Journal of Scientific Research and Reports

Volume 30, Issue 8, Page 729-734, 2024; Article no.JSRR.120886
ISSN: 2320-0227

Evaluation of the Parasitic Potential of Pupal Parasitoid, *Nesolynx thymus* (Hymenoptera: Eulophidae) During Different Seasons for Biological Control of Uzi Fly

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i82293

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/120886

Original Research Article

Received: 05/06/2024
Accepted: 09/08/2024
Published: 13/08/2024

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Cite as: *Chakraborty, Rushali, Dipankar Brahma, Nilav Ranjan Bora, Roshmi Borah Dutta, Jugabrat Sarma, and Abhigyan Rajkhowa. 2024. "Evaluation of the Parasitic Potential of Pupal Parasitoid, Nesolynx Thymus (Hymenoptera: Eulophidae) During Different Seasons for Biological Control of Uzi Fly". Journal of Scientific Research and Reports 30 (8):729-34. https://doi.org/10.9734/jsrr/2024/v30i82293.*

ABSTRACT

The study was conducted during October 2021 to May 2022 in the laboratory of department of Entomology, AAU, Jorhat and in the experimental rearing room of College of Sericulture, Titabor, AAU, Jorhat. The endo parasitic uzi fly can cause significant crop losses in muga and mulberry silkworm, necessitating effective pest management strategies. A black scar in the silkworm body is the main characteristics symptoms of uzi fly attack. The present study investigated on parasitic potential of the gregarious pupal parasitoid, Nesolynx thymus (Eulophidae), on the Uzi fly. Present study revealed that N. thymus effectively parasitized the Uzi fly pupae, with higher parasitization rates during the autumn season (63%) compared to spring (47%). Notably, younger pupae (1-2 days old) were more preferred for oviposition, with parasitization rates reaching 68.33% and 65%, respectively. The study also documented the presence of predatory ants, Oecophylla smaragdina, which preyed upon the Uzi fly maggots and eggs.

Keywords: Muga; uzi fly; Nesolynx thymus; biological control; parasitization.

1. INTRODUCTION

Silkworm is infested by several pests viz., Uzi fly, dermistid beetle, earwigs, ants, etc. The Uzi fly, *Exorista bombycis*, is a major pest in sericulture which belongs to the Dipteran family Tachinidae., particularly infesting the domesticated silkworm *Bombyx mori* Linn. The history of the uzi fly infestation in India goes back centuries and highlights the ongoing threat to sericulture [1]. The female Uzi fly lays on the inter-segmental region of the dorsal surface of the silkworm body. When the eggs hatch, they emerge from the operculum which faces the silkworm body, and penetrate the larval body leaving a black scar behind [2]. Inside the silkworm body, the maggots complete their three larval instars while feeding on the fat bodies. After larval development, larvae pupate on the host body, adults emerge and the cycle continues [3]. The primary distinguishing features of an infestation with Uzi flies are a black scar on the larval body and an emerging hole on the cocoons. Biologically, infected silkworms exhibit several symptoms. These include reduced mobility and abnormal behavior. The parasitized silkworms may spin cocoon but ultimately die as the uzi fly larvae develop within their bodies.

Over-reliance on insecticides has led to resistance and environmental residues [4]. Integrating cultural and biological control measures can be effective in controlling pests without endangering the environment. This can be achieved through the use of biocontrol agents, botanochemicals, and behavior-modifying chemicals. *Nasonia* and *Spalangia* species are effective parasitoids for managing houseflies in manure pits and poultry sheds[5,6]. The *N. thymus* effectively reduce housefly populations in poultry and dairy units, highlighting its potential as a sustainable biological control agent [7]. Biological control can be enhanced by weekly releases of laboratory-reared parasitoids, as well as cost reduction by recycling parasitoids. Keeping all the factors in mind the study has been conducted to evaluate the Gregarious Pupal Parasitoid *Nesolynx thymus* (Hymenoptera: Eulophidae) for Biological Control of Uzi Fly.

Uzi fly infestations occur throughout the year, but their intensity varies by seasons. The rainy season experiences the highest infestation rates and in the Winter season moderate levels of infestation. During summer, although lower than other seasons, the incidence of Uzi fly infestation remains significant. The study on uzi fly infestation during silkworm rearing in West Bengal under different seasons revealed higher infestation in rainy season, followed by summer, with almost negligible infestation in winter [8]. This seasonal pattern suggests that environmental factors play a crucial role in the population dynamics of Uzi flies [9]. Uzi fly infestations result in significant economic and biological impacts on silkworm populations. Economically, these infestations can lead to a substantial reduction in silk yield, ranging from 10% to 40% [10].

2. METHODOLOGY

The experiment was conducted during October 2021 to May 2022 in the laboratory of department of Entomology, AAU, Jorhat and in the experimental rearing room of College of Sericulture, Titabor, AAU, Jorhat. Fresh pupa of Uzi fly in a Petri plate was kept outside the rearing room to observe the natural enemy

infestation. Observation of pupa was done periodically at a time interval of 4 hours in a day (8 AM, 12 PM, 4 PM). If natural enemies were found on the pupae, they were collected and kept in glass chimneys for further study. Based on three observations, data was collected. Additionally, any natural enemies that attacked the eggs during the incubation period or the maggots when they emerged from the silkworm body in search of a pupation site were also collected and kept in glass chimneys for further observation. Different ages of the pupa of Uzi fly i.e., 1 day, 2 days old, 4 days old, 6 days old, 8 days old, 10 days old, 12 days old and 14 days old pupa were allowed to oviposit by natural enemies. 20 numbers pupa of each age group were kept in each Petri plate and the data was obtained from 3 observations in each age group. The mean of the 3 observations and the standard error of the mean were calculated.

3. RESULTS AND DISCUSSION

One pupal parasitoid was seen to infest the Uzi fly pupa when the pupae were kept outside the rearing house. They were small hymenopteran parasitoids identified as *Nesolynx thymus* belongs to the family Eulophidae of the order Hymenoptera by following the identification key and references of earlier published paper [11]. They were gregarious. The adult female laid eggs on the Uzi pupa and then the larva penetrates the pupa and came out as adult. They were seen laying their eggs mainly on the intersegmental region of the Uzi fly pupa. The eggs were creamy white in color. The percent Parasitization was found to be high in autumn season (63%) than in spring season (47%) and young age pupa were mostly preferred by them for infestatation (Table 1 and Table 2).

Fig. 1. Uzi fly pupa

Table 1. Parasitization of *Nesolynx thymus* on Uzi fly pupa in Different Seasons

Seasons	Mean±SEm	Parasitization (%)
Autumn	12.60±0.5	63
Spring	9.40±0.5	47

Table 2. Percent parasitization of *N. thymus* depending upon host age (Uzi pupa)

Age of Uzi pupa (days)	Mean±SEm	Parasitization (%)
1	14.50±0.88	68.33
2	13.00±0.57	65.00
4	10.00±0.57	50.00
6	7.33±0.33	35.00
8	4.00±0.57	20.00
10	1.33±0.33	6.66
12	0	0
14	0	0

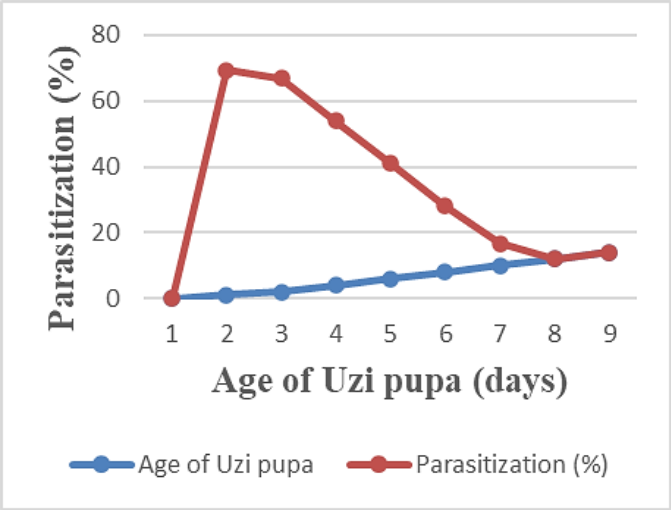

Fig. 2. Parasitization of *N. thymus* increases with host age

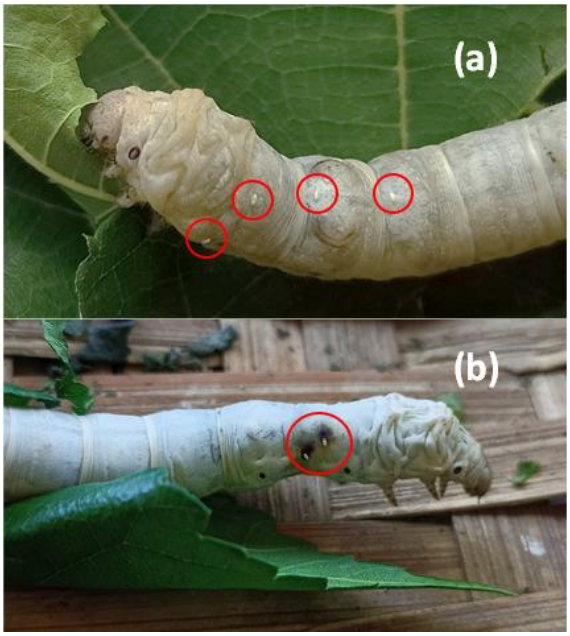

Fig. 3. *Bombyx mori* larva infested by uzi fly (a-b)

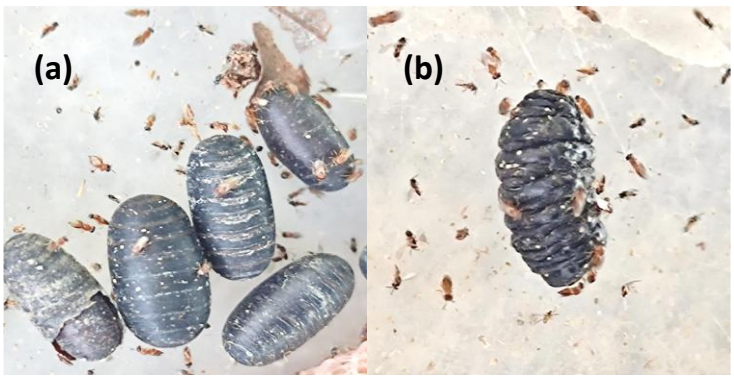

Fig. 4. Uzi fly pupa infested by Nesolynx thymus (a-b)

Based on 3 observations in both the season and 20 numbers of pupa in each observation.

Based on 3 numbers of observation in each age-old pupa and 20 numbers of pupa in each observation.

In an experiment, Bhat [12] found that the uzi infestation in mulberry silkworm (*Bombyx mori* L.) reduced from 0.5% to 0.2% by the release of transported *N. thymus*-a bio control agent but also economically viable and Choudhury et al. (2014) found that the pupa of the uzi fly of the muga silkworm, *Antheraea assamensis* (Helfer), was successfully parasitized by the solitary (*Dirhinus* spp.) and augmentative discharge of indigenous gregarious (*Nesolynx thymus*) parasitoids [13]. Belgumpe and Jadav (2017) also found that the bio-control agent *N. thymus*, an ecto-pupal parasitoid, was shown to be more suited, accessible and effective for Uzi fly control up to 70% for boosting cocoon yield and profit at the farmer level in Maharashtra [14]. In this experiment it has been found that the parasitic potential was more efficient in colder climates, and during the summer they go into aestivation. Additionally, it was noted that they parasitized the young pupae and did not prefer the older pupae. The highest Parasitization percentage was found to be in the 1-day old pupa with 68.33% Parasitization followed by 2-day old pupa with 65% of Parasitization.

Host searching behavior of *Nesolynx thymus* (Girault): The adults of *N. thymus*, when allowed to search for host i.e.,*B. zebina* pupa, were observed to search the host randomly instead of regular manner of searching. They did not go directly for oviposition, instead the adult *N. thymus* first searched their host through a series of random to and fro motion and when they found the host, they either accepted it or rejected it. When the host was accepted, they went for a series of action like drumming, tapping and the spent some time in recognizing the host after which they went for oviposition. The oviposition by *N. thymus* females was done by making holes on the surface of the puparium by pointing their ovipositor vertically and puncturing the puparia.

The oviposition behaviour of *N. thymus* exhibits a distinct sequence of responses, including host recognition, drumming, tapping, drilling, oviposition, and withdrawal of the ovipositor. The host recognition phase involves the parasitoid detecting and identifying suitable host insects, while the subsequent drumming, tapping, and drilling behaviors facilitate the location and assessment of the oviposition site [15].

4. CONCLUSION

The study found that *Nesolynx thymus*, a small hymenopteran parasitoid, is an effective natural enemy of the Uzi fly. The parasitoid prefers younger pupae, with the highest parasitism rate of 68.33% observed in 1-day-old pupae. With increasing age, parasitism rates decrease dramatically, eventually dropping to zero in pupae older than 12 days. Seasonal variations in parasitization rates show higher rates in autumn (63%), suggesting *N. thymus* may be more effective as a biocontrol agent during cooler seasons. The parasitoid's host-seeking behavior demonstrates its ability to locate and evaluate suitable hosts. Strategic releases of *N. thymus* could represent an ecologically and economically viable approach to combat Uzi fly infestation in silkworm rearing.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT,etc) and text-to-image generators have been used during writing or editingof manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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