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THE ROLE OF THE PARASITOID *HYPOSOTER DIDYMATOR* (Thunberg) IN REGULATING POPULATIONS OF *HELICOVERPA ARMIGERA* (Hübner)

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KEYWORDS

Hyposoter didymator
Helicoverpa armigera
Parasitoid
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ABSTRACT

It was demonstrated that the entomophage *Hyposoter didymator* is present and active in tomato agroecosystems in the Republic of Moldova, playing a significant role in the natural regulation of *Helicoverpa armigera* populations. The parasitoid shows a clear preference for third-instar larvae, followed by second instar, while first-instar larvae are less frequently parasitized. Parasitism leads to strong inhibition of host growth and feeding activity, significantly reducing food consumption and crop damage. The relatively short developmental cycle (approximately 14 days) highlights the species' adaptation to local agroclimatic conditions. The results confirm the ecological and practical value of *H. didymator* as a biological control agent in integrated pest management strategies.

INTRODUCTION

The species *Helicoverpa armigera* (Hübner, 1808) is one of the most polyphagous and dangerous pests of agricultural and vegetable crops in temperate regions. Its larvae feed on more than 180 host plant species, causing significant damage to tomato, maize, soybean, sunflower, cotton, and other crops (European and Mediterranean Plant Protection Organization [EPPO], 2022). In the Republic of Moldova, over the last decade, the intensification of adult (imago) activity and the increase in the number of generations per year have been directly influenced by climatic conditions, which favor pest development and the expansion of its ecological range (Nastas et al., 2023).

Under these conditions, plant protection methods based exclusively on chemical treatments are gradually losing their effectiveness. Therefore, biological control, through the utilization of natural entomophages, is gaining increasing importance. Among the most effective biological agents associated with *H. armigera* is the parasitoid *Hyposoter didymator* (Thunberg, 1822). This species belongs to the family Ichneumonidae, known for its ability to naturally reduce larval densities of pests in numerous agroecosystems across the Mediterranean region, the Near East, and Central Asia (Șimșek et al., 2018; Morales et al., 2007).

H. didymator is a solitary endophagous parasitoid, whose females lay eggs inside the larvae of *H. armigera* (usually in instars I–III). The entomophage larva develops within the host, gradually feeding on its tissues and causing the cessation of growth and feeding of the host larva.

This preference is explained by the suitable size of the host larva and the sufficient nutritional reserves required for complete parasitoid development.

In the Republic of Moldova, studies on the behavior of *H. didymator* are limited. However, our recent observations conducted under field conditions in tomato crops, as well as under controlled laboratory conditions, confirm the biological activity of this species on *H. armigera* larvae.

The aim of the present study is to highlight the role of the entomophage *H. didymator* in regulating the population density of *Helicoverpa armigera* under current agroclimatic conditions in the Republic of Moldova, by correlating morphological and behavioral observations from field and laboratory studies with data from the scientific literature.

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MATERIALS AND METHODS

The research was conducted during 2025 in a tomato crop (*Solanum lycopersicum* L.) located in the central region of the Republic of Moldova. The experimental plot was monitored throughout the growing season for both the pest *Helicoverpa armigera* (Hübner) and the entomophage *H. didymator* (Thunberg), in order to estimate the natural parasitism potential.

Larvae of *H. armigera* were manually collected from leaves, inflorescences, and fruits at different phenological stages of the crop. The larvae were transported to the laboratory and placed individually in transparent containers with a volume of 100 ml. As a feeding substrate, larvae were provided with both artificial diet and natural food (fresh tomato leaves and fruits).

Each larva was subjected to daily visual and behavioral analysis to identify signs of parasitism: pale coloration, reduced mobility, decreased feeding activity, and delayed development. Suspected larvae were maintained until pupation, and pupae were examined under a binocular microscope to confirm the presence of parasitoid pupae.

Under controlled laboratory conditions, after obtaining adults of *H. didymator*, additional experiments were conducted to determine female parasitization preferences toward *H. armigera* larvae. Three experimental variants were established, corresponding to larval instars I, II, and III. In each variant, larvae of the respective age and experienced ovipositing females of *H. didymator* were introduced, and parasitization behavior was observed.

The results showed that third-instar larvae were the most preferred, followed by second-instar larvae, while first-instar larvae were rarely parasitized.

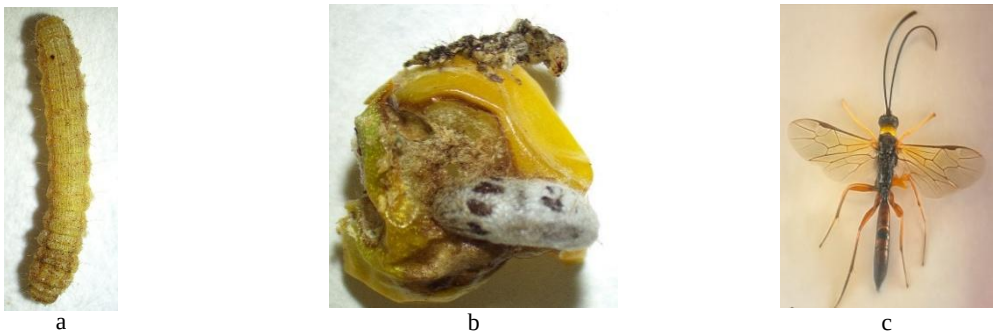
The development of the entomophage from egg deposition to pupation lasted on average approximately 14 days (±1 day), depending on ambient temperature. After pupation, the adult emerged within approximately two days, confirming rapid development under favorable laboratory conditions.

The methodology for larval collection and observation was adapted after Şimşek and Kondur (2018), who used first–third instar larvae of *H. armigera* under controlled conditions (25 ± 1°C, humidity 65 ± 5%) to determine parasitization preference. In the present study, laboratory conditions were similar, with temperatures maintained between 24–26°C and relative humidity between 60–70%.

The obtained results were comparatively analyzed, focusing on the consistency between field and laboratory observations, as well as their correlation with published scientific data.

RESULTS AND DISCUSSION

During monitoring of tomato crops, *H. armigera* larvae showing clear morphological signs of parasitism were identified. These larvae were distinguished by a paler coloration compared to healthy larvae, with a diffuse greenish or yellowish tint, reduced mobility, and significantly decreased feeding activity. In the final stages of infestation, larvae exhibited slow movements, were unable to feed actively, and often remained in the same larval stage for extended periods (Figure 1).



a b c

Figure 1. Stages of parasitism of *Helicoverpa armigera* larvae by *Hyposoter didymator*
a. parasitized larva; b. silken cocoon; c. adult.

Under controlled laboratory conditions, the presence of the parasitoid *H. didymator* was confirmed by obtaining characteristic pupae, light brown to greyish-brown in color, observed both inside host larval remains and on the substrate. After approximately 14 days from egg deposition, the entomophage larva pupated, and the adult emerged on average two days later. This rapid development reflects a high adaptability of the species to local thermal conditions (24–26°C).

Laboratory experiments on parasitization preference showed that females of *H. didymator* exhibited a clear preference for third-instar larvae of *H. armigera*. These were parasitized most frequently, followed by second-instar larvae, while first-instar larvae were parasitized insignificantly.

This behavior confirms literature data (Şimşek et al., 2018), which report a parasitization rate of approximately 52% for third-instar larvae, compared to 32% for second instar and only 16% for first instar.

Table 1. **Parasitization preference of *Hyposoter didymator* females according to the larval instar of the pest *Helicoverpa armigera* under laboratory conditions**

Larval instar of *H. armigera*	No. of larvae exposed	No. of parasitized larvae	Parasitized larvae (%)	Duration of entomophage development (days)	Main morphological observations
I	30	5	16.7	13–15	Small size, active mobility, low resistance to oviposition
II	30	10	33.3	13–14	More robust larvae, moderately accepted by *H. didymator* females
III	30	16	53.3	12–13	Resistant integument, optimal nutritional volume, intense parasitization
Mean	30.0	10.3	34.4	12.7 – 14.0	Major preference for third-instar larvae

This preference is explained by host body size and available nutritional resources. First-instar larvae have a thin cuticle and limited internal structure, making ovipositor insertion difficult and limiting parasitoid development. In contrast, third-instar larvae provide sufficient tissue volume and optimal conditions for endoparasite development.

The development of parasitized larvae was significantly reduced, and food consumption decreased visibly within the first days after oviposition. This metabolic inhibition is characteristic of endophagous parasitoids and is caused by biologically active substances that regulate host growth while maintaining a stable internal environment for the entomophage.

Similar phenomena have been reported by Morales et al. (2007) and Kumar et al. (1992), who showed that host larvae (*Spodoptera littoralis*) parasitized by *H. didymator* reduced food intake by more than 50% and lost up to 13% of body weight within 5-6 days.

In tomato crops, active parasitization of young larvae significantly contributes to reducing pest population density and, consequently, crop damage.

Comparison with international scientific literature confirms that *H. didymator* plays a major ecological role in the natural regulation of *H. armigera* populations. Parasitization of early larval stages prevents reaching the economic threshold of damage and reduces the need for chemical treatments, representing a valuable component of integrated pest management. This preference is explained by host body size and available nutritional resources.

First-instar larvae have a thin cuticle and limited internal structure, making ovipositor insertion difficult and limiting parasitoid development. In contrast, third-instar larvae provide sufficient tissue volume and optimal conditions for endoparasite development.

CONCLUSIONS

1. It was demonstrated that the entomophage *H. didymator* is present and active in tomato agroecosystems in the Republic of Moldova, playing a significant role in the natural regulation of *Helicoverpa armigera* populations;
2. The parasitoid's ability to attack young host larvae was confirmed, with a clear preference for third instar, followed by second instar, while first-instar larvae were parasitized to a lesser extent;
3. Parasitism of *H. armigera* larvae by *H. didymator* leads to a pronounced inhibition of host growth and feeding activity, resulting in reduced food consumption and decreased damage to tomato crops;
4. The relatively short developmental cycle of the entomophage (approximately 14 days) indicates strong adaptation to current agroclimatic conditions in the Republic of Moldova;
5. The obtained results are consistent with international scientific literature and confirm the ecological and practical value of *H. didymator* as a biological control agent within integrated plant protection strategies.

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