Economic efficiency of biological preparation application in protected ground vegetable growing

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Abstract. The paper describes the characteristics of biologic preparations and their application in protected ground conditions. In the course of the work, it was revealed that at present, vegetables are becoming more and more popular on the market, the use of chemicals in their cultivation is limited. As a result of the experiment, the effectiveness of the use of biologic preparation Alirin-B and Gairn against diseases of protected soil cucumber and tomato was studied. The effectiveness of chemical and biological protection systems was compared, and the economic effect of their use was calculated.

1. Introduction

The modern approach to the production of protected soil vegetable products is based on the use of phytosanitary technologies aimed at reducing the pesticide load and minimizing the negative consequences of the use of chemical plant protection products [6,7,9,13,14]. Along with agricultural and technical measures, the stability of varieties and hybrids, an important component of phytosanitary technologies is the use of biological preparations that provide effective and safe plant protection [2,3,4,10,12]. Research on the identification of bioagents and the creation of effective biological preparation is actively conducted in many countries [19,20,21,23,25], technologies for their use on various protected soil crops are being developed[15,16,17,18,22,24,26].

Protected soil conditions are favorable for the development of pathogens. Spores of pathogens are transferred by air, with irrigation water, on the clothes of workers, with containers and tools. Drop liquid moisture on the film and surface of the leaves contributes to their germination and rapid spread of diseases during the growing season of plants. The development of plant diseases increases as a result of reducing the stress resistance of plants in conditions of insufficient light, sharp changes in day and night temperatures in greenhouses, high humidity, etc., which reduces the yield of standard products, worsens its quality, and reduces the fruiting period by 1-1.5 months. With a high infectious background and weak organization of protective measures, crop losses can reach 50% or more [1,4,5].

Chemical treatments cause the occurrence of resistant forms of pathogens, worsens working conditions in the greenhouse, and can have a negative impact on plants and product quality. In this regard, biological plant protection products (BPPP) occupy an increasingly important place in greenhouse technologies. According to the FSBI “Rosselkhoznadzor” there has been a steady growth in the use of BPPP both in greenhouses and in farms recently. Currently, the List of drugs approved for use in Russia includes more than 50 biological preparations, the use of which can significantly reduce the volume of chemical treatments, provides an environmentally friendly vegetable production. Biological preparations are not phytotoxic, do not harm pollinating insects and entomophages in the...
greenhouse, and do not affect the timing of harvest. Proper use of biological preparations reduces the development of diseases, reduces the cost of production and increases productivity and product quality.

2. Materials and methods
We studied the protective effect of biological preparations against the main diseases of protected soil cucumber and tomato. The research was conducted in 2017-2018 in film greenhouses on the basis of ARSRI - a branch of FSBSI FSCVG (Moscow region) using standard methods [8]. In the experiments, we used microbiological preparations Alirin-B and Gamair based on Bacillus subtilis strains (produced by AgroBioTechnology Group of Companies). These drugs are characterized by high activity against phytopathogenic fungi; do not have a negative impact on the environment. They are safe from environmental, toxicological and sanitary points of view, harmless to humans, warm-blooded animals, birds, fish, bees and other useful insects. The preparations have the necessary technological properties – they completely dissolve in water and do not clog the injectors. Dry preparation forms have a long shelf life (3 years from the date of manufacture at a temperature of -30° up to + 30°C), reliable, cost-saving and easy to use. Biological preparations were applied by 3-fold filling under the root and by 2-fold spraying of plants with an interval of 15-20 days at a rate of 60 g/ha. The flow rate of the working fluid is 1000-3000 l/ha. Accounting for the development of diseases was carried out according to the standard method [11].

Topaz (consumption rate 0.3 l/ha), Quadris (consumption rate 0.5 l/ha), Previcur Energy (consumption rate 0.3 l/ha), widely used for protecting cucumbers and tomatoes from diseases, were used as a reference.

3. Results
On cucumber, the main diseases during the growing season were root rot (pathogens Fusarium sp, Pythium debaryanum, Rhizoctonia solani) and powdery mildew (pathogen Oidium erysioides) on tomato – trachemycosis wilt (pathogen Fusarium oxysporum f. sp. lycopersici) and solanaceae buck eye rot (pathogen Phytophthora infestans).

The use of BPPP reduced the level of development of diseases of vegetable crops and increased their productivity. The biological effectiveness of treatments against leaf diseases was 49.2-63.9%, against root rot - 54.2-95.5%. To the greatest extent, biological preparation limited the development of diseases in the initial period. In the second half of the growing season, as the plants aged and the infectious background in the greenhouse increased, the effectiveness of biological preparations decreased. The same tendency to decrease the effectiveness of fungicides was observed in the variants of the experiment with the use of chemical means of protection. Evaluation of the economic efficiency of biological preparations in the experiment on vegetable crops showed a significant increase in fruit yield as a result of plant treatments. The value of the stored crop was 15.3-19.4% of the control.

To calculate the economic efficiency of the use of biological preparations against diseases of vegetable crops, the following indicators were used: the cost of biological preparation Alirin-B and Gamair 3500 rubles/kg, the cost of the chemical drug Previcur Energy - 4132 rubles/l, Topaz - 4880 rubles/l, Quadris - 6250 rubles/l. The sale price of cucumber with a chemical protection system is 50 rubles/kg, with a biological one – 55 rubles/kg. The price of selling tomatoes with a chemical protection system is 100 rubles/kg, with a biological one – 110 rubles/kg. The calculation results are presented in tables 1 and 2.

It is found that the use of biological preparations against diseases of protected soil vegetable crops is cost-effective. On cucumber culture, the economic effect of the use of biological preparation Alirin-B and Gamair was 748950 rubles/ha and 773950 rubles/ha, respectively, and was not inferior to this indicator on the variant of the experiment with the use of chemicals Previcur Energy and Topaz, where the economic effect was 748129 rubles/ha. On tomato culture, the greatest economic effect was observed on the variant with the use of the biological preparation Alirin-B (1298950 rubles/ha). The results obtained allow concluding that the biologized system of protection of vegetable crops from
diseases is not inferior in efficiency to chemical protection and at the same time provides the production of environmentally friendly products.

**Table 1.** Economic efficiency of application of biological preparations against diseases of protected soil cucumber (Podarok F₁ hybrid).

| Indicator                                      | Control - without treatment | Previkur Energy, 0.3 l/ha, 2-fold+Topaz, 0.3 l/ha (3-fold) – reference | Alirin-B, 60 g/ha 5-fold | Gamair, 60 g/ha 5-fold |
|------------------------------------------------|----------------------------|------------------------------------------------------------------------|--------------------------|------------------------|
| Output of standard products, kg/ha             | 98000                      | 117000                                                                 | 115000                   | 115500                 |
| Increase to control, kg/ha                     | -                          | 19000                                                                  | 17000                    | 17500                  |
| Cost of additional products, rubles/ha         | -                          | 104500                                                                 | 1020000                  | 1050000                |
| Costs for processing, collecting and selling additional products, rubles/ha | -                          | 296871                                                                 | 271050                   | 276050                 |
| Economic effect, rubles/ha                     | 748129                     | 748950                                                                 | 773950                   |                        |

**Table 2.** Economic efficiency of application of biological preparations against diseases of protected soil tomato (Ostrovok F₁ hybrid).

| Indicator                                      | Control - without treatment | Previkur Energy, 0.3 l/ha, 3-fold+Quadris, 0.3 l/ha(2-fold) – reference | Alirin-B, 60 g/ha 5-fold | Gamair, 60 g/ha 5-fold |
|------------------------------------------------|----------------------------|------------------------------------------------------------------------|--------------------------|------------------------|
| Output of standard products, kg/ha             | 87500                      | 102700                                                                 | 101500                   | 100600                 |
| Increase to control, kg/ha                     | -                          | 15200                                                                  | 14000                    | 131000                 |
| Cost of additional products, rubles/ha         | -                          | 1520000                                                                | 1540000                  | 1440000                |
| Costs for processing, collecting and selling additional products, rubles/ha | -                          | 259469                                                                 | 241050                   | 232050                 |
| Economic effect, rubles/ha                     | 1260531                    | 1298950                                                                | 1207000                  |                        |

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