Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(1): 161-165

Received: 17-11-2017
Accepted: 20-12-2017

Poonam Singla
Department of Entomology
Punjab Agricultural University,
Ludhiana, India

Manmeet Brar Bhullar
Department of Entomology
Punjab Agricultural University,
Ludhiana, India

Paramjit Kaur
Department of Entomology
Punjab Agricultural University,
Ludhiana, India

Correspondence
Paramjit Kaur
Department of Entomology
Punjab Agricultural University,
Ludhiana, India

Biological studies on brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee

Poonam Singla, Manmeet Brar Bhullar and Paramjit Kaur

Abstract
The biology of brinjal shoot and fruit borer, *Leucinodes orbonalis*, was studied on brinjal variety *Punjab Sada bahar*. The different parameters of biology viz. incubation period, larval period, pupal period, oviposition, fecundity, adult longevity and sex ratio were studied during different months i.e. June, August and October. The results revealed that there was significant difference in duration of all the biological parameters during three different seasons and minimum duration of incubation period (3.19 days), larval period (11.31 days), pupal period (7.11 days) was observed during August when mean temperature and relative humidity was 29.5 ºC and 79.25 per cent respectively. The total life span was observed to be short during August followed by June and October.

Keywords: Biology, Brinjal, Shoot and fruit borer

1. Introduction
Brinjal (*Solanum melongena* L.) belonging to family Solanaceae is a popular and economically important vegetable crop among small-scale farmers and low-income consumers of South Asia and this region accounts for nearly 60 per cent and 53 per cent of the world's area and production, respectively [1]

In India, brinjal is grown throughout the year with an area of 7.05 thousand ha and a production of 12.995 thousand MT. [2] In Punjab, the crop is grown intensively with a production of 82800 MT [3]. Though brinjal is a summer crop, it is being grown throughout the year under irrigated conditions and is subjected to attack by a number of insect and mite pests right from the nursery stage till harvesting. Among the insect pests infesting brinjal, the major ones are shoot and fruit borer, *Leucinodes orbonalis* Guenee; whitefly, *Bemicia tabaci* (Gennadius); leafhopper, *Amrasca biguttula biguttula* (Ishida); Epilachna or hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.) and non insect pest, red spider mite, *Tetranychus macfarlanei* (Baker and Pritchard) and *Tetranychus urticae* Koch. Out of these, brinjal shoot and fruit borer (BSFB), *L. orbonalis* is the key pest throughout Asia [4, 5] In India this pest has a countrywide distribution and has been categorized as the most destructive and serious pest causing huge losses in brinjal and is considered a limiting factor in brinjal cultivation causing losses as high as 70-92 per cent [6].

BSFB has a very wide host range. Besides brinjal, it attacks other solanaceous plants such as *Solanum tuberosum*, *S. aculeatissimum*, *S. indicum*, *S. myriacanthum*, *S. torvum*, *Lycopersicon esculentum*, *Capsicum annum* and some weeds [7]

The research and development activities to combat BSFB have largely been confined to screening pesticides to select the most effective chemical and determining the frequency of their use. At one time, researchers developed pesticide spray schedules that involved calendar spraying whether the pest was present or not [8, 9] This approach led to increased dependence on pesticides and consequent adverse effects of higher costs of production, environmental pollution, destruction of natural enemies, and development of pesticide resistance in BSFB. The current pesticide use is not only non-sustainable but, if continued will adversely affect brinjal and other vegetable production. So, there is an urgent need for developing alternative control strategies. Hence keeping the above points in view, the present investigation on biological studies was under taken to know the total developmental period of BSFB under laboratory conditions and also the weakest link in its life cycle at which the pest can be effectively controlled.

2. Materials and Methods

The study of biology and seasonal incidence of Brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyraustidae) on brinjal was conducted during 2012 in three different months at the Entomological Research Farm and the Acarology laboratory of the Department of Entomology, Punjab Agricultural University, Ludhiana.

2.1 Raising of crop

Brinjal crop was sown at Entomological Research Farm, Punjab Agricultural University, Ludhiana. Three successive crops of brinjal (variety – *Punjab sada bahar*) were grown for recording the seasonal incidence in different seasons and for getting a regular supply of food throughout the year for the larvae reared in the laboratory. The crop was raised as per the recommended Package of Practices for cultivation of Vegetable crops, except that no spraying was done at the crop.

2.2 General Culture

Field collection of grown up larvae of BSFB was made from the Research Farm of the University and fields in and around Ludhiana. The larvae collected were transferred to the plastic vials of 25 ml size containing fresh pieces of brinjal fruit. The vials were then covered with a lid and the food was changed daily in the morning hours to prevent fungal contamination till the fifth instar larvae got ready for pupation. As the larvae fed on brinjal pieces by making tunnels and excrete exuviae, so there was a need to change the food in the vials and also the vials daily. When the fifth instar larvae got ready to pupate then these full grown larvae were shifted to glass jar, containing sand, covered with muslin cloth for pupation. The sand in the jar was kept moist by sprinkling water over it to provide sufficient moisture for the survival of pupae. The sand was autoclaved to prevent any pathogenic infection to the pupae. The adults that emerged from pupae were sexed on the same date by observing the body size and presence of tuft of hairs at the tip of the abdomen. These adult moths were used for the further studies. One pair of freshly emerged male and female moth was released in glass jar (15cm x 10cm) having moist filter paper placed at the bottom. Fifteen such glass jars were prepared consisting of five jars in each replication with three replications in each case. The glass jars were then covered with black chart from outside and the cotton swabs dipped in 5 per cent honey solution were hung from the upper side with the help of pins to provide food for the adults. The mouth of the glass jars was covered with muslin cloth. A 50 ml plastic vial containing a twig of the brinjal plant dipped in water was also placed in the glass jar to provide a natural environment for adults to facilitate oviposition.

The eggs thus obtained were examined daily to record the incubation period of eggs and also for the emergence of neonate larvae. To record the incubation period three replications were made consisting of ten eggs in each replication. The larvae that hatched from the eggs on the same date were used for biological studies. All the parameters were recorded at room temperature and relative humidity observed during three different months i.e. June, August and October. The mean temperature and relative humidity recorded were 31.45 ºC, 29.65 ºC and 25.33 ºC and 59.00, 79.25 and 65.88 per cent during June, August and October respectively.

2.3 Biological studies of brinjal shoot and fruit borer, *Leucinodes orbonalis*

Incubation period: To observe the incubation period freshly laid eggs were observed daily for the emergence of neonates.

Larval period: Ten neonate larvae were transferred by moist camel hair brush in small vials containing pollen grains of flowers of brinjal. The food in the vials was changed daily in the morning hours to prevent fungal growth over the food. On formation of second instar larvae, the food was changed from pollen to brinjal slices as BSFB is an internal feeder and feeds by making tunnels in the fruit. The time when full grown larvae stopped feeding and became inactive was considered as the termination of the larval and initiation of pupal stage.

Pupal period: The fully grown fifth instar larvae were transferred to small vials having a moist layer of autoclaved sand and observed daily in the morning hours to study the pupal period during different months of the year.

Oviposition period and fecundity: The adults that emerged were sexed by examining the presence of tuft of hairs at the end of the abdomen and their body size. The males were smaller in size and do not posses abdominal tuft. The females were larger in size and had tuft of hairs at the tip of abdomen. One pair was released in each glass jar (15cm x 10cm) covered with black chart from outside and the cotton swabs dipped in 5 per cent honey solution were hung from the upper side with the help of pins to provide food to the adults. These pairs were observed daily for studying the oviposition period and fecundity of the adults. To determine the oviposition period, the eggs laid by female in the jars were observed daily till the death of the female moths. The fecundity was calculated by counting the number of eggs laid by the female on the moist filter paper, glass jar, brinjal leaves on the twig placed in the jar and the muslin cloth.

Adult Longevity: To determine the longevity of adults, both male and female, observations were recorded daily from their emergence till death.

Sex Ratio: Sex ratio was observed by counting the number of male and female moths emerged.

Sex differences in pupal stages: For determining the sex differences in the pupal stage, the observations were made on the last abdominal segment of the pupae. In case of female the distance between the genital slit and the last abdominal segment was less whereas in case of male pupae the distance between genital slit and the last abdominal segment was more. Ten pupae were examined for each sex.

2.4 Biometric analysis: For biometric analysis, each stage of BSFB was examined and data regarding their length, width and head width was recorded using an image analysis system under stereozoom microscope (Carl Zeiss Discovery V8).

2.5 Statistical analysis

The experimental data was analysed statistically by applying Complete Randomized Design.

3. Results and Discussion

3.1 Biological studies of brinjal shoot and fruit borer, *Leucinodes orbonalis*

Egg stage: The eggs were laid in batches of 5 to 6 or singly on the under surface of brinjal leaves or on glass jar or on muslin cloth or on filter paper. Freshly laid eggs were oval in shape and creamy white in colour and measured 0.17 mm in

length and 0.10 mm in width (Table 3). When the egg of this pest was about to hatch, it turned into deep orange color with prominent black spot at the tip of the egg which was the developing head of the larva. The present results were in contrast with the findings of Varma and Anandhi who reported that the mean length varied from 0.56 to 0.63 mm and mean width varied from 0.34 to 0.45 mm. [10]

Incubation period: The mean incubation period was observed during three different months viz. June, August and October. It was found to vary from 3.19 to 5.72 days (Table 1). The minimum incubation period was observed during August (3.19 days) which was statistically at par with June (3.22 days) and differed significantly from October (5.72 days). The results were in accordance with the observations of Varma and Anandhi who reported the mean incubation period of 4.00 days on brinjal. On garden pea, the incubation period of 5.93 days was reported by other authors [10, 11].

Larval stage: The larvae moulted four times and passed through five instars. The larval instars were determined by the number of moults manifested by exuviae formed during moulting. The newly hatched larva was creamy white in colour. The full grown larva was cylindrical and pinkish in colour. The head of the larva was dark brown and had strong mandibles for mastication. The thorax of larva showed three distinct segments with a pair of well-developed thoracic legs on each segment. The abdomen had ten segments and five pairs of prolegs.

First instar: The young larvae were creamish in color. The mean duration of first instar larvae ranged from 2.53 to 4.08 days. The minimum duration was observed during August (2.53 days) followed by June (3.53 days) and October (4.08 days) (Table 2). The mean duration during three months varied significantly from each other. The first instar larvae fed on the pollen of brinjal flowers. The mean length of first instar was 1.94 mm, width 0.50 mm and head width was observed to be 0.33 mm (Table 3). In contrast to the present findings, Varma and Anandhi reported duration of 1.40 days with the mean length of 1.21 mm, width 0.27 mm and head width of 20 mm. [10]

Second instar: After moulting, the second instar larvae immediately fed on fresh brinjal slices and as it matured, it produced regular holes in the brinjal slices filled with exuviae. The larva stopped feeding a few minutes before moulting. The mean duration of second instar larvae varied from 2.11 to 3.61 days during three different months. The minimum duration was observed during August (2.11 days) followed by June (3.47 days) and October (3.61 days) (Table 2). The mean duration during three months varied significantly from each other. The mean length of second instar was 4.55 mm, width 0.80 mm and head width was observed to be 0.43 mm (Table 3). This instar was marked by the brownish head which was narrower than prothorax. The results collaborate the findings of Varma and Anandhi who observed the duration as 2.00 days [10].

Third instar: Third instar larva was 8.48 mm in length and 1.69 mm in width with the head width of 0.77 mm (Table 3). Small brown spots appeared on the dorsal and ventral sides of the body, the number on the dorsal side being more and from the center of each spot emerged a fine spine. The mean duration of third instar larvae was 3.11 to 5.83 days. The minimum duration was observed during August (3.11 days) followed by June (5.27 days) and October (5.83 days). The mean duration during three months varied significantly from each other (Table 2). In contrast to the present findings, other authors observed the duration of 1.48 days [11].

Fourth instar: At this stage the fourth instar larva measured 10.05 mm in length and 2.10 mm in width with head width of 1.34 mm (Table 3). The mean duration of fourth instar larvae was 2.00 to 3.69 days. The minimum duration was observed during August (2.00 days) followed by October (3.58 days) and June (3.69 days). The mean duration during three months varied significantly from each other (Table 2). In contrast to the present findings, Saxena reported duration of 1.00 day with mean larval length and width of 9.30 mm and 1.80 mm, respectively [12].

Fifth instar: During this instar, the larva did not appear to feed so voraciously as during the previous instars. The morphology of the larva was almost the same except that there was a proportionate increase in the size of different parts of the body and the pupating behavior was more pronounced at this stage. The duration of fifth instar larvae varied from 1.56 to 3.80 days. The minimum duration was observed during August (1.56 days) followed by October (3.61 days) and June (3.80 days). The mean duration during three months varied significantly from each other (Table 2). The mean length of fifth instar larva was 13.08 mm and mean width was 2.28 mm with head width of 1.36 mm (Table 3). The fifth instar larvae became sluggish and inactive before pupation. It lost its body pigmentation and started preparing cocoon for pupation.

Total larval period: The total larval duration observed varied from 11.31 to 20.72 days (Table 2). The minimum duration was observed during August (11.31 days) followed by June (19.78 days) and October (20.72 days). The mean duration during three months varied significantly from each other. The results showed similarity to the earlier findings of Radhakrishore and co-workers who found it to vary from 16.86 days [13].

Pupal stage: The pupa was 9.49 mm long and 3.13 mm broad with head width of 1.48 mm (Table 3). The freshly formed pupa was pinkish which changed to dark brown with time, elongate oval in shape, gradually tapering posteriorly with almost straight abdomen; wing margins extended up to the posterior margin of the abdominal segment. Pupation occurred on the glass jars, sand, muslin cloth and inside the rotten fruit. The pupal period was found to vary from 7.11 to 9.69 days (Table 5). The minimum duration was observed during August (7.11 days) which was statistically at par with October (7.53 days) and varied significantly from June (9.69 days). The present results are in line with the findings of Saxena who found it to vary from 8 to 9 days and other authors who observed pupal period to be from 7 to 11 days under laboratory conditions [4, 12] Male and female was also distinguished at pupal stage on the basis of genital slit. In case of male the distance between last abdominal segment and genital slit was more whereas in case of female the distance between two was less.

Adult stage: The adult moth was of white colour with head and thorax covered with greyish and brown scales. The fore wings were creamish white with reinform large patches of

light brown colour over it. In case of hind wing a faint black wavy line was observed close to the apical margin. The wings were slightly fringed at the margins. The female moth was generally larger than the male and had tuft of hair at the tip of the abdomen. The mean length of an adult male was observed as 7.66 mm and mean width was observed as 17.66 mm across the wings whereas in case of female the mean length was observed as 10.50 mm and mean width was observed as 19.00 mm across the wings (Table 3).

O**viposition period:** The oviposition period was observed to vary from 1.54 to 2.40 days (Table 4). The maximum duration was observed during August (2.40 days) followed by June (1.90 days) and October (1.54 days). The mean duration during three months varied significantly from each other. The results were almost similar to the observations of Jat and co-workers who observed the oviposition period of 2.43 days [14]

Fecundity: The fecundity of *L. orbonalis* was observed to vary from 38.20 to 74.60 during three different months (Table 4). The maximum egg laying was observed during August i.e. 74.60 eggs followed by 42.60 eggs during June and 38.20 eggs during October. The fecundity during three months varied significantly from each other. In contrast to the present findings, Singh and Singh reported average egg laying of 174.95 eggs per female [15].

Longevity of adults: In general, females lived longer than males. Mean longevity of adults was observed to be 1.83 to 2.00 days whereas in case of female, the longevity varied from 3.66 to 4.16 days (Table 5). The results are in accordance with other authors who observed male longevity as 1.82 days and female longevity as 3.12 days, while these differ from the observations of Kavitha and co-workers who observed male longevity as 3.50 days and female longevity as 5.70 days [14, 16].

Total life span: The total life span was observed to vary from 25.06 to 36.72 days (Table 5). The minimum duration was observed during August (25.06 days) followed by June (35.61 days) and October (36.72 days) (Fig. 1). The mean duration during three months varied significantly from each other. The present findings are in accordance with Singh and Singh who reported life cycle of 36.82 days [15].

Sex ratio: Sex ratio (female: male) was observed to be varying from 1.16:1 to 2.00:1 days (Table 6). Females outnumbered males and the sex ratio observed was 1.3:1 (female: male) which is very near to our results [17].

4. Conclusion

The month of August was found to be favourable for the growth and development of BSFB and thus the farmers should be more cautious for this pest from July onwards and adopt the management strategies of BSFB in the field.

5. Acknowledgement

The authors are grateful to Professor and Head, Department of Entomology, Punjab Agricultural University, Ludhiana, for providing the necessary laboratory and field facilities.

Table 1: Incubation period of *L. orbonalis* Guenee on brinjal during different months

Months	Incubation period Mean* (days)	Temp. (ºC)	RH (%)
June	3.22 (2.05)	31.45	59.00
August	3.19 (2.04)	29.65	79.25
October	5.72 (2.59)	25.33	65.88
CD (p=0.05)	(0.18)	-	-

*figures in parentheses are n+1 square root transformed values

Table 2: Larval Duration of *L. orbonalis G*uenee on brinjal during different months

Months	Duration of different larval instars Mean* (days)						Temp (ºC)	RH (%)
	1st	2nd	3rd	4th	5th	Larval period		
June	3.53 (2.12)	3.47 (2.11)	5.27 (2.50)	3.69 (2.16)	3.80 (2.19)	19.78 (4.55)	31.45	59.00
August	2.53 (1.87)	2.11 (1.76)	3.11 (2.02)	2.00 (1.73)	1.56 (1.59)	11.31 (3.50)	29.65	79.25
October	4.08 (2.25)	3.61 (2.14)	5.83 (2.61)	3.58 (2.14)	3.61 (2.14)	20.72 (4.66)	25.33	65.88
CD (p=0.05)	(0.20)	(0.13)	(0.10)	(0.11)	(0.19)	(0.22)	-	-

* figures in parentheses are n+1 square root transformed values

Table 3: Measurements of different developmental stages of *L. orbonalis* Guenee

Growth Stage		Length	Width	Head width
		Mean±SD (mm)		
Egg*		0.17± 0.06	0.10± 0.05	-
Larval stages**	1st instar	1.94±0.02	0.50±0.09	0.33±0.02
	2nd Instar	4.55±0.56	0.80±0.21	0.43±0.05
	3rd Instar	8.48±0.36	1.69±0.14	0.77±0.06
	4th Instar	10.05±0.43	2.10±0.25	1.34±0.08
	5th instar	13.08±0.00	2.28±0.06	1.36±0.08
Pupa**		9.49±0.09	3.13±0.05	1.48±0.57
Adult	Male	7.66±0.58	17.66±0.58	-
	Female	10.50±0.71	19.00±1.14	-

*Observations at 80X magnification

**Observations at 10X magnification

Table 4: Oviposition period and fecundity of *L. orbonalis G*uenee on brinjal during different months

Months	Oviposition period	Fecundity	Temp. (ºC)	RH(%)
June	1.90 (1.70)	42.60 (6.56)	31.45	59.00
August	2.40 (1.84)	74.60 (8.66)	29.65	79.25
October	1.54 (1.59)	38.20 (6.12)	25.33	65.88
CD (p=0.05)	(0.14)	(1.45)	-	-

***** figures in parentheses are n+1 square root transformed values

Table 5: Pupal period, adult longevity and total life span of *L. orbonalis G*uenee on brinjal during different months

Months	Mean* (days)				Temp. (ºC)	RH (%)
	Pupal period	Adult longevity		Total life span		
		Male	Female			
June	9.69 (3.26)	3.66 (2.15)	1.83 (1.63)	35.61 (6.05)	31.45	59.00
August	7.11 (2.84)	4.16 (2.27)	2.00 (1.73)	25.06 (5.10)	29.65	79.25
October	7.53 (2.91)	3.66 (2.15)	2.00 (1.73)	36.72 (6.14)	25.33	65.88
CD (p=0.05)	(0.10)	NS	NS	(0.17)	-	-

***** figures in parentheses are n+1 square root transformed values

Table 6: Sex ratio of *L. orbonalis G*uenee on brinjal during different months

Months	Sex-ratio (female: Male)	Temp. (ºC)	RH (%)
June	2.00 : 1	31.45	59.00
August	1.16 : 1	29.65	79.25
October	1.40 : 1	25.33	65.88

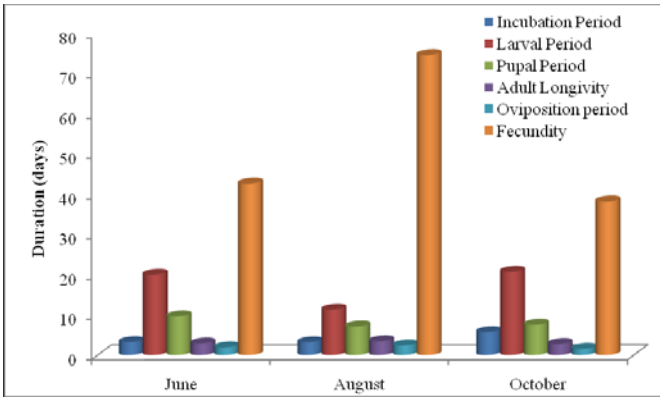

Fig 1: Total life span of brinjal shoot and fruit borer, *L. orbonalis* during different months

6. References

1. Singhal V. Indian Agriculture. Indian Economic Data Research Centre, New Delhi, 2003.
2. Anonymous. Area and production of brinjal in India and Punjab. http//www.indiastat.com, 2013.
3. Anonymous. Package of Practices for Cultivation of Vegetables. Punjab Agricultural University, Ludhiana, 2016, 37.
4. Allam MA, Rao PK, Rao BHK. Biology of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. Indian Journal of Agricultural Sciences. 1982; 52:391-395.
5. Patial A and Mehta PK. Pest complex of brinjal and their succession under mid hills of Himachal Pradesh. Journal of Insect Science. 2008; 21:67-71.
6. Patil PD. Technique for mass rearing of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. Journal of Entomological Research. 1990; 14:164-172.
7. Anonymous, 2011. www.ento.csiro.au.
8. Atwal AS. Agricultural Pests of India and Southeast Asia. Kalyani Publishers, New Delhi, 1976, 529.
9. Srivastava KP, Butani DK. Pest Management in Vegetables, Part 1. Research Periodical and Book Publishing House, Houston, USA, 1998, 294.
10. Varma S, Anandhi P. Biology and morphometry of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on brinjal (*Solanum melongena*) under Allahabad conditions. Journal of Insect Science. 2009; 22:3-10.
11. Onekutu A, Omoloye AA, Odebiyi JA. Biology of the Eggfruit and Shoot Borer (EFSB), *Leucinodes orbonalis* Guenee (Crambidae) on the Garden Egg, *Solanum gilo* Raddi. Journal of Entomology. 2013; 10:156-162.
12. Saxena PN. The life history and biology of *Leucinodes orbonalis* Guen. (Lepidoptera: Pyraustidae). Journal of the Zoological Society of India. 1965; 17:64-70.
13. Radhakrishore RK, Singh TK, Shah MAS. Biology of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen (Lepidoptera: Pyralidae). National journal of Life Sciences. 2010; 7:77-79.
14. Jat KL, Pareek BL, Singh S. Biology of *Leucinodes orbonalis* an important pest of brinjal in Rajasthan. Indian Journal of Entomology. 2003; 65:513-517.
15. Singh YP, Singh PP. Biology of shoot and fruit borer (*Leucinodes orbonalis* Guen.) of egg-plant (*Solanum melongena* L.) at medium high altitude hills of Meghalaya. Indian Journal of Entomology. 2001; 63:360-368.
16. Kavitha VS, Revathi N, Kingsley S. Biology of brinjal pest, *Leucinodes orbonalis* Guen. Of Erode region in Tamil Nadu. Journal of Entomological Research. 2008; 32:255-257.
17. Patial A, Mehta PK, Sood AK. Developmental biology of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. in mid hills of Himachal Pradesh. Entomon. 2007; 32:137-142.