Studii şi Cercetări	Mai 2023	Biologie	32/2	81-86	Universitatea"Vasile Alecsandri" din Bacău

ENHANCING PEST CONTROL THROUGH BIOLOGICAL METHODS: A CASE STUDY ON *CYDIA POMONELLA* L. USING PHEROMONAL TRAPS

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Key words: *codling moth, biological methods, pheromonal traps, apple pests*

INTRODUCTION

The broadening and restructuring of biological methods of pest control is one of the future guidelines for the development of plant protection, especially in order to reduce and eliminate the pollution that can be caused by the chemical substances increasingly used to control pests (Meissle et al., 2010). The basic idea behind the notion of biological control is the biocenosis equilibrium, whereby the population level of a species (prey, host) is closely related to other species (predators, parasites, pathogens). However, this balance is fluctuating and dynamic and can be disturbed by certain agro-technical practices or by over-protection of plants with various synthetic products (Huffaker, 2012). Pheromones and hormones, as regulators of insect growth, development and behaviour, are chemical messengers and do not have a toxic action affecting their development. As transmitters of information, they deregulate the developmental programme at certain times and they also ensure more rigorous selectivity (Weinzierl et al., 2005).

Biological control methods

The basic principle of biological control is to highlight the natural mechanisms regulating the concentrations of populations of harmful organisms, maintaining the biocenosis balance whereby the population level of one species is conditioned by other species. However, this balance is variable and can be easily disturbed by some agro-technical or plant protection practices (Heimpel & Mills, 2017). Biological control research carried out internationally and in our country has been oriented in the following directions: quantitative ecology studies, knowledge of the faunal composition of different types of agrobiocenoses, establishment of the release procedure of zoophages, control by genetic methods, hormonal control and microbiological control of some pests (Bajeux et al., 2017; Bueno et al., 2010; Lewis et al., 1997).

Biological control with pheromonal traps

A trap with a specific pheromone targets only the target insect species (Karmakar et al., 2021), ultimately resulting in its elimination from its range, which can be achieved in the same or previous growing seasons. By successively capturing males, the insect population is considerably reduced until it reaches expansion. This method of control is environmentally friendly and does not cause any changes to the environment (Karmakar et al., 2021; Niogret et al., 2022; Solangi et al., 2023). Recognising when insect pests are flying most frequently is particularly important, even for those who do not consider biological crop control. By realising the flight curve, you can act with plant protection treatments even when the population density is highest (Beşleagă et al., 2013).

Description of the codling moth

With pheromone traps we can control pests such as codling moth (*Cydia pomonella*, Linnaeus, 1758) (Beşleagă et al., 2013).

Cydia pomonella L. is a member of Filum: Arthropoda; Class: Insecta; Order: Lepidoptera; Family: Tortricidae; Genus: Cydia; Species: pomonella. The species is a major pest of agricultural crops. **The egg** has a greenish-white disc configuration. Eggs are deposited singly on leaves, branches, shoots near fruit (Roşca I. et al. 2011). **The larva**, the true caterpillar, has a body 18-20 mm long when fully developed (Tălmaciu M. & Tălmaciu N., 2004). The head and pronotum are brown and the rest of the body light pink. **The pupa** is 9-12 mm long and reddish-brown (Roşca I. et al. 2011). **Adults** have a wingspan of 15-20 mm and a body length of 10-12 mm. On the dark grey forewings there are several narrow, dark grey transverse bands. In the apical region of the forewings there is an oval brown spot with metallic sheen, crossed by three golden sinuous lines. The hindwings are reddish-brown with coppery highlights (Tălmaciu M. & Tălmaciu N., 2004).

In most parts of the country, the species has two generations per year and, exceptionally, can have three generations. As a fully developed larva, it overwinters in a silky cocoon under partially exfoliated tree bark. In spring it pupates. The first butterflies fly in late April, a few days later they mate and the females lay eggs, from which the larvae hatch after 6-13 days (Boboc et al., 2019; Paraschiv et al., 2019). The hatched larvae are in search of fruit to reach the seed lodges and consume the seeds. After about a month, the adult larvae migrate under

the exfoliated bark of trunks and branches, where they pupate in a silky cocoon. In the first half of July, the adults of the first generation emerge, their flight being staggered until August. The females lay their eggs directly on the fruit, resulting the second generation. After mid-August, the larvae leave the attacked fruit and retreat under the exfoliated bark for the winter (Simpson, 1903). By utilizing pheromone traps placed in the apple orchard, the method of mass male capture facilitated the investigation and monitoring of populations (Fig. 4 and 5 a,b,c). This approach allowed for forecasting pest appearances through the creation of flight curve graphs and enabled the implementation of treatments during a phase of maximum efficiency, minimizing adverse environmental impacts.

MATERIALS AND METHODS

Field observations were carried out at regular intervals, every two days, from 1 April to 13 June 2023, in the apple orchard located in the village of Fântânele, Bacău County (GPS coordinates: 46°36'01.6 "N 26°51' 10.2 "E).

Insect trapping was carried out using Delta-type pheromone traps, specifically using atraPOM pheromones to target males of *C. pomonella* L. For precise species identification, the guides by Ivascu A. (2009), Porca M.M. & Oltean I. (2004) and Gilligan T.M. & Epstein M.E. (2014) were also consulted. Mean temperatures and precipitation were recorded consistently throughout the study period to provide valuable environmental background information.

All data were recorded in an observation notebook and numerous photographs were taken to visually document important aspects of the research and to aid in the analysis of the study results.

RESULTS AND DISCUSSIONS

Following the assembly of the traps, they were fixed on the branches of the apples trees from orchard. The pheromone's effectiveness lasts for a duration of 6-8 weeks. After this period, the used nads should be replaced with spare ones, which are stored in a refrigerator at temperatures between 0-4°C until they are needed (Fig. 4 and 5 c). Observations were made every two days, during which catches were recorded and the surface also inspected for adhesion to avoid dust, dirt or excessive catches. In case of bad weather conditions or intense insect activity, the trap were either cleaned or the sticky surface was replaced.

The pheromone trap was set up on April 1 (Fig. 4-6) when the initial air temperature was 7°C, this day also marking the start of pest monitoring observations. During the monitoring period until May 10, weather conditions from study area wase characterized by snow, heavy rain, and strong winds. These conditions are described as unfavorable for the biology of *C. pomonella*. by Alston & Reding (2011), the optimum temperature being between 10°C and 31°C. the presence of unfavorable weather conditions, particularly temperatures outside the optimal range, may have influenced the activity and behavior of *C. pomonella,* resulting in no captures in the pheromone trap during that time (Fig.1). Understanding the specific timing of pest activity, as influenced by temperature and weather conditions, is crucial for pest management and agricultural practices.

The first males of *C. pomonella* were captured between May 10 and May 20 (Fig. 3). This timeframe corresponds to the early spring period, suggesting that codling moths become active relatively early in the growing season. The air temperature gradually increased to 18°C during the period when the first males were captured (Fig. 1). This observation aligns with existing research that demonstrates how temperature plays a crucial role in influencing the behavior of *C. pomonella* (Chidawanyika & Terblanche, 2011). Insects, including codling moths, are ectothermic, meaning their activity and development are strongly influenced by external temperatures. Warmer temperatures often signal the onset of favorable conditions for flight and other activities (May, 1979). Understanding the relationship between temperature and codling moth flight is valuable for pest management in orchards. Changes in temperature patterns due to climate change can potentially alter the timing and duration of codling moth flight, which may have implications for pest management strategies in the long term.

Figure 2 highlights the variability in rainfall values and we make a connection between rainfall and the appearance of butterflies. The butterflies began to appear as rainfall decreased. Favorable conditions for butterfly emergence are contained within a range of less than 3 mm of rainfall, with 0 mm being the most optimal. Pitcairn et al. (1990) support the idea that minimal rainfall conditions are optimal for butterfly emergence. The observed relationship between rainfall and butterfly appearance has ecological implications. It suggests that *C. pomonella*, like many other insects, are influenced by environmental factors such as rainfall.

Figure 3 describes a seasonal flight pattern of *C. pomonella* L., indicating that the intensity of flight begins around May 20 and continues for approximately three weeks until mid-June. This observation aligns with the typical behavior of codling moths, which are known to be active during the late spring and early summer months (Alston & Reding, 2011; Beşleagă et al., 2013). the number of moths catches steadily increases during this period. By mid-June, the number of captured males reaches 13 per trap (Fig. 7).

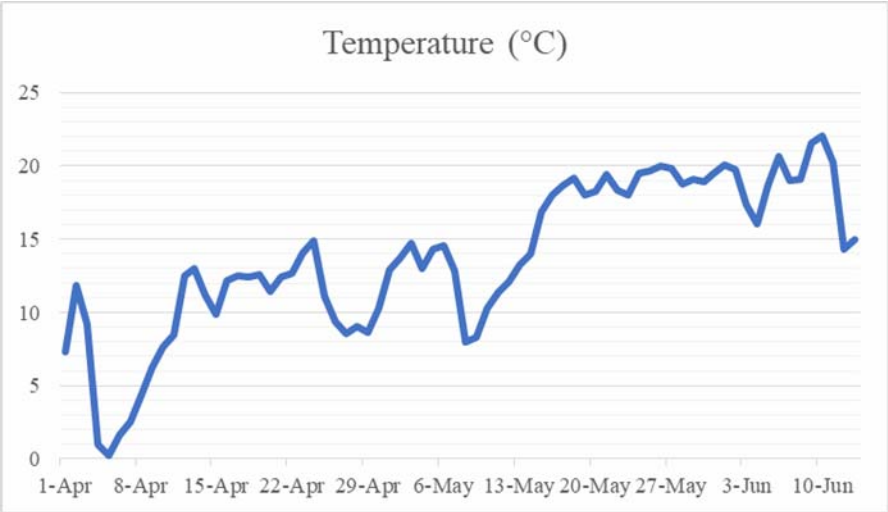

Fig. 1. Spring 2023 Conditions Study (April-June)

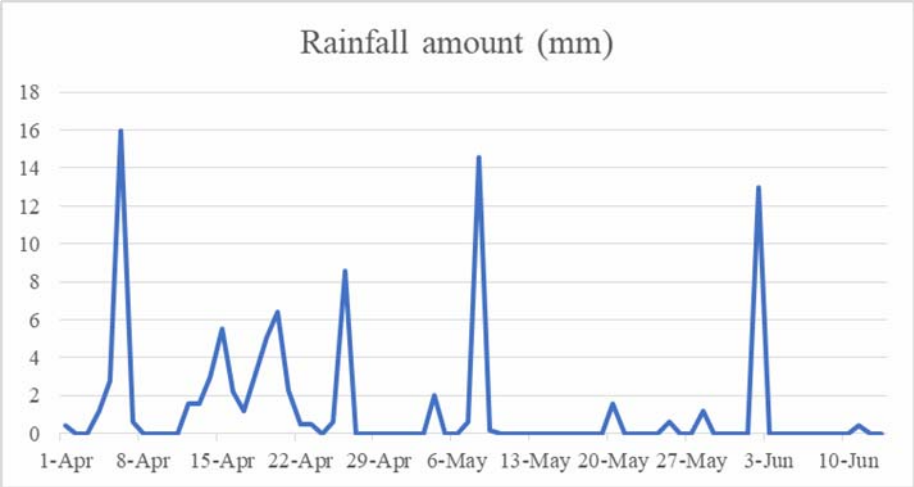

Fig. 2. Precipitation value for the period 1 April – 13 June 2023

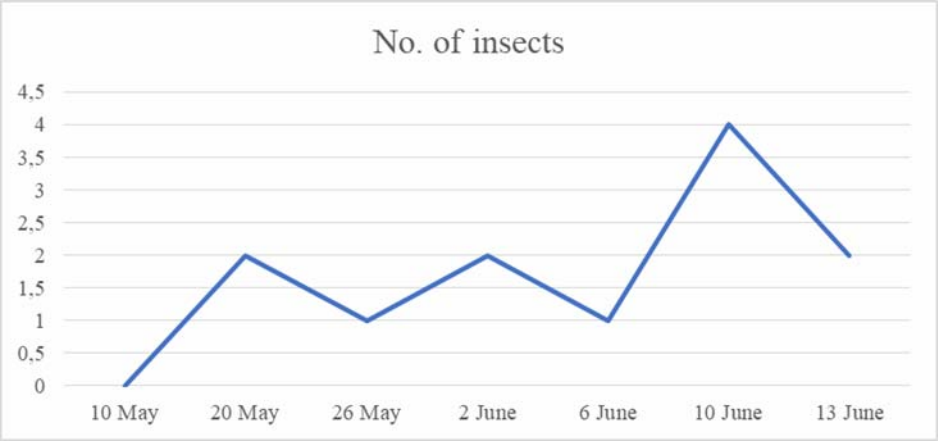

Fig. 3 . Pheromone trap monitoring and flight curve tracking of the pest *Cydia (Laspeyresia) pomonella*

Fig. 4. The apple tree in the orchard (original photo)

Fig. 5-a. Kit – Trap (original photo)

Fig. 5-b. Valves with adhesive surface (original photo)

Fig. 5-c. Pheromone attractant atraPom (original photo)

Fig. 6. Two adult males of *C. pomonella* caught using the tetratrap pheromone trap 20 May (original photo)

Fig. 7. Adult males of *C. pomonella* caught using the tetratrap pheromone trap on 13 June (original photo).

This progressive increase in catches reflects the emergence and increasing activity of adult males in the area. Understanding the timing of codling moth flight is essential for orchard management. The use of pheromone traps to monitor codling moth flight is a common and effective practice in IPM strategies. These traps attract and capture male moths, providing valuable data on the presence and activity of the pest.

Pheromone traps are a valuable tool for tracking the presence and activity of specific pests, allowing for timely interventions. Codling moth is a well-known pest in apple orchards, as its larvae can cause damage to apple fruits by tunneling inside them. According to observations made in apple orchards owned by SC Service SRL Deleşti-Vaslui, the weather patterns play a crucial role in pest infestations. The observation that researcher have made in 2017 indicates that the pest had favorable conditions for reproduction, because there were two generations of *C. pomonella*. Early detection of pest populations allows for more precise and effective phytosanitary treatments. This proactive approach can help minimize pest damage and reduce the need for excessive pesticide use (Tălmaciu et al., 2018).

CONCLUSIONS

The future development of plant protection should focus on the broadening and restructuring of biological methods of pest control. This implies a shift away from heavy reliance on chemical substances and towards more environmentally friendly approaches. The use of pheromone traps for biological control of pests, specifically codling moth (*C. pomonella*), is highlighted as an environmentally friendly and effective method. This novel approach targets specific insect species and can result in the elimination of pests without causing harm to the environment.

The data presented in this paper, underscores the intricate relationship between weather conditions, temperature, and the behavior of the codling moth in orchards. It emphasizes the importance of precise pest monitoring using pheromone traps and the potential influence of climate change on pest management strategies. This information contributes to more effective and environmentally sustainable orchard management practices, aiming to minimize pest damage while reducing the ecological footprint of pest control measures.

ABSTRACT

This paper outlines the shift to forward-looking biological methods of pest control to address environmental concerns arising from chemical use. Biological control relies on the balance of species interactions, which can be disrupted by agro-technical practices or excess chemicals. Pheromones and hormones regulate insect behaviour without toxic effects, contributing to selectivity. Biological control research includes various strategies such as faunal composition studies and pheromone traps targeting specific pests. Pheromone traps, which use species-specific compounds, effectively reduce insect populations while maintaining ecological balance. Recognising pest flight patterns helps both biological and non-biological strategies for optimal interventions. This study evaluates the efficacy of pheromone traps for *Cydia pomonella* L. through mass male reception, revealing correlations between flight frequency and temperature. Inclement weather delayed pest flight in 2023, while pheromone control substantially reduced attacks, maintaining crop health. This research highlights the success of pheromone traps as a sustainable pest management tool.

REFERENCES

1. ALSTON, D. G., & REDING, M. E., 2011 - Codling Moth *Cydia pomonella*.
2. BAJEUX, N., GROGNARD, F., & MAILLERET, L. (2017). Augmentative biocontrol when natural enemies are subject to Allee effects. Journal of Mathematical Biology, 74(7), 1561–1587.
3. BEŞLEAGĂ, R., TĂLMACIU, M., DIACONU, A., TĂLMACIU, N., CÂRDEI, E., & CORNEANU, G., 2013 - Control of the codling moth (*Cydia pomonella* L.) in accordance with the special evolution of biology of Iaşi county. Journal of Food, Agriculture & Environment, 11(1), 634–640.
4. BOBOC, C. I., PERJU, I., UNGUREANU, I. V., SIRBU, S., IUREA, E., GHERGHEL, M. I., & CHELARU, S. M., 2019 - Researches concerning the fight against *Cydia pomonella* L. from the apple tree plantation in the nord east area of Romania. Current Trends in Natural Sciences Vol, 8(15), 149–155.
5. BUENO, R. C. O. DE F., CARNEIRO, T. R., BUENO, A. DE F., PRATISSOLI, D., FERNANDES, O. A., & VIEIRA, S. S., 2010 - Parasitism capacity of Telenomus remus Nixon (Hymenoptera: Scelionidae) on Spodoptera frugiperda (Smith)(Lepidoptera: Noctuidae) eggs. Brazilian Archives of Biology and Technology, 53, 133–139.
6. GILLIGAN T.M. & EPSTEIN M.E., 2014 - *Cydia pomonella* (https://idtools.org/id/tortai/Cydia_pomonella.htm), data accesării 2023.
7. CHIDAWANYIKA, F., & TERBLANCHE, J. S., 2011 - Costs and benefits of thermal acclimation for codling moth, *Cydia pomonella* (Lepidoptera: Tortricidae): Implications for pest control and the sterile insect release programme. Evolutionary Applications, 4(4), 534–544.

8. HEIMPEL, G. E., & MILLS, N. J., 2017 - Biological control. Cambridge University Press.
9. HUFFAKER, C. B., 2012 - Theory and practice of biological control. Elsevier.
10. IVAŞCU A., 2009 - Ghid pentru determinarea rezistenței la boli şi dăunători.
11. KARMAKAR, S., CHAKRABORTY, R., & ANSAR, W., 2021 - Insect Pheromone: A tool in agricultural pest management.
12. LEWIS, W. J., VAN LENTEREN, J., PHATAK, S. C., & TUMLINSON III, J., 1997 - A total system approach to sustainable pest management. Proceedings of the National Academy of Sciences, 94(23), 12243–12248.
13. MEISSLE, M., MOURON, P., MUSA, T., BIGLER, F., PONS, X., VASILEIADIS, V. P., OTTO, S., ANTICHI, D., KISS, J., & PÁLINKÁS, Z., 2010 - Pests, pesticide use and alternative options in European maize production: Current status and future prospects. Journal of Applied Entomology, 134(5), 357–375.
14. MAY, M. L., 1979 - Insect thermoregulation. Annual review of entomology, 24(1), 313-349.
15. NIOGRET, J., EKAYANTI, A., & ZHANG, A., 2022 - Sex pheromone of cocoa pod borer, Conopomorpha cramerella: Field activity evaluation of pheromone formulations in an Indonesia plantation. Insects, 13(8), 663.
16. PARASCHIV, M., HORNOIU, S., CHIŞ, C., & VÎRTEIU, A., 2019 - The flight of codling moth (Cydia pomonella Linnaeus, 1758) population in apple orchards in Săliştea (Alba: Romania). Research Journal of Agricultural Science, 51(4), 121–126.
17. PORCA M. M., OLTEAN I., 2004 - Ghid practic pentru recunoaşterea dăunătorilor plantelor de cultură.
18. PITCAIRN, M. J., ZALOM, F. G., & BENTLEY, W. J., 1990 - Weather factors influencing capture of *Cydia pomonella* (Lepidoptera: Tortricidae) in pheromone traps during overwintering flight in California. Environmental Entomology, 19(5), 1253–1258.
19. ROŞCA I., I. OLTEAN, I. MITREA, M. TĂLMACIU, D.I. PETANEC, H.Ş. BUNESCU, ISTRATE RADA, TĂLMACIU NELA, C. STAN, MICU LAVINIA MĂDĂLINA, 2011 - Tratat de entomologie generală şi specială. Editura "Alpha MDN", Buzău.
20. SIMPSON, C. B., 1903 - The codling moth (Issue 41). US Department of Agriculture, Division of Entomology.
21. SOLANGI, B. K., SHAHWANI, N. A., KHAN, M., HUSSAIN, B., BANGULZAI, G. R., ADNAN, F., AMIN, M., KHAN, M., KHAN, A. W., & IQBAL, S., 2023 - Fruit fly and their management by IPM techniques in Balochistan. Pure and Applied Biology. Vol. 12, Issue 2, pp1224-1233.
22. TĂLMACIU, N., HEREA, M., CROITORU, N., & TĂLMACIU, M., 2018 - Observations on Cydia Pomonella (apple worm) dynamics in the apple orchards and warning about chemical treatments.
23. TĂLMACIU M., TĂLMACIU N., 2004 - Entomologia agricolă.
24. WEINZIERL, R., HENN, T., KOEHLER, P., & TUCKER, C., 2005 - Insect attractants and traps. ENY277, Avalaible: Http://Ufdcimages. Uflib. Ufl. Edu/IR/00/00/27/94/00001/IN08000. Pdf [Accessed 23 Maret 2015].

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