International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(6): 2088-2091

Received: 07-08-2020
Accepted: 19-09-2020

Mallikarjun CJ
College of Horticulture, Bagalkot, Karnataka, India

Suvarna Patil
Assistant Professor, Department of Entomology, RHREC, Dharwad, Karnataka, India

Kotikal YK
Professor, Department of Entomology and Director of Extension, UHS, Bagalkot, Karnataka, India

Athani SI
Professor, Department of Fruit Science, Dean Students Welfare, UHS Bagalkot, Karnataka, India

Mastiholli AB
Professor, Department of Agronomy, RHREC, Dharwad, Karnataka, India

Naik KR
Professor, Department of Post-Harvest Technology and Head RHREC, Dharwad,

Vinaykumar MM
Assistant Professor, Department of Entomology, COH, Bagalkot, Karnataka, India

Ambika DS
Assistant Professor, Department of Plant Pathology, COH, Bagalkot, Karnataka, India

Corresponding Author:
Mallikarjun CJ
College of Horticulture, Bagalkot, Karnataka, India

Studies on biology of mango leaf webber *Orthaga exvinacea* (Hampson)

Mallikarjun CJ, Suvarna Patil, Kotikal YK, Athani SI, Mastiholli AB, Naik KR, Vinaykumar MM and Ambika DS

DOI: https://doi.org/10.22271/chemi.2020.v8.i6ad.11077

Abstract
The laboratory studies on biology of mango leaf webber was conducted at the Department of Entomology, College of Horticulture, Bagalkot during 2018-19. The studies revealed that the mean preoviposition, oviposition and postoviposition periods lasted for 2.60±0.52, 4.10±0.74 and 1.90±0.74 days, respectively. The larva moulted six times by passing through seven larval instars. The mean durations of 1st, 2nd, 3rd, 4th, 5th, 6th and 7th instar were 4.80±0.92, 4.65±0.90, 4.41±0.63, 4.16±0.87, 4.52±0.51, 5.20±0.42 and 6.50±0.53 days, respectively with mean total larval period of 42.54±2.53 days. The mean duration of male and female pupal stage were 11.80±0.63 days and 14.30±1.43 days respectively. The mean longevity of adult male and female were 4.10±0.74 days and 5.80±0.42 days, respectively. The total life cycle completed in 58.44±3.90days in male and 62.64±4.59 days in female.

Keywords: Mango, *O. exvinacea*, leaf webber, biology, life cycle

Introduction
The Mango (*Mangifera indica* L.), fall under the family Anacardiaceae and is classified under the order Sapindales. It is originated in the Indo-Burma region. It is considered as the "King of fruits". Mango flowers are borne on the inflorescence called flower panicles which appear to be creamy white to pinkish in colour. Now a days, incidence of leaf webber has been increasing in many areas. Mango leaf webber *Orthaga exvinacea* Hampson is considered to be a pest of occasional significance in the mango ecosystem. *O. euadrusalis* in the recent years are attaining a major pest status (Sisodiya *et al.*, 2003) [5]. The extent of damage caused by this pest under favorable condition was estimated as 35 per cent (Srivastava and Tandon, 1980) [6]. The heavily infested trees appear to be burnt like from a distance and a closer look taken the leaves are dried, webbed and filled with excreta. The early instars (*i.e.*, 1st and 2nd instars). scrape the chlorophyll content of the leaves and after they hatch. Later instars start forming the webs by webbing 3-4 leaves together and larvae are very active in their movement inside the web where they will have tunnels made up of silken webs to escape, hide and pupate inside the webbings itself in a silken cocoon like case covered with its excreta outside. So, this severe infestation results in complete failure in flower initiation and finally the yield is affected (Anon, 2017) [1].

Materials and Methods
The study on biology of leaf webber, *O. exvinacea* on mango were carried out in the laboratory at Department of Entomology, College of Horticulture, Bagalkot during 2018-2019. The initial culture of the mango leaf webber was obtained from the mango orchard and reared in cages (60×45×45 cm) on fresh mango twigs and mango seedlings. The twigs collected from the orchard with leaf web culture were plugged with cotton at their cut ends.
Both cotton plugs and seedlings were watered daily for maintaining their freshness. After pupation, the pupae were separated out and kept for sexing. The identification of male and female was done in the pupal stage by examining the location of genital slit in relation to anal slit with the help of binocular microscope. The male and female pupae were kept in a separate cages provided with perforated lid for aeration and emergence of the adults. A same pair of adults were released in separate test tubes provided with cotton swab soaked in 5 per cent honey solution and they laid the eggs on the walls of the test tubes and same was recorded.

Freshly laid eggs were counted and placed on fresh leaves with the help of moist soft camel hairbrush. Observations were recorded on their colour, size, shape and incubation period. Measurement of various stages was taken under the stereo microscope. The preoviposition, oviposition and post-oviposition periods, fecundity and longevity were studied by keeping the paired moths in glass jars. The sex ratio was worked out on the basis of number of male and female moths emerged from total number of pupae as per the formula-

$$\text{Sex ratio} = \frac{\text{No. of females emerged}}{\text{Total no. of males and females emerged}}$$

Results and Discussion

Adults Mating

During the present study adults were found to mate during night hours and mating extended upto midnight hours and laid eggs by early morning. The present findings were in conformity with Wang *et al*. (2009) [7], the female *O. achatina* did not call until the start of scotophase, with the calling percentage increased sharply at the 5th hour and reached the peak at the 6th to 7th hour of scotophase.

Fecundity

A mated adult female of *O. exvinacea* laid the eggs ranging from 57 to 61 with mean of 59.39± 1.20 eggs per female. The present study is in conformity with Kavitha *et al*. (2005) [3] where female moth had mean fecundity of 58 eggs. Patel *et al.* (2007) [4] reported mean fecundity of 63.00 ± 20.14 eggs, which is more or less in close agreement with present findings.

Site of oviposition

Usually eggs were laid on lower surface of leaves near the midrib and occasionally it is observed that eggs were also laid on upper surface of leaves and also on tender mango twigs (Kavitha *et al*. 2005 and Patel *et al.* 2007) [3, 4]. However, in the present study the pair of adults released in cages with seedlings did not lay the eggs on any part of the seedlings but laid on the walls of the test tubes provided with cotton swab soaked with 5 per cent honey solution. This variation may be due to surface area of leaf which consists of slippery and shiny surface.

Preoviposition, oviposition and postoviposition period

The experiment was continued further and the moths were observed for preoviposition, oviposition and post oviposition periods in the same laboratory. The preoviposition period ranged from 2.0 to 3.0 days with a mean of 2.60± 0.52 days, whereas oviposition period ranged between 3.0 to 5.0 days with a mean of 4.10± 0.74 days. Post oviposition period was ranged from 1.0 to 3.0 days with mean of 1.90±0.74 days. The present findings are in conformity with findings of Sisodiya *et al.* (2003) [5] with mean pre-oviposition, oviposition and post-oviposition period of 3.0, 4.0 and 1.40 days, respectively. Whereas, Patel *et al.* (2007) [4] reported pre-oviposition, oviposition and post-oviposition period of 3.30 ± 0.82, 3.70 ± 0.82 and 1.30 ± 0.48 days, respectively. These observations are more or less similar to present findings, however, little shorter preoviposition period of 1.7 days was reported by Kavitha *et al.* (2005) [3]. This variation in the variation might be due to the variation in the location's weather parameters which mainly influence the biology of the insect pest, Kavitha *et al.* (2005) [3] and Patel *et al.* (2007) [4].

Eggs and the morphometrics

The freshly laid eggs were creamish yellow in colour and oval in shape. However, when laid in groups no proper shape was observed. A few hours before hatching, the colour of the eggs turned to light pink. Eggs measured in the range of 0.86 - 0.90 mm with mean of 0.88± 0.02 mm in length and 0.39 - 0.42 mm with mean of 0.40± 0.02 mm in width, the present findings were in line with Kavitha *et al*. (2005) [3], who reported the similar observations.

Incubation period and hatching percentage

It is evident from the data that incubation period was ranged from 3.0 to 9.0 days with mean of 5.60±0.44 days. Present findings are more or less in close with earlier report of Kavitha *et al*. (2005) [3], whereas shorter incubation period of 2 to 4 days with mean 3.16 ± 0.81 reported by Beria *et al.* (2008) [2]. Hatching percentage varied from 72 to 75 per cent with mean of 73.5±1.50 per cent under laboratory conditions. Patel *et al.* (2007) [4] observed mean number of eggs with hatching per cent in the range of 81.58 to 96.92 per cent with mean of 93.03 per cent, which is more or less similar to present findings.

Larval developmental period

The development period for larva ranged from 39 to 48 days with mean of 42.54±2.53 days. Present observations are in close conformity with earlier reports of Kavitha *et al.* (2005) [3] who reported 40–44 days larval period, whereas shorter larval developmental period of 31.57 days was reported by Beria *et al.* (2008) [2]. Similarly, Patel *et al.* (2007) [4] reported larval period which ranged between 23 to 40 days with mean of 29.70 ± 3.77 days. Whereas, the difference in the larval period might be due to varied climatic conditions of the locality during experimental period. During the developmental period, the freshly hatched larva moulted six times and passed through seven instars. Some of the common characters observed in all instars were, the body was smooth with long setae arising from dark patches of body laterally, two continuous mid dorsal white bands, two black discontinuous lines on the lateral sides and a pair of symmetrical dots on each segment were observed. Five pairs of slender pale white prolegs were arranged from 3rd to 6th and at last abdominal segments and similar findings were also reported by Kavitha *et al.* (2005) [3] in *O. euadrusalis*.

First instar: The newly hatched first instar larvae were pinkish to light green colour with brownish head scraped the chlorophyll content which looked patch like appearance. The period of first instar larva ranged from 3 to 6 days with mean 4.80±0.92 days.

Second instar: Second instar larva was light green in colour with dark brown head and they fed upon the chlorophyll content of the leaf similar to that of first instar larvae. The larval period ranged from 3 to 6 days with mean of 4.65±0.90 days.

Third instar: The third instar was dark greenish in colour with dark colour head and fed voraciously on the webbed leaves and twigs by chewing the leaves from the leaf edge, leaving only the midrib and veins. The larval period for third instar ranged from 4 to 5 days with mean of 4.65±0.90 days.

Fourth instar: The larvae of fourth instar was greenish in colour with dark head and they fed upon the entire leaves

except the midrib and veins. The larval period ranged from 3 to 6 days with mean of 4.16±0.87 days.

Fifth instar: The colour of fifth instar larva was dark greenish black, with very clear dark brown markings on prothorax. The larval period for fifth instar ranged from 4 to 5 days with mean of 4.52±0.51 days.

Sixth instar: The sixth instar larvae were greenish grey in colour with dark brown head capsule and brown spots on the prothorax. The larval period for sixth instar was ranged from 5 to 6 days with mean of 5.20±0.42 days.

Seventh instar: The seventh instar larvae were not much differed from sixth instar, however larvae was stout and light coloured compared to sixth instar with dark colour head and The feeding was totally reduced and attained cessation as they were entering the prepupal stage. The larval period for seventh instar was ranged from 6 to 7 days with mean of 6.50± 0.53 days.

Prepupal, pupal duration and morphometrics

The full grown larva passed through a prepupal stage before pupation, it ceases feeding, became inactive and gradually shrink in size. All the longitudinal bands disappeared in this stage and larva attained an overall creamish colouration. The pre-pupal stage lasted for 2 to 3 days with mean of 2.70±0.48 days. It constructs a tough silken cocoon with larval castings and its excreta, after which it got transformed into pupa. The pupation occurred within the webbed leaves inside the silken cocoon. Pupa was dark brown in colour, obtect type, broader anteriorly and tapering posteriorly. The duration of the male pupal stage ranged from 11 to 13 days with mean of 11.80±0.63 days, while the female pupal stage last till 13 to 15 days with mean of 14.30±1.43 days. The male pupa measured from 11.59 to 12.55 mm with mean of 12.14±0.30 mm in length and 4.05 to 4.45 mm with mean of 4.25±0.05 mm in width. The female pupa measured from 13.51 to 13.80 mm with mean of 13.69±0.27 mm in length and 5.38 to 5.76 mm with mean of 5.60±0.11 mm in width. The pupal length and width were more or less similar to findings of Kavitha *et al.* (2005) [3] with average length and width of 12.8±0.78 mm 4.4±0.513 mm respectively.

Adult

As observed from the experimented conducted the adult found to be medium sized, grey coloured moth with brown forewings and dark white coloured hind wings. The male moths ranged from 11.31 to 11.85 mm with mean of 11.54±0.33 mm in length and 10.28 to 10.93 mm with mean of 10.56±0.25 mm in width at wing expanse. The adult female moths ranged from 12.96 to 13.38 mm with mean of 13.22±0.20 mm in length and 11.36 to 12.17 mm with mean of 11.66±0.30 mm in width at wing expanse. The present observations with respect to length of male and female adult are more or less similar with that reported by Kavitha *et al.* (2005) [3] where female moths have average length of 12.06±0.16 and width of 11.60±51 respectively. Patel *et al.* (2007) [4]. However, little variation has been found with respect to width (wing expanded) of male and female adult, respectively.

Adult longevity

The adult longevity was studied in the laboratory for both the sexes. Observations are presented in Table 5. Male moths lived for 3 to 5 days with mean of 4.10±0.74 days, while the female lived for 5 to 6 days with mean 5.80±0.42 days. The present observations on adult male longevity are in close agreement except adult female longevity studied by Patel *et al.* (2007) [4]. They reported that the average longevity of male and female was 4.00 ± 0.82 days and 8.30 ± 0.68 days, respectively.

Total developmental period

The total period required to complete the life cycle from eggs to emergence of female adult was varied from 58 to 67 days with a mean of 62.64± 4.59 days. The total life period required to complete the life cycle from eggs to emergence of male adult was varied from 55 to 62 days with mean of 58.44±3.90days. Kavitha *et al.* (2005) [3] reported total life period from egg to death of adult was 81.7 days in males and 84.0 days in females. Whereas, Patel *et al.* (2007) [4] recorded total life cycle period from egg to death of adult was 56.60 days in male and for female was 59.60 days. The little beat variation observed in the developmental periods might have attributed to the nutritional status of host plants and climatic variation in the location of study.

Sex ratio

The present findings under laboratory conditions showed 1:1.5 of female to male sex ratio. The present findings are in confirmity with Kavitha *et al.* (2005) [3] found predominance of females with 1:0.4 sex ratio and Patel *et al.* (2007) [4] also reported female predominate with sex ratio of 1.14:1 with respect to *O. euadrusalis*. However, Beria *et al.* (2008) [2] reported the predominance of male with sex ratio 1:1.11 with respect to *O. exvinacea* Hampson.

Table 1: Biology of mango leaf webber *Orthaga exvinacea* Hampson under laboratory conditions

Stages	Duration Mean±SD (in days)
Fecundity (No. of Eggs)	59.39±1.20
Preovipostion	2.60±0.52
Oviposition	4.10±0.74
Post Ovipositon	1.90±0.74
Incubation period	5.60±0.44
Hatching percentage	73.5±1.5
Larvae	
1st Instar	4.80±0.92
2nd Instar	4.65±0.90
3rd Instar	4.41±0.63
4th Instar	4.16±0.87
5th Instar	4.52±0.51
6th Instar	5.20±0.42
7th Instar	6.50±0.53
Prepupa	2.70±0.48
Total larval duration	42.54±2.53
Pupae	
Male	11.80±0.63
Female	14.30±1.43
Adult	
Male	4.10±0.74
Female	5.80±0.42
Total Duration Male	58.44±3.90
Total Duration Female	62.64±4.59
Number of males emerged	79
Number of females emerged	53
Female: Male sex ratio	1:1.5

SD – Standard deviation

Table 2: Morphometric studies of mango leaf webber *Orthaga exvinacea* Hampson under laboratory conditions

Stage of mango leaf webber	Length (mm) Mean± SD	Width (mm) Mean± SD	Head capsule	
			Length (mm) Mean± SD	Width (mm) Mean± SD
Egg	0.88±0.02	0.40±0.02	-	-
Larval Instars				
1st Instar	1.68± 0.05	0.19±0.02	0.42±0.02	0.30±0.01
2nd Instar	2.38 ±0.03	0.30 ± 0.02	0.52 ±0.01	0.34 ±0.01
3rd Instar	4.23 ±0.09	0.49 ±0.02	0.63 ±0.02	0.55 ±0.03
4th Instar	8.98 ±0.26	1.40 ±0.03	1.42 ±0.02	1.21 ±0.02
5th Instar	14.81 ±0.30	2.17 ±0.04	1.76 ±0.05	1.52 ±0.03
6th Instar	21.64 ±0.72	2.67 ± 0.09	3.02 ± 0.07	2.05 ±0.03
7th Instar	28.64 ± 0.65	3.50 ± 0.10	3.45 ±0.05	3.02 ±0.08
Pupae				
Male	12.14±0.30	4.25±0.20	-	-
Female	13.69±0.27	5.60±0.11	-	-
Adult (Wing expanse)	**Length (mm) Mean± SD**	**Wing Expanse (mm) Mean± SD**	-	-
Male	11.54±0.23	10.56±0.25	-	-
Female	13.22±0.26	11.66±0.30	-	

mm – milimeter, SD – standard deviation

Conclusion

The biology of *O. exvinacea* during present studies provided adequate information on which stage of the pest and in particular which instar cause economic damage to the crop and helped to take necessary management strategies and will also help scientists engaged in the pest management of mango in deciding the future management strategies against mango leaf webber. So, the present findings are helpful in effective control of these pests and to protect the environment at the same time against rise of the pests.

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