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Biology of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on brinjal crop under laboratory conditions

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Abstract

The present studies on biology of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on brinjal cvs. 'Neelkanth' and 'Pusa Purple Long' was carried out during 2016 in the laboratory conditions in the Department of Entomology, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan. From studies it was found that the incubation period was 3.72 and 3.51 days on 'Neelkanth' and 'Pusa Purple Long' whereas the larval period was found 13.52 and 14.39 days on 'Pusa Purple Long' and 'Neelkanth'. The total developmental period was 24.52 and 26.41 days on 'Pusa Purple Long' and 'Neelkanth' cultivars, respectively. The fecundity was more on 'Pusa Purple Long' (210.20 eggs per female), as compared to 'Neelkanth' cultivar (193.40 eggs per female). From studies, it was also found that developmental biology was shorter in 'Pusa Purple Long' whereas longer in 'Neelkanth'.

Keywords: Brinjal, eggplant, *Leucinodes orbonalis*, Brinjal shoot and fruit borer

Introduction

Brinjal (*Solanum melongena* L.) or eggplant belongs to family Solanaceae and is a species of night shade which in British English is commonly known as aubergine. It is also known as brinjal, melongene, garden egg, or guinea squash ^[1]. Brinjal is one of the widely used vegetable crops and is popular in many countries viz. Central, South and South East Asia, some parts of Africa and Central America ^[2]. In India, it is cultivated over an area 663 thousand hectares with production of 12515 metric tonnes and productivity of 18.9 t/ha ^[3]. West Bengal, Orissa, Andhra Pradesh, Gujarat, Bihar is the leading states in the country for cultivation of brinjal. In Himachal Pradesh, it is cultivated over an area of 1.08 thousand hectares with production of 23.52 thousand tonnes and productivity of 21.7 t/ha ^[4]. One of the major factors which is responsible for the low productivity of brinjal is a variety of insect pests which not only reduce the yield but quality also. In Himachal Pradesh, 28 species of insect pests and mite have been reported to be associated with brinjal, of which the brinjal shoot and fruit borer (*Leucinodes orbonalis* G.), jassid (*Amrasca biguttula* Ishida and *Amrasca devastans* Distant), hadda beetle (*Henosepilachna* (*Epilachna*) *vigintioctopunctata* Fabricius), aphids (*Aphis gossypii* Glover), white flies (*Bemisia tabaci* Gennadius and *Trialeurodes vaporariorum* Westwood), brinjal leaf roller (*Eublemma olivacea* Walker), brinjal mealy bug (*Phenacoccus insolitus* Green) are found to be abundant on this crop ^[5].

Among these, the brinjal shoot and fruit borer have been reported to be the serious pest which reduces the crop yield up to 60-70% and inflicts the colossal loss in production ^[6]. This pest has a very wide host range. Besides brinjal, it attacks other solanaceous plants such as *S. tuberosum* L. (Potato), *S. aculeatissimum* Jacq. (Indian nightshade), *S. indicum* L. (Black nightshade), *S. myriacanthum* Dunal (Kota bengena), *S. torvum* Swartz (Turkey berry), *Lycopersicon esculentum* Mill. (Tomato), *Capsicum annum* L. (Bell pepper) and some weeds ^[7]. This pest is active during the rainy and summer seasons and has a specific nature of feeding behaviour. In early stage of the crop growth, the larva bores into the shoots resulting in drooping, withering and drying of the affected shoots due to disruption of the vascular system and translocation of food materials. At a later stages of the plant growth, the larvae bore generally through calyx and later into the flower buds and fruits, the bored holes are invariably plugged with excreta ^[8]. The infested fruits become unfit for human consumption due to loss of quality and lose their market value.

It has also been reported that there could be a reduction in vitamin C content in the infested fruits^[9, 10]. Hence, the present investigation biology of *Leucinodes orbonalis* on brinjal crop was undertaken.

Materials and Methods

For the biology purpose, stock culture of the brinjal shoot and fruit borer was maintained in rearing cage (30×30 cm), with two brinjal cultivars viz. 'Neelkanth' and 'Pusa Purple Long' at room temperature (20 to 25 °C) throughout the period of studies to ensure availability of the pest for various studies. For this, the larvae of the brinjal shoot and fruit borer on fruits and shoots were collected from naturally infested brinjal plants grown under field condition and were kept in rearing cages. The adults thus emerged were released in another rearing cage (30×30 cm) for mating and egg laying. In each cage, two pairs of adults were kept along with potted brinjal plants of each cultivar as ovipositing substrate. Sugar solution (10%) in cotton swab was also kept in the cage as food for the adults. Old and exhausted plants were replaced periodically with fresh and newly raised plants. Different biological parameters of the brinjal shoot and fruit borer were studied under laboratory conditions on two brinjal cultivars viz. 'Neelkanth' and 'Pusa Purple Long'. For this purpose, two pairs of newly emerged adults were released inside the rearing cage (30×30 cm). The following biological parameters were studied on two brinjal cultivars such as incubation period, larval period, pupal period, adult longevity, pre- oviposition period, oviposition period, post oviposition period and total no of eggs laid per female.

Incubation Period

Newly emerged males and females from the stock culture were kept in the glass chimney (15×7.5 cm) which were provided with fresh brinjal plants along with 10% sugar solution with a cotton swab to stimulate egg laying. The eggs thus laid were counted carefully till the emergence of larvae to work out the duration of eggs and hatchability on two brinjal cultivars.

Larval Period

The duration of larval stage was counted from the emergence of the larva till it transformed to pupa. Newly hatched larvae were transferred by camel hair brush in petri dish on brinjal leaves. The food in the petri dish was changed daily in the morning hours. On formation of second instar larvae, the food was changed from leaves to brinjal slices as brinjal shoot and fruit borer 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 the pupal stage. Thus the live feeding larvae were counted till pupation to work out the duration of the larval period and survival of the larva on each cultivar.

Pupal Period

The fully grown larvae were transferred to glass chimney having a moist layer of autoclaved sand and soil at the base. Since, the pupation takes place in the soil with optimum moisture, so observations were taken daily in the morning hours to study the pupal period. The healthy and viable pupae were counted till adult emergence to work out the duration of the pupal stage.

Adult Longevity

On emergence, the adults were kept separately in a glass

chimney (15×7.5 cm), the top of which was covered with muslin cloth. Fresh brinjal leaves and 10% sugar solution in cotton swab were kept inside the chimney as food for adult moth. The longevity of male and female was recorded on each cultivar till the death of the adult moth.

Pre-oviposition period

Pre-oviposition period is the interval from adult emergence to the onset of oviposition. For this purpose, two pairs of adults were released inside the glass chimney (15×7.5 cm) and were provided with brinjal plants in pots and 10% sugar solution in cotton swab. The sugar solution was replaced after every 24 hrs. The brinjal plants were examined carefully with the help of a hand lens for the presence of eggs. The duration between adult emergence to the first egg laying was considered as the pre-oviposition period of the brinjal shoot and fruit borer on each cultivar.

Oviposition period

Oviposition period is the interval from the first egg laying to the last oviposition. The ovipositing substrate i.e. fresh brinjal plants were offered for the adult moth and were further examined carefully with the help of a hand lens for the presence of eggs. The oviposition period was worked out by calculating the duration between the first egg laid to the last egg laid during the entire life span of the female moth.

Post-oviposition period

Post-oviposition period is the interval from the last oviposition to the death of the female. The brinjal plants were offered as ovipositing substrate and were replaced with fresh brinjal plants periodically as and when exhausted till the death of female adult. The replaced brinjal plants were examined with the help of a hand lens for the presence of eggs. Post-oviposition period was considered as the period (duration) from the day of the last egg laying to the death of an adult female.

Total number of eggs laid

The adults thus emerged were sexed by examining the presence of tuft of hairs at the end of abdomen and their body size. For calculating the total number of eggs laid per female, two pairs of adult brinjal shoot and fruit borer were released inside the glass chimney (15×7.5 cm) along with fresh and new brinjal plants as ovipositing substrate and 10% sugar solution in cotton swab as food for the adult moth. The brinjal plants were replaced periodically with fresh and new brinjal plants till the death of the female moth. The periodically replaced plants were carefully examined with the help of a hand lens for the presence of eggs and total number of eggs on the leaves was counted for each day till the death of the adult female. The total fecundity during the entire life span i.e. during the oviposition period of the female was calculated and denoted as fecundity per female.



Fig 1: Egg



Fig 2: Larva



Fig 3: Pupa



Fig 4: Adult

Results and Discussion

Different biological parameters of brinjal shoot and fruit borer was studied on two brinjal cultivars *i.e.* 'Neelkanth' and 'Pusa Purple Long' under laboratory conditions. Freshly laid eggs (Fig.1) were oval in shape and creamy white in color before hatching. These turned to deep orange colour with prominent black spot at the tip of the egg. The incubation period of the brinjal shoot and fruit borer on 'Neelkanth' varied from 3-5 days with a mean duration of 3.72 ± 0.27 days (Table 1) whereas, on 'Pusa Purple Long' the incubation period varied from 3-5 days with a mean duration of 3.51 ± 0.31 days (Table 2). These results are in accordance with the observations of ^[11] who reported the mean incubation period of 3.66 days on brinjal. The present findings are also in accordance with the findings of ^[12-14] who reported incubation periods of 5.4, 4.30 and 5.65 days. On potato, the incubation period of 5.40 days was reported by ^[15]. Slight variations in the duration may be due to variation in the host on which the previous generation of the moth was reared which might have contributed this in the next generation.

The newly hatched larva was creamy white in colour while the full grown larva was cylindrical and pinkish in colour

(Fig. 2). The head of the larva was dark brown and had strong mandibles for mastication. The thorax of the 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. The total duration of the larval period varied from 13-16 days with a mean duration of 14.39 ± 0.15 days in 'Neelkanth' (Table 1), 12-14 days with a mean duration of 13.52 ± 0.25 days in 'Pusa Purple Long' (Table 2). These results are in accordance with those of ^[16] who reported that the total larval period varied from 12-15 days. These results also showed similarity to the findings of ^[17] who reported that the total larval period varied from 15-18 days. The present findings are more or less in confirmity with the findings of ^[12, 13, 18] who reported the total larval periods of 17.5, 15.0 and 18.6 days, respectively. On the other hand, ^[14] reported a larval period of 12.83 days.

The full-grown larva came out of the infested shoots and pupated in the dried shoots and leaves in tough silken cocoons (Fig. 3). The mean pupal period in 'Neelkanth' was 8.29 ± 0.25 days (7-9 days) (Table 1) whereas, in 'Pusa Purple Long', the pupal period varied from 6-8 days with a mean duration of 7.48 ± 0.12 days (Table 2). These results are in accordance with the findings of ^[19] who reported that the pupal period varied from 7 to 11 days under laboratory conditions while ^[20] reported that the pupal period varied from 7-10 days. Comparatively longer duration of pupal period was reported by ^[12-14, 18] which could be attributed to variation in host on the larvae were reared.

The period of development from egg to adult emergence is known as the total development period. The total developmental period varied from 25-27 days with a mean duration of 26.41 ± 0.54 days in 'Neelkanth' (Table 1) whereas, in 'Pusa Purple Long' it was 24.52 ± 0.41 days with a range of 23-25 days (Table 2). The present findings are more or less in confirmity with the findings of ^[21] who reported the total developmental period varied from 26.61 days to 28.57 days with an average of 27.49 days while ^[22] reported that the total developmental period of this pest varied from 17 to 28 days. A range of 22 to 27 days as the total developmental period of brinjal shoot and fruit borer was reported by ^[23] and a mean of 28.82 days was reported by ^[24]. The present findings also find support with the findings of ^[13, 25] who reported a total developmental periods of 25.8 days and 27.07 days, respectively. ^[14, 26] on the other hand reported a longer developmental period of 36.82 days and 42.5 days, respectively which may be due to difference, in prevailing climatic conditions under which the pest was reared. Besides, variations in host might have contributed to the difference in the developmental period.

The adult moth was of white colour with head and thorax covered with greyish and brown scales. The fore wings were creamish white with large patches of light brown color over it. In case of the hind wing, a faint black wavy line was observed close to the apical margin (Fig. 4). 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 pre-oviposition period is the period before oviposition of the first egg. The pre-oviposition period were found to vary from 1-2 days with an average duration of 1.20 ± 0.04 days in 'Neelkanth' (Table 1) whereas, in 'Pusa Purple Long,' it varied from 1-2 days with a mean duration of 1.20 ± 0.04 days (Table 2). These results are in accordance with a those of ^[11] who reported the pre-oviposition period of 1.15 days and is also in agreement with the findings of ^[22] who reported the pre-oviposition averaged 1.35 days. The period of egg laying *i.e.*

after the pre-oviposition period till the termination of egg laying was considered as the oviposition period. The oviposition period was found to vary from 1-2 days with an average duration of 1.60 ± 0.05 days in 'Neelkanth' (Table 1) whereas, in 'Pusa Purple Long', it varied from 1-3 days with an average duration of 2.00 ± 0.07 days (Table 2). These results are more or less are agreement with those of [22] who reported that mean oviposition period averaged 2.09 days.

Females lived longer than males. The mean longevity of the ovipositing female was 3.17 ± 0.30 days which varied from 3-4 days in 'Neelkanth' (Table 1) whereas, in 'Pusa Purple Long', the longevity of female varied from 3-4 days with a mean longevity of 3.17 ± 0.40 day (Table 2). The mean longevity of the male was 1.80 ± 0.75 days which varied from 2-3 days in 'Neelkanth' (Table 1) whereas, on 'Pusa Purple Long', the longevity of male ranged from 2-3 days with a mean longevity of 1.97 ± 0.30 days. These results are in accordance with those of [27] who reported the longevity of male and female as 1.82 days and 3.12 days, respectively but contrary to the findings of [28] who observed that male longevity was 3.50 days while, the female longevity was 5.70 days. The present findings are also in contrary with the findings of [12,14,18, 26] who reported that male and female lifespan varied few days 1.5-2.4 and 2.0-3.9 days, 4.0 and 7.5 days, 3.53 and 5.80 days, 3.53 and 5.51 days, respectively. These variations in the duration of life stages may be due to variable food and temperature.

The fecundity is defined as the number of eggs produced during the lifespan of female. In the present study, the fecundity of the brinjal shoot and fruit borer was found to vary from 156-239 eggs per female in 'Neelkanth' (Table 15) with an average fecundity of 193.40 ± 2.52 eggs whereas, in 'Pusa Purple Long', the fecundity varied from 176-245 eggs per female with an average fecundity of 210.20 ± 2.32 eggs (Table 16). These results are more or less in confirmity to those of [29] who reported that average fecundity of this pest was 174.95 eggs per female. [30] However reported the fecundity to vary between 92.5 and 233 eggs per female while [14] reported a fecundity of 175 eggs per female in Meghalaya, India. [31] Also reported that a single female may lay 80-120 eggs. The differences observed might be attributed to location, altitude and agroecological characteristics [21].

Conclusion

The total developmental period of the brinjal shoot and fruit borer was maximum on 'Neelkanth' cultivar while, it was minimum on 'Pusa Purple Long' cultivar. The fecundity was found to be maximum on 'Pusa Purple Long' cultivar as compared to 'Neelkanth' cultivar.

Table 1: Duration of different stages of *Leucinodes orbonalis* on 'Neelkanth'

Biological Parameters	Duration (days)	
	Mean±SE	Range
Incubation period	3.72 ± 0.27	3-5
Larval period	14.39 ± 0.15	13-16
Pupal period	8.29 ± 0.25	7-9
Total developmental period	26.41 ± 0.54	25-27
Pre-oviposition period	1.2 ± 0.04	1-2
Oviposition period	1.6 ± 0.05	1-2
Post-oviposition period	1.2 ± 0.04	1-2
Adult longevity	Male	1.80 ± 0.75
	Female	3.17 ± 0.30
Fecundity (eggs/female)	193.40 ± 2.52	156-239
Sex ratio (Female: Male)	2.2:1	-

Table 2: Duration of different stages of *Leucinodes orbonalis* on 'Pusa Purple Long'

Biological parameters	Duration (days)	
	Mean±SE	Range
Incubation period	3.51 ± 0.31	3-5
Larval period	13.52 ± 0.25	12-14
Pupal period	7.48 ± 0.12	6-8
Total developmental period	24.52 ± 0.41	23-25
Pre-oviposition period	1.20 ± 0.04	1-2
Oviposition period	2.00 ± 0.07	1-3
Post-oviposition period	1.40 ± 0.05	1-2
Adult longevity	Male	1.97 ± 0.30
	Female	3.17 ± 0.40
Fecundity (eggs/female)	210.20 ± 2.32	176-245
Sex ratio (Female: Male)	2:1	-

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