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Research on Botrytis cinerea-caused gray rot disease in strawberries with Carpathian genus bees and entomovector technology

Gray rot is a widespread disease that is harming a lot of cultivated plants worldwide. It seriously impairs the strawberry industry's profitability by causing harm to the crop both during and after harvest. The article describes how biocontrol tests were conducted against the gray rot disease that affects strawberry plants, with the use of entomovector technology that uses biopreparations and bees. As a consequence of the study of the disease of gray rot of strawberries caused by the fungus *Botritis cinerea* with entomovector technology, the fight against the disease is carried out. Carpathian genus pollinating bees are employed as an entomovector agent during the investigation. They are members of a widely distributed bee order, and before this study, there was ample evidence that they boost production through plant pollination. The pathogen *Gliocladium catenulatum*, which is the basis for the medicine *Prestop-Mix*, as well as *Trichoderma asperellum Botrytis cinerea* identified from local soil, are suppressed by the drug as a biopreparation, according to research using entomovector technology. The article presents the results of a study of the disease of gray rot in experimental areas of strawberry fields in the Eastern region, caused by the fungus *Botritis cinerea*, using entomovector technology. By comparing the results with control options, it was determined that using Carpathian bees to apply biofungicide is one of the most efficient ways to combat gray rot damage to strawberry plants. Dispensers were placed in specially designed apiaries. During an investigation into the battle against Gray rot disease in Symphony strawberries cultivated in dedicated research areas, the impact of fruit weight following pollination as well as the effect of both pollination and the biocontrol agent on overall weight were discovered. Both the quantity of strawberry blooms and fruit production are rising. The study's findings demonstrated that one of the best strategies for preventing gray rot damage to strawberry plants is to employ biofungicide in conjunction with Carpathian genus bees. However, weather conditions will directly affect how successful control efforts are.

Keywords: gray rot, Carpathian wasp, trichodermin, entomovector technology, biopreparation, lesion, biocompatibility agent.

Introduction

In addition to harming fruit and berry plants by decreasing their output, phytopathogenic organisms also result in financial losses. The issue is not entirely resolved by the chemical preparations used today to combat phytopathogens. As of right now, the Environmental Protection Organization states that the efficacy of biological plant management has been demonstrated. Living microorganism-antagonists or their biomass are used to make biopreparations. When used in large quantities, they can be a good substitute for chemical preparations and guard against pesticide pollution of the environment [1].

This makes the research of efficient pest control techniques for outdoor settings and vacation homes increasingly pertinent.

Entomovector technology appeared relatively recently. The term «Entomovecor technology» was introduced in 2007 by Finnish scientists Hokannen and Mentzler-Hokkanen [2].

Using a vector, entomovector technique transfers a biopreparation to a biocontrol plant. For instance, when bees come into touch with a material containing a spore of a biocontrol agent at the tip and entrance from the hive, a biopreparation is attached to the body of the bee like pollen grains. They sufficiently transport biopreparations to the blooms. Even in this short time, this technology has had positive outcomes. While entomovecor technology works well, more research into the specific circumstances, local environment, and other variables is necessary.

First, there are instances of honey-collecting bees acting as carriers of a biocontrol chemical. It has been demonstrated that the frequency with which bees fly to plants affects how well the circumstances for preventing plant diseases in open soil work.

As an excellent illustration, let's consider the following: the infection with the fungus *Botritis cinerea* in raspberries reached 68–90 %, the disease caused by *Monilinia vacciniicorymbosi* in blackberry plants dropped from 21–67 % to 7–44 % when transferred to the biopreparation *Bacillus subtilis,* and the infection with *Sclerotinia sclerotiorum* in sunflowers fully recovered after 31 days when carrying the *Trichoderma* species with a vector [3]. In other words, when the quantity of the biocontrol agent, biopreparation, in flowers reaches an ideal level, a favorable outcome can be obtained.

The biocontrol agent was widely dispersed to a variety of plants by the bee species Bombus impatiens, as reported by Kapongo et al. (2008). In tomato plants and sweet peppers, for instance, bees carried 1,000–5,000 CFU (collonia-forming units) of biopreparation by landing on blossoms, which led to a 57–59 % decrease in the disease *Botritis cinerea* [4].

The vast expansion of fungal infections and Kazakhstan's unstable environment need the research of novel strategies in the biological battle against phytopathogens.

The *Ascomycota* division, the *Pezizomycotina* genus, the *Leotiomycetidae* class, the order *Helotiales,* the *Sclerotiniaceae* family, and the genus Botrytis are all home to the fungus *Botrytis* cinerea [5].

About 200 plants worldwide are harmed by this virus both throughout the growth season and even during storage following harvest, resulting in significant financial losses.

Among necrotrophic fungi, *Botrytis cinerea* has gained importance recently due to its strong disease-causing potential and utility in molecular research [6].

Strawberries and blackberries belong to the most important Berry cultivated plants of the world class. The production of strawberries in many respects depends on fungal diseases, including Gray rot, the causative agent of which is *Botrytis cinerea*. *Botrytis cinerea* is the main plant pathogen among pathogens. Therefore, it's critical to develop new defenses against this virus in order to research the harm it causes to strawberry plants and lessen the extensive usage of synthetic fungicides. In addition, in order to stay competitive in the market, organic farming practices need to find alternate ways to battle gray mold. It has been demonstrated that the biofungicide trichodermin can have an antagonistic effect on *Botrytis* infections [7].

But even when farmers use it frequently, the costs are substantial. The anthogonist mushroom mixture must be sprayed on, which takes time and could not give total control. Applying this product diluted in an aqueous solution to plants can only provide the intended outcome when plants are treated repeatedly, as the biocontrol needs to land on the flowers, which are the primary site of infection. Furthermore, because the spraying method covers the entire surface of the plants as well as nearby materials, soil, and strawberry leaves, it is wasteful.

Currently, farmers are employing a strategy that has been tested for over 20 years: deploying visiting vector bees as biocontrol agents in flowers. In this manner, honey bees, hairy bees, and mason bees were used.

The distribution of biopesticide by honey collecting bees guarantees that the biocontroller reaches the flowers at the peak of their bloom. Furthermore, bees that disperse biopesticides also serve as extra pollinators, which increases fruit output and bulk.

Bee behavior when visiting flowers is greatly influenced by the chemical makeup of the target crop as well as the quantity of pollen and nectar it contains. The weather also has an impact on the activity of all bees during their search for food. When there is a plenty of food within the nest, bees will remain inside even in inclement weather, even though they can still forage.

The weather has an impact on the disease's dissemination as well because gray mold can grow quickly thanks to wind, rains, and even insects that feed on plants. Treatment options may become ineffective as the disease spreads, and the only ways to save the crop are preventive ones.

Depending on the species, different insects require different amounts of pollination to produce blossoms as beautiful as strawberries.

Similar to this, the plant communities in the area that influence how hairy bees behave when seeking food might vary from season to season. There are notable regional variations in the nation's natural circumstances, and information specific to some areas is required for agricultural purposes. Consequently, (1) shows that the medication may be carried by Carpathian family bees in efficient, open-field settings, and two years of research in this area has demonstrated a notable decrease in *Botrytis* infections; (2) the degree of attraction of strawberry blossoms for hairy bees; (3) the effectiveness of the use of trichodermin biofungicidal additive to combat botrytis, the field propagation distance and (4) the effect of additional pollination activity on fruit size were determined.

Experimental

Mushroom strains and the preparation of inoculations

The fungi *Botrytis sypegea* (Fig. 1), isolated from the strawberry fruit that was impacted, and *Trichoderma viride* (Fig. 2), isolated from the local soil using dilution and identified through sequencing using a molecular genetic approach, were employed in bio-samples and field experiments.

Figure 1. Culture and spores of the fungus *Botrytis cinerea*

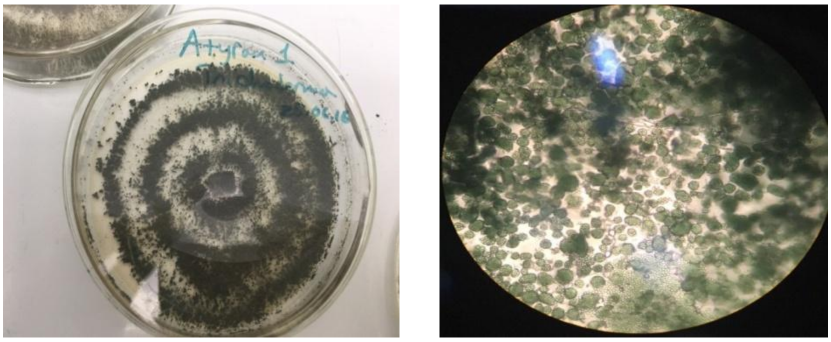

Figure 2. Culture and spore of the fungus *Trichoderma asperellum* isolated from local soil

These strains were maintained at 80 °C in 20 % glycerin and cultivated in potato dextrose Agar (PDA) at room temperature (20–23 °C).

Gray rot pathogens can develop in a variety of fertile substrate compositions. They can process the pulp and thrive well in sugar environments. They can grow in glycerin, cottonseed, and wine oils as well as in a 2 % solution of tannin and nicotine. They can also develop in malic, wine, and formic acids. They can also use nicotine as a source of nitrogen and grow in peptide and asparagine oils. It can take up nitrogen from the air if there is a tiny amount present in a fertile area. According to research done by A.I. Oparin and O.I. Kuplenskaya on the carbon-feeding mycelium of botrytis, the dry weight of the growing mycelium in glucose is 0.08 g, in lactose it is 0.06 g, and in manite it is 0.04 g [8]. According to certain theories, the elements potassium, phosphorus, nitrogen, sulfur, magnesium, manganese, etc. are required for the correct growth of botrytis.

Research findings indicate that *Gliocladium catenulatum (Clonostachys rosea f)*, the source of the medication *Prestop-Mix*, controls the growth of *Botrytis cinerea*. The antagonistic property was examined in laboratory settings with a thorough description of the cultures of catenulate (previously *Gliocladium roseum*) and the fungus *Trichoderma asperellum* obtained from local soil (Fig. 2)

The actively growing culture is grafted onto new PDA plates, matched to a 12-hour photoperiod under cold white light, and cultivated for 7–10 days at a temperature of 25 °C in order to prepare the requisite anthogonists and pathogen inoculations for research. To make inoculations for bioprobes, combine 10 milliliters of sterile tap water with 0.05 % twin 80 surface active substance. Pour the mixture into Perti plates, collect mycelium with spores, and shake hands for a minute to guarantee conidium dispersal. After that, remove the mycelium with a glass rod and filter it through three layers of sterile Marl for purification.

A hemocytometer is used to measure the concentration of the resultant suspension, which is then diluted to the required concentration. Large amounts of spores were accumulated by rinsing the PDA plates containing the spores with sterile water and filtering them using sterile Marl, which is how the inoculations required for field research were made. Before usage, the inoculations required for biotalysis were made, and two weeks prior to use, at 4 °C, the concentrated suspension of inoculants required for field study was made. Suspensions of freshly made or nutrient-activated conidias can be kept for up to two months at 4 °C, according to preliminary research.

Activated by nutrients *Trichoderma asperellum* conidia are made using the following procedure: 500 ml of potatoes in 1 liter bottles in dextrose broth with a final concentration of approximately 1×10^7 conidium/ML, and incubated at 6 H 22 °C in a reversible lifting (piston) mixer at 150 rpm. The conidia of 2-3 week-old cultures grown in the middle of the PDA are briefly washed. The Whatman GF/C filter is then used to perform vacuum filtration in order to extract the nutrient-activated but ungrown conidiums from the solution. It is resuspended as a concentrated suspension in 50 milliliters of sterile water after being rinsed three times with sterile water. Before being used, the activated conidia should be diluted to a concentration of 10^6 conidia/ml and kept at 4 °C for up to two weeks. Spraying mycelium and fungal spores is not the most straightforward method. The medicine's biocontrol agent only enters the infected floral organ when it is used repeatedly, which is why the drug crushed with water is only useful in certain situations. Due to its dispersal of the entire crop area as well as surrounding regions like soil and leaves, the method is not economically efficient.

Preparing strawberry flowers for research

Fresh smallpox-bitten strawberry blossoms are gathered and put in 10 cm petri dishes with 1 flower and 15 ml of 1.5 % vertical sterile water Agar.

At one point near the base of the acorns, each bloom receives an injection of 10 microns of spore solution. Conidium/ML combinations of *Gliocladium catenulatum, Clonostachys rosea, or Trichoderma asperellum* are made in combination, or 10^3, 10^4, or 10^5 conidium/ML B. *cinerea*, singular.

Instead of using conidial suspension, flowers under control are treated with sterile water. Every aspect of the trial design followed a randomized block approach. Three plants are used to repeatedly complete each operation.

For two days, flowers that have been inoculated and regulated are kept in the dark at a temperature of 25 ± 1 °C. After that, the flowers are left on the study table for a total of twelve hours of light and darkness.

At a temperature 25 °C, 20 sagebrush, the conidial germination of mushrooms in water agar increased steadily by 98 %.

Four days following the inoculation with strawberry flowers, the disease's severity is evaluated. The percentage of ash-affected areas on strawberry plants that have gray rot is as follows: 0 represents no disease symptoms; 1-0,1-5 %; 2-5,1-20 %; 3-20,1-40 %; 4-40,1-100 %.

Disease complication is calculated using the following formula: disease severity (%) = ((Σ(number of diseased leaves × disease ghost index))/(4×number of graded leaves))×100.

The importance of Disease Control is calculated using the following formula: Disease Control Value (%) = $((A–B)/a)\times100$, where A is the severity of the disease caused only by inoculation of the pathogen, and B is the severity of the disease after various treatments. The experiments were repeated in different ways.

Preparation of the carrier vector bees and the apiary

Using a multi-map of Carpathian bees, biocontrol techniques were implemented with the aid of the Trichoderma fungus. Apiary Styrofoam is a huge multi-map that can withstand a variety of climatic conditions. It is divided into three distinct areas, each housing a colony of 350 worker bees and a queen. Every apiary has a bilateral dispenser (either with or without a preparation for anthogonist mushrooms). Carpathian bees are bioprepared and escape through the exit lot with the aid of a two-way dispenser; nevertheless, internal movement occurs through an empty tunnel to prevent contamination of the apiary's interior.

Valley research

The study was conducted in a strawberry field during the growing season for two years in the village of Stary serf' (2016-2017), Semey (Fig. 3). In June 2016, strawberries were planted in perennial fields. Planting strawberry plants requires spacing them 25–30 centimeters apart and covering them with black plastic. Bees belonging to the Carpathian family are found within 0.5 km of the open farmed fields. Every strawberry was produced following the guidelines for organic gardening; no chemical pesticides were used to the plants during the study phase to safeguard them. GPS coordinates: width: 50º 29129i 52º N; Length: 80º 51 52 17º E.

Figure 3. Strawberry field map. Old serf, Semey, East Kazakhstan Region.
Theses strawberry fields are surrounded by rectangles; dots in the Valley indicate
the apiary's arrangement with the experimental Valley sign

The type of strawberry under study is "Symphony", which is the most commonly used and cultivated variety of strawberry species. The flowering period begins on May 25–28 and ends on June 10–14 (2016, 2017), as observed during the two-year period.

In the Valley, 7,564 plants were grown in systems consisting of 21 rows. The systems were irrigated by drip irrigation. After a month, the flowers and stolons were cut to be even, and intensive growth began.

Procedure of the experiment

The entire experiment plan was executed in four random iterations. Plots measuring 3.30 m by 4 m are planted with 70 strawberry plants, both with and without trellis. The size of G/plant was determined by dividing the total yield of each site by the total number of plants at each location.

Strawberries were collected with their hands twice a week over the summer, three times total. Berries that were clean and ripe were gathered separately, and berries that were damaged were gathered separately and weighed.

From the start of the strawberry flowering season until the finish, bees kept spreading anthogonis. A total of 300–500 g of the drug — five grams per dose — were added to the drug-antagonist dispenser.

A net against neutral pollen was placed across four plots (Fig. 4, 5), allowing wind pollination to occur during the flowering stage. Carpathian bees assist in pollinating strawberry blooms in other regions by carrying opponent biopreparations together with wind.

Figure 4. Carpathian bee apiary and dispenser

Figure 5. Experimental fields of strawberries

After flowering, the protective netting was taken down. Three times over the course of three weeks, the disease known as strawberry gray rot was controlled (matching to the period of fruit harvesting). Data were gathered from a weather station close to the study region about specific humidity and air temperature.

Approximately around June 26–28, the strawberry harvest season started and lasted until July. Strawberry fruits were gathered every third day. The amount of gray rot infection was ascertained by counting the number of uncontaminated and damaged fruits.

Results and Discussions

Throughout the two years, there were variations in the weather. While May averages in 2016 were above 15 °C, May averages in 2017 were 20 °C higher. In June, the average temperature was 23 °C.

With 140 % of total rainfall in 2016 and 136 % of total rainfall in 2017, May had substantial rainfall on average. Overall monthly rates were 128 % in June 2016; they were 193 % in July and June 2017 respectively. In general, the average monthly level was 78 % in 2017 and 92 % in 2016.

Compared to 2016, there were twice as many rainy days in 2017.

B in conidium/ml suspensions of 10^3, 10^4, and 10^5 as determined by analyses in Agar media. The differences between *cinerea* disorders are negligible (Fig. 6).

Figure 6. Strawberry flowers damaged by a suspension of spores of different concentrations

Anthogonist activity was higher in flowers inoculated with concentrated suspensions of *Gliocladium catenulatum* 10^5, *Clonostachys rosea* 10^5 and *Trichoderma asperellum* 10^5 (Table 1). And there was no difference in the result in strawberry flowers treated with concentrations of 10^3 and 10^4.

Table 1

Ways to combat gray rot on a strawberry plant in laboratory conditions using BCA

	Disease severity (%)	Disease control value (%)
B. cinerea10^3conidia/ml	91.67cd	
x *G. catenulatum* 10^3	75.00cd	19.43abc
x *G. catenulatum* 10^4	66.67bcd	33.33bcd
x *G. catenulatum* 10^5	58.33abc	38.90cd
x *C.rosea* 10^3	91.67cd	0.00a
x *C.rosea* 10^4	75.00cd	16.67abc
x *C.rosea* 10^5	41.67ab	55.57de
x *T.asperellum* 10^3	91.67cd	0.00a
x *T. asperellum* 10^4	100d	0.00a
x *T. asperellum* 10^5	66.67bcd	30.57abcd

As given in Figure 7 it is observed that pain reliever of suspensions of cineria B. 10^3 concentration of other fungi at a concentration of 10^5 conidium/ML. *B.cineria* 10^3 x *C.rosea* 10^5 variant showed efficacy, reducing the progression of the disease by 55.57 %.

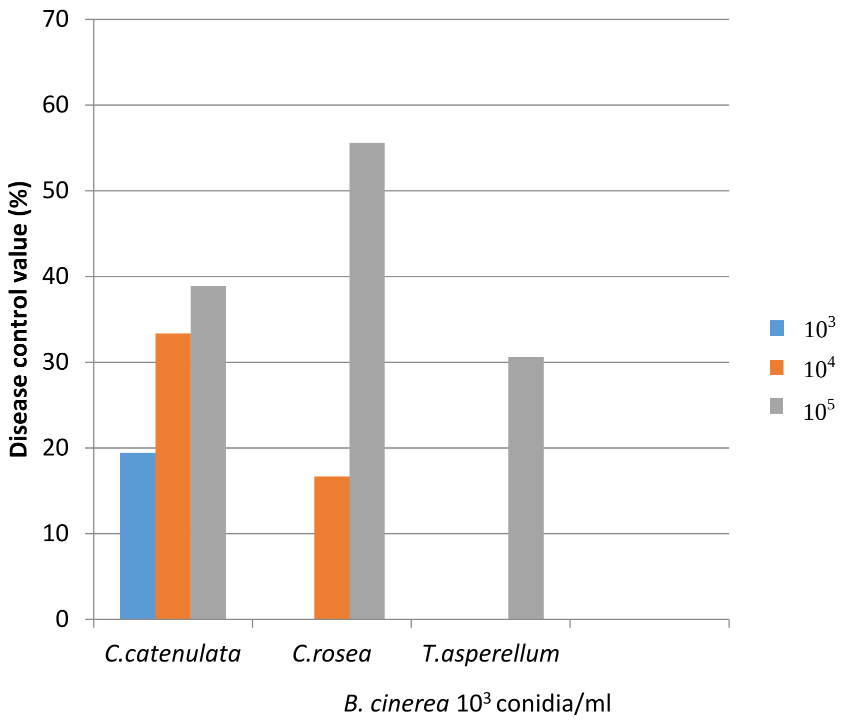

Figure 7. The effect of the combination of different concentrations with asperellum fungi against Gray rots of the concentration of *B. cineria* 10^3 spores *C. catenulatum, C. rosea and T. asperellum*

T a b l e 2

Ways to combat gray rot on a strawberry plant in laboratory conditions using BCA

	Disease severity (%)	Disease control value (%)
B. cinerea 10^4 conidia/ml	100d	
x *G. catenulatum* 10^3	100d	0.00a
x *G. catenulatum* 10^4	75.00cd	22.23abc
x *G. catenulatum* 10^5	33.33a	66.67e
x *C. rosea* 10^3	100d	0.00d
x *C. rosea* 10^4	91.67cd	8.33ab
x *C. rosea* 10^5	100d	0.00d
x *T. asperellum* 10^3	100d	0.00d
x *T. asperellum* 10^4	100d	0.00d
x *T. asperellum* 10^5	91.67cd	8.33ab

In Figure 8 and Table 2 the pain relief of suspensions of *cineria B.* 10^4 concentrations of other fungi at a concentration of 10^3, 10^4, 10^5 conidium/ML is different. Cineria B. at the concentration of 10^4 x *G. catenulatum* 10^5, inhibition decreased by 66.67 %, and in the 10^5 version it was 22.23 %. Moreover, *C. rosea* 10^4 and *T. asperellum* 10^5 disease inhibition was only slightly observed than in other unchanged versions (8.33 %).

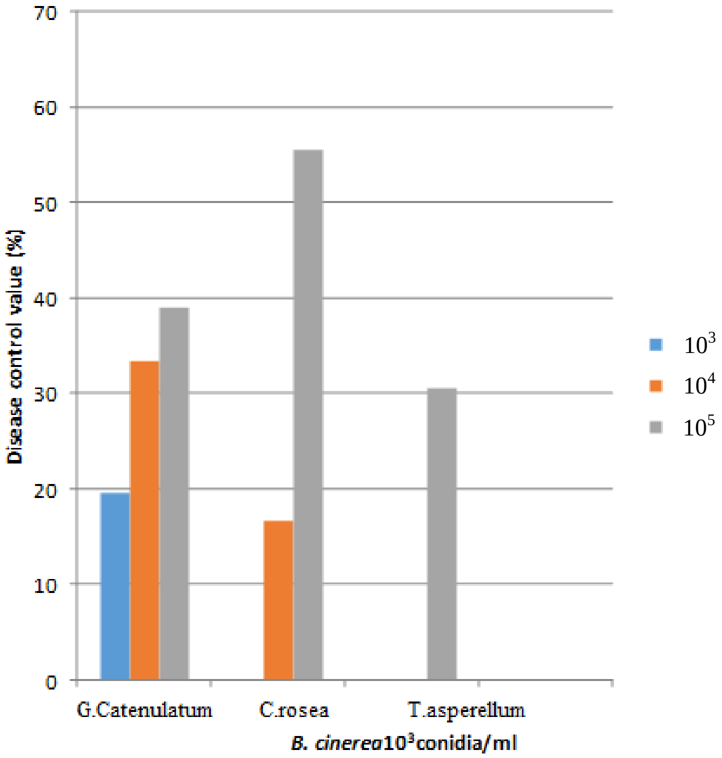

Figure 8. The effect of the combination of different concentrations with asperellum fungi against Gray rot of the concentration of *cineria spores B.g, catenulatum, C. rosea and T. Asperellum*

Table 3

Ways to combat gray rot on a strawberry plant in laboratory conditions using BCA

	Disease severity (%)	Disease control value (%)
B. cinerea 10^5 conidia/ml	100d	
x *G. catenulatum* 10^3	100d	0.00d
x *G. catenulatum* 10^4	91.67cd	8.33ab
x *G. catenulatum* 10^5	100d	0.00d
x *C. rosea* 10^3	100d	0.00d
x *C. rosea* 10^4	100d	0.00d
x *C. rosea* 10^5	100d	0.00d
x *T. asperellum* 10^3	100d	0.00d
x *T. asperellum* 10^4	100d	0.00d
x *T. asperellum* 10^5	91.67cd	8.33ab

Figure 9, 10 and Table 3 demonstrate that *B.cineria B.* the pain relief of suspensions of *B. cineria* 10^5 concentrations of other fungi at a concentration of 10^3, 10^4, 10^5 conidium/ML is different. *B. cineria* 10^5 x *G. catenulatum* 10^4 and *T. asperellum* 10^5 at a concentration of *T. asperellum* 10^5, the prevalence of the disease is limited to 91.67 %. In the rest of the variants, the development of the disease remained unchanged.

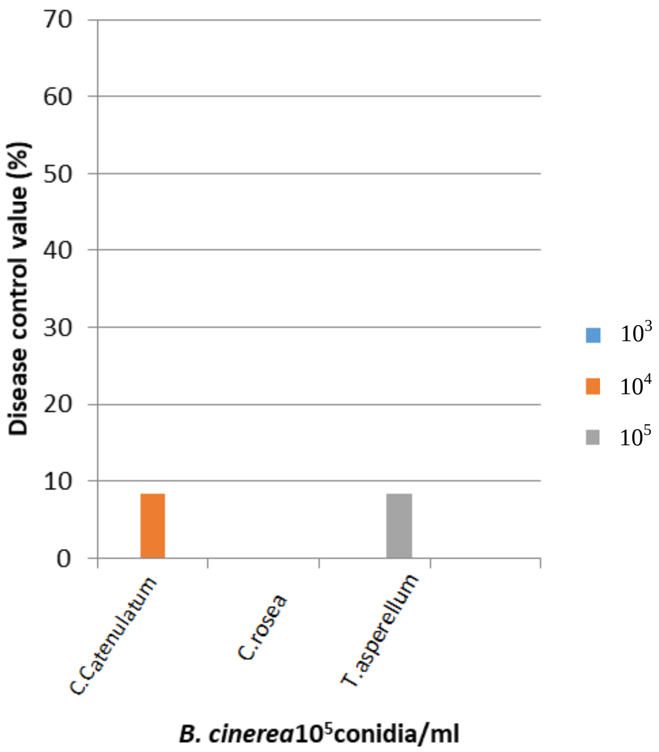

Figure 9. The concentration of *cineria B. 10^5 spores. catenulatum, C. rosea and T. asperellum* the effect of the combination of different concentrations with asperellum fungi against Gray rot

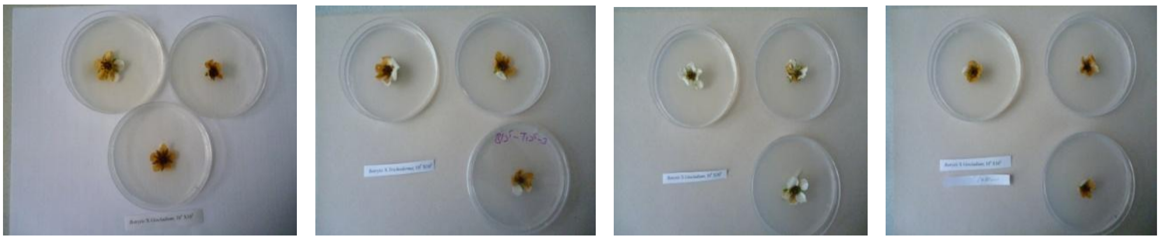

Figure 10. Manifestation of disease development in strawberry flowers of different concentration

As a result of the development of the disease of gray rot in strawberry flowers, it can be seen that under the influence of a high concentration of anthogonist fungi, the development of the disease develops at best by only 33.33 %, and the spread to the plant stops somewhat.

In valley conditions, a strawberry plant is used by bees of the Carpathian genus carried out using *G. catenulatum spores* (Table 4).

T a b l e 4

Variants of experiment

Condition	vegetable (gr/plant)*
No grid	1.97
In the grid, y	1.92

Effectiveness of biocontrol against gray rot infection. At the control sites, the extent of gray rot damage varied throughout the course of the control years. The annual treatment effectiveness of gray rot infection is shown to be drastically lowered when trichodemin is used. There was a decrease in the gray rot infestation between the two years.

In terms of the effect of pollination on fruit mass, the average weight of ten fruits varied between 53.2 = 3.2 (2016) and 192.8 = 9.8 g (2017).

Impact of biocontrol on mold infection rates. The level of infection with mold at the control sites varied over the years of observation ($F1,\ 162 = 1386.6$, $P < 0.001$; Fig. 11). The use of Prestop mixture significantly reduced the infection with mold ($F1,\ 162 = 132.06$, $p < 0.001$).

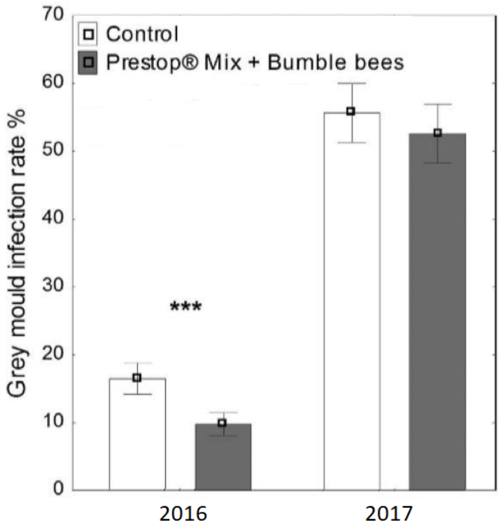

Figure 11. The level of mold infection at Control sites (untreated) and in places treated by bees with the drug "stop mixture". Average values with standard error bars are presented. Asterisks (***) indicate a decrease in the level of infection in years with low pathogenic pressure (p < 0.001)

At the same time, a significant concomitant effect was observed during the year of treatment ($F1,\ 162 = 39.44$, $P < 0.001$). A pair analysis found a significant decrease in mold infection rates in the first two years (2016: $t = –8.20$, $df = 162$, $P < 0.001$), but not in the third year (2017: $t = –0.56$, $df = 162$, $p = 0.57$).

The combined effect of pollination and biocontrol on gross output. The use of biopreparations with the participation of bees significantly affected the overall yield ($F1,\ 18 = 9.7$, $P = 0.006$; Fig. 12*a*), and the pollination services were not affected ($F1,\ 12 = 0.14$, $P = 0.7$; Fig. 12*b*). The overall yield was different in different years (bioagent pollination: $F1,\ 18 = 33.31$, $P < 0.001$; pollination: $F1,\ 12 = 113.3$, $P < 0.001$), although there was no effect of year and treatment ($F1,\ 18 = 0.20$, $P = 0.8$), year and type of pollination ($F1,\ 12 = 0.11$, $P = 0.7$) was not found. Areas pollinated by insects and pre-treated with biopreparations 123 % 112 % (2016: $t = 1.58$, $df = 18$, $P = 0.13$) and 120 % (2017: $t = 1.51$, $df = 18$, $P = 0.15$) are shown in Figure 13. The level of mold infection at control sites (untreated) and in areas treated with prestop-Mix by bees.

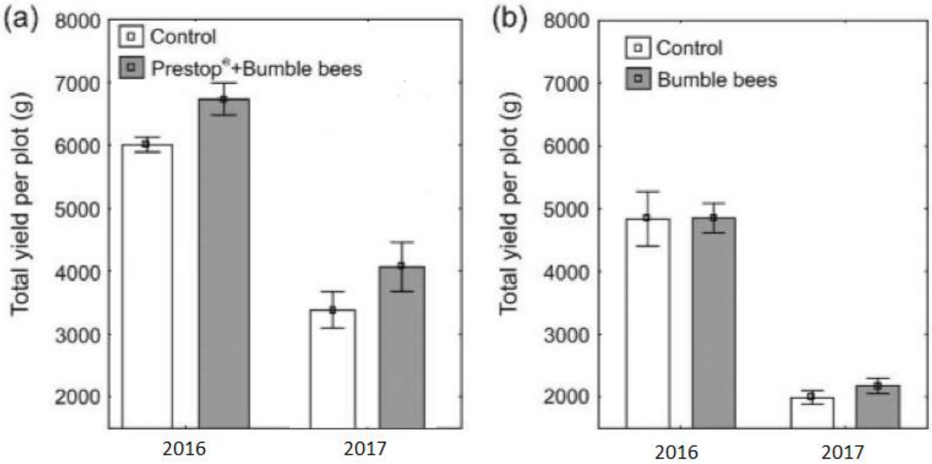

Figure 12. Average yield of strawberries collected during the period of fruit collection. (A) the preliminary application of the mixture in the presence of bees increased the yield every year. (B) The "symphony" variety's yield has not changed as a result of pollination services. The values are displayed as averages with standard error bars. A significant difference in productivity between cultivated and untreated land (p < 0.05) is shown by the asterisk (*)

Average values with standard error bars are presented. Asterisks (***) indicate a significant decrease in productivity between cultivated and untreated areas ($p < 0.05$). Crops are harvested from control sites (without wind pollination and processing), and insect-pollinated sites are harvested from 100 % (2016: $t = 0.03$, $df = 12$, $P = 0.9$) and 109 % (2017: $T = 0.5$, $df = 12$, $P = 0.6$) wind-pollinated sites.

Conclusion

According to our data, using biofungicide to prevent mold on strawberries in open ground works well. However, the weather had an impact on how well the treatment worked. Because of the heavy rains and cold temperatures, there was a significant pressure of pathogens even though the infection rate dropped by 2.9 and 1.7 times in 2016 and 2017, respectively. Our research has demonstrated that excessive precipitation and cool temperatures are conducive to the formation of mold.

Even with chemical fungicides, effective mold control is challenging when the incidence is high if the right decision-making support systems are not accessible. In our experiment, the monthly precipitation in May and June of 2017 was about twice as high as the long-term normal, while the year 2016 was warm and dry.

The gross production from processed and unprocessed sites has increased over the years that Prestop-Mix research has been undertaken, despite the lack of statistically significant differences between them. The adoption of entomovector technology in strawberry farming, particularly in organic production, may be encouraged by this ongoing good trend.

It is thought that plants, insects, and animals can safely handle Gliocladium catenulatum. Since it is a naturally occurring soil fungus, wild organisms carry the soil dust into the air. G. catenulatum is a universal communicator. Processing has little effect on infections; all it does is increase the concentration of color on flowers. Pre-stop-Mix mixture does not negatively impact life expectancy or foraging activity, even though vector insects passing through the dispenser are subjected to extremely high dosages of the material.

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Карпат тұқымдасының араларын пайдалана отырып *Botrytis cinerea* тудыратын құлпынайдың сұр шірік ауруын энтомовектор технологиясымен зерттеу

Сұр шірік ауруы әлемде көптеген дақылды өсімдіктерді зақымдап, кең көлемде таралуда. Құлпынайды вегетациялық кезінде және жиналғаннан кейін де зақымдап, экономикалық орасан зор зиянын келтіреді. Мақалада биопрепарат пен араларды пайдалана отырып, энтомовектор технологиясының көмегімен құлпынай өсімдігінде кездесетін сұр шірік ауруына қарсы биобақылау зерттеулері жүргізілгені баяндалған. *Botritis cinerea* саңырауқұлағы тудыратын құлпынайдың сұр шірік ауруын энтомовекторлық технологияның көмегімен зерттеу аурумен күресіп қана қоймайды, сонымен қатар құлпынай гүлдерінің санын көбейтіп, өнімділікті арттырады. Зерттеуде энтомовекторлық агент ретінде Карпат тұқымдас тозаңдатқыш аралар пайдаланылған. Олар кең профильді аралар қатарына жатады және осы зерттеу жұмысына дейін олардың өсімдіктерді тозаңдандыру арқылы өнімділігін арттыратыны жайлы мәліметтер толықтай келтірілген. Энтомовектор технологиясының нәтижесінен биопрепарат ретінде *Prestop-Mix* препараты негізі болып табылатын *Gliocladium catenulatum* және жергілікті жер топырағынан бөлініп алынған *Trichoderma asperellum Botrytis cinerea* қоздырғышын супрессиялайтындығы зерттелді. Мақалада *Botritis cinerea* саңырауқұлағы тудыратын шығыс өңіріндегі құлпынай алқаптарының тәжірибелік алаңдарындағы сұр шірік ауруын энтомовектор технологиясымен зерттеу нәтижесі берілген. Арнайы омарталарға орнатылған диспенсерлер және Карпат тұқымдас аралардың көмегімен биофунгицидті қолдану құлпынай өсімдігінің сұр шірік ауруымен зақымдануымен күресі кезінде тиімді әдістердің бірі болып табылатыны бақылау нұсқаларымен салыстыра отырып айқындалды. Арнайы зерттеу алқаптарында өсірілген «Симфония» құлпынайының сұр шірік ауруымен күресін зерттеу барысында тозаңдандыру тиімділігінің жеміс салмағына әсері, тозаңдану және биобақылау агентінің жалпы салмаққа әсері анықталды. Құлпынай гүлдерінің саны көбейіп, жемістерінің өнімділігі артады. Зерттеу нәтижелері Карпат тұқымдас аралардың көмегімен биофунгицидті қолдану құлпынай өсімдігінің сұр шірік ауруымен зақымдануымен күресі кезінде тиімді әдістердің бірі болып табылатынын көрсетті. Бірақ күресу шараларының тиімділігі ауа-райы жағдайларына тікелей байланысты болады.

Кілт сөздер: сұр шірік, Карпат арасы, триходермин, энтомовекторлы технология, биопрепарат, зақымдану, биобақылау агенті.

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Исследование болезни серой гнили клубники, вызываемой *Botritis cinerea*, с использованием пчел семейства Карпатские с помощью энтомовекторной технологии

В статье с помощью технологии энтомовекторов с использованием фитопатогенного противогрибкового биопрепарата и пчел был осуществлен биоконтроль болезни серой гнили, обнаруженной на клубнике. Исследование болезни серой гнили клубники, вызываемой *Botritis cinerea*, с помощью энтомовекторной технологии не только борется с болезнью, но и увеличивает количество цветков клубники и урожайность. В исследовании в качестве энтомовекторного агента использованы пчелы-опылители Карпатского рода, которые имеют широкий профиль, и до этого исследования были полностью приведены данные об их повышении продуктивности при опылении растений. Из результатов энтомовекторной технологии в лабораторных условиях было рассмотрено, что вред, наносимый возбудителем *Botrytis cinerea,* на рост и растение, ингибируется антогонистическим грибком *Trichoderma viride*, выделенным из местной почвы. Приведены результаты исследования болезни серой гнили клубники восточного региона, вызываемой грибком *Botritis cinerea*, по энтомовекторной технологии. Очевидно, что применение биофунгицида с помощью карпатских пчел является одним из наиболее эффективных способов борьбы растения клубники с поражением серой гнилью. Было показано, что все другие виды опыления дают успешные результаты в технологии энтомовекторов. В ходе исследования борьбы клубники «Симфония», выращенной на специальных исследовательских полях, с серой гнилью было выявлено влияние эффективности опыления на вес плодов, опыления и биоконтроля на общий вес. Результаты исследования показали, что применение биофунгицида с помощью карпатских пчел является одним из наиболее эффективных методов борьбы растения клубники с поражением серой гнилью. Но борьба также зависит и от погодных условий.

Ключевые слова: серая гниль, карпатская пчела, триходермин, энтомовекторная технология, биопрепарат, повреждение, биоконтрольный агент.

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