Biology of shoot and fruit borer, *Leucinodes orbonalis* (Guenee) in Brinjal

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Abstract: - Investigations on biology of shoot and fruit borer, *Leucinodes orbonalis* Guenee in brinjal" were carried out under laboratory condition at the Department of Entomology, B. A College of Agriculture, AAU, Anand during *kharif*, 2021. Biological studies of *L. orbonalis* under laboratory conditions on brinjal (variety GAB 6) revealed that eggs were flat, oval, and creamish white which later changed to pale orange with noticeable black dots before its hatching. It was recorded that the fecundity and hatching per cent of the egg was 197.3 eggs and 66 per cent, respectively. The average pre-oviposition, oviposition, post-oviposition, incubation, larval, pre-pupal, and pupal period was 1, 3.3, 1.7, 3.8, 13.87, 1.35 & 8.45 days, respectively. The sex ratio *i.e.,* (male: female) was recorded as 1: 1.5, and the average male and female longevity was recorded as 2.9 & 3.8 days, respectively. The total longevity of *L. orbonalis in* male and female adults was 30.25 and 31.15 days, respectively. These findings provide sufficient knowledge about the biology of an insect which is necessary for adopting suitable control measures.

Key-words: - Shoot and Fruit borer, *Leucinodes orbonalis*, brinjal, biology, kharif, fecundity, sex ratio

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1 Introduction

Brinjal or eggplant (*Solanum melongena* L.) belongs to the family Solanaceae and is an important solanaceous crop of sub-tropics and tropics. The name brinjal is popular in Indian subcontinents and is derived from Arabic and Sanskrit whereas the name eggplant has been derived from the shape of the fruit of some varieties, which are white and resemble in shape to chicken eggs. India is the second-largest producer of brinjal being cultivated over an area of 0.74 million ha, production of 12.78 million tons with an average annual production of 17.36 million tons per ha in the year 2020 (Anon, 2020) [5]. In India, Gujarat ranks third in brinjal production with 1.5 million tons of production, occupied 0.077 million ha area and has a productivity of 19.7 million tons per ha during the year 2020-21 (Anon, 2021) [6]. In Gujarat, it is mainly grown in Vadodra, Anand, Surat, Kheda, Tapi, Banaskatha, Navsari, and Ahmedabad districts. Brinjal crop occupied an area of 0.0096 million ha, 0.20 million tons production and 21 million tons per ha productivity during the year 2020-21 (Anon, 2021) [6] at Anand district in Gujarat. Several abiotic and biotic factors contribute to lowering the yield in brinjal. Among various biotic factors, insect pests are important which greatly affect the quality and productivity of brinjal crops by inflicting direct damage.

Among the major insect pests infesting the brinjal crop, the brinjal shoot and fruit borer, *Leucinodes orbonalis* which is considered the most destructive pest of brinjal in India. Studies on the biology of the pest helps in developing pest management strategies. Though the information on the biology of *L. orbonalis* is available in the literature (Ali and Sanghi, 1962 [2]; Lall and Ahmed, 1965 [14]; Allam *et al.,* 1982 [3]; Jat *et al.,* 2003) [11], however, the biology differs in different regions. Therefore, it has been thought essential to study biology in detail under agro-climatic conditions of middle Gujarat.

2 Materials and Methods

The initial culture of shoot and fruit borer, *L. orbonalis* was collected from infested fruits of unsprayed brinjal crop which was sown at Entomology farm, B. A. College of Agriculture and Main Vegetable Research Station, AAU, Anand during second fortnight of August, 2021. The infested fruits were cut open to obtain larvae. These larvae were reared in a plastic box (15 cm in diameter and 6 cm in height) with flat bottom and fed on fresh pieces of brinjal fruits. The pieces of brinjal fruits were changed every alternate day. Open top of the plastic box was covered with muslin cloth tied with rubber band to prevent larval escaping. Freshly formed cocoons in the plastic box were transferred daily into Petri plates for emergence of the adults. The adults obtained were used for maintaining mass culture and further study.

The newly emerged female and male moths in the proportion of 1:2 was released in the oviposition cage (30 × 30 × 30 cm) for mating purpose. A fresh brinjal twig with three to four tender leaves, cut ends of which was dipped in fresh water filled in conical flask to maintain turgidity of the shoots. The conical flask with these shoots were kept inside the oviposition cage for resting and oviposition of adults. A Cotton swab dipped in five per cent honey solution were placed in oviposition cage as a food for moths. The eggs were collected from the leaf and shoots and then collected eggs were used for further study.

2.1 Biology

In order to study the hatching percentage, the eggs laid by female moth were picked up with the help of a fine camel hair brush on the same day and transferred into 9 cm diameter Petri plates containing moist blotting paper at their bottoms seated over moist cotton wad as shown in Plate 3.2. Five eggs were placed in one Petri plate with a set of ten Petri plates. The blotting papers were moistened periodically. The observation on the number of eggs hatched had been recorded daily in the morning till unhatched eggs were shrinked. For incubation period, thirty eggs were examined from the date of egg-laying to the date of hatching. With a view to determine the larval period, newly hatched larvae were placed individually on a small piece of brinjal fruit with the help of a moist fine camel hair brush in a plastic box. A moist blotting paper was seated over the moist cotton wad at the bottom to prevent desiccation. The pieces of fruit which were provided as food for larvae were changed every alternate day till the pupation. Such 30 Petri plates were maintained to study the larval instars. The Petri plates containing developing larvae were observed daily for studying the larval instars. The presence of head capsule exuviae was the indication for the change of larval instar. The period from the hatching of eggs till the cessation of feeding was recorded as the larval period. The period required from the cessation of feeding by the full-grown larvae to the formation of pupa was recorded for 20 larvae as a pre-pupal period. The period from the formation of the pupa to the emergence of an adult was recorded as the pupal period. Such 20 pupae were kept under observation.

The newly emerged adults were kept separately in an oviposition cage. A cotton swab dipped in a five per cent honey solution was placed in an oviposition cage as food for moths. The life span of each adult was recorded by counting the period from the emergence of adults from pupa till death to study the longevity of adults. The longevity of both male and female was recorded for ten individuals each. The period between the emergence of female moths from pupa to the commencement of egg-laying was recorded for ten females, as the pre-oviposition period. The period during which the female moth laid eggs was recorded for ten females as the oviposition period. The period from the cessation of oviposition by a female moth till its death was recorded for ten females as the post-oviposition period. The females were allowed to lay eggs till their death and the total no. of eggs laid by each female in its lifetime was recorded as fecundity. The sex ratio was observed by counting the number of male and female moths that emerged. The moths that emerged were separated as male and female confirmed by the presence of pointed and curl upward abdomen at resting time in case of female, while which was blunt in male. The period, in days from the date of egg-laying to the date of adult death, was considered as a total life cycle.

3 Results and Discussion

3.1 Egg Hatching (%)

Freshly laid eggs were oblong, elliptical in shape, and creamish white in color, subsequently, before hatching their color changed to pale orange with prominent black spots that represent the developing head of larvae. During the laboratory study, fifty eggs were investigated following oviposition using a set of ten Petri plates with five eggs per Petri plate. This takes 3-5 days to hatch after egg-laying, and it produced 33 hatched eggs. As a result, hatching per cent ranged between 40-80 per cent with an average of 66 per cent as given in Table 1. The current findings are consistent with those of Abro *et al.* (2016) [1], who reported that the hatching per cent ranged from 61.3 to 66 per cent.

3.2 Incubation Period

It is clear from the Table 1 that the incubation period of *L. orbonalis* ranged between 3-5 days with an average value of 3.8 ± 0.761 days. After hatching, it turned into translucent, glossy, creamish white color larvae. Similar findings are also reported by Nair (1975) [16] and Gaurat (2006) [9] who showed an incubation period of 3 to 5 days. The present investigations are also more or less in agreement with those of Kumar *et al.* (2011) [13], Singla (2014) [23], Ambhure *et al.* (2016) [4], Raina and Yadav (2017) [19], Rohokale *et al.* (2018) [20], and Iesa (2021) [10].

3.3 Larval Period

The data observed during the larval development period was given in Table 1. It is evident from the data that the larval period varied from 11-15 days, with an average of 13.87 ± 1.04 days. Present findings are in close conformity with those of Nair (1975) [6], Yadav *et al.* (2015) [24], Sharma *et al.* (2017) [21], and Raina & Yadav (2017) [19] who reported that the larval period varied from 10-15, 13.27, 13.52, 13.5 & 13.40 days, respectively.

During the larval developmental phase, the larva was molted four times and, in that way, passed through five larval instars. Thirty larval instars were examined in each Petri plate under laboratory conditions by providing fresh brinjal fruits on alternate days, consequently, an instar-wise description was studied and presented below.

3.1.1 First instar larva

The first instar larva emerges promptly after hatching and moves rapidly in quest of food. With a noticeable glistening dark brown head, the body is tiny, cylindrical, pale transparent, filthy white, and covered with fine hairs. The head is larger than the body, and the lateral side possesses apparent compound eyes. The abdomen is divided into ten segments, with two tiny spines present at the end. The duration of the first instar larva ranged from 1-2 days with an average of 1.5 ± 0.51 days (Table 1).

3.1.2 Second instar larva

The body of the second instar larva was pale yellow with a yellowish-brown head and dark brown streaks are present on the prothoracic region. On the ventral side of the body, 3 developed pectoral legs are present. On each abdominal segment, two greyish spots are present on either side of the mid-dorsal line. From Table 1, it is indicated that the period of the second instar larva ranged from 2-3 days with an average of 2.6 ± 0.49 days.

3.1.3 Third instar larva

The body of the third instar larva was substantially bigger, yellowish-brown in color, with a light brown head capsule which thus exhibited an epicranial suture. The prothoracic region had a horizontal dark brown stripe, specks on the abdominal region are now apparent, and the body is clearly lit. Small brown spots appeared on the dorsal and ventral sides of the body, with more on the dorsal side, and a fine spine protruding from the center of each spot. The average duration of third instar larvae was 3.0 ± 0.83 days, however, it ranged from 2-4 days (Table 1).

3.1.4 Fourth instar larva

The body of this instar becomes light pink, with a brownish head. V-shaped was distinctly noticeable on the upper part of the head capsule, and transverse brown streaks appeared on the front of the thorax. The mid-dorsal line was evident on the abdomen, with many dark brown spots on each segment. This larva's lifespan ranged from 2-4 days, with a mean value of 3.2 ± 0.71 days (Table 1).

3.1.5 Fifth instar larva

The body of the fifth instar larva was dark pink, like the fourth instar larvae. The body becomes spindle-shaped and tapered towards the anterior and posterior sides. This larva was comparatively more sluggish than the earlier instars. The period of fifth instar larvae ranged from 3-4 days with an average value of 3.5 ± 0.51 days (Table 1).

As a consequence, the larva passed through five instars also confirmed by the findings of Singh & Singh (2001) [22], Jat *et al.* (2003) [11], Abro *et al.* (2016) [1], Raina & Yadav (2017) [19], and Bhoya & Patel (2018) [8] while in contrast with that, Allam *et al.* (1982) [3] and Radhakishore *et al.* (2010) [18] reported six larval instars.

3.4 Pre-pupal Period and Pupal Period

Table 1 summarizes the observations recorded during the pre-pupal and pupal period of the investigation**.**

3.4.1 Pre-pupal period

At the time of pupation, full-grown larvae move out of the fruits, became sluggish, and seek a suitable place for pupation. They pupate on muslin cloth, plastic boxes, fruits, and twigs, then secrete silken thread through the cremaster and spin a silken cocoon, thereby attaining the pre-pupal stage. The duration of the pre-pupal stage varied from 1- 2 days with an average value of 1.35 ± 0.49 days. Bhoya and Patel (2018) [8] reported a pre-pupal period of 1.3 ± 0.46 days which is consistent with the present findings.

3.4.2 Pupal period

Initially, the pupa is light brown and covered with a brown-colored cocoon, which eventually turns dark brown. The pupa is of the obtect type, with a blunt anterior end and a conical posterior end. As a result of the findings, pupal duration ranged from 7 to 10 days, with an average of 8.45 ± 0.99 days. Allam *et al.* (1982) [3] confirmed pupal period in the range of 7-11 days which lies in close conformity with the present findings. Present observations also are more or less in agreement with those of Kavitha *et al.* (2008) [12], Bindu *et al.* (2015) [7] and Padwal and Srivastava (2018) [17].

Male pupa: Male gonopore was present at two-segment after the segment having larval prolegs scars that marked the identification of male pupa. The male pupa has eight pregenital abdominal segments, with a pair of knobs on the ninth abdominal segment indicating a male genital pore.

Female pupae: It can be characterized by the presence of female genital pore one segment after the segment having larval prolegs scars. So, there are 7 pregenital abdominal segments present in the female pupa. Also, there was a simple cut in the middle of the ventral side of the 8th abdominal segment, which indicates a genital pore in female pupa.

3.5 Adult Longevity

The newly emerged adults from the pupae as shown in Plate 4.6 were kept separated in an oviposition cage with a 5 per cent honey solution for both sexes. Males, on average, had shorter life span than females. Hence, the results revealed that the longevity of male adults varied from 2-4 days with a mean value of 2.9 ± 0.88 days, while female longevity ranged from 3-5 days with a mean value of 3.8 ± 0.79 days as presented in Table 1. The present findings are more or less in agreement with Padwal and Srivastav (2018) [17] & Bhoya and Patel (2018) [8] who found that the longevity of male ranged from 2.3 – 3.4 days and mean value of 2.33 days while that of female longevity ranged from 4.2 – 5.00 and mean value of 4.61 days, respectively.

3.5.1 Male adult

Male moths were considerably smaller than female moths. Wing expanse and antenna of male moth were likewise smaller than the female moth, while color and patterns on the body were comparable with those of a female moth. The abdomen of the male moth was cylindrical and relatively more pointed and covered with numerous brownish-white hairs on the last two abdominal segments.

3.5.2 Female adult

Female moths were white, featuring whitish-grey wings, a blackish-brown head, and a thorax. The forewings exhibit golden and brown markings, while minute black dots and an angled margin are present on the hindwings. The wings were slightly fringed at the margins. Abdomen of female moth was white grey, swollen in the middle, and seemed to be ovate in structure and marked with a tuft of dark brown hairs at the intersegmental position.

3.6 Pre-oviposition, Oviposition and Post-oviposition Period

During laboratory study, it was observed that the pre-oviposition period is of short duration for about 1 day and oviposition period varied from 2-4 days with a mean value of 3.3 ± 0.67 days, and the post-oviposition period ranged from 1-2 days with an average value of 1.7 ± 0.48 days (Table 1). The present investigations are closely related by Kumar *et al.* (2011) [13], Yadav *et al.* (2015) [24], and Iesa (2021) [10] who reported the pre-oviposition

period of 1.2 days, 1.29 days, and 1.15 days respectively. Rohokale *et al.* (2018) [20] reported an oviposition period of 3.2 days which confirmed the present findings.

3.7 Fecundity

Female laid eggs in a scattered pattern mostly under the surface of leaves near leaf veins or edges, with a few eggs being found on the upper surface of leaves, on stems, and on flower buds either singly or in groups of 2-4. From Table 1, it is evident that the number of eggs laid by female moths varied from 147 – 262 with an average value of 197.3 ± 37.17. Nair (1975) [16] and Sharma *et al.* (2017) [21] reported the fecundity of 250 eggs and 193.40 eggs respectively which was in close conformity with the present findings. Also, Allam *et al.* (1982) [3] reported fecundity of 5-242 eggs that confirmed the present observations.

3.8 Sex Ratio

During the laboratory study, the sex ratio was determined by observing 100 adults. The results revealed that there were 40 male moths and 60 female moths. The male-to-female ratio was 1: 1.5, indicating a higher female population than the male moths (Table 1). Maravi *et al.* (2013) [15] confirmed these findings, reporting a male to female ratio of 1:1.53, while on the other extreme, Ambhure *et al.* (2016) [4] and Rohokale *et al.* (2018) [20] reported male: female ratio as 1:1.95 and 1:1.94 respectively. During laboratory study, female moths were identified in general by their size *i.e.,* females were larger than male moths. Besides from this, some other distinguishing characteristics were observed and mentioned further below.

The labium of a female moth has two distinctly separated ends of labial palpi; however, a male moth's labium does not have two separated ends of labial palpi. During resting position, the abdomen of the female moth is pointed and tapering towards the posterior end, whereas in the case of the male moth, the posterior end is blunt and slender. It was also observed that both male and female moths tend to curve their abdomen anteriorly in an upward direction, but in comparison to the female moth, the male moth tends to bend its abdomen more towards the anterior direction till it formed a half-circle, while the female moth only bends her abdomen slightly upward.

3.9 Total Life Cycle

The total life cycle of shoot and fruit borer moth from egg to adult is variable in male and female moths. Table 1 showed that the total life cycle of shoot and fruit borer, *L. orbonalis* in brinjal. It was obvious from this table that the total time required to complete one life cycle from egg to emergence of adult ranged from 22-32 days with an average value of 27.35 days. On the other hand, the period required from egg to death of male adults varied from 24 – 36 days, with a mean value of 30.25 days, although female adults completed within 25 – 37 days with a mean value of 31.15 days. Present observations on the total life cycle of *L. orbonalis* are in close conformity with Raina and Yadav (2017) [19], who reported that the total life cycle completed in 27-32 days.

4 Conclusion

The biological research on shoot and fruit borer in brinjal during *kharif* season revealed that the total life cycle of shoot and fruit borer was completed in 30.25 and 31.15 days in male and female respectively and the mean fecundity of this pest was recorded as 197.3 eggs per female. Consequently, conditions were favorable for the growth and development of *L. orbonalis* and thus the farmers should be more cautious for this pest from July onwards and implement the management strategies of BSFB in the field. Also, this study corresponds the growth rate statistics of this pest, which can be exploited as a predictive basis for the control of BSFB.

Table 1: Biology of shoot and fruit borer, *L. orbonalis* in brinjal under laboratory conditions

Life stages		Minimum (days)	Maximum (days)	Mean ± S. D. (days)	Sample size (n)
Egg hatching (%)		40	80	66 ± 13.50	50
Incubation period		3	5	3.8 ± 0.76	30
First instar		1	2	1.5 ± 0.51	
Second instar		2	3	2.6 ± 0.49	
Third instar		2	4	3.0 ± 0.83	
Fourth instar		2	4	3.2 ± 0.71	
Fifth instar		3	4	3.5 ± 0.51	
Larval period		11	15	13.87 ± 1.04	
Pre-pupal period		1	2	1.35 ± 0.49	20
Pupal period		7	10	8.45 ± 0.99	
Egg to adult emergence		**22**	**32**	**27.35**	
Male longevity		2	4	2.9 ± 0.88	10
Female longevity		3	5	3.8 ± 0.79	
Pre-oviposition period		1	1	1± 0	
Oviposition period		2	4	3.3 ± 0.67	
Post-oviposition period		1	2	1.7 ± 0.48	
Fecundity (eggs/female)		147	262	197.3 ± 37.17	
Sex ratio (Male: Female)		1:1.5			
Total life span	**Male**	**24**	**36**	**30.25**	
	Female	**25**	**37**	**31.15**	

References:

[1] Abro G H., Rajput L B., Sultana T., Syed S N., Bukero A. (2016). Biology of brinjal fruit borer, *Leucinodes orbonalis* Guenee in laboratory conditions. *The Entomological Society of Karachi*, Vol.31, No.1, 2016, pp. 73-80.

[2] Ali M H., Sanghi P M. (1962). Observations on oviposition, longevity and sex ratio of brinjal fruit borer, *Leucinodes orbonalis* Guen. *Madras Agricultural Journal*, Vol.49, No.8, 1962, pp. 267-268.

[3] Allam M A., Rao P K., Rao B H K. (1982). Biology of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. *Indian Journal of Agricultural Science***,** Vol.52, No.6, 1982, pp. 391-395.

[4] Ambhure K., Dubey V., Rana, D. (2016). Biology of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee). *Advances in Life Sciences*, Vol.5, No.24, 2016, pp. 11153-11156.

[5] Anonymous. (2020). Food and agriculture organization corporate statistical database of the United Nations, 2020, Retrieved from http://www.fao.org/statistics/en/.

[6] Anonymous. (2021). District-wise area and production of Gujarat State, Directorate of Horticulture, Gandhinagar, Gujarat, India, 2021, Retrieved from doh.gujarat.gov.in.

[7] Bindu S P., Pramanik A., Padhi G K. (2015). Studies on biology and physical measurements of shoot and fruit borer (*Leucinodes orbonalis* Guenee) of brinjal in West Bengal, India. *Global Journal of Biology, Agriculture and Health Sciences,* Vol.4, No.1, 2015, pp. 215-219.

[8] Bhoya K M., Patel C J. (2018). Biology of brinjal shoot and fruit borer. *International Journal of Current Microbiology and Applied Sciences*, Vol.**7**, 2018, pp. 2605-2612.

[9] Gaurat A B. (2006). *The studies on bionomics of brinjal shoot and fruit borer* (Doctoral thesis, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli), 2006.

[10] Iesa M A. (2021). Biology of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) and screening of various genotypes for resistance. *Turkish Online Journal of Qualitative Inquiry,* Vol.6, 2021, pp. 6025-6032.

[11] Jat K L., Pareek B L., Singh S. (2003). Biology of *Leucinodes orbonalis* an important pest of brinjal in Rajasthan. *Indian Journal of Entomology*, 2003, pp. 513-517.

[12] Kavitha V S., Revathi N., Kingsley S. (2008). Biology of brinjal pest, *Leucinodes orbonalis* Guen. of erode region in Tamil Nadu. *Journal of Entomological Research,* Vol.32, No.3, 2008, pp. 255-257.

[13] Kumar L R., Ghante V N., Chowdary L R., Benki A M. (2011). Biology of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) in Raichur district of Karnataka. *International Journal of Plant Protection,* Vol.4, No**.**2, 2011, pp. 298-300.

[14] Lall B S., Ahmed S Q. (1965). The biology and control of eggplant shoot and fruit borer (*Leucinodes orbonalis*). *Journal of Economic Entomology*, Vol.58, No.3, 1965, pp. 448-451

[15] Maravi M S., Dubey V K., Paikra M K. (2013). Biology of *Leucinodes orbonalis* Guen. on brinjal (*Solanum melongena*) crop. *Indian Horticulture Journal,* Vol.3, No.3&4, 2013, pp. 91-94.

[16] Nair M R G K. (1975). *Insects and mites of crops in India*, 1975, p. 149. ICAR Publishers (Eds 1), New Delhi.

[17] Padwal K G., Srivastava C P. (2018). Comparative biology of *Leucinodes orbonalis* Guenee from different regions of India in particular reference to its developmental stages. *Journal of Experimental Zoology,* Vol.21, No.1, 2018, pp. 461-466.

[18] Radhakrishore R K., Singh T K., Shah M A S. (2010). Biology of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen (Lepidoptera: Pyralidae). *National Journal of Life Sciences*, Vol.7, No.1, 2010, pp. 77-79.

[19] Raina J., Yadav G S. (2017). Studies on biological parameters of *Leucinodes orbonalis* Guenee on brinjal under laboratory conditions. *Journal of Experimental Zoology India*, Vol.20, No.2, 2017, pp. 795-800.

[20] Rohokale Y A., Sonkamble M M., Bokan S C. (2001). Biology of brinjal shoot and fruit

borer *Leucinodes orbanalis* Guenee in laboratory condition. *Journal of Entomology and Zoology Studies,* Vol. 6, No.4, 2018, pp. 1878-1881.

[21] Sharma A., Rana R S., Sharma K C., Singh S., Kumar A. (2017). Biology of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on brinjal crop under laboratory conditions. *Journal of Entomology and Zoology Studies,* Vol.5, No.6, 2017, pp. 415-419.

[22] Singh Y P., Singh P P. (2001). Biology of shoot and fruit borer (*Leucinodes orbonalis* Guen.) of eggplant at medium high-altitude hills of Meghalaya. *Indian Journal of Entomology,* Vol.63, No.3, 2001, pp. 221-368.

[23] Singla P. (2014). *Biology and seasonal incidence of brinjal shoot and fruit borer, Leucinodes orbonalis* Guenee (Doctoral thesis, Punjab Agricultural University, Panjab), 2014.

[24] Yadav A., Sachan S K., Yadav A., Yadav T. (2015). Biology of brinjal shoot and fruit borer, *Leucinodes orbonalis* G. under lab condition at 35 ºC temperature and 90 per cent relative humidity during 2009 and 2010. *Plant Archives*, Vol.15, No.2, 2015, pp. 889-893.