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EVALUATION OF ZEUZERA PYRINA INFESTATION IN WALNUT ORCHARDS AND PROPOSAL OF AN ALTERNATIVE ECOLOGICAL CONTROL METHOD

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***Abstract**: The study assessed the impact of the xylophagous pest Zeuzera pyrina on walnut orchards in the central region of the Republic of Moldova, providing a detailed phenological and ecological profile. Monitoring of adult populations revealed an active flight period between May and August, correlated with temperatures above 25°C. Field data indicated an average infestation rate of 24.4% among the analyzed trees, with 58.1% of their branches being affected. The larvae produce galleries up to 50 cm in length, causing significant structural damage. An unusually high trophic plasticity was observed, with larvae also feeding on foliage under limiting conditions. Given the difficulty of applying contact insecticides, the study proposes an innovative ecological control method: detection of larvae using acoustic sensors and injection of a biologically active substance. This approach offers ecological, selective advantages and is compatible with modern technologies, representing a viable solution for sustainable pest management and the preservation of walnut orchard health.*

Keywords: ***ecological control, Juglans regia, phenological monitoring, larval stage, Zeuzera pyrina.***

INTRODUCTION

Zeuzera pyrina L. (Lepidoptera: Cossidae), also known as the "leopard moth" or "wood borer," is a polyphagous pest of major economic importance for orchards of apple, pear, plum, cherry, and especially walnut. Its negative impact on tree health and productivity is associated exclusively with the larval stage. Adult females, with a lifespan of 8–10 days, lay eggs in bark crevices or wounded areas of the trees, in groups of 50–200, totaling up to 800–2000 eggs over their lifetime, depending on climatic conditions and region. After an incubation period of 10–15 days, larvae hatch and penetrate the woody tissues of the host trees [1].

Newly hatched larvae initially settle in soft tissues (leaves, shoots), then bore into branches and trunks, creating ascending or labyrinthine galleries with diameters up to 7 mm and lengths exceeding 30–50 cm. These galleries severely compromise sap circulation, weaken the wood structure, and may lead to wilting or drying of branches, or even the death of young trees. The larvae also exhibit migratory behavior within the tree under favorable conditions of nighttime humidity, contributing to a high invasive potential and increased difficulty of control [2].

In studies conducted in walnut orchards in the central region of the Republic of Moldova between 2022 and 2024, a significant infestation rate was observed: on one hectare, 30% of trees were affected, with 58% of the branches on infested trees showing active galleries.

The biological cycle of *Z. pyrina* varies by region: in temperate areas it is predominantly biennial, while in warmer regions it can be completed within a single year. The pest overwinters in the larval stage inside the galleries. In the central region of Moldova, adult flight occurs from the second decade of June to the first decade of August, with a peak in July. In 2022, this schedule was significantly delayed (starting only on July 27), a phenomenon correlated with local climatic anomalies such as low temperatures and lack of precipitation.

Population monitoring of *Z. pyrina* was carried out using pheromone traps in walnut plantations in Sadova (Călărași district) and Bubuieci (Chișinău municipality), where attraction levels were three times higher in walnut orchards than in apple orchards. These phenological data are essential for planning phytosanitary measures, as the flight period coincides with oviposition — a critical moment for preventing infestations. Monitoring adult populations serves both informative and preventive purposes, providing valuable data for determining optimal intervention times.

The main problem lies in the damage caused by Z. pyrina in its larval stage. Control measures must focus primarily on this stage, as it is the most destructive and hardest to manage — the larvae are protected inside woody tissues, making them practically inaccessible to most conventional treatments.

Unfortunately, control measures targeting the larval stage are still underdeveloped and insufficiently researched. The existing literature offers few effective solutions, and current methods — such as systemic chemical treatments or the introduction of natural parasitoids — have limited efficacy, are difficult to implement, or carry uncertain ecological impacts. Moreover, the lack of technologies well-adapted to walnut crops further limits intervention possibilities. Therefore, there is an urgent need for in-depth research into larval-stage control methods, as well as for the development of integrated, sustainable strategies that are practically applicable in commercial plantations.

MATERIALS AND METHODS

For monitoring the species Z. pyrina, Δ type pheromone traps equipped with species-specific pheromones were used to attract males. Three traps were placed in a walnut orchard of the Fernor variety (1.5 ha, Sadova, Călărași district, Republic of Moldova), at a height of 1.5–2 meters within the tree canopy, spaced evenly to ensure uniform coverage. The traps were checked weekly, and the captures were recorded and analyzed to identify peak flight periods.

The data were correlated with climatic conditions (temperature, humidity) to understand their influence on flight dynamics. Visual inspections of the trees were also

conducted to detect larval galleries and specific symptoms of infestation (bored branches, dried shoots). The collected information allowed for the determination of the optimal timing for implementing control measures.

RESULTS AND DISCUSSIONS

The study dedicated to assessing the impact of *Zeuzera pyrina* on walnut (*Juglans regia* L.) orchards in the central region of the Republic of Moldova enabled the development of a detailed phenological and ecological profile of this xylophagous species, with significant implications for tree health and plantation productivity. Monitoring the dynamics of adult populations revealed that the flight of male moths consistently begins in the third decade of May and remains active until the second decade of August, with a peak recorded in July. Adult activity is closely correlated with the thermal regime of the period, being favored by stable temperatures above 25°C and calm, windless nights—conditions that facilitate mating and oviposition behaviors.

Analysis of pheromone traps indicated an average capture rate of three males per trap per week, which, although seemingly low, must be interpreted in the context of the species' cryptic and endophagous nature—where the larval stage is the destructive component of the biological cycle.

Field data regarding the infestation level showed that, on average, 24.4% of the analyzed trees were affected by Z. pyrina larvae, indicating that nearly a quarter of the tree population is under significant biotic stress. A detailed analysis of the main branches of affected trees revealed that approximately 58.1% of branches showed clear signs of infestation, indicating not only the presence of larvae but also active damage, directly impacting the conductive vessels and woody tissues of the tree. Proportionally, this translates into about 14.2% of the total number of branches at the plantation level being damaged by this insect, a value relevant for estimating the decline in photosynthetic capacity and overall productivity of the orchards.

Each infested tree showed, on average, between 3 and 5 larval galleries, each ranging from 15 to 30 cm in length, with severe cases reaching up to 50 cm. Assuming a conservative average of 4 galleries per tree and a gallery length of 25 cm, one infested tree can suffer approximately 1 linear meter of dislocated woody tissue—equivalent to significant internal damage compromising the tree's structural integrity and sap flow (both raw and elaborated). These injuries are often accompanied by visible external perforations (1–5 per tree), appearing as circular holes 5–20 mm in diameter, serving as both entry points and exits for frass and wood debris.

An interesting and ecologically important observation is the larvae's ability to shift their food source depending on availability. During periods when woody resources are limited or inaccessible — either due to high larval density or severe tree weakening— they may switch to feeding on foliage. This behavior can significantly damage leaves, indirectly impairing photosynthesis. Such trophic plasticity is remarkable and requires a

reevaluation of control strategies, as not only the woody structure but also the tree's overall vitality is at risk. Moreover, foliar feeding in the later part of the season may compromise carbohydrate reserve accumulation necessary for overwintering, reducing the tree's resilience during the cold season.

Furthermore, analysis of the ratio of galleries to the number of main branches revealed that, on average, 50.8% of the primary branches of an infested tree were affected, indicating that the damage is diffuse and not localized—making it harder to isolate and treat. In a typical tree with five main branches, where three are infested and each has an average of two galleries, this results in 6–10 infestation channels per tree — a density sufficient to compromise long-term tree development.

Another revealing aspect is that late-stage larvae are largely inaccessible to contact treatments, as they are sheltered deep within the wood. This biological adaptation makes Z. pyrina a highly resilient pest, requiring systemic or innovative biological control solutions, such as the introduction of entomopathogenic nematodes or specific predators. Preliminary pheromone trap data also suggest the presence of predator species that could be utilized in integrated biological control.

An effective strategy for controlling xylophagous pests like Z. pyrina involves using modern detection technologies and precisely applying biological agents. The proposed method involves locating larvae within branches using a device equipped with acoustic vibration sensors, capable of accurately identifying larval galleries [3]. Such systems have already been developed and tested for detecting other wood-boring insects.

Subsequently, in infested zones, a controlled injection of a biologically active substance can be carried out, with a dual purpose:

- To attract the larva to the injection site through chemical signals that mimic the composition of preferred plant tissues;
- To release, upon contact, a biocidal compound or pathogenic biological agent, such as a granulovirus specific to lepidopteran larvae [4], or an entomopathogenic fungus (e.g., *Beauveria bassiana*) [5], enzymes, or volatile proteins mimicking natural phloem/xylem signals [6, 7].

Consequently, the larva is lured to the injection point, comes into contact with the active agent, and is neutralized inside the gallery. Alternatively, if drawn to the surface, it can be mechanically removed or locally destroyed [8].

This method offers several advantages:

- Minimally invasive – does not require bark removal or branch cutting, preserving tree integrity;
- Ecological – eliminates the need for synthetic insecticides;
- Selective – attractant enzymes and biological agents can be tailored to target *Z. pyrina* specifically;
- Compatible with precision technology – well-suited for modern, sustainability-focused orchards.

Implementing this method could represent a major step forward in developing

smart, sustainable, and environmentally efficient agriculture.

CONCLUSIONS

Zeuzera pyrina is an especially dangerous wood-boring pest for walnut orchards in central Moldova, affecting tree health and plantation productivity. Its activity, with a flight peak in July, is closely linked to favorable climatic conditions, allowing the synchronization of monitoring and control interventions. The high infestation level observed in the field and the severity of the damage caused confirm the significant impact of this pest.

The endophagous larvae cause severe damage by boring into branches, impairing the trees' physiological functions and leading to losses in vitality and yield. Furthermore, the larvae's trophic adaptability and the inefficiency of conventional contact treatments highlight the need for innovative solutions.

In this context, modern methods such as acoustic detection and targeted injection of biological agents, combined with technology based on attracting and eliminating larvae using specific organisms, offer ecological, effective, and sustainable alternatives for protecting walnut orchards.

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REFERENCES

1. GARDENER, Y. Leopard Moth – "Zeuzera pyrina". Organic Seeds, [accessed 20.05.2025]. Available: https://organicseeds.top/zeuzera_pyrina
2. SEDQ. Zeulab – Sedq healthy crops. Sedq.es, 30.04.2024 [accessed 20.05.2025]. Available: https://sedq.es/en/producto/zeulab
3. MANKIN, R.W. Applications of acoustics in insect pest management. In: CAB Reviews, 2012, vol. 7, nr. 020, pp. 1–7. ISSN 1749-8848.
4. BUTT, T.M., JACKSON, C., MAGAN, N. Fungi as biocontrol agents: progress, problems and potential. Wallingford: CABI Publishing, 2001. 390 p. ISBN 978-0-85199-356-0.
5. LACEY, L.A., KAYA, H.K. Field manual of techniques in invertebrate pathology. Dordrecht: Springer, 2007. 868 p. ISBN 978-1-4020-5932-2.
6. BRUCE, T.J.A., PICKETT, J.A. Perception of plant volatile blends by herbivorous insects – finding the right mix. In: Phytochemistry, 2011, vol. 72, nr. 13, pp. 1605–1611. ISSN 0031-9422.
7. COOK, S.M., KHAN, Z.R., PICKETT, J.A. The use of push–pull strategies in integrated pest management. In: Annual Review of Entomology, 2007, vol. 52, pp. 375–400. ISSN 0066-4170.
8. VEGA, F.E., KAYA, H.K. Insect pathology. 2nd ed. Amsterdam: Academic Press, 2012. 508 p. ISBN 978-0-12-384984-7.