Economic efficiency of biological protection of cucumber from root rot in a closed ground

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Abstract: The article presents an analysis of the world and Russian production of cucumbers, as one of the most common vegetable crops in many countries, open and closed ground. Among the vegetable crops grown in protected soil, the most profitable is cucumber. The share of each district in the gross harvest of cucumbers closed in Russia is calculated, and the regions with the maximum absolute index are listed. The volume of imports to Russia is shown in terms of value and in kind, indicating the key supplier countries. In recent years, more and more demand in the market is becoming environmentally friendly vegetable products, the cultivation of which is widely used biological remedies. To obtain environmentally friendly products, it is necessary to use plant protection systems based on the use of biological plant protection products and growth regulators, which increase the disease resistance of plants in adverse conditions. To analyze the effectiveness of such means, in the course of research, the effect of the drug Gliocladiun in combination with the growth regulator Zircon against the root rot was studied. On the basis of the obtained data, the economic effect of their use in the conditions of film greenhouses is calculated.

1. Introduction
Cucumber is one of the most common vegetable crops in many countries, the world production of which reached 83.8 million tons in 2017. Russia’s share in world production is not yet large and it is 2.5% [4]. In Russia, the gross yield of cucumbers is close to 2 million tons, including the gross yield in protected soil amounted to 0.9 million tons (in 2017). To the level of 2016, the increase in gross yield amounted to 47.7 thousand tons (5.6%). More than 75% of greenhouse cucumbers are grown in the Volga, Central, South and Siberian districts (Fig. 1).
Fig. 1. Gross yield of greenhouse cucumbers in Russia, thousand tons.

In 2017, among the subjects of the federation, the following regions with the maximum collection of greenhouse cucumbers are highlighted (in thousand tons): Republic of Bashkortostan (68.9), Krasnodar Region (63.1), Republic of Tatarstan (53.1), Republic of Crimea (44.3), Moscow region (38.8), Lipetsk Region (32.4), Leningrad region (28.0), Volgograd region (27.3), Perm region (25.4), Belgorod region (22.1), Saratov region (19.9), Nizhny Novgorod region (18.8), Novgorod region (18.5), Stavropol region (16.7), Udmurt Republic (14.1), Rostov region (14.0), Republic of Mordovia (13.4), Vladimir region (11.1), Samara Region (10.9), and Yaroslavl region (10.7).

Currently, cucumber is the most common and profitable crop among greenhouse vegetable crops. The dynamics of its production remains positive, but so far insufficient to provide the population according to WHO-recommended increased standards of vegetable consumption and reduce inter-regional imbalances.

The lack of domestically produced vegetables, including cucumbers, is partially compensated by imports, which amounted to 107.3 thousand tons in the amount of $ 118 million, which is 2% more in weight and less than 5% in value to the level of 2016. In 2017, the main suppliers of cucumbers to Russia were Iran, China, Azerbaijan, Turkey, Georgia, Serbia, Morocco. It should be noted that the imported greenhouse vegetables, including cucumbers, are grown using significant quantities of agrochemicals and plant protection products, many of which are not registered in Russia. To reduce crop losses from diseases and pests, cucumber plants are repeatedly treated with pesticides (10–12 treatments per crop turnover), which reduces their nutritional value, but allows one to transport these perishable products over long distances and extend shelf life.

To obtain environmentally friendly products, plant protection systems based on the use of biological plant protection products and growth regulators increasing the disease resistance of plants in adverse conditions are important.

2. Materials and Methods
In experiments on a protected cucumber culture conducted at the All-Russian Research Institute of Vegetable Growing – a Branch of the Federal Research Center for Vegetable Growing (Moscow region, Ramensky district), the effectiveness of using the microbiological drug *Gliocladin* (d.v. *trichoderma harziannum*) in combination with growth regulators *Zircon* (d.v. *hydroxycinnamic acid*...
0.1 g/l) against the root rot of cucumber studied. The work was carried out in a film greenhouse with the use of *Parthenocarpic F1 Forsazh* hybrid. *Glyocladin* was applied by watering under the root three times as follows: when transplanting seedlings and then with an interval of two weeks. The drug consumption was 60 g/ha, consumption of the working solution was 1000 l/ha. The treatment of plants with *Zircon* was carried out three times as follows: the first treatment was carried out in the phase of 2–4 true leaves, the second treatment was carried out in the budding phase, the third was carried out after 14 days. The drug consumption was 30 ml/ha, consumption of the working solution was 1000 l/ha. Our control is water, the standard is *Previkur Energy, VC* (watering was carried out at the root 3 times as follows: after transplanting the seedlings and then with an interval of 2 weeks). The consumption of the drug was 3 l/ha, the flow rate of the working fluid was 2000 l/ha. The repetition of the experiment was 4 times. The area of the accounting plot was 5 m². Standard methods adopted in greenhouse vegetable farming were used in the formulation of experiments and data processing [1], [2], [3].

### 3. Results and Discussion

As studies have shown, the processing of *Glyocladin* in combination with *Zircon* reduced the root rot’s prevalence next to cucumber plants in the greenhouse by 78.2%. Acceleration of the timing of mass flowering on average by 3 days compared with the control, the timing of mass ripening of the fruits - by 4-5 days was noted under the influence of treatments. By stimulating the growth and development of cucumber plants and reducing the prevalence of root rot, the yield of early production increased in the greenhouse, and the total yield increased by 1.5 kg/m² (19.2% of the control).

To calculate the economic efficiency of using *Glyocladin* in combination with *Zircon* against the root rot of a cucumber, the following indicators were used: the cost of the *Glyocladin* biopreparation – 2,080 rubles/kg; costs of the growth regulator *Zircon* – 5,760 rubles/l; costs of the *Previkur Energy* chemical drug – 4,132 rubles/l; s selling price of a cucumber with a chemical protection system – 50 rubles/kg, with a biological one – 60 rubles/kg. The results of calculations are presented in Table 1.

**Table 1. Economic efficiency of using the biological product *Glyocladin* in combination with the growth regulator *Zircon* against the root rot in cucumber plants.**

| Indicator                                | Control, without treatment | *Previkur Energy, 300 ml/ha, three times (standard)* | *Glyocladin, 60 g/ha + Zircon, 30 ml/ha, three times* |
|------------------------------------------|----------------------------|-----------------------------------------------------|-----------------------------------------------------|
| Output of standard products, kg/ha       | 78,000                     | 96,000                                              | 93,000                                              |
| Gain to control, kg/ha                   | -                          | 18,000                                              | 15,000                                              |
| Cost of additional products, rubles/ha   | -                          | 900,000                                             | 900,000                                             |
| The cost of drugs, processing, collection, and sale of additional products, rubles/ha | -                          | 237,188                                             | 210,893                                             |
| Economic effect, rubles/ha               | -                          | 612,812                                             | 689,107                                             |

As follows from the data presented in Table 2, using the biological product *Glyocladin* in combination with the growth regulator *Zircon* against the root rot for cucumber plants is cost-effective. The economic effect amounted to 689,107 rubles/ha. In the experiment, using the drug *Previkur Energy*, the economic effect amounted to 612 & 812 rubles/ha. The results obtained allow us to conclude that the biological system of protecting cucumbers is not inferior in terms of chemical protection effectiveness. At the same time, it ensures the production of environmentally friendly products.

### References

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