Journal of Advanced Zoology

ISSN: 0253-7214

Volume 43 Issue 01 Year 2022 Page 333:338

Uzi Fly (*Exorista Sorbillans*) In Muga Silkworms (*Antheraea Assamensis* Helfer) And Its Management Practises: A Review

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Abstract

Assam's traditional heritage is muga silk. Muga silk has a unique reputation due to its inherent golden yellow tint. Muga silkworm raising is an outdoor crop; hence, crop loss due to insect pests is a big issue for muga rearers. Several insect pests harm silkworms, including the uzi fly, earwig, dermestid beetle, praying mantis, reduviid bug, stink bug, wasps, and red ants. Among pests, the Uzi fly is an economically significant endo-larval parasitoid that produces a 15% to 20% yield loss. In addition to the economic impact, these insect pests also pose a threat to the overall sustainability of muga silk production. Efforts are being made by researchers and farmers to develop effective pest management strategies to minimise crop losses and ensure the continued success of the muga silk industry in Assam.

Key words: Uzi fly, traditional, heritage, insect, pests, silk, industry, parasitoid, muga, rearers, yield loss, pest management.

The Muga silkworms are attacked by a variety of parasitoids (*Apanteles sp., Exoristabombycis*, etc.) and predators (ants, wasps, birds, etc.). Among these, *E. bombycis* is a serious endo-parasitoid, especially during the Jarua (December–January) and Chotua (February–March) crop seasons, causing 20–90% loss (Anon, 2007). The infestation of *E. bombycis* is particularly detrimental to the Muga silkworms because it occurs during the crucial Jarua and Chotua crop seasons. This parasitoid is responsible for a significant loss of 20–90% in the silkworm population during these months (Anon, 2007). Additionally, the presence of other predators such as ants, wasps, and birds further exacerbates the vulnerability of Muga silkworms to these attacks. The Uzi fly is a member of the Diperan family, *Tachinidae*. Tachinids are useful agricultural crop parasites, but they are hazardous to silkworms in sericulture. *Exorista bombycis, Exorista sorbilans*, and *Blepheripa zebina* are the most common uzi flies in sericulture. Infested silkworms or cocoons are invariably killed by Uzi fly infestations (Indirakumar et al., 2022). *E. bombycis* prefers to lay eggs immediately in the intersegmental area of the larval body. After hatching, maggots enter the larval body and begin feeding on inner tissues or fat bodies, after which the maggots exit the body and pupate in the soil (Reddy, 2011). These uzi flies pose a significant threat to sericulture as they cause extensive damage to both silkworms and cocoons. The infestation by *E. bombycis* is particularly destructive, as the maggots feed on vital tissues and eventually lead to the death of the larvae or cocoons. This highlights the urgent need for effective control measures to protect sericulture from these devastating Uzi fly infestations.

Description of Uzi fly:

Adults have a dark grey coloration. The body length of a male is roughly 12 mm little longer than that of a female (roughly 10 mm). The Head has a triangular form. On the dorsal side of the thorax, the body is grey with four longitudinal black bands. It has a conical abdomen. The first abdominal segment is black, while the remainder are a greyish-yellow colour (Subharani & Jayaprakash, 2015).

Activity Period of Uzi fly:

This endoparasitoid attacks heavily during the Jarua (December–January) and Chotua (February–March) crop seasons, inflicting 15 to 20% crop loss (Subharani & Jayaprakash, 2015).

Host parasite Interaction:

When uzi fly larvae feed on silkworm larvae, the host eventually sustains significant damage. The maggots exit the host after feasting on the body, crawl on the ground, and pupate in the soil. However, some maggots pupate inside the cocoon and do not leave the larvae before spinning out of the cocoon. As a result, the uzi fly's peculiar pupation behaviour is very important to the organism since it affects its survival because uzi fly pupation inside silkworm cocoons is suicide for the fly (Indirakumar et al., 2022).

The Uzi fly's Life Cycle:

Four longitudinal lines can be seen on the thorax of adults, who are dark grey. In comparison to the female, the male is longer and bigger. A male has a lifespan of 5–15 days, whereas a female has one of 20–25 days. It consumes nectar and honeydew for food. To locate the host, it can fly up to 2.7 kilometres. Uzi fly loves to lay her eggs on silkworm larvae in their fourth, third, and fifth instars. Each fly larva has one to two eggs. 90 to 900 fecundity is typical. On the intersegmental area of the abdominal segments, eggs are primarily laid (Indirakumar et al., 2022). The Uzi fly completes its life cycle in four stages: egg, maggot pupa, and adult (Baruah and Kalita, 2020).

i) Egg:

The macrotype egg is creamy white, pointy on the front, and broadly rounded on the back (Indirakumar et al., 2022). The egg is 0.45-0.56 mm long and 0.25-0.30 mm wide. They are oblong in shape and hatch about 2–5 days after oviposition. Once hatched, the maggot enters the muga silkworm's body (Goswami & Nath, 2011).

ii) Maggot:

This is the second stage of the Uzi fly. Maggots have three instars. The juvenile maggot emerges from the eggshell via the operculum, which normally faces the silkworm's body. The maggots of the fly hatch from the eggs and feed on the tissues of the worms (Narayanaswamy & Devaiah, 1998). The body is made up of 12 segments (1+3+8). The first-instar maggot uses its mouth hook to puncture the silkworm cuticle and enter the host body. It is sedentary and whitish to yellowish-white in coloration. It feeds on bodily fluids. The entrance hole is open, with a caudal section facing the place of entry for respiration. The first instar period is 1.5–2.5 days. The second instar also consumes host fluid. The duration is 1.5 to 2.5 days. The third instar feeds on fat bodies and muscles that receive silk glands. 3 days (Indirakumar et al., 2022). By puncturing the integument with their thoracic hooks, mature maggots can break free from the host body (Baruah & Kalita, 2020).

iii) Pupa:

Pupae have an oblong form with a circular posterior. The coloration of pupae ranges from bright reddish brown to dark reddish brown. The 11 body segments range in length from 0.9 to 1.2 cm and in lateral breadth from 0.4 to 0.6 cm. In about 10 to 12 days, adults appear (Thangavelu & Sahu, 1986). In crevices and cracks, pupation occurs (Indirakumar et al., 2022).

iv) Adult:

The colouring of adults is a dark grey. Females are shorter than males. A triangle forms the shape of the head. Four longitudinal black bands can be found on the dorsal side of the thorax. It has a conical abdomen. The first segment of the abdominal wall is black, while the other segments are greyish-yellow. According to the season and sex, adult fly lifespans vary (Reddy, 2011). Males last for 10 to 18 days on average. Males often live 1-2 days less than females do. In the summer, the survival span is shorter (Baruah & Kalita, 2020).

Uzifly damage:

The gravid female parasitic fly lays 250–300 eggs on a single host, with an average of 30–40 hatching within three days following oviposition. The fly prefers to lay eggs on the 4th and 5th-stage worms' bodies. The maggots bore into the silkworm larva's body, producing a black scar at the entry point, and began feasting on silkworm fluid. After murdering the pupae, the mature maggot emerges through a hole in the cocoon shell. The maggot develops inside the earth. In the early fourth stage of infestation, the worms do not spin cocoons, but later stages of infestation allow the worms to spin cocoons (Choudhury et al., 2014).

Management practises to be followed for *Exorista sorbillans*:

i) Manual/Mechanical control:

When silkworms are raised in nylon nets at the peak of the infection (December to March), 80–90% control is guaranteed (Subharani & Jayaprakash, 2015). This method of raising silkworms in nylon nets during the peak infection period ensures a high success rate in controlling the spread of infections. The controlled environment provided by the nets helps minimize contact with external pathogens, leading to effective disease management. Farmers can also use forceps to remove the fly eggs from the silkworm larvae's integument before transferring the late-stage worms (Subharani & Jayaprakash, 2015). This step is crucial as it prevents the transmission of infection from the eggs to the healthy silkworms. Additionally, transferring the late-stage worms to a clean environment after removing the fly eggs further reduces the risk of contamination and promotes healthy growth. For Jali (montage), dried leaves should be utilised to speed up cocoon spinning and reduce the time it takes for uzi maggots to emerge (Subharani & Jayaprakash, 2015). The use of dried leaves in Jali (montage) is beneficial because it provides a suitable environment for the silkworms to spin their cocoons and allows for a faster emergence of uzi maggots. This technique can help increase productivity and efficiency in silk production. Worms with uzi infestations need to be mounted in separate "Jalis" (Subharani & Jayaprakash, 2015) to prevent the spread of the infestation to healthy silkworms. This isolation technique ensures that the uzi maggots do not harm or infect other worms, allowing for a successful and uninterrupted silk production process. It is necessary to gather and destroy the uzi maggots that emerge three days after spinning in the jali (mountain) (Subharani & Jayaprakash, 2015). This step is crucial to prevent the uzi maggots from causing further damage to the silk production. Additionally, regular monitoring and inspection of the jalis is essential to identify any signs of uzi infestation and take immediate action to control it. Farmers can also install electricity-powered cocoon suffocation chambers to monitor the emergence of uzi maggots from contaminated cocoons 3-5 days after spinning (Reddy, 2011). These chambers will help to effectively eliminate the uzi maggots and prevent them from spreading to other cocoons. It is important to regularly clean and maintain these chambers to ensure their efficiency in controlling the infestation.
Reeling cocoons should be adequately smothered within two to three days of spinning in order to eliminate any uzi maggots and pupae that may occasionally be found inside the cocoon (Subharani & Jayaprakash, 2015). This process will help prevent the infestation from spreading to other cocoons during the reeling process. Additionally, proper hygiene practices should be followed to minimise the risk of contamination and ensure the production of high-quality silk fibers. On the 4^{th} and 5^{th} days of spinning, it is best to harvest the uzi-infested cocoons (Subharani & Jayaprakash, 2015) and dispose of them properly to prevent further infestation. It is important to closely monitor the spinning process and separate any cocoons showing signs of infestation to avoid compromising the quality of the silk fibers.

ii) Cultural methods:

In rearing plots, plough or dig the soil to expose the maggots or pupa to predators or intense sunlight to lessen the infestation (Reddy, 2011). This method can be particularly effective in reducing the population of pests such as flies or beetles. Additionally, it is important to regularly monitor the rearing plots to ensure that any remaining infestations are promptly addressed. To reduce the uzi fly invasion, avoid raising muga silkworms continuously (monocropping) from December to April (Reddy, 2011), as this is the peak season for uzi fly infestation. Instead, consider implementing crop rotation by introducing different crops during this period to disrupt the life cycle of the Uzi fly. Furthermore, practicing good sanitation measures such as removing fallen leaves or debris from the rearing plots can also help minimise the risk of uzi fly infestation. Besides, farmers should maintain a clean raising field and sprinkle bleaching powder on it regularly (Baruah & Kalita, 2020) to further deter uzi flies. To reduce the uzi fly infestation, avoid continually raising muga silkworms from December to April (monocropping) (Bindroo et al., 2008). Monocropping creates a favourable environment for Uzi flies to thrive, as they can easily move from one silkworm batch to another. Farmers can also practice crop rotation by alternating the cultivation of muga silkworms with other crops during those months. This will disrupt the life cycle of Uzi flies and make it more difficult for them to establish a stable population. Additionally, maintaining proper hygiene and regularly cleaning the rearing equipment can help eliminate any potential breeding grounds for Uzi flies.

iii) Biological methods:

Several parasitoids have been tested for parasitization against uzi fly pupae, including *Nesolynx thymus, Trichopria sp., Exoristobia philippiensis, Dirhinus sp., Brachymeri alugubris, Spalangi aendius, Pachycrepoideus veerannai,* and *Spilomicrus karnatakensis* (Kumar et al*.,* 1988; Samson and Ramadevi, 1985). *Nesolynx thymus* Girault, an inundative pupal parasitoid of the Hymenoptera: Eulophidae, is released to control the uzi fly infestation in Muga culture (Reddy, 2011). There are a number of hymenopteran parasitoids that can be used in nature to reduce the number of Uzi flies. These unidentified organisms have the potential to be used as weapons and biological control agents (Kerrich, 1960) in managing Uzi fly populations. By utilising these hymenopteran parasitoids, we can tap into their natural behaviour of parasitizing Uzi fly larvae, effectively curbing their population growth and minimising the need for chemical insecticides. This eco-friendly approach not only ensures a sustainable solution but also promotes the overall balance of the ecosystem. Farmers can release 2 pouches/100 dfls of *N. thymus* between the third and fifth days of the fifth instar of muga silkworms (Baruah & Kalita, 2020). This additional step of releasing *N. thymus* can further enhance the effectiveness of controlling Uzi fly populations. By targeting the specific instar of muga silkworms, farmers can ensure that the parasitoids have a higher chance of successfully parasitizing Uzi fly larvae, leading to a more efficient reduction in their numbers. Beside these, keeping the identical pouches next to the manure pile after cocoon harvesting (Subharani & Jayaprakash, 2015) can also help the entire process by attracting the uzi flies and providing a suitable environment for the *N. thymus* to lay their eggs. This method allows for the continuous release of parasitoids, increasing the chances of controlling Uzi fly populations effectively. Additionally, regularly monitoring the pouches and removing any dead or diseased silkworms can help maintain the health and productivity of the muga silkworms. Transfer the identical near mountages once the spinning worms are mounted (Baruah & Kalita, 2020), as this will prevent overcrowding and ensure proper development of the cocoons. It is also important to maintain a consistent temperature and humidity level in the rearing room to support healthy growth and silk production.

Table 1. Some important parasitoids against uzi fly pupae

Sl No.	Scientific name	Order	Family	Nature	Status
1	*Nesolynx thymus*	Hymenoptera	Eulophidae	Ecto-Pupal parasitoid	Gregarious
2	*Trichopria sp.*	Hymenoptera	Diapriidae	Endo-Larval-Pupal parasitoid	Gregarious
3	*Exoristobia philippiensis*	Hymenoptera	Encyrtidae	Endo-Larval-Pupal parasitoid	Gregarious
4	*Dirhinus sp*	Hymenoptera	Chalcididae	Ecto-Pupal Parasitoid	Solitary
5	*Brachymeri alugubris*	Hymenoptera	Chalcididae	Ecto-Pupal Parasitoid	Solitary
6	*Spalangi aendius*	Hymenoptera	Ptermalidae	Endo-Larval-Pupal parasitoid	Solitary
7	*Pachycrepoideus veerannai*	Hymenoptera	Pteromalidae	Endo-Larval-Pupal parasitoid	Gregarious
8	*Spilomicrus karnatakensis*	Hymenoptera	Diapriidae	Ecto-Pupal Parasitoid	Solitary

(Mahesha, 2018)

iv) Quarantine method:

Limit the movement of seed cocoons across regions and states to lessen the infestation (for example, private cocoon marketplaces, graineries, and reeling units should be regularly inspected) (Reddy, 2011). In addition, implementing strict quarantine measures at transportation checkpoints can help prevent the spread of infested seed cocoons. Furthermore, raising awareness among farmers and providing them with proper training on identifying and managing infestations can also contribute to effectively controlling the problem.

CONCLUSION

Antheraea assamensis Helfer, the muga silkworm, is endemic to Assam and surrounding regions in North-Eastern India and naturally produces golden silk. The production of muga silk has recently sharply decreased as a result of the high prevalence of illnesses, pests, and varying weather conditions. In particular, uzi infection in muga silkworm is extremely high. Controlling the uzi fly in the Muga silkworm is crucial. A comprehensive strategy that incorporates techniques for effective pest control is integrated pest management, and it is used to control the uzi fly. Integrated pest management (IPM) is an approach that combines various methods such as biological control, cultural practises, quarantine practises and manual treatments to effectively manage pests like the uzi fly in muga silkworms. By implementing IPM, farmers can reduce their reliance on harmful pesticides and instead focus on sustainable and environmentally friendly pest control measures. Additionally, regular monitoring and early detection of uzi fly infestations are essential for the successful implementation of IPM strategies.

ACKNOWLEDGEMENT

The authors wants to thank Assam Agricultural University, Jorhat, Assam for the guidance and support.

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