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ESTIMATION OF KAIROMONE SUBSTANCES ON THE BEHAVIOR OF ENTOMOPHAGES *TRICHOGRAMMA EVANESCENS* WESTW. AND *BRACON HEBETOR* SAY.

The aim of the given paper was to estimate the effectiveness of biologically active substances with kairomone properties on the behavior of the entomophagy's *Trichogramma evanescens* and *Bracon hebetor* in the vision of increasing the parasitism potential of different ontogenetic stages of pest development. Biologically active substances with kairomone properties were obtained and tested for increasing the biological indices of the entomophagy's *Trichogramma evanescens* and *Bracon hebetor*. The alcohol-based extract and eggs of the laboratory host *Sitotroga cerealella* — as a source with kairomone properties for the entomophagy *Trichogramma evanescens*, and the alcohol-based extract from the larvae and excrement of the laboratory host *Galleria melonella* — as a source with kairomone properties for the entomophagy were used *Bracon hebetor*. It was found that due to the influence of kairomone substances, the female entomophagy's *Trichogramma evanescens* and *Bracon hebetor* become more active in searching for eggs and larvae for parasitism, compared to the control variant. It has been demonstrated that biologically active substances, emitted by pest species for the purpose of communication between individuals of the same species, can also be used as kairomone substances by different species of entomophagy's. The given factor can be further developed with the aim of application in plant protection as a means of activating and increasing the effectiveness of both released and natural entomophagy's.

***Trichogramma evanescens*; *Bracon hebetor*; Kairomone; Plant protection; Entomophagous**

Agricultural plants are one of the key elements of the modern biosphere and life on Earth. However, every year there is a growing threat of reduced plant productivity due to various types of insect pests and other biotic and abiotic stressors. This factor stimulates the active research of new methods of plant protection in order to ensure their sustainability and increase yields in a changing environment. One of the innovative and promising approaches to solving the problem of plant protection is the use of biologically active substances with kairomone properties. Kairomones, also known as kairomones, are a group of biologically active agents that are produced by plants and microorganisms in response to stressful conditions caused by the presence of pests or pathogens. These substances serve as an important means of communication between plants and help them mobilize their defense mechanisms. Despite the fact that a certain amount of data has already been accumulated, the mechanisms of action of kairomones and their practical application in agriculture and the protection of natural ecosystems are still the subject of active research. But nevertheless, it is already possible to formulate some of the main mechanisms of action and interaction of kairomones with entomophagy's:

- **Attracting Entomophagy's:** Kairomones, which are released by plants in response to pest attack, serve as a signal to the entomophagy's about the presence of food in the form of pests. This attracts entomophagy's to the place where harmful insects are concentrated, which allows them to effectively contain pest populations;
- **Entomophagy Search Behavior Improvement:** Some kairomones can improve the search behavior of entomophagy's, making them more effective pest hunters. This can occur, for example, by increasing the frequency of movement or improving the dexterity of entomophagy's when searching for and attacking their prey;
- **Increasing the reproductive activity of entomophagy's:** Some kairomones can increase the reproductive activity of entomophagy's, which contributes to an increase in the populations of these predators and, as a result, an increase in the effectiveness of biological control of pests;
- **Pest Aggression:** Some kairomones can induce pest hostile behavior in entomophagy's, stimulating their aggressiveness and targeting them to reduce pest populations;
- **Transfer of kairomones from plants to entomophagy's:** The interaction of kairomones with entomophagy's is the possibility of transferring kairomones from plants to predators. Entomophagy's that feed on pests that are under the influence of kairomones can also

metabolize these substances, which increases their effectiveness as predators.

Understanding these mechanisms can help improve the effectiveness of biological pest control and facilitate the development of new and more effective strategies for the use of kairomones in plant protection.

The control of the population density of harmful insect species in modern concepts of plant protection constitutes one of the important links in trophic chains and trophic networks, which would ensure a higher quality of the environment, with the possibility of obtaining ecological agro-food products.

Ensuring an adequate quality of the environment represents a problem of major interest for social evolution, the main objectives being the adoption of solutions to reduce pollution and increase the level of environmental quality as a whole [1]. Substances with kairomone properties improve the ability of the recipient being beneficial for the producers and negative for the recipient. These substances eliminated by one sex (often by the female) in very small quantities, transmit an informational message for the survival and reproduction of the species, they can also be used to influence other species.

The role of biologically active substances with kairomone properties in the biological control of pests in agricultural crops has been described to some extent by some scientists [2; 3; 4]. Some species of pests, during the laying of eggs, mark them with biologically active substances, which act as an indicator for other females of its species, that the given space is already populated. But these biologically active substances, with the purpose of being an indicator for the given species, can also be used as a guide for different species of entomophagy's.

The aim of the given work was to estimate the effectiveness of biologically active substances with kairomone properties on the behavior of the entomophagous species *Trichogramma evanescens* and *Bracon hebetor* in the vision of increasing the parasitism potential of different ontogenetic stages of pest development.

Materials and methods. To achieve the goal, biologically active substances with kairomone properties were obtained and tested to increase the biological indices of the entomophagy's *Trichogramma evanescens* and *Bracon hebetor*. In our experiments, the alcohol-based extract and eggs of the laboratory host *Sitotroga cerealella* were used — as a source with kairomone properties for the entomophagous *Trichogramma evanescens*, and the alcohol-based extract, larvae and excrement of the laboratory host *Galleria melonella* — as a source with properties kairomones for the entomophagous *Bracon hebetor*. The substances obtained were tested to assess their influence on the behavior of the corresponding entomophagy's compared to those in conditions without the influence of these substances («CONTROL»). The research was carried out in laboratory and field conditions during the years

2020—2023. The study subjects were the entomophagous *Trichogramma evanescens*, *Bracon hebetor* and their laboratory hosts *Sitotroga cerealella* and *Galleria melonella*. The experiments in laboratory conditions were carried out at a temperature of 24—27°C, according to the «Box-3» plan, where the level of the factors is presented: concentrations (X1) — 10%, 20%, 30%; number of eggs — (X2) — 1g, 2g, 3g; Exhibition — (X3) — 5 minutes, 10 minutes, 15 minutes. The optimal variant was determined according to the «Optimclas» program.

Results. The behavior of the entomophagous *Trichogramma evanescens* W. in the presence of biologically active substances with kairomone properties: It was found that in the presence of substances with kairomone properties the prolificacy of females varied from 28.5 to 32.6 eggs/female. At the same time, in the control variant, the fecundity of the females varied from 19.1 to 22.8 eggs/female. Thus, in the experimental variant the prolificacy of the females increased by about 1.4—1.5 times compared to the prolificacy of the females in the control variant. As a result, there is a quantitative economy of *Sitotroga cerealella* eggs in the reproduction process by 20—25% and of the elite entomophagous *Trichogramma* spp. by about 15—20%.

Subsequently, the searching ability of the entomophagous *Trichogramma evanescens* was determined as a result of the influence of the biologically active substance with kairomone properties in two types of mini olfactometer with a length of 1.5 meters. At one end of the mini tubular olfactometer, a pad soaked with biologically active substances with kairomone properties obtained on the basis of eggs aged 24, 48, and 72 hours was mounted. At the other end of the mini olfactometer, female *Trichogramma evanescens* were released — 160 in total. The time the females took to cover the 1.5 m distance ranged from 29.8 minutes to 36.2 minutes. At the same time, in the control version this index varied on average from 46.7 minutes to 54.9 minutes, which is about 1.6 times higher than in the experimental version. Thus, the obtained results demonstrate a significant activation of entomophagous females in the presence of substances with kairomone properties.

The rate of parasitized eggs in the rectangular mini olfactometer with obstacles ranged from 69.6% to 89.9%. In the version with a rectangular mini olfactometer, without obstacles, the rate of parasitized eggs was from 63.1% to 91.2%. At the same time, it was found that in the control variant the rate of parasitized eggs varied from 64.9% to 74.3%, and correspondingly, from 58.4% to 79.2%. Thus, in the given case, it was demonstrated that due to the influence of kairomone substances, the females of the entomophagous *Trichogramma evanescens* are more active in searching for eggs for parasitism due to which the rate of parasitized eggs increased by about 10% compared to the control variant.

The assessment of the influence of kairomone substances on the degree

of parasitism of eggs by the female entomophagous *Trichogramma evanescens* was analyzed under controlled laboratory conditions. Two variants were mounted — experimental and control.

Experimental variant: On the internal surface of the glass vessels (volume 2 liters), the kairomone substance was applied, obtained in the same way as in the previous experiments. Cartons with eggs (age 24 hours) of *Sitotroga cerealella* were placed in the dishes and then the female entomophagous *Trichogramma evanescens* were released with the optimal parasite: host ratio 1:30, i.e. 1 female produced 30 eggs. Performing the analysis after 3 days found that the rate of parasitized eggs was on average from 74.6% to 87.6%.

Control variant: Distilled water and egg cartons (aged 24 hours) of *Sitotroga cerealella* were applied to the internal surface of the glass vessels (volume 2 liters) and then the female entomophagous *Trichogramma evanescens* were released with the optimal parasite:host ratio of 1:30, i.e. 30 eggs returned to 1 female. Performing the analysis after 3 days found that the rate of parasitized eggs was on average from 67.3% to 76.8%.

Thus, in this case too, the action of the kairomone substances on the increase in the rate of parasitized eggs compared to the females in the control version was confirmed — by about 10%.

The testing of biologically active substances with kairomone properties was carried out in the sunflower culture in three repetitions on the surface of 10 m² each. Two variants were installed.

Experimental variant: In the corners of the plots, 3 plants each were treated with the kairomone substances. The search ability of *Sitotroga cerealella* eggs by the female entomophagous *Trichogramma evanescens* was determined. Labels with 24-hour-old *Sitotroga cerealella* eggs were fixed on the treated plants, then 3 releases of the entomophagy were made in the center of the plots, with an interval of 7 days. Egg tag analysis was performed on the third day. Thus, it was found that the rate of parasitized eggs, the percentage of parasitism varied from 57.2% to 64.3%.

Control version: it was mounted according to the same scheme as in the experimental version. The plants in the plots were treated with distilled water. The entomophagous *Trichogramma evanescens* launched itself into the center of the plot. 24-hour-old *Sitotroga cerealella* egg tags were fixed on the plants treated with distilled water. Egg tag analysis was performed on the third day. Thus, it was found that the rate of parasitized eggs varied from 10.5% to 20.5%.

Thus, also in the case of experiments carried out in field conditions, the action of kairomone substances on a considerable increase in the rate of parasitized eggs compared to females in the control variant was confirmed — by about 45%.

The behavior of the entomophagous *Bracon hebetor* in the presence of

biologically active substances with kairomone properties: The experiments were mounted in mini olfactometers with a length of 50 cm, divided into two chambers by a mesh wall — in the first chamber 10 females of the entomophagous were released, and in the second room — 10 larvae of the III—IV age of the laboratory host *Galleria mellonella* were released. As a result of the tests, it was found that the rate of parasitized larvae (60.0%) was approximately at the level of the control variant (56.6%). Thus, the preventive results showed that the attractiveness of the larvae of the laboratory host *Galleria mellonella* for the females of the entomophagous *Bracon hebetor* is within 50—60%.

In the subsequent experiments, the biologically active substances obtained as a result of the extraction with ethyl alcohol from the macerated larvae of the laboratory host and from the excrement of the larvae of the same host — *Galleria mellonella*, were tested. The experiments were also mounted in two-chamber mini olfactometers. In the first room, 10 females of the entomophagous *Bracon hebetor* were released, and in the second room — or the walls were treated with the biologically active substances obtained by extracting from the larvae and excrement of the larvae of the laboratory host — *Galleria mellonella*. 10 larvae of the III—IV age of the laboratory host *Galleria mellonella* were also released in these rooms. The analysis of the obtained results found that there is a significant difference between the experimental and control variants. Thus, if in the experimental variants about 90—100% of the larvae exposed to the experiment were paralyzed, then in the control variant the rate of parasitized larvae was within the limits of 60%.

CONCLUSIONS

Preventive experiments have shown that the biologically active substances obtained by extracting from the larvae and excrement of the larvae of the laboratory host *Galleria mellonella* possess kairomone properties and lead to a substantial activation of the entomophagous *Bracon hebetor*. Thus, they increase the search and parasitism rate of the larvae by about 30—40% compared to the control variant.

The above is proof of the fact that biologically active substances, emitted by pest species for the purpose of communication between individuals of the same species, can also be used as kairomone substances by different species of entomophagy's. The given factor can be further developed with the aim of application in plant protection as a means of activating and increasing the effectiveness of both released and natural entomophagy's.

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Вплив кайромонових речовин на поведінку ентомофагів *Trichogramma evanescens* Westw. та *Bracon hebetor* Say.

Метою даної роботи було оцінити ефективність впливу біологічно активних речовин з властивостями кайромонів на поведінку ентомофагів *Trichogramma evanescens* та *Bracon hebetor* з точки зору підвищення потенціалу паразитизму на різних онтогенетичних стадіях розвитку шкідників. Отримано біологічно активні речовини з властивостями кайромонів та проведено їх випробування для підвищення біологічних показників ентомофагів *Trichogramma evanescens* та *Bracon hebetor*. Як джерело з властивостями кайроному для ентомофага *Trichogramma evanescens* використовували спиртовий екстракт та яйця лабораторного хазяїна *Sitotroga cerealella*, а для ентомофага *Bracon hebetor* — спиртовий екстракт з личинок та екскрементів лабораторного хазяїна *Galleria melonella*. Встановлено, що під впливом кайромонових речовин самиці ентомофагів *Trichogramma evanescens* та *Bracon hebetor* стають більш

активними у пошуку яєць та личинок для паразитування, порівняно з контрольним варіантом. Продемонстровано, що біологічно активні речовини, які виділяються видами шкідників з метою комунікації між особинами одного виду, можуть також використовуватися як кайромонні речовини різними видами ентомофагів. Даний фактор може бути надалі розроблений з метою застосування в захисті рослин як засіб активації та підвищення ефективності як вивільненої, так і природної ентомофагії.

***Trichogramma evanescens*; *Bracon hebetor*; Кайромон; захист рослин; ентомофаги**

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