЕ  
КАК ФАКТОР СОХРАНЕНИЯ И УКРЕПЛЕНИЯ ЗДОРОВЬЯ ЧЕЛОВЕКА**

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**COMPLEX BIOPREPARATION IN AGRICULTURE AS A FACTOR  
OF HUMAN HEALTH PRESERVATION AND PROMOTION**

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**Резюме.** Переход к органическому земледелию рассматривается как путь, обеспечивающий экологизацию окружающей среды и фактор, способствующий сохранению и укреплению здоровья человека. В статье представлены результаты исследования влияния комплексных биопрепаратов на активизацию ростостимулирующих, защитных и иммуномодулирующих свойств растений.

**Ключевые слова:** здоровье человека, экология, органическое земледелие, биопрепараты.

**Resume.** The transition to organic farming is considered as the way ensuring the environment greening and the factor contributing to the human health preservation and strengthening. The article presents the study results of the complex biological products effect on the activation of growth-stimulating, protective and immunomodulatory plants properties.

**Keywords:** human health, ecology, organic farming, biopreparations.

**Relevance.** One of the sustainable development goal of the Republic of Belarus is “Good health and well-being” (No. 3, p. 3.9): by 2030, significantly reduce the deaths and illnesses number as the exposure result to hazardous chemicals and air, water and soil pollution and poisoning. So the Republic economic development strategic objectives include the gradual transition to a “green economy”, the key component of which is the organic agriculture development. Giving the phytopathogenic load current level on agrobiocenoses, the agricultural production efficiency is improved by increasing the chemicals dose used and the treatments multiplicity. This leads to the human health and environmental situation deterioration. The biopreparations use based on microorganisms cultures, which are safe for human health and environmentally friendly, is becoming relevant.

**Aim:** is to develop new complex biological products as the preserving and strengthening human health means and to study their growth-stimulating, protective and immunomodulatory properties that increase plant productivity.

**Objectives:**

1. To develop new complex biopreparations based on the biopreparations Bactogen and MaxImmun.

2. To prove the developed biopreparations effectiveness based on their growth-promoting, protective and immunomodulating properties study.

3. To develop the complex biopreparations practical use recommendations in agriculture as the greening environment and human health preserving mean.

**Material and methods.** The study plan included the following steps:  
culture media preparation, containers for cultivation and equipment;  
plants sowing seeds;  
watercress and rapeseed germination in the dark;  
complex biopreparations samples preparation;  
seedlings cultivation;  
plants treatment in accordance with the developed options;  
rapeseed plants treatment with *Alternaria brassicicola*'s spores;  
the plants morphological parameters assessment;  
the complex biopreparations growth-promoting, antagonistic and immunomodulating properties evaluation;

the results analysis using the mathematical statistics methods and the most effective complex biopreparations determination;

practical recommendations development on the complex biopreparations use as a means of the plants systemic resistance growth stimulation, protection and induction.

Watercress (*Lepidium sativum* L.) varieties "Zvychainy" and rape plants (*Brassica napus*) varieties "Zorny" have been the objects under study. We have modeled 6 complex biopreparations variants based on the biopreparation Bactogen (B) and MaxImmune (MI) growth regulator using coniferous extract and minor nutrient complex according to the scheme: "biopreparation + coniferous extract (CE)", "biopreparation + minor nutrient complex (MNC)" and "biopreparation + coniferous extract + minor nutrient complex".

The experiment scheme is shown on the Figure 1.

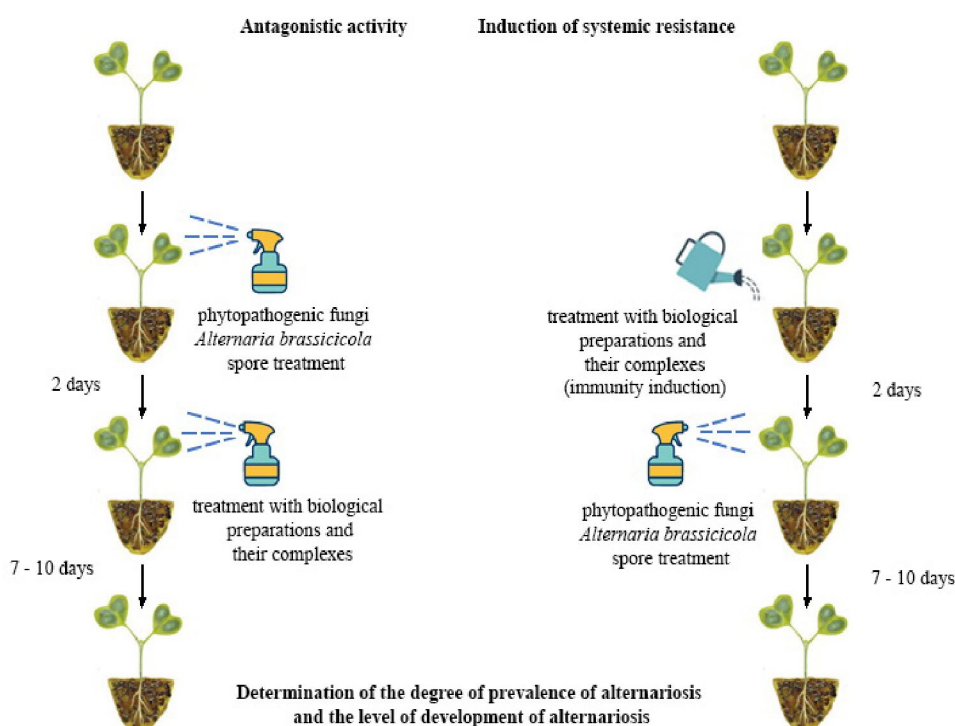


Fig. 1 – The scheme of the experiment

**Results and its discussion.** In the study course, 11 treatment variants with complex biopreparations were tested. To identify the most effective biopreparations complexes, we compared different treatment options by the Students' T-test using.

The complexes "B + CE"; "MI + CE"; "B + MNC" and "MI + MNC" are the most effective. Obviously, the synergistic effect is observed. Using the complex which includes 3 components leads to leveling the synergistic effect. Statistically significant differences have been revealed only in the cases shown on the table 1.

**Table 1.** Information about the average values and their errors in the watercress plants measured parameters.

Processing option	The average value and standard error of the mean			
	seedling length, mm	root length, mm	Wet weight of 10 seedling, mg	Dry weight of 10 seedling, mg
Control	4,96±2,55	23,38±2,23	288,09±6,66	13,13±0,59
Bactogen (B)	54,86±2,54*	27,09±2,5*	323,8±6,86*	15,2±0,62*
MaxImmun (MI)	61,09±3,19*	29,72±2,35*	364,14±9,25*	16,6±1,12*
Caniferous extract (CE)	47,98±2,39*	23,01±2,125	290,61±7,79	13,84±0,44*
Minor nutrient complex (MNC)	49,28±2,69*	24,04±2,28	294,2±7,00	13,86±0,69*
B + CE	56,53±2,63*	27,84±2,61*	373,19±8,51*	17,93±1,08*
B + MNC	58,2±2,24*	28,26±2,46*	343,78±5,57*	16,75±0,93*
B + CE + MNC	54,4±3,37*	26,22±2,27*	325,35±7,08*	15,95±0,3*
MI + CE	63,3±3,16*	31,99±2,6*	405,94±12,27*	19,21±1,33*
MI + MNC	64,43±2,85*	32,66±2,91*	375,59±7,29*	17,99±0,52*
MI + CE + MNC	61,75±2,34*	30,27±2,4*	364,83±7,62*	17,71±0,27*

\* - statistically significant differences compared with control when  $p < 0,05$

We have used the Pearson correlation coefficient. Between the indicators "wet weight - dry weight" there is the connection different degree. We have hypothesized that a low degree means the water accumulation by the plant without a significant increase in biomass. The correlation high level means plant biomass increasing, which is one of the productivity indicators in green crops.

The biopreparations can make protective or immunomodulating effects. We simulated the second experiment to demonstrate these properties. The 1-st option included the plants artificial infection and then the plants treatment with biopreparations to estimate their protective properties. The 2-nd option included the plants treatment with biopreparations to induce immunity, followed by artificial infection with the alternariosis pathogen. The analysis criteria were: 1) the disease spreading degree; 2) the disease development degree. According to the results, the complex "B + CE" was the most effective for the disease spread and development reducing. In the experiment with the immunity induction, the most effective was complex "MI + CE".

Recommendations for their practical use have been developed.

### **Conclusions:**

1. We have developed and tested 6 complex biopreparations variants based on the Bactogen and MaxImmune biopreparations, coniferous extract and minor-nutrient complex.

2. We have obtained the results, characterizing the developed complex biopreparations growth-stimulating, antagonistic and immunomodulatory effects. This may be the basis for the new complex biopreparations creation with the biofungicide and plant growth regulator properties with the immunomodulator functions.

3. The data obtained in the study course expand the using biopreparations possibility idea as the increasing plant productivity means based on their growth stimulating, developing protective properties and inducing systemic resistance, as well as the factor in reducing the phytopathogenic load on agrobiocenoses. Biopreparations have the following properties: environmentally friendly; non-pathogenic and non-toxic to humans and animals; do not have mutagenic and oncogenic activities. The developed biopreparations use will reduce the residual pesticides level in the final product (food), that will ensure the human health preservation and strengthening.

### **Literature**

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