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Biology of mulberry leaf roller, *Diaphania pulverulentalis* (Lepidoptera: Pyralidae) under laboratory conditions on mulberry

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Abstract

Mulberry being the sole food for silkworm *Bombyx mori* L. it is known to be attacked by many insect pests. The major pests of mulberry are Leaf roller, Bihar hairy caterpillar, Cut worm (Lepidoptera), Jassid, Spiralling white fly, Mealybug, Scale insect (Homoptera) (Naik S L., 1997). Among the various pests, the Leaf roller, *Diaphania pulverulentalis* (Lepidoptera: Pyralidae) causes damage to the mulberry plant by infesting the apical portion and it occupies the key position in reducing the mulberry leaf yield and quality with an average incidence of 27.85% in Karnataka, 20.98% in Andhra Pradesh and 16.48% in Tamil Nadu and the incidence is severe during winter months (October- February) (Geethabai *et al.*, 1999). The leaf roller, *D. pulverulentalis* (Hampson) (Lepidoptera: Pyralidae) is a major pest of mulberry causes considerable reduction in mulberry leaf yield resulting in economic loss to sericulturists. The incidence of leaf-roller and mulberry leaf yield loss were 70.30 and 25.20 percent, respectively. To understand the duration of life cycle, longevity and fecundity of the insect, newly hatched larvae were separated from the stock culture. Twenty pairs of Mulberry leaf roller adult moths were released into the cage for pairing and egg laying under controlled conditions (26±2 °C and 75 to 80% RH). The investigation was carried out during 2018-21 at the Department of Sericulture UAS, GKVK, Bengaluru-65 and revealed the *D. pulverulentalis* eggs incubation period was about 2.11 to 4.01 days with a mean of 3.14±0.96 days. The hatching percentages were found to be in the range of 88.07 to 96.03 percent, with a mean of 93.10±4.38 percent. The duration of first, second, third, fourth and fifth instar were 1.54 to 3.47 with the mean of 2.53±0.97 days., 1.84 to 2.74 days with the mean of 1.51±1.07 days, 1.94 to 3.51 days with mean of 2.67±0.79 days, 2.00 to 4.01 days with the mean of 3.19±1.05 days and 3.51 to 5.01 days with a mean of 4.35±0.77 days, respectively. The pupal period was 3.51 to 5.01 days with a mean of 4.35±0.77 days. The adult longevity of male moths in the present study ranged between 3.02 to 5.02 days, with a mean longevity of 4.00±1.00 days, whereas that of female moths ranged between 6.32 to 8.44 days with a mean of 7.52±1.1 days. The adult longevity was greater in female moths than that of the male moths. The average fecundity of adult female was 80.02 to 150.12 eggs with an average 108.46±36.87 eggs.

Keywords: Bioactive compounds, solvent extract, anti-microbial activity, skin treatment

Introduction

Mulberry being the sole food for silkworm *Bombyx mori* L. it is known to be attacked by many insect pests. The major pests of mulberry are Leaf roller, Bihar hairy caterpillar, Cut worm (Lepidoptera), Jassid, Spiralling white fly, Mealybug, Scale insect (Homoptera) (Naik S L., 1997) [3]. Among the various pests, the Leaf roller, *Diaphania pulverulentalis* (Lepidoptera: Pyralidae) causes damage to the mulberry plant by infesting the apical portion and it occupies the key position in reducing the mulberry leaf yield and quality with an average incidence of 27.85% in Karnataka, 20.98% in Andhra Pradesh and 16.48% in Tamil Nadu and the incidence is severe during winter months (October-February) (Naik S L., 1997) [3]. The leaf roller, *D. pulverulentalis* (Hampson) (Lepidoptera: Pyralidae) is a major pest of mulberry causes considerable reduction in mulberry leaf yield resulting in economic loss to sericulturists. The incidence of leaf-roller and mulberry leaf yield loss were 70.30 and 25.20 percent, respectively. It appeared during June and persisted upto February and the disappearance of this pest from March to May focused the possible pupal diapause (Rajadurai *et al.*, 1999) [6].

In Karnataka, the incidence of *D. pulverulentalis* on mulberry ranged from 0 to 100 percent, being severe in winter months (October to February) and reduced to 0 to 30 percent in summer months (March to June) in Koppa, Mandya, Mysore and Kanakapura Taluks (Siddegowda *et al.*, 1995) [11]. The IPM (integrated Pest Management) requires prior knowledge of the biology and ecology of insect pests. The present study focuses on the biology of Mulberry Leaf roller on mulberry.

Materials and Methods

To understand the duration of life cycle, longevity and fecundity of the insect, newly hatched larvae were separated from the stock culture. Twenty pairs of Mulberry leaf roller adult moths were released into the cage for pairing and egg laying. Cotton wad soaked in 10 percent of honey solution was provided as food for the Mulberry leaf roller adults. The oviposition set containing eggs was transferred to larval rearing containers. Adult moths were released into the cage for pairing and egg laying. The oviposition set containing eggs was transferred to larval rearing containers. Were fed with fresh mulberry leaves daily. In order to maintain proper hygiene the left over debris like faecal matter, dried leaves, dead larvae, *etc.* were removed regularly from the rearing box. Data pertaining to egg output, egg incubation period, larval duration, adult longevity were recorded during respective stages of development.

Determination of larval instars

The size variation of head capsule is an index of growth and development of the larvae. Therefore, head capsule measurement was considered to determine the immature instars of the insect. Eggs from the culture were allowed to hatch. From the emerging larvae, twenty larvae were reared individually on host. The head capsules were collected at every successive moult, right from initial stage and were stored separately in a small labelled plastic vial for the individual instars. At the end of the experiment, all the head capsules were separately measured across the greatest width (at the base of mandible) with the help of stereomicroscope having an ocular micrometre. The data thus obtained were computed and subjected to statistical analysis.

Results and Discussion

Biology of Mulberry leaf roller *Diaphania pulverulentalis* (Hampson) Incubation period of *D. pulverulentalis* eggs

During the present investigation it was observed that the eggs were often securely glued to the lower leaf surface. Incubation period of the egg ranged between 2.11 to 4.01 days with a mean of 3.14 ± 0.96 days. However, Yokoyama (1925) [13] reported that they mulberry pyralid eggs hatch in about 5 to 6 days. Similarly, an incubation period of 4 to 5 days was reported by Anonymous (1999) [2], while Srinivasa Gowda (2000) [12] reported they hatch in 4 days. These reports are contradictory to the present findings (3.28 ± 0.04 days) which could be due to differences in the geographical location and environmental factors. Hatching percentage of *S. ohliqaa* eggs Observations on hatching percentage of *D. pulverulentalis* eggs were recorded by putting five sets each of fifty eggs. Egg hatchability in the present study was observed to be in the range of 88.07 to 96.03 percent, with a mean of 93.10 ± 4.38 percent.

Eggs

Eggs were laid in a single way on the tender shoots on the under surface of the leaves along the mid rib or the veins. The convex top rough surface has irregular crimps or lines on the surface of the egg. Yokoyama (1925) [13] reported that the adults of mulberry pyralid, *G. pyloalis* lay eggs on the lower surface of the mulberry leaves. Similarly, Sengupta *et al.* (1990) [9] observed that *D. pulverulentalis* eggs were deposited along the leaf vein on the under surface of the leaves. The freshly laid eggs are greenish yellow with gel like appearance. The eggs turn to pinkish red on the second day, and light pink colour on the third day of oviposition. The microscopic observation on third day showed a brown head with light brownish slender body through the chorion. Prior to hatching, the eggs are dull whitish to cream colour. When observed under microscope, the fully grown 'C' shaped embryo with black head was clearly visible through the chorion. The mature embryo emerges through the chorion by feeding little part of the egg shell. Incubation period of the egg ranged between 2.11 to 4.01 days with a mean of 3.14 ± 0.96 days. Geetha Bai *et al.* (1999) [4] observed that the incubation period of *D. pulverulentalis* on mulberry varied from 4 to 5 days indicating similarity with the present findings.

Larva

The larva passed through five instars and the total larval period ranged from 11.21 to 14.59 days with the mean of 12.82 ± 1.70 days (Table 1).

First Instar

The first instar larva had light yellow colored transparent body with minute black spots on lateral, upper lateral, lower lateral, ventral and dorsal regions of each segment with a single seta on each spot. The head is dark brown in color followed by a light brown coloured prothoracic segment. The newly emerged larva starts feeding by scraping the green matter. The larva remains within the silken web throughout the instar. Pre-moulting symptoms show yellow colored transparent body, narrow head and caudal region, the larva rests flatly on the leaf surface. The mean first instar period was 1.54 to 3.47 with the mean of 2.53 ± 0.97 days (Table 1).

Second instar

The width of the head capsule of the newly moulted larva varies from 0.091-0.103 mm with a mean of 0.098 ± 0.003 mm. The feeding behaviour and webbing nature was similar to that of first instar whereas the expansion in area of black spots with slender setae, dull yellow color body with translucent skin, the later stage of the instar showed light greenish color with scarce white mid dorsal line. The second instar duration ranges from 1.84 to 2.74 days with the mean of 1.51 ± 1.07 days (Table 1).

Third instar

The head capsule width after the second moult ranged from 0.33 to 0.37 mm with a mean of 0.353 ± 0.013 mm (Table 1). The larva turns light green with prominent black spots on the body with a brown coloured seta on each spot towards lateral and sublateral region. The prothoracic segment is fully covered with brown band. The larva starts feeding on whole leaf by biting holes leaving the large veins and mid rib. The fully grown third instar larva turns to green colour.

The duration of third instar ranged from 1.94 to 3.51 days with mean of 2.67 ± 0.79 days (Table 1).

Fourth instar

The width of the head capsule of the larva after third moult varies from 0.85 to 0.95mm with a mean of 0.892 ± 0.031 mm (Table 2). The feeding behavior and presence of black spots are similar to that of third instar, except the division of brown band on the prothoracic segment. The fully grown larva is light greenish with discontinuous white middorsal line. The instar duration ranged from 2.00 to 4.01 days with the mean of 3.19 ± 1.05 days (Table 1).

Fifth instar

The head capsule at fourth moult was dark brown, highly sclerotized and hard. The larva was dark green in colour at the beginning of the fifth instar, later it turned to light pinkish. The black spots became prominent and increase in the area, a discontinuous white mid dorsal line was clearly seen, which starts from second thoracic segment to last abdominal segment. The larva feeds on the whole leaf leaving the large veins and mid ribs from inside the leaf fold. Fifth instar duration ranged from 3.51 to 5.01 days with a mean of 4.35 ± 0.77 days (Table 1). Seelan (1999) [8] reported the duration of each larval instar of *D. pulverulentalis* in the range of 1.85 days (I instar), 2.84 days (II instar), 3.43 days (III instar), 3.64 days (IV instar) and 3.92 days (V instar). Srinivasa Gowda (2000) [12] reported that duration of the five successive larval instars was 2.78 ± 0.03 days, 1.08 ± 0.01 days, 2.14 ± 0.01 days, 2.18 ± 0.02 days and 2.11 ± 0.04 days, respectively. Seol *et al.* (1986a) [10] reported that the number of larval instars in mulberry leaf roller as five. Rangaswami *et al.* (1976) [7] reported number of larval instars in mulberry leaf roller as four. Sengupta *et al.* (1990) [9] and Rajadurai *et al.* (1999) [6] reported number of larval instars in a mulberry as three. However, Manjunath Gowda and Narayanaswamy (2009) [5] reported that the number of larval instars in case of mulberry leaf roller, *D. pulverulentalis* as five based on Dyar's law.

Total larval duration

The larval period ranged from 11.21 to 14.59 days with a mean of 12.82 ± 1.70 days which under goes 4 moults. The mature larvae had blackspots on its body and a white discontinuous mid dorsal line. The results of larval instars were in agreement with the findings of Sengupta *et al.* (1990) [9], Anon. (1996a) [1] and Geetha Bai *et al.* (1999) [4].

Pupa

The pupa of leaf roller was dark brown in colour and the pupation occurred in dry mulberry leaves. The rate of pupation ranged between 78.15 to 90.00 days with a mean duration of 82.42 ± 6.58 percent. The pupal period ranged between 7.18 to 11.06 days with a mean duration of 8.93 ± 1.97 days (Table 1). Similar pupal period was also observed by Anonymous (1996a) [1], Geethabai *et al.* (1999) [4] and Rajadurai *et al.* (1999) [6]. However, Srinivasa Gowda (2000) [12] reported a mean pupal period of 11.02 ± 0.08 days.

Longevity and fecundity

The adult longevity of male moths in the present study ranged between 3.02 to 5.02 days, with a mean longevity of 4.00 ± 1.00 days, whereas that of female moths ranged between 6.32 to 8.44 days with a mean of 7.52 ± 1.1 days.

The adult longevity was greater in female moths than that of the male moths.

The fecundity was varied from 80.02 to 150.12 eggs with an average 108.46 ± 36.87 eggs (Table 1) which is in the conformity with the report of Rajadurai *et al.* (1999) [6] reported that the longevity of female and male moths of mulberry leaf roller *D. pulverulentalis* was 9 to 14 and 7 to 12 days, respectively. Srinivasa Gowda (2000) [12] reported that adult longevity in male moths was 19.87 ± 0.04 whereas in case of female moths was 20.39 ± 0.04 days.

Table 1: Biology of Mulberry leaf roller, *D. pulverulentalis* under laboratory conditions

	Minimum	Maximum	Mean \pm SD
*Egg Incubation period (days)	2.11	4.01	3.14 ± 0.96
1st instar duration	1.54	3.47	2.53 ± 0.97
2nd instar duration	1.84	2.74	1.51 ± 1.07
3rd instar duration	1.94	3.51	2.67 ± 0.79
4th instar duration	2.00	4.01	3.19 ± 1.05
5th instar duration	3.51	5.01	4.35 ± 0.77
*Total larval duration	11.21	14.59	12.82 ± 1.70
Larval survivability (%)	60.31	69.14	65.86 ± 4.84
Pupal period (days)	7.18	11.06	8.93 ± 1.97
Pupation rate (%)	78.15	90.00	82.42 ± 6.58
Moth emergence (%)	80.77	95.30	90.21 ± 8.18
**Adult longevity (days)	Male	3.02	5.02
	Female	6.32	8.44
Total life-cycle (days)	Male	24.41	31.25
	Female	6.32	8.44
Fecundity (No.)	80.02	150.12	108.46 ± 36.87
Hatchability (%)	88.07	96.03	93.10 ± 4.38
*N=30 **N=20			

Table 2: Measurements of head capsule of mulberry leaf roller, *D. pulverulentalis*

	Measurements width (mm)	
	Range	Mean \pm SD
1st moult	0.091-0.103	0.098 ± 0.003
2nd moult	0.33-0.37	0.353 ± 0.013
3rd moult	0.85-0.95	0.892 ± 0.031
4th moult	1.03-1.16	1.106 ± 0.044

N=20

Conclusion

The investigation was carried out during 2020-21 at the Department of Sericulture UAS, GKVK, Bengaluru-65 and revealed the *D. pulverulentalis* eggs incubation period was about 2.11 to 4.01 days with a mean of 3.14 ± 0.96 days. The hatching percentages were found to be in the range of 88.07 to 96.03 percent, with a mean of 93.10 ± 4.38 percent. The duration of first, second, third, fourth and fifth instar were 1.54 to 3.47 with the mean of 2.53 ± 0.97 days., 1.84 to 2.74 days with the mean of 1.51 ± 1.07 days, 1.94 to 3.51 days with mean of 2.67 ± 0.79 days, 2.00 to 4.01 days with the mean of 3.19 ± 1.05 days and 3.51 to 5.01 days with a mean of 4.35 ± 0.77 days, respectively. The pupal period was 3.51 to 5.01 days with a mean of 4.35 ± 0.77 days. The adult longevity of male moths in the present study ranged between 3.02 to 5.02 days, with a mean longevity of 4.00 ± 1.00 days, whereas that of female moths ranged between 6.32 to 8.44 days with a mean of 7.52 ± 1.1 days. The adult longevity was greater in

female moths than that of the male moths. The average fecundity of adult female was 80.02 to 150.12 eggs with an average 108.46 ± 36.87 eggs

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