

# Impact of *Diaphania pulverulentalis* (Glyphodes pulverulentalis) on mulberry leaf under laboratory conditions

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## Abstract

A significant lepidopteron pest, *Diaphania pulverulentalis* (also known as *Glyphodes pulverulentalis*), causes considerable damage to mulberry gardens in India, resulting in considerable leaf loss (up to 78%) and lower cocoon output. On young apical leaves, it functions as a leaf roller/webber, resulting in stunted plant development and lower nutritional content. The leaf webber *Diaphania pulverulentalis* is recognized as a key pest that infests mulberry orchards, causes damage to mulberry growth and development, and lowers the nutritional content of the leaves. Because silkworm *Bombyx mori* L. primarily consumes mulberry, the leaf webber-infested leaves that the silkworm feeds on have a larger effect on the output of, cocoon both quantitatively and qualitatively. Therefore, the current study was conducted to determine the effects of leaf webber infestation on several well-known mulberry types as well as on silkworm development and cocoon production. Because mulberry is the only food for the silkworm *Bombyx mori* L., it is known to be targeted by numerous insect pests, with the defoliating species being more prevalent. The *Diaphania pulverulentalis*, often referred to as the leaf webber caterpillar or Jute hairy caterpillar, is a polyphagous pest that poses a threat to the output of mulberry. Additionally, it's a significant and harmful pest of several crops. The newly hatched larvae were taken out of the stock culture in order to learn about the insect's longevity, fecundity, and lifespan. Under regulated conditions (26±1°C, 12±1 hrs, and 80±5% RH), five pairs of adult leaf webber caterpillar moths were let into the cage to pair and lay eggs. The Department of Sericulture Govt. Model Degree College in Barakhal, Sant Kabir Nagar, conducted the investigation and found that the incubation period for *Diaphania pulverulentalis* eggs was between four and six days, with an average of 5.0±1.00 days. The percentage of hatched eggs ranged from 88.25 to 94.25 percent, with an average of 91.9%±3.19. The first, second, third, fourth, fifth, and sixth instars lasted 3.31 to 4.82 days, with an average of 3.85±0.84 days; 2.21 to 2.39 days, with an average of 2.27±0.20 days; 2.29 to 5.43 days, with an average of 4.30±0.10 days; 3.41 to 3.61 days, with an average of 3.50±0.10 days; and 5.40 to 5.60 days, with an average of 5.50±0.10 days, respectively. The longevity of female leaf webber moths was discovered to be between 4.21 and 4.48 days, with an average of 4.31±0.1 days, while the pupal period lasted 10.61 to 12.62 days, with an average of 11.5±1.03 days. In contrast, the average lifespan of male moths was found to be between 3.33 and 3.52 days, with an average of 3.42±0.1 days. The average fecundity of adult females was 620 to 900, with an average of 740±14.22.

**Keywords:** Leaf webber, *Diaphania pulverulentalis*, lifecycle, longevity

## 1. Introduction

Silk's supremacy as a textile fiber has been acknowledged since the beginning of time, and even now, no other material can compare to its brilliance and grace. As mulberry is the sole diet for the silkworm *Bombyx mori* L., it is known to be targeted by several insect pests, with the defoliating ones being the most prevalent. The quick-growing tree mulberry *Morus alba* L., which belongs to the Moraceae family, is kept as a shrub for the sake of silk culture. It yields a great deal of renewable biomass in the form of branches, shoots, leaves, and fruits (Nath, p. et al., 1996 & Warad, M. A. et. al., 2017) [26, 34]. The mulberry foliage is the sole food source for the silkworm, *Bombyx mori* L., and a fundamental component of sericulture. Mulberry is known to be attacked by over 300 different insect and non-insect pest species at various points throughout the crop's life cycle and throughout the year. The primary insect pests are responsible for economic harm to the mulberry crop. The *Diaphania pulverulentalis*, which is often referred to as the

leaf webber caterpillar or grass feeder caterpillar, is a monophagous insect from the Pyralidae family (or Crambidae) that poses a danger to productivity. It poses a significant threat to a wide range of crops. Mulberry leaves, which silkworms eat, are also consumed by the leaf webber. Yield loss is caused by the severe infestation of leaf webber larvae on the mulberry trees. Prior understanding of the biology and ecology of insect pests is necessary for the IPM (integrated Pest Management). On mulberry, the biology of *Diaphania pulverulentalis* is the main subject of this research (Anonymous, 1996a & 1996b and Kirk, J. T. O., 1965) [2, 1, 13]. The mulberry is a perennial, fast-growing tree that is grown all over the world, primarily to raise the *Bombyx mori* mulberry silkworm. Mulberry leaves are the sole food source for the monophagous *Bombyx mori*, which is essential for its healthy growth and development. In the field, the mulberry plant is vulnerable to a variety of diseases that damage the quantity and quality of its leaves, including leaf spot, powdery mildew, leaf rust, and pests such as mealy bugs,

leaf rollers, and leaf webber caterpillars. Defoliators are of particular importance among these pests since they harm mulberry leaves, making them unsuitable for silkworm farming, by up to 12–25% (Lowery, O. H et. al., 1951; Malik, C. P. et. al., 1980 and Narayanswamy, T. K., 2003) [14, 20, 25]. Currently, leaf rollers are significant pests that are wreaking havoc on mulberry trees throughout India and other regions of the planet. Therefore, this paper has made an effort to provide new insights into the leaf roller pests and develop a more sustainable management of this pest through an integrated pest management (IPM) approach to control it, thereby improving the overall global cocoon crop production (Umesh Kumar, N. N., 1991; Bhat, D. M., et. al, 2020; & Biradar, N. A., 1989) [32, 4, 5]. The current study was conducted to ascertain the seasonal incidence, which will ultimately aid in the development of timely management strategies against leaf roller, but the data on seasonal incidence, the nature of the damage, and the amount of yield loss caused by the pest are limited.

## 2. Materials and Methods

Newly hatch larvae were segregated from the stock culture in order to determine the insect's lifecycle length, lifespan, and reproductive rate. For mating and egg laying, five pairs of adult leaf webber caterpillars were introduced into the enclosure. The adult leaf webber caterpillars were fed a diet consisting of grasses and *Morus* that had been soaked in 10% honey solution. The egg containing oviposition set was moved into larval rearing tanks. The cage was filled with adult moths for mating and oviposition. Fresh mulberry leaves were given to the egg-containing oviposition set every day after it was moved into larval rearing containers. To ensure adequate hygiene, the remaining waste, such as faecal material, dried leaves, dead

larvae, etc., was routinely taken out of the rearing container. Data on egg production, egg incubation period, larval duration, and adult lifespan were gathered at each stage of development. The growth and development of the larvae are indicated by the size change of the head capsule. As a result, the juvenile instars of the insect were identified using head capsule measurement. The culture's eggs were allowed to hatch. 20 larvae were raised separately on host from the developing larva. The head capsules for each individual instar were gathered during each subsequent moult, right from initial stage, and kept separately in a little, well-marked plastic container. At the conclusion of the experiment, a stereo microscope with an ocular micrometer was used to measure each head capsule separately at its widest point (at the base of the mandible). The data were then processed and analyzed statistically.

## 3. Results and Discussion

### Incubation period of leaf webber

As soon as the eggs were laid, the incubation period of *Diaphania pulverulentalis* was observed and continued until the eggs hatched. With an average of  $5.0 \pm 1.00$  days, the incubation duration ranged from 4 to 6 days (Table-1). The present research on the incubation period of *Diaphania pulverulentalis* produced results that are consistent with those of previous researchers, who found that the incubation period of eggs ranged from 3 to 12 days (Singh and Singh., 1995; Borgohain, A., 2015; Chakraborty, I. R. et. al., 2005) [31, 6, 7]; 5.60 days (Nath and Singh, 1996; Dandin, S. B., et. al., 2010 & Geethabai, M. et. al., 1997) [26, 8, 11]; and 6.5 to 10.5 days (Madyarov, S.H.R. et al., 2006 & Debaraj and Singh, 2010) [15, 9].



**Fig 1:** Shows (A) Adult (B) Eggs (C) Pupa of *Diaphania pulverulentalis*

### Hatchability of leaf webber

An observation on hatching percentage of leaf webber eggs were recorded by putting five sets each of 50 eggs. The hatching percentages (Table-1) were found to be of 88.25 to 94.25 with an average of  $91.9 \pm 3.19$ . The results are in conformity with the report of (Hedge, J.E. et. al., 1962) [12] who observed 83.5 to 99.33 percent hatchability for the eggs of *Diaphania pulverulentalis*.

### Egg of leaf webber

The eggs laid by mated adult female moths were grouped together, and they were originally green in hue. The eggs

change from a greenish hue to a light yellow one, and they become dark brown before they hatch. The biology of *Diaphania pulverulentalis* was similarly investigated (Arnon. Daniel I, 1949 & Maheswari, M. et. al., 2017 & 2018) [3, 18, 19], and it was discovered that the eggs of *Diaphania pulverulentalis* are creamy white when they are laid and that they turn pale yellow before they hatch. The female moth laid between 620 and 900 eggs per mass (Table-1) in batches, which were covered with hairy scales from the tip of her abdomen. The eggs turned blackish just before they were about to hatch, which was the developing head of the larvae. The young larva's black head was seen inside the eggshell a day before it hatched.

The incubation period lasted between four and six days, with an average of five days. Pandit and Veeranna., et. al., 2020 & Mahadeva, A., 2011 & 2018 [28, 17, 16] reported the biology of the leaf webber caterpillar on mulberry and the incubation period was found to be between four and six days, which is

consistent with the current findings. (Djou, et. al., 1938) [10] studied the biology of the *Diacrisia oblique* Walk and discovered that a female lays 342–1356 eggs and that the incubation period lasts for 6-11 days.



**Fig 2:** Shows adult of *Diaphania pulverulentalis* and morus leaf roll

#### Larva of leaf webber

After hatching, the larva comes out from the egg. During its larval developmental period, the caterpillar moulted five times and had six larval instars. The total larval period ranged from 24.61- 28.40 days with an average of  $26.2 \pm 0.71$  days (Table-1).

#### First instar larva of leaf webber

The newly hatched larva was creamy whitish with shining brown head and having brown spots over entire body from which white hair arises which later turn black. The integument was transparent, abdominal segments were distinct with three pairs of pro legs. Larvae turned pale yellow colour within a few hours after hatching. The data (Table-1) on first instar larvae of

*Diaphania pulverulentalis* revealed that the duration of first instar was found to be 3.31 to 4.82 days with an average of  $3.85 \pm 0.84$  days.

#### Second instar larva of leaf webber

As the larva advances to second instar, the body grows faster and as a result, the body turns wider than the head. The larva was translucent light yellow in colour with prominent setae and tubercles. The width of the head capsule of the newly moulted larva ranged from 0.05- 0.07mm with an average  $0.06 \pm 0.008$  (Table-2). The second instar varied from 2.21 to 2.39 days with an average of  $2.27 \pm 0.20$  days to enter into next instar (Table-1).



**Fig 3:** Shows adult of *Diaphania pulverulentalis* and morus leaf roll

#### Third instar larva of leaf webber

Third instar larvae were similar to second instar but the coloration of head and body segments were little darker compared to the second instar. The third instar larvae were more active than the first and second instar larvae (Manjunath Gowda, et. al., 2005 and Manjunath, D., et., 2000) [21, 22]. The larva was light yellowish in colour with black patches on the anterior and posterior region of the body. The spiracles were

black in colour and are nine in number. The width of the second moult head capsule was 0.08-0.16mm with an average of  $0.11 \pm 0.02$  (Table-2). The duration of third instar larvae was 2.29 to 5.43 days with an average of  $4.30 \pm 0.10$  days (Table-1).

#### Fourth instar larva of leaf webber

The larva was yellowish in colour with yellow longitudinal stripes. Head and prothoracic shield were dark brown (Mittal,

V. et. al., 2016 and Miyashita, Y. A., 1986) [23, 24]. Black patches were present on the anterior and posterior region. The head capsule width of third moult was 0.14 to 0.19 mm with an average of  $0.16\pm 0.15$  (Table-2). The duration of fourth instar larvae was 3.41 to 3.61 days with an average of  $3.50\pm 0.10$  days (Table-1).

#### Fifth instar larva of leaf webber

Fifth instar larva was almost similar to fourth instar, except in its size. Black patches were present on the anterior and posterior region. The larvae had dense hairs on its body. The width of fourth moult larva head capsule measured 0.21 to 0.29 mm with an average of  $0.24\pm 0.22$  (Table-2). The duration of fifth instar larvae was 3.40 to 3.70 days with an average of  $3.50\pm 0.15$  (Table-1).

#### Sixth instar larva of leaf webber

The fully-grown larva was stout and cylindrical, brown in colour; the head of the larva was dark brown and conspicuous dark anterior and posterior patches of the larva. The larvae had dense hairs on its body (Nighat, M. et. al., 2002 and Rajadurai, S. et. al., 2010) [27, 22]. The head capsule width of fifth moult larva was 0.39 to 0.55 mm with an average of  $0.44\pm 0.04$  (Table-2). The duration of sixth instar larvae was 5.40 to 5.60 days with an average of  $5.50\pm 0.10$  days (Table-1).

#### Total larval duration of leaf webber

The total larval period (Table-1) of *Diaphania pulverulentalis* was ranged from 24.61 to 28.40 days with an average of  $26.2\pm 0.71$  days. Earlier workers also reported larval period of 17.22 days 24.72 days and 24 days (Debaraj and Singh, 2010) [9]. Mallikarjun warad and Kalleshwara swamy C. M., 2017 [33] observed the total larval period ranged from 24 - 26 days with an average of 25.75 days.

#### Pupa of leaf webber

Pupation occurred in the soil as soil was provided as medium. The pupa was elongated and oval in shape. The eyes and the antennal case were prominent. The freshly formed object pupa was yellowish and gradually reached to dark brown. They undergone pupation inside the hairy cocoon, hence pupal sexing was not possible. The rate of pupation ranged between 73.56 to 90.12 days with a mean duration of  $82.0\pm 8.59$  per cent (Table-1).

#### Pupal period of leaf webber

The duration of pupae was varied from 10.61 to 12.62 days with an average of  $11.5\pm 1.03$  days, (Table-1). The present findings are in close conformity with the report of (Singh and Singh., 1995) [31] and (Nath and Singh., 1996) [26] in which they reported pupal period of 10.25 and 11.46 days, respectively. Longevity and fecundity the data on longevity of female moths were found in the range of 4.21 to 4.48 days with an average of  $4.31\pm 0.1$  days, while in case of male moth sit was found to be of 3.33 to 3.52 days with an average of  $3.42\pm 0.1$  days (Table-1). The fecundity was varied from 620 to 900 eggs with an average of  $740\pm 14.22$  eggs (Table-1) which is in the conformity with the report of (Singh and Singh., 1995) [31] who reported that the *Diaphania pulverulentalis* laid 1849 eggs /female while (Debaraj and Singh., 2010) [9] reported that the fecundity was 987 eggs /female.

#### Total life span of leaf webber

The total life span was found to be of 39.25 to 43.25 days with an average of  $41.2\pm 2.0$  days in case of male, while it was ranged from 43.44 to 45.65 days with an average of  $44.6\pm 1.1$  days in case of female. The present findings are in close conformity with the report of (Singh and Singh, 1995; Nath and Singh, 1996) [31, 26] and (Debaraj and Singh, 2010) [9] as they reported that the total life span was found to be 37.50; 53.06 and 39.60 days, respectively.

**Table 1:** Impact of *Diaphania pulverulentalis* (Glyphodes pulverulentalis) on mulberry leaf under laboratory conditions

Leaf webber developmental stages		Minimum	Maximum	Mean $\pm$ SD
Incubation period of eggs(days)		4.00	6.00	5.0 $\pm$ 1.00
1st instar larval duration		3.31	4.82	3.85 $\pm$ 0.84
2nd instar larval duration		2.21	2.39	2.27 $\pm$ .20
3rd instar larval duration		2.29	5.43	4.30 $\pm$ 0.10
4 <sup>th</sup> instar larval duration		3.41	3.61	3.50 $\pm$ 0.10
5 <sup>th</sup> instar larval duration		3.40	3.70	3.50 $\pm$ 0.15
6 <sup>th</sup> instar larval duration		5.40	5.60	5.50 $\pm$ 0.10
Total larval duration		24.61	28.40	26.2 $\pm$ 0.71
Survivability percentage of larva (%)		80.36	85.32	82.7 $\pm$ 2.50
Pupal period (days)		10.61	12.62	11.5 $\pm$ 1.03
Pupation rate (%)		73.56	90.12	82.0 $\pm$ 8.59
Moth emergence (%)		0.56	93.36	88.7 $\pm$ 7.09
Adult longevity	Male longevity	3.33	3.52	3.42 $\pm$ 0.10
	Female longevity	4.21	4.48	4.31 $\pm$ 0.10
Total life-cycle(days)	Male	39.25	43.25	41.2 $\pm$ 2.00
	Female	43.44	45.65	44.6 $\pm$ 1.10
Fecundity (No. of eggs)		620	900	740 $\pm$ 14.22
Hatchability (Emergence of egg into larva (%))		88.25	94.25	91.9 $\pm$ 3.19

\*N=20 \*\*N=5pairs

**Table 2:** Measurements of head capsule of leaf webber caterpillar, *Diaphania pulverulentalis*

<i>Diaphania pulverulentalis</i>	Measurements width (mm)	
Leaf webber caterpillar	Range	Mean $\pm$ SD
1 <sup>st</sup> moult	0.05-0.07	0.06 $\pm$ 0.008
2 <sup>nd</sup> moult	0.08-0.16	0.11 $\pm$ 0.02
3 <sup>rd</sup> moult	0.14-0.19	0.16 $\pm$ 0.15
4 <sup>th</sup> moult	0.21-0.29	0.24 $\pm$ 0.22
5 <sup>th</sup> moult	0.39-0.55	0.44 $\pm$ 0.04

#### 4. Conclusion

According to the current research, the leaf webber pest *Diaphania pulverulentalis* has had a notable influence on mulberry, changing its nutritional and metabolic functions as well as its growth parameters across all three varieties, namely V<sub>1</sub> mulberry, Mysore local, and S-36. This infestation resulted in a decline in leaf yield and quantity, a decline in the quality of mulberry leaves, and its impact on the development of silkworms and the quality of cocoon production, all of which contribute to financial losses for sericulture producers in the silk industry. In the current investigation, it was discovered that silkworm development and cocoon development were significantly impacted by feeding mulberry leaves that were infested with leaf Webbers. The leaf's nutritional content is reflected in the decreased economic traits seen in these silkworms. Mulberry leaves that were infested with leaf webber pests were used to raise silkworms, and the resulting cocoons were of extremely poor quality, with shorter filament lengths, less compactness, more breaks during reeling, and less continuity. A considerable drop in silk output occurred when the silk worms were given mulberry plant leaves that had been infected. The prevalence of pests presents a significant threat to mulberry plants, lowering leaf quality, and eventually leading to lower cocoon output. The onslaught of pests, such as defoliators, on mulberry plants causes significant damage to silkworm producers, making it essential to create long-term IPM management strategies to combat it. Using biological methods, such as its natural predators, is the best way to naturally maintain the balance in the mulberry ecosystem, since the extensive use of chemicals is not a long-term solution to pest management because it leaves more residues that are bad for the environment. Therefore, a multipronged IPM strategy should be used to monitor the leaf roller populations, such as *D. pulverulentalis* and *G. pyloalis*, in order to increase the silk industry's efficiency.

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