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Integrated pest management of uzi fly (*Exorista sorbillans*) in Muga silkworm *Antheraea assamensis* Helfer (Lepidoptera: saturniidae): A review

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Abstract
Muga silkworm rearing being an outdoor crop due to insect pests is a major problem encountered by the muga rearers. It is mostly high in the pre-seed (Aherua and Jarua) and seed crop (Chotua and Bhodia) compared to the commercial crops. A preliminary study from 2010 to 2011 revealed 12 (Twelve) insect pests belonging to family Tachinidae, Vespidae, Ichneumonidae, Braconidae, Formicidae, Pentatomidae, and Mantidae infesting the silkworm. Among these families, the Tachinidae family infest the silkworm more and the uzi fly belongs to the Tachinidae family. *Exorista sorbillans*, Widemann, otherwise called the uzi fly is a serious pest of muga silkworm and is a problem for silkworm rearing. The incidence of this fly is very high in tropical Sericultural regions. Uzi fly damages 25% crop loss in the 4th to 5th instar and 20% at harvesting stage of cocoons during Chotua crop (March-April). Applications of insecticides for control of the uzi fly is not advocated in muga rearing as it is lethal to the muga silkworm itself. This review mainly focuses on Integrated Pest Management of Uzi fly, (*Exorista sorbillans* Wideman) in muga silkworm (*Antheraea assamensis* Helfer). This review also covers the life cycle of the uzi fly and its nature of the damage.

Keywords: *Antheraea assamensis*, muga silkworm, uzi fly, integrated pests management, lepidoptera

Introduction
Muga silkworm, *Antheraeaassamensis* Helfer (Lepidoptera: Saturniidae) is semi-domesticated, polyphagous, multivoltine, and endemic to Assam, yields golden yellow silk. The Tibeto-Burmese and Indo-Mongoloid tribes successfully domesticated muga silkworm similar to that of farm animals possibly for getting proteinous dishes from the larvae and pupa initially and at the advent of civilization they exploited golden yellow muga silk for preparation of fabric for their domestic us [1]. Gradually it became an indispensable traditional symbol in the Assamese way of life. Muga silkworm feeds primarily on 'som', *Persea bombycina* Kost and 'Soalu', *Litsea polyantha* Juss and many other secondary food plants. The muga silkworm is reared in 5-6 seasons in the year. The Jethua (April-May), & Kotia (October-November) rearings are commercial crops, Chotua (February-March) & Bhodia (August-September) as seed and Jarua (December-January) & Aherua (June-July) as pre-seed crops [1].
Muga Silkworm is attacked by several parasitoids (*Exorista sorbillans*; *Apanteles* sp.) and predators (ants, wasps, birds etc). Among these *E. Sorbillans* is one of the serious larval endoparasitoids of silkworm (*Antherea assamensis*). It causes extensive damage to the sericulture industry. During Jarua (December-January) and Chotua (February-March) crop seasons and reported 20-90% loss in winter & post winter (December-March) [4] and 50-70% cocoon rejection during February-March [3]. The mature maggots come out of the larvae/pupae and undergo pupation in the rearing field or grainage hall. The uzi infested muga silkworm dies during the larval or pupal stage. This parasitoid was also reported on 95 species of insects belonging to 20 families of Lepidoptera and one family of Hymenoptera worldwide in the absence of silkworm [2].
Thangavelu and Sahu [6] reported that the maggots of the Uzi fly exhibited considerable variation in their body size and the maggots developed within *B. mori* larvae were generally smaller in size while those developed within *A. assamensis* larvae were comparatively larger. They also pointed out that the considerably large sized muga silkworm might have provided a more suitable niche to the uzi fly maggot than the smaller silkworm.

As per the recent survey results indicates that the maximum infestation of uzi fly was recorded in 5th instar larvae (43.0%) and harvesting of cocoons (35.0%) during Chotua crop (March-April 2010) followed by Jarua crop, Dec. 2009-Jan. 2010 (19.0%) infestation at larval stage & 27.50% at harvesting stage of cocoons) reported in upper Assam [5]. To reduce the infestation level of uzifly, the following intregated management practices to be recommended.

The Life cycle of uzi fly

Uzi fly completes their life cycles in four stages, viz egg, maggot pupa, and adult.

Egg: Eggs are creamy white in colour. The egg measures 0.45-0.56 mm in length and 0.25-0.30 mm in width. They are oblong in shape and hatch in about 2-5 days after oviposition. Once hatched, the maggot penetrates into the body of the muga silkworm [12].

Maggot: This is the second stage of uzi fly. Maggot has three instars. The young maggot hatches out of the eggshell through the operculum which generally faces the silkworm body. After hatching from the eggs, the maggots of the fly penetrate into the larval body and feed on the tissues of the worms [2]. In the 1st two instars, they develop just below the skin of the host body and in the final instar, they leave this site and move into the body cavity. Maggots are yellowish-white in colour and measure 1.3-1.6 cm in length. Maggots have eleven body segments. They feed on various tissues of the silkworm body. The mature maggots escape from the host body by piercing the integument by its thoracic hooks.

Pupa: Pupae are oblong in shape and round posteriorly. Pupae are light reddish-brown to dark reddish-brown in colour. The body has 11 segments and measuring 0.9 to 1.2 cm in length and 0.4 to 0.6 cm in lateral width. Adults emerge in about 10-12 days [6].

Adult: Adults are blackish-grey in colour. Male is longer than the female. The head is triangular in shape. On the dorsal side of the thorax, there are four longitudinal black bands. The abdomen is conical. In the abdominal segments, the first one is black and the rest grayish-yellow. The life span of adult flies varies with sex and season [5]. Males survive for about 10-18 days. Females live 2-3 days longer than males. The survival period is less during the summer months.

Integrated management practices to be followed for *Exorista sorbillans*

The extensive damage to silkworm crops due to uzi menace in sericulture created an appalling situation and shaken the very root of sericulture in India. Thus, the threat of notorious fly pests becomes a serious concern especially because no preventive/control measures were known to
check completely the uzi infestation. Control of Indian Uzi fly and non mulberry uzi fly has engaged the attention of several workers in the past and various approaches such as preventive measures using mosquito nets, trapping of female uzi fly have been suggested.

1) Mechanical methods

- Rear the silkworm under a nylon mosquito net during peak infestation period (December to March), which ensures 80-90% control.
- During the transfer of late-stage worms, remove the fly eggs from the integument of the silkworm larvae with the help of forceps.
- Collect the destroy uzi maggots which come out at three days after spinning in the Jali (mountage).
- Install electricity operated stifling chambers for cocoons to check the emergence of uzi maggots from infested cocoons at 3-5 days after spinning [5].

2) Cultural methods

- Plough or dig the soil in rearing plots to expose the maggots /pupa for predators / strong sunlight to reduce the infestation.
- Keep the rearing field clean and dust with bleaching powder during rearing.
- Avoid rearing of muga silkworms continuously (monocropping) from December-April to minimize the uzi fly infestation [10].

3) Biological methods

- *Nesolynx thymus* is an ecto-pupal parasitoid of uzi fly. About 40-60 parasitoids develop on each uzi pupa.
- *N. thymus* is produced on house fly pupa. 50 ml of parasitoid pupae are packed in a nylon net pouch (Rs 50/pouch). About 10,000 NT adults emerge from the pouch.
- Release *N. thymus* between the 3rd-5th day of 5th instar @ 2 pouches/100 dfls.
- After mounting of spinning worms, transfer the same near mountages.
- After harvesting cocoons, keep the same pouches near the manure pit [13].

4) Quarantine method

- Restrict the transport of seed cocoons from one location and state to another to reduce the infestation (ex: private cocoon markets/grainages/reeling units should be kept under regular vigilance) [5].

Conclusion

Muga silkworm (*Antheraea assamensis* Helfer) is endemic to Assam and adjoining areas in North-Eastern India and naturally produces golden silk. Due to the high incidence of diseases, pests, and variations in climatic conditions, the production of muga silk has recently declined dramatically. Especially,uzi infestation in muga silkworm is so high. So, control of the uzi fly in muga silkworm is very important. The control of the uzi fly through Intregated pest management is a broad-based approach that integrates practices for economic control of pests. IPM aims to suppress pest populations below the economic injury level (EIL). IPM program will enhance the long-term stability of the holdings over and provide long term solutions of pests.

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