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# EFFICACY OF BIOACTIVE COMPOUNDS WITH KAIROMONAL PROPERTIES ON BIOLOGICAL INDICATORS OF THE ENTOMOPHAGE TRICHOGRAMMA PINTOI V. DEPENDING ON STORAGE DURATION

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KEYWORDS

*T. evanescens kairomone*
Percentage of parasitism
Cereal moth
*Sitotroga cerealella Ol.*

ABSTRACT

Analysis of the biological indices of *Trichogramma pintoi* at 23–25°C, depending on the storage duration of the extract at 4°C, revealed a decreasing trend in biological indices. The longer the extract was stored (28 days), the lower the biological index values. At 4°C, the biological indices varied as follows: fecundity: 22.1–24.8 eggs per female; hatching rate of individuals: 80.5–92.2%, female hatching rate: 51.0–56.0%, host-seeking ability: 79.2–90.2% in the mini-olfactometer, parasitism rate: 76.36–89.4%, static quality criterion: 9.0–12.8. At 26–30°C, a decreasing trend in biological indices was also observed. The longer the extract storage period (28 days), the lower the biological index values. At 26–30°C, the biological indices varied as follows: fecundity: 22.1–23.3 eggs per female, hatching rate of individuals: 75.5–85.0%, female hatching rate: 50.0–54.0%, host-seeking ability: 82.1–85.6% in the mini-olfactometer, parasitism rate: 76.9–87.0%, static quality criterion: 8.3–10.7.

## INTRODUCTION

The role of kairomones in biological control of pests in agricultural crops was described by Murali-Baskaran et al. (2018). The impact of plant phenols as semi chemicals on the performance of *Trichogramma chilonis Ishii* was described by Rani et al. (2017). Initially, research focused on kairomones (in particular) from a fundamental perspective, for their role in modeling reproductive behavior, but later studies uncovered other particularly interesting aspects. These substances, released by one sex (often the female) in very small amounts, transmit an extraordinarily important informational message for species survival, which can be used for the destruction of pest species. This new approach targets certain species of insects and can lead to pest elimination without causing environmental harm. The presented data highlights the intricate relationship between weather conditions, temperature, and bioactive substances with kairomonal properties and the behavior of the entomophage *Trichogramma*. It emphasizes the importance of precise monitoring of *Trichogramma* under the potential influence of climate change on entomophage management strategies. These insights contribute to more efficient and ecologically sustainable management practices, aiming to minimize pest damage while reducing the ecological footprint of pest control measures. Combating harmful insects in modern plant protection concepts constitutes one of the important links in food chains and networks, ensuring a higher quality environment with the possibility of obtaining organic agri-food products. A wide range of research has been carried out using chemical mediators (especially pheromones, kairomones, synomones, and allomones), as a way to be used in monitoring, management, or combating many harmful insect species, while reducing to elimination pesticide treatments and replacing them with biopesticides (Bakthavatsalam et al., 2013). The kairomonal effect of some saturated hydrocarbons on egg parasitoids, *Trichogramma brasiliensis (Ashmead)* and *Trichogramma exiguum*, *Trichogramma chilonis Ishii* (Hym., Trichogrammatidae) was described by Paul et al. (2008). Kairomone enhances the recipient's capacity and, in this sense, differs from an allomone (which is the opposite: beneficial for the producer and harmful for the

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receptor). Initially, research focused on the study of sexual pheromones (in particular), from a fundamental perspective, for their role in modeling reproductive behavior, but later studies uncovered other particularly interesting aspects. These substances, released by one sex (often the female) in very small amounts, transmit an extraordinarily important informational message for survival and perpetuation of the species, which can be used for species destruction. The role of kairomones in biological control of pests in agricultural crops was described by Murali-Baskaran et al. (2018). The impact of plant phenols as semiochemicals on the performance of *Trichogramma chilonis Ishii* was described by Rani et al. (2017). To compensate for the limited flight capacity and to access freshly laid host eggs of egg parasitoids, several strategies were developed such as the use of kairomones (Rani et al., 2017). The experiments of Vasileva (2010) showed that extracting from the mandibular glands of certain Lepidoptera insects has attractive properties with influences on Lepidoptera insect density in stored grain products. These insects harm both the larvae and the egg-laying process of adults, attracting parasites and predators with kairomonal properties. Annual crop losses of agricultural crops range from 15-80%. The wide use of the entomophage *Trichogramma spp.* in plant protection is linked to its quality during mass multiplication and field application. The research goal for 2024 is to estimate the efficacy of bioactive compounds with kairomonal properties on enhancing the effectiveness of the entomophage *Trichogramma pintoi* depending on the storage duration of the extract.

## MATERIALS AND METHODS

Field research was conducted on soybean crops at the Institute of Genetics, Physiology, and Plant Protection in Chișinău, Moldova, to assess the efficacy of *Trichogramma pintoi V.* in the presence of kairomones. Alcohol extract and eggs of the Angoumois grain moth (*Sitotroga cerealella Ol*) were utilized as the source of kairomones (Biologically Active Substance). The impact of the fractions extracted from moth scales on the searching capacity of *T. pintoi V.*, an active component enhancing the quality of the entomophage and reducing the density of harmful insects, was evaluated. In the 2024 experiments, the kairomone with optimal properties obtained in 2020 using the "Optim clas" program and following Box 3 Plan was employed.

The formula for determining the amount of water required to dilute the alcohol to the necessary strength is as follows: X = P * (N/M-1). Here, *X* represents the amount of water needed to dilute ethyl alcohol to the required strength, P is the amount of ethyl alcohol for dilution in each variant, *N* is the initial strength of ethyl alcohol (96%), and *M* is the required strength of ethyl alcohol (30%). The research was conducted in laboratory conditions (Phytopharmacy and Ecotoxicology) at the Institute of Genetics, Physiology, and Plant Protection during the years 2024.

The research objectives: *Trichogramma pintoi* species, laboratory host - *Sitotroga cerealella Ol.* Location of Research in 2024: The research was conducted in laboratory and field conditions at the Institute of Genetics, Physiology, and Plant Protection.

Determining the efficacy of bioactive compounds with kairomonal properties on biological indicators of the entomophage *Trichogramma pintoi V.* depending on the storage duration of the extract. The research was conducted in the first half of 2024 at a temperature of 23°C–25°C in the first variant and at a temperature of 26°C–30°C in the second variant, in the second half of 2024 in controlled conditions, according to the 2024 Experimental Plan (Table 1).

**Table 1. Experimental plan, 2024**

| **N Variants** | **Temperature = 23°C – 25°C, First Half of 2024** | | | | | |
|---|---|---|---|---|---|---|
| | **Duration of SBA Efficacy Retention (days)** | | | | | |
| I-Variant: T = 23°C – 25°C | 0 | 7 | 14 | 21 | 28 | 35 |
| | **Temperature = 26°C – 30°C, Second Half of 2024** | | | | | |
| II-Variant: T = 26°C – 30°C | 0 | 7 | 14 | 21 | 28 | 35 |

In both variants, the duration of SBA efficacy retention was determined after 0, 7, 14, 21, and 28 days, during which the biological indices of *Trichogramma pintoi* were assessed. In each variant, the following biological indices were evaluated: fecundity (eggs per female), individual hatching rate (%), female hatching rate (%), static quality criterion, parasitism rate, and host-seeking ability.

## RESULTS AND DISCUSSION

### Efficacy of biologically active substances with kairomonal properties on the biological indices of the entomophage *Trichogramma pintoi* depending on storage duration

During the first half of the year, the research was conducted at a temperature of 23°C–25°C.

Table 2 and Figure 1 present the results obtained during the first half of 2024, under experimental conditions maintained at 23°C–25°C, according to the experimental design outlined in Table 1.

**Table 2. Implementation of the experimental plan, 2024**
**Temperature = 23°C – 25°C**

| Biological indices of *Trichogramma pintoi* V. | | | | | | |
|---|---|---|---|---|---|---|
| **Duration of extract storage (days)** | **Fecundity (eggs/female) (P)** | **Hatching rate of individuals (%) (a)** | **Female hatching rate (%) (b)** | **Host-seeking ability (%)** | **Parasitism rate** | **Static quality criterion (Y)** |
| 0 | 24.8±1.6 | 92.2±4.3 | 56±2.6 | 90.2±4.8 | 89.4±4.2 | 12.8 |
| 7 | 24.2±1.3 | 90.0±3.9 | 54±2.3 | 88.1±4.6 | 89.1±4.1 | 11.7 |
| 14 | 23.6±1.2 | 88.0±3.7 | 53±2.2 | 86.8±4.2 | 87.7±4.1 | 11.1 |
| 21 | 23.1±1.1 | 85.0±3.3 | 52±2.1 | 84.1±4.1 | 81.03±4.0 | 10.2 |
| 28 | 22.1±1.1 | 80.5±3.3 | 51±2.0 | 79.2±4.1 | 76.36±3.3 | 9.0 |
| DEM | Td=2.0-2.6>1.96=T0.05 | | | | | |

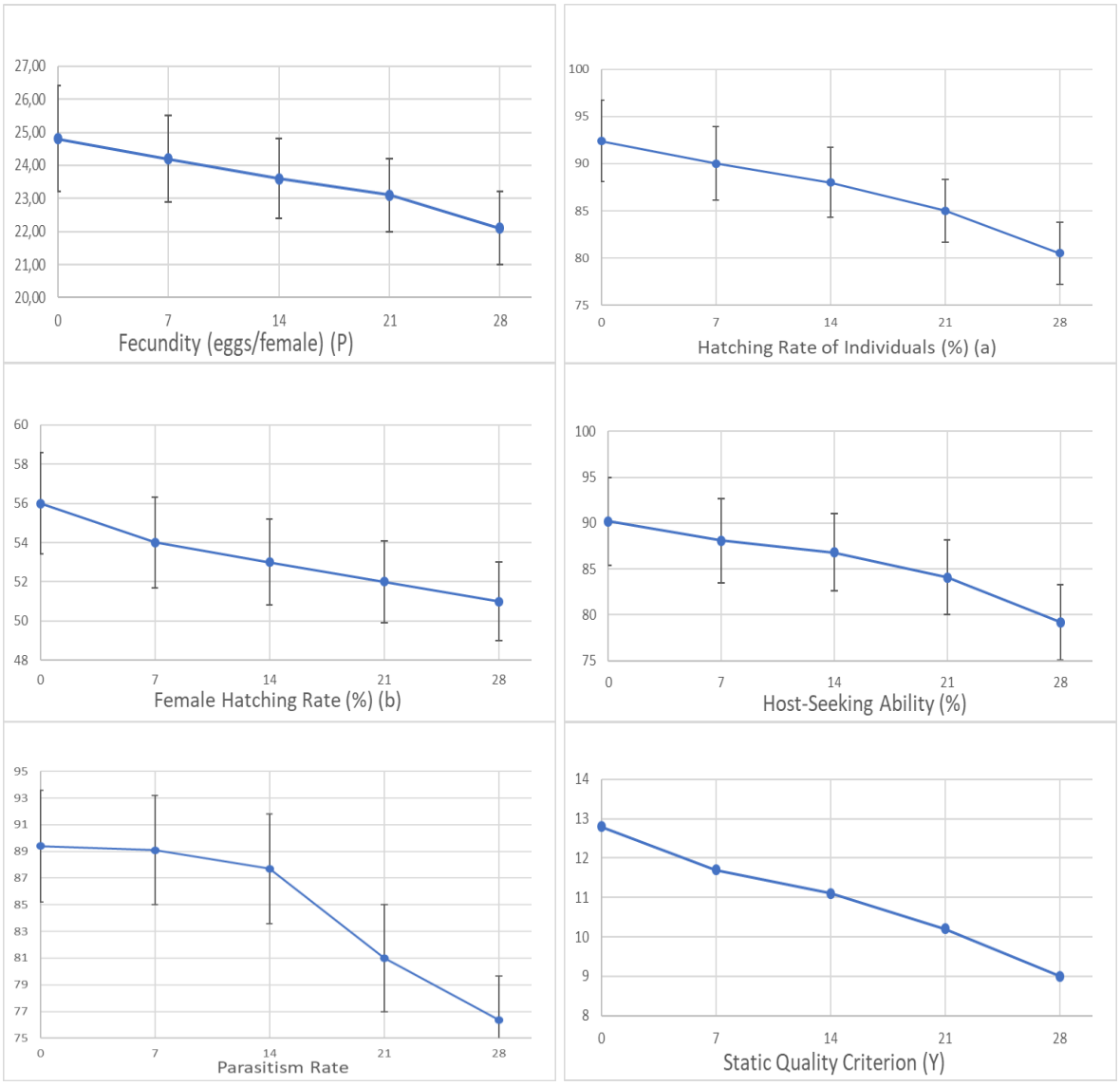


**Figure 1. Biological Indices of *T. pintoi* at Temperature 23°C–25°C**

## Storage duration of the extract

Analyzing the biological indices of the entomophage *Trichogramma pintoi* depending on the storage duration of the extract (0, 7, 14, 21, and 28 days) at a temperature of 4°C, on the following dates: 07.05.24, 14.05.24, 21.05.24,

28.05.24, and 04.06.24, a decreasing trend in biological indices was observed. The longer the storage period of the extract (28 days), the lower the values of the biological indices.

- Fecundity varied between 22.1–24.8 eggs per female.
- Hatching rate of individuals ranged from 80.5% to 92.2%.
- Female hatching rate varied between 51.0% and 56%.
- Host-seeking ability ranged from 79.23% to 90.23% in the mini-olfactometer.
- Parasitism rate varied from 76.36% to 89.43% in two-liter cylinders.
- Static quality criterion ranged from 9.0 to 12.8.

At a temperature of 26–30°C (Table 3), a decreasing trend in biological indices was also observed. The longer the storage period of the extract (28 days), the lower the values of the biological indices.

- Fecundity ranged from 22.1 to 23.3 eggs per female.
- Hatching rate of individuals varied between 75.5% and 85.0%.
- Female hatching rate ranged from 50.0% to 54.0%.
- Host-seeking ability varied between 82.1% and 85.6% in the mini-olfactometer.
- Parasitism rate ranged from 76.9% to 87.0%.
- Static quality criterion ranged from 8.3 to 10.7.

At a temperature of 23–25°C, the biological indices of *Trichogramma pintoi* were slightly higher than those recorded at 26–30°C, as the optimal developmental conditions for *T. pintoi* fall within the temperature range of 23–25°C.

**Table 3. Implementation of the experimental plan, 2024**

**Temperature = 26°C – 30°C**

| Biological indices of *Trichogramma pintoi* V. | | | | | | |
|---|---|---|---|---|---|---|
| **Duration of extract storage (days)** | **Fecundity (eggs/female) (P)** | **Hatching rate of individuals (%) (a)** | **Female hatching rate (%) (b)** | **Host-seeking ability (%)** | **Parasitism rate** | **Static quality criterion (Y)** |
| 0 | 23.3±1.5 | 85.0±4.0 | 54±2.5 | 85.6±3.7 | 87.0±3.5 | 10.7 |
| 7 | 23.0±1.4 | 83.0±3.8 | 53±2.4 | 85.2±3.5 | 80.9±3.3 | 10.1 |
| 14 | 22.1±1.2 | 80.0±3.6 | 52±2.3 | 84.3±3.2 | 77.9±3.1 | 9.5 |
| 21 | 23.1±1.1 | 78.0±3.5 | 51±2.2 | 83.1±3.1 | 75.1±3.0 | 8.9 |
| 28 | 22.1±1.0 | 75.0±2.6 | 50±2.1 | 82.1±3.0 | 76.9±2.0 | 8.3 |
| DEM | Td=2.2-2.8>1.96=T0.05 | | | | | |

## CONCLUSIONS

Analysis of the biological indices of *Trichogramma pintoi* at 23–25°C, depending on the storage duration of the extract at 4°C, revealed a decreasing trend in biological indices. The longer the extract was stored (28 days), the lower the biological index values.

At 4°C, the biological indices varied as follows:

- Fecundity: 22.1–24.8 eggs per female
- Hatching rate of individuals: 80.5–92.2%
- Female hatching rate: 51.0–56.0%
- Host-seeking ability: 79.2–90.2% in the mini-olfactometer
- Parasitism rate: 76.36–89.4%
- Static quality criterion: 9.0–12.8

At 26–30°C, a decreasing trend in biological indices was also observed. The longer the extract storage period (28 days), the lower the biological index values.

At 26–30°C, the biological indices varied as follows:

- Fecundity: 22.1–23.3 eggs per female
- Hatching rate of individuals: 75.5–85.0%
- Female hatching rate: 50.0–54.0%
- Host-seeking ability: 82.1–85.6% in the mini-olfactometer
- Parasitism rate: 76.9–87.0%
- Static quality criterion: 8.3–10.7

At 23–25°C, the biological indices of *Trichogramma pintoi* were slightly higher than those at 26–30°C, as 23–25°C represents the optimal temperature range for the development of *T. pintoi*.

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