

Impact and management of damage caused by the infestation of Mulberry leaf (*Morus alba* L.) by *Spilosoma obliqua* defoliator insect pests

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Received 26 Oct 2021; Accepted 5 Dec 2021; Published 20 Dec 2021

DOI: <https://doi.org/10.64171/JAES.1.2.19-23>

Abstract

A significant polyphagous defoliator pest, *Spilosoma obliqua* (Walker), often called the Bihar hairy caterpillar, causes severe damage to mulberry plants, especially during the rainy and winter months (August through January). The larvae eat voraciously and target the foliage, resulting in significant quantitative and qualitative losses in leaf yield, which has a direct effect on silk production and silkworm rearing. Sericulture is an agro-based industry that is also a significant branch of agricultural entomology. There are four varieties of silk made in this industry, including mulberry, muga, eri, and tassar. One of these is mulberry silk, which is highly sought after in the global agricultural market. The *Bombyx mori* mulberry silkworm (Order: Lepidoptera & family: Bombycidae) produces this mulberry silk. Only the mulberry tree (*Morus alba* L) sustains the mulberry silkworm (*Bombyx mori*). For a full successful rearing of the mulberry silkworm (*Bombyx mori*), the host plants are extremely important. However, a variety of insect pests infest the host plant severely. The most significant insect pest of the mulberry plant among them is the defoliator. They have an impact on different aspects of the plant, including the leaf, bud, stem, and others. The development of afflicted plants is halted, and their leaf output is reduced. Additionally, silkworms cannot survive on infected leaves. The primary emphasis of this review is on mulberry plant defoliators (Orders Lepidoptera, Orthoptera, and Coleoptera), the harm they cause, and how to control them. According to the study area, various pests are harming the mulberry crop, which is causing significant financial harm to sericulture farmers and breeders. Among the insect fauna, Hemipterans, Thysanopteran, Homopteran, and Lepidopteran species were observed. The fact that insect pests are found in a variety of locations proves that the incidence of two Hemipterans, specifically the Jassid and pink mealybug, one Thysanopteran, namely thrips, one Homopteran, namely whitefly, and four Lepidopterans, specifically the leaf-eating caterpillar, leaf roller, wasp moth, and Bihar hairy caterpillar, is increasing. The harm caused by *S. obliqua* results in a large decline in the quantity and quality of mulberry leaves. This loss has a direct impact on silkworm rising, which results in lower cocoon output.

Keywords: Sericulture, *Spilosoma oblique*, Lepidoptera, Defoliator, *Bombyx mori*, Damage, Pest, Light trap and Mulberry

Introduction

Among all the businesses in the agricultural industry, sericulture is one of the most significant agro-based industries. The unemployment issue in society is addressed by this sector. Mulberry, muga, eri, and tassar are the four varieties of raw silk produced by the sericulture industry (Dandin. et al., 2000) [4]. "Sericulture" is the main end product of silk, which is the only naturally occurring protein fiber that is utilized commercially worldwide. Indian sericulture is a unique ancient cottage industry in the world since it generates four varieties of silk: mulberry, Eri, Muga, and tasar. In Uttar Pradesh and the agricultural sector at large, sericulture is a vital source of income and socio-economic progress. In addition to the silk industry's ongoing contribution to the Indian economy as a steady source of foreign exchange revenue (Rs. 3000 Crores annually) (Kshama, Giridhar., et. al., 2008; Maki, M., 1918 & Umeya, Y. et. al., 1935) [16, 19, 27], India ranks second among silk-producing nations, accounting for around 12.00% of the world's raw silk production. The quality and yield of mulberry

leaves determine the productivity and profitability of silkworm rearing. The only sustenance for the silkworm, *Bombyx mori* L., is mulberry leaves. Its manufacture on scientific principles is necessary for the sound economic practice of sericulture. From an economic standpoint, mulberry cultivation paired with silkworm rising continues to be a labor-intensive industry that offers a wide range of job opportunities. Mulberry supports a wide range of insects and non-insect pests by providing food and shelter because of its evergreen, perennial, and lush foliage. Mulberry has been reported to have a wide variety of insect pests from different nations. In contrast, 118 insects were found on mulberry in Korea [3], while 87 insects and 6 non-insect pests were listed on mulberry in Formosa (Chu, chi., 1936 & Kukuchi, W., 1976) [3, 17]. Over 126 insect species in China and over 200 in Japan cause harm to mulberry (Biradar, N., 1989 & Hemalatha. et. al., 2008) [2, 10]. In India, mulberry is known to be consumed by over 70 different insect and non-insect species in the Lepidoptera, Hemiptera, Coleoptera, Thysanoptera, Orthoptera, Isoptera, and Tetranychidae

families (Sathe, T.V., 1998 & Rajadurai, S., 2005) [23, 22]. In India, the state's output increased from 7338 MT of the nation's total 16360 MT in 2010–11 to 11592 MT of 25213 MT in 2018–19. Due to infestation by numerous pests, the output of mulberry has been reported as low. Leaf roller, Bihar hairy caterpillar, wingless grasshopper, mealybug, thrips, weevils,

root grubs, etc., occur in significant numbers, causing leaf loss, which subsequently has an impact on silk production (Siddhegowda, D.K. et. al., 1995 & Rajadurai, S. et. al., 1999) [26, 21]. As a result, a current survey was carried out in the mulberry garden to examine the distribution and occurrence of the insect fauna linked to Indian mulberry fields.

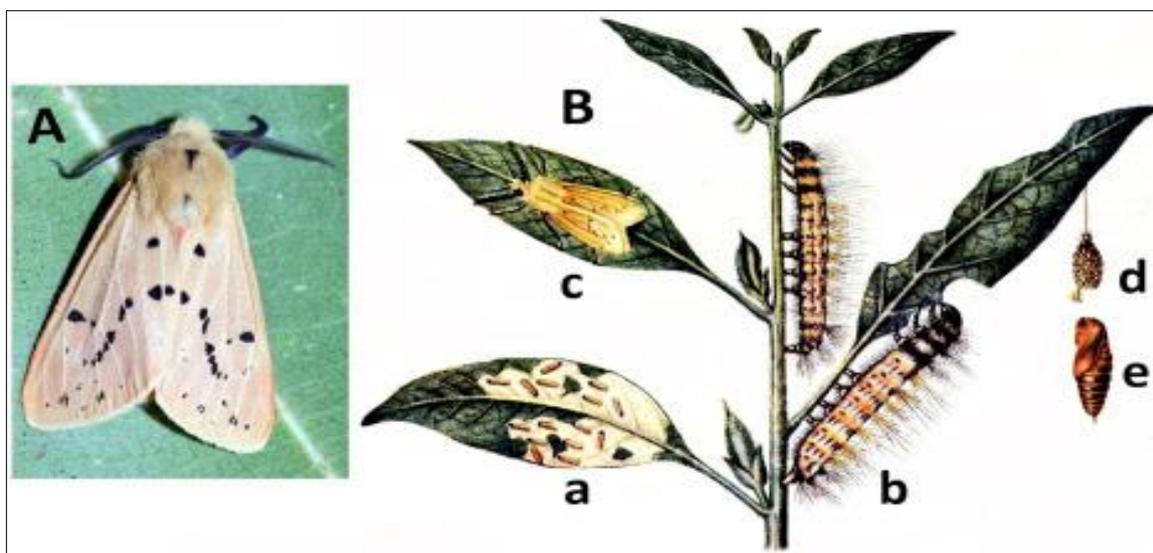


Fig 1: Show adult stage of *Spilosoma oblique*

Materials and Methods

The present study was carried out during season June to April, Indian insect fauna associated with mulberry crop. India’s northern 8°4’8°4’ N and 37°6’37°6’ N Uttar Pradesh state situated at Northern most latitude of India is 37°6’N East longitude and at a formerly part of Jammu and Kashmir. The temperature and relative humidity ranges from 15 to35°C and 35 to 70 per cent, respectively. In Jammu district, some of the mulberry fields were selected for the collection of insect pests. The selected fields were from Gorakhpur and Faizabad district and are Basti, Santkabirnagar, Gorakhpur and Deoria. Insects were collected by visiting each mulberry garden from June to April with more or less monthly periodicity. The representative samples of each of the pest observed during the course of the study was collected and identified to the level of species, when possible; using published systematic keys and with the help of available literature.

Results and Discussions

The present investigation shows that there was occurrence of insect pests from mulberry garden surveyed from various villages in Gorakhpur and Faizabad district. Amongst the insect fauna; Hemipterans, Thysanopteran, Homopteran and Lepidopteron species were recorded. The occurrence of insect-pest from various sites shows that, the incidence of two Hemipterans namely viz., jassid and pink mealy bug, one Thysanopteran i.e., thrips, one Homopteran is whitefly and four Lepidopterans namely viz., leaf eating caterpillar, leaf roller, wasp moth and Bihar hairy caterpillar. The occurrence of thrips, whitefly, jassid, leaf roller and Bihar hairy caterpillar was noticed in all the villages of Gorakhpur rearing while the presence of pink mealy bug was observed in all villages except in Gorakhpur rearing centre. The wasp moth was noticed only in Basti rearing centre village. Leaf eating caterpillar presence was not noticed in Deoria and Sant Kabir Nagar rearing centre. A detail of occurrence in various collection sites from Gorakhpur district are shown in Table-1.

Table 1: Incidence of mulberry insect-pests in various districts of Gorakhpur rearing centre

S. No.	Mulberry insect-pests	Villages			
		Gorakhpur rearing centre	Basti rearing centre	Deoria rearing centre	Santkabirnagar rearing centre
1	Thrips	+	+	+	+
2	Whitefly	+	+	+	+
3	Pink mealy bug	+	+	+	-
4	Jassid	+	+	+	+
5	Leaf roller	+	+	+	+
6	Bihar hairy caterpillar	+	+	+	+
7	Wasp moth	+	-	-	-
8	Leaf eating caterpillar	+	+	-	+

Remark represent: +: Present -: Absent

The insect-pests based on their orders namely; Hemiptera, Thysanoptera, Homoptera and Lepidoptera having total 8 insect species was found around mulberry garden of Gorakhpur, Santkabirnagar, Deoria and Basti rearing centre of Uttar Pradesh district. The classification, locality and habitat, occurrence and type of damage symptoms caused by these insect-pests were described below as follows:

Order: Hemiptera

a) Pink mealy bug, *Maconellicoccus hirsutus* Green

- **Classification:** [Common name: Pink mealybug; Phylum: Arthropoda; Class: Insecta; Order: Hemiptera; Family: Pseudococcidae; Genus: *Maconellicoccus*; Species: *hirsutus*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from all mulberry fields surveyed in Gorakhpur district.
- **Occurrence:** The pest is found to occur from June to August and severe infestation was noticed in the month of March.
- **Type of damage symptoms:** The nymphs feed by sucking the sap from tender leaves and stem portion. Hence the affected apical shoots show bunched appearance due to curling of leaves, shortening of internodes and thickening of stem. This symptom is popularly known as 'Tukra' in India. In advance stages of infestation black sooty mould is developed in the affected area due to growth of fungus on the honeydew secreted by the mealy bug.

b) Jassid, *Empoasca flavescens* F.

- **Classification:** [Common name: Leaf hopper/jassids; Phylum: Arthropoda; Class: Insecta; Order: Hemiptera; Family: Cicadellidae; Genus: *Empoasca*; Species: *flavescens*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from all mulberry fields surveyed in Gorakhpur district.
- **Occurrence:** Occurrence was noticed during November to January
- **Type of damage symptoms:** Both nymphs and adults damage the plant by sucking the sap of young leaves and tender shoots. The early symptoms are; the appearance of yellow or brown patches at the margin of the leaves followed by distortion of leaf veins. Finally, leaves curl upward becoming cup shaped, margins turn brown, dry and wither off prematurely. This characteristic symptom is known as "Hopper burn".

Order: Thysanoptera

a) Thrips, *Pseudodendrothrips mori* Newa:

- **Classification:** [Common name: Thrips; Phylum: Arthropoda; Class: Insecta; Order: Thysanoptera; Family: Thripidae; Genus: *Pseudodendrothrips*; Species: *mori*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from all mulberry fields surveyed in Gorakhpur district.

- **Occurrence:** Occurrence was noticed during February to April
- **Type of damage symptoms:** Affected leaves showed white streaks or blotches which become yellowish brown on maturity.

Order: Homoptera

a) Whitefly, *Dialeuropora decempuncta* (Quaintance & Baker)

- **Classification:** [Commonname: Whitefly; Phylum: Arthropoda; Class: Insecta; Order: Homoptera; Family: Aleyrodidae; Genus: *Dial europora*; Species: *decempuncta*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from all mulberry fields surveyed in Gorakhpur district.
- **Occurrence:** Occurrence was noticed during October to December and in March.
- **Type of damage symptoms:** The adult and nymphal stages of white fly infest lower surface of mulberry leaves, suck the sap, cause speckling, upward curling, yellowing of leaves, premature fall and retardation of growth.

Order: Lepidoptera

a) Leaf roller, *Diaphania pulverulentalis* Hampson

- **Classification:** [Common name: Leaf Webber/roller; Phylum: Arthropoda; Class: Insecta; Order: Lepidoptera; Family: Pyralidae; Genus: *Diphania*; Species: *pulverulentalis*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from all mulberry fields surveyed in Gorakhpur district.
- **Occurrence:** Occurrence was noticed during June to December.
- **Type of damage symptoms:** The target area of the leaf roller is apical portion of the mulberry leaves, the young caterpillar binds the leaflet together by silky secretion and settle inside and devour the soft green tissues of the leaf surface. Grown up caterpillars feed on the tender portion and their faecal matter can be seen on the leaves below the affected portions.

b) Bihar hairy caterpillar, *Spilosoma oblique* Walker:

- **Classification:** [Common name: Bihar hairy caterpillar; Phylum: Arthropoda; Class: Insecta; Order: Lepidoptera; Family: Arctidae; Genus: *Spilosoma*; Species: *obliqua*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from all mulberry fields surveyed in Gorakhpur district.
- **Occurrence:** Occurrence was noticed with onset of monsoon and attained peak in July and August months.
- **Type of damage symptoms:** Dried or mesh like appearance of the leaves. The grown-up larvae feed on the entire leaf rendering the branches without leaves.

c) Waspmoth, *Amata passalis* Fab:

- **Classification:** [Common name: wasp moth; Phylum: Arthropoda; Class: Insecta; Order: Lepidoptera; Family: Arctidae; Genus: *Amata*; Species: *passalis*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from the mulberry fields surveyed in Gorakhpur village.
- **Occurrence:** Occurrence was noticed in the month of August.
- **Type of damage symptoms:** They feed by scraping the chlorophyll layer of the leaf.

d) Leaf eating caterpillar, *Spodoptera litura* Fab:

- **Classification:** [Common name: Cutworm/ leaf eating caterpillar; Phylum: Arthropoda; Class: Insecta; Order: Lepidoptera; Family: Noctuidae; Genus: *Spodoptera*; Species: *litura*].
- **Locality and Habitat:** From the mulberry plant, *Morus alba* L., from all mulberry fields surveyed in Gorakhpur district.
- **Occurrence:** Occurrence was noticed during August to September.
- **Type of damage symptoms:** They feed on mulberry leaves voraciously. In heavily infested mulberry gardens, the plants are seen without branches and sometimes with dried leaves.

The present findings are consistent with the research conducted in Gorakhpur, Santkabirnagar, Basti and Deoria district (Uttar Pradesh) over two consecutive years on the seasonal occurrence of common leaf-eating pests of mulberry, namely leaf roller, Bihar hairy caterpillar, and wingless grasshopper. This research revealed that these pests caused severe to moderate infestation in the rainy and winter seasons, but mild infestation in the summer (Geethabai, M et. al., 1997; Aruga, H., 1994; Danin, S.B., et al., 2001 & Govindaiah, D, et. al., 2005) [7, 1, 5, 9]. The distribution of the Bihar hairy caterpillar as an occasional pest in the eastern region was noted in a number of agricultural plants (Gopal, A., 1998; Ganga, G, et. al., 2012 & Shree, M.P. et. al., 2008) [8, 6, 25]. A study conducted in Mysore, India, by CSR&TI found that the mulberry defoliator included 13 species of Lepidoptera, 3 species of Coleoptera, and 2 species of Orthoptera (Jadhav, Y.T.V. et. al., 2019; Kamil, A.S.M. et. al., 2000 & Katiyar, R.L.P.K et. al. 2002 & Kishor, R.D. et. al., 1994) [11, 12, 13, 14]. With a high rate of infection, the lepidopteran leaf roller, *D. pulverulentalis*, has recently become a significant pest in southern India during the rainy and winter months (Kotikal, Y.K. et.al., 1982; Manjunath, D., 2004 & Mahiam, A.S., 2010) [15, 20, 18]. In addition, the current data indicated that leaf roller was more active on mulberry.

Conclusion

The quality and quantity of mulberry leaves are crucial to the success of silkworm cultivation. Therefore, it is essential to use the permitted integrated pest management methods to combat the threat of *Spilosoma oblique* infestation of mulberry while

minimizing environmental harm, particularly when autumn rearing is done on a commercial scale. Therefore, if ignored, *Spilosoma oblique* walker may turn out to be one of the significant biological determinants of silk production in rearers. The *Bombyx mori*, also known as the mulberry silkworm, is a key component of the sericulture business. It is in high demand in the agricultural sector because it is made of white silk naturally. Silkworm rearing depends primarily on favorable agro climatic and environmental circumstances, as well as on sound seeds and healthy host plants. In order to successfully raise silkworms, one healthy host plant is essential. Due to significant infestation of host plants, the current study found that different insect pests pose the biggest threat to mulberry silkworm culture. Defoliators are the most harmful insect pest of the mulberry tree among these. For this reason, the protection of mulberry silkworm food plants necessitates the application of scientific methods to manage insect pests.

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