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MATING AND OVIPOSITION BEHAVIOUR OF BRINJAL SHOOT AND FRUIT BORER, *LEUCINODES ORBONALIS* GUENEE

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Abstract

Mating and oviposition behaviour of brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee (Lepidoptera:Pyralidae) were carried out in the laboratory on brinjal plants maintaining the temperature (20-25^{0}C) and relative humidity (80-85%). The moths were found active at night for mating and oviposition. Mating usually occurred at late night but a few moths were found to continue mating up to 8.0 hour of the day. Maximum moths completed mating between 4.00 to 6.00 hour of the day. Mating period ranged from 28-50 minutes. Mating occurred in first and second night of the adult emergence. Majority of the moths (90.80%) were found to mate in the first night and the rest went for mating in the following night. Oviposition always occurred at night. Females were always found to oviposit at night with an average 86.62% oviposition during the first half of the night. Again 60% egg deposition of first half of the night occurred during 20.00 to 22.00 hours. A female laid 241.50 eggs in an average of 2.70 days of oviposition. The egg laying pattern indicates that the egg laying continued for a maximum of 4 days showing a decreasing pattern of deposition with the increase of age. About 50% of the total eggs were deposited on the first day. The BSFB females preferred brinjal leaves for oviposition. Distribution of the eggs on the upper and lower surfaces of the leaves was found 1:2.74. Females showed higher preference for upper canopy of the brinjal plant as oviposition site.

Keywords: Brinjal, *Leucinodes orbonalis*, mating, fecundity.

Introduction

Brinjal (*Solanum melongena* L) is an economically important vegetable crop grown throughout Bangladesh. It is the leading vegetable in the country and ranks first among summer and winter vegetables in terms of total acreage. Brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee is the most destructive pest of brinjal and has become a serious production constraint in all brinjal growing countries (Alam *et al*. 2003). The BSFB is very active during the rainy and summer seasons and often causes more than 86% damage (Prodhan *et al*., 2018). The yield loss has been estimated to be about 86% (Ali et al. 1996) and more than 85% (Rashid *et al*. 2003) in Bangladesh. BSFB starts the damage from seedling stage but severe attack occurs soon after reaching the maximum vegetative stage and continues till the last harvest of the fruits and is very

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difficult to control since it feeds inside the shoots and fruits (Ghosh and Senapati 2009).

Farmers are applying toxic chemical pesticides indiscriminately to control the pest. Frequent use of systemic insecticides makes the vegetables poisonous, ecologically unsafe and economically unviable. It is easy to replace the poisonous chemicals to control the pest with the knowledge through understanding the nature and behaviour of insect. The behavioral activities of insect such as adult emergence, oviposition site, mating frequency & time and duration of neonate larvae development can help to apply IPM approach. Many researchers had few knowledge on mating, oviposition, preference of egg laying site, distribution of eggs at different plant canopies, fecundity and viability of eggs of BSFB. Appropriate knowledge on these parameters can contribute to develop an IPM strategy for the effective management of BSFB. It is also important to know the life cycle of an insect so that control mechanisms may be undertaken during the most susceptible stage of the life cycle. Therefore, a study was undertaken on the mating and oviposition behavior of BSFB.

Materials and Methods

Mating behaviour

To study the mating behaviour, twenty field collected pupae of BSFB were kept in Petri dish (14.0 cm x 1.5cm) and were under close observation for adult emergence. From the observation of its biology in the laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh, it was found that BSFB adult started to emerge from the pupae within 10-12 days at 20-25^{0}C temperature with relative humidity of 78-86%. About 75-85% adults were emerged from pupae. Usually it occurred just after sunset. Therefore, the freshly emerged adults were observed for mating into two groups and it started from 8.0 PM. Grouping was made according to the time of adult emergence. The population which were emerged during the first half of the night were kept in one group and another group was made with the population emerged during the second half of the night. One group is kept under observation for the period of 8.0 PM to 8.0AM and another group is from 8.0 AM to 8.0 PM. To record the number of mating of the same group it was left for up to two days. Starting time and duration of mating of the above two groups were recorded through video camera. The mating frequency at different time was calculated.

Oviposition behaviour

Adult behavior and oviposition were recorded in the cylindrical jars (40 cm x 10cm). BSFB adult usually lays eggs on the brinjal leaves and twigs both of which are rough surfaced. In the laboratory, the fine meshed net was used to cover both open sides of the cylinder to encourage the females to lay eggs on it.

BSFB female adult was transferred into a both side open cylindrical glass jar containing a few pieces of green papers inside. The inner surface of the glass jar was wrapped with green papers to make the environment of the jar somewhat green like brinjal leaves. Sugar solution of 5% soaked in cotton was placed inside the cylinder to provide nourishment for the adults during the period of oviposition. Immediately after transferring the adult both the open ends were covered carefully with small pored net so that the moths were not injured during the process. The moth was transferred to another similar jar (40 cm x 10cm) after 24 hours of the placement of the adult following the same procedures. This was continued till the moths survived. Twenty mated females from the Petri dish (14.0 cm x 1.5cm) were used separately as 20 replications for recording the egg laying trend (Plate 1). After removal of adults the green papers and the fine meshed net were checked thoroughly for the presence of BSFB eggs.

Plate 1. Oviposition chamber wrapped with green paper inside the glass cylinder.

Plate 2. Eggs laid by BSFB female on the nylon net.

As expected the female laid all the eggs on the net (Plate 2). There was no trace of eggs on the green papers. The eggs on the net were very tiny and were clearly seen with the help of magnifying glass. Then those were counted and it was continued until the death of the female. This counting was done at midnight and early in the morning as it was observed to lay eggs after sunset. From the keen observation it was found that no eggs were laid in day time. After counting of eggs, the net with eggs was placed in a plastic film container (Plate 3) and allowed to hatch. For all the batches of eggs, the same procedure was maintained. All the batches of eggs of an individual were added to get the fecundity of the female. Twenty mated females were observed for laying their eggs and mating was observed through Camera. The age specific egg laying pattern of the female was determined. The eggs laid by a female per day from the first oviposition day

to the last oviposition day were counted daily. The longevity of the adults was recorded also.

Net with eggs were cut into several pieces carefully with minimum damage and kept in plastic film container and allowed to hatch. The eggs were observed for hatching everyday. The time of egg hatching was also recorded. Fecundity was recorded from 6:00 to 14:00 hour of the day. Once the eggs hatched into neonate larvae the duration of the incubation period was recorded. The mean incubation period and percentages of hatching were calculated.

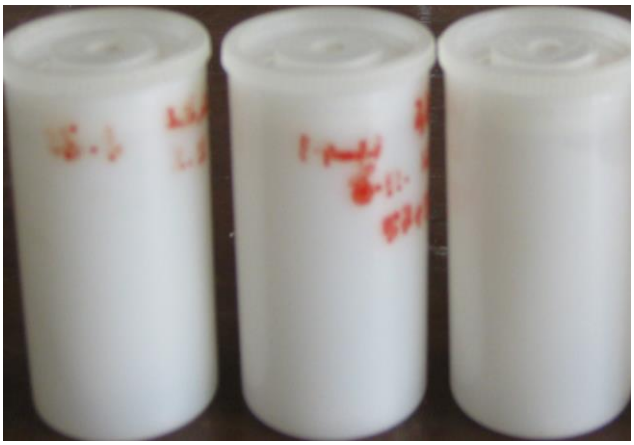

Plate 3. Eggs of BSFB on piece of net kept in film container for hatching.

Preference of egg laying site

To study the preference of egg laying on various brinjal plant locations, a tub grown brinjal plant was kept in a large bowl and covered with polythene in such way so that mated females were not able to go outside. Then one mated female was released in one brinjal plant with fruits. The eggs deposited on the different parts of the brinjal plant were recorded. To determine the egg laying preference of BSFB at three plant canopies the plant was divided vertically in three equal portion named upper, middle and lower canopy. The number of eggs deposited on three canopies were recorded. The percentage of egg laying at different locations and plant canopy was calculated. There were 10 replications in each experiment of complete randomized design. The data were analyzed statistically using ANOVA in MSTAT-C and compared using LSD values.

Results and Discussions

Mating behavior

BSFB moths were found active at night when the mating usually took place. The percentage of adult emergence was 88.90±1.07 at first half of the night (Table 1). Mating frequency was found to vary with the adult emergence time. The

percentage of mating was 90.80±0.59 in the night of adult emergence and it was 9.20±0.59 in the next night (Table 2). It was also revealed from the study that the mating of BSFB moths generally occurred at late night usually between 4.0 to 6.0 AM. (Fig. 1). In some occasions mating was noticed in the early morning up to 8.0 AM. Maximum mating frequency (53.90%) was observed during the period of 5.0-6.0 AM and minimum (4.40%) was in the 7.0-8.0 AM. The moths went for mating only once either on the same day of emergence or a day after emergence. The average mating period was 43.27±1.07 minutes (Table 3). Singh and Singh (2001a) reported mating more than once in the life span of female which occurred at night or very early hours in the morning. Yasuda and Kawashaki (1994) observed the copulation of male and female at 4.40 AM which lasted for 43 minutes. Das and Islam (1982) showed that the virgin 1-day old females began calling from 18:15 to 23.45 hours and duration was 33 minutes. Kavitha *et al.* (2008) showed that mating took place on the same or next day after emergence. Prabhat and Johnsen (2000) reported that the feeding and mating activities occurred during night and mating lasted for about 16 minutes. The findings of the above authors supported the present investigation on mating behavior of adult moths of *L. orbonalis.*

Table 1. Adult emergence and oviposition behaviour of brinjal shoot and fruit borer

Parameters	Mean percentage± SE	
	First half of the night	Second half of the night
Adult emergence	88.90±1.07	11.10± 1.07
Oviposition	86.62±2.53	13.38±2.53

*SE Values were determined from the mean of 20 individuals

Table 2. Mating and oviposition behaviour of brinjal shoot and fruit borer

Parameters	Mean percentage± SE			
	First night	Second night	3rd night	4th night
Mating	90.80±0.59	9.20±0.59	-	-
Oviposition	47.05±2.88	23.11±2.88	23.06±2.88	6.78±2.88

*SE Values were determined from the mean of 20 individuals

Table 3. Some biological parameters of brinjal shoot and fruit borer

Biological parameters observed	Mean±SE (range)
Copulation period in minutes	43.27±1.07 (28-50)
Pre-oviposition period in days	1.10±0.52 (1.08-1.21)
Oviposition period in days	2.70±0.04 (1-4)
Fecundity	241.50±2.32 (149-334)
Percentage of egg hatching	77.43±0.30 (54-88)
Egg hatching period	3.52±0.53 (3-5)

*SE Values were determined from the mean of 20 individuals.

The present results and the findings of different authors confirm that BSFB moths undergo mating at night preferably during the later part of the night. In most studies it revealed that the duration of mating is more than half an hour except the finding of Prabhat and Johnsen (2000). Duration of mating in the present study is same as reported by Singh and Singh (2001a) but it varies from the findings of Das and Islam (1982) and Prabhat and Johnsen (2000). The probable reason of this variation might be due to variation of environmental condition and the ability of mating of the studied insect(s).

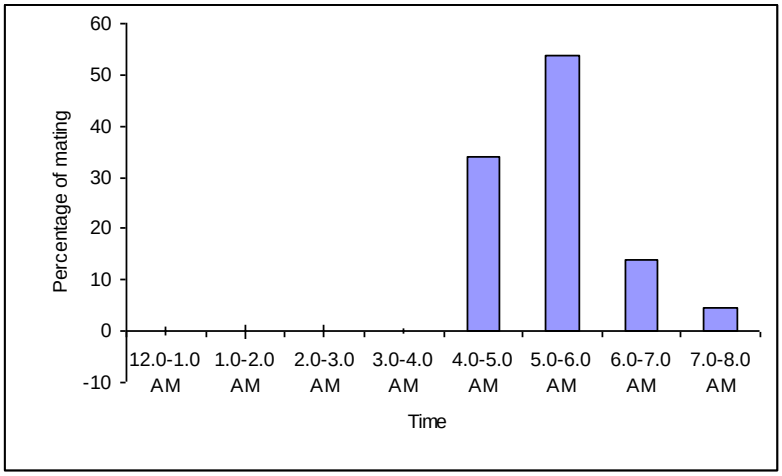

Fig. 1. Mating frequency of brinjal shoot and fruit borer at different hours from midnight to morning.

Oviposition behaviour

BSFB usually lays eggs on the brinjal leaves and twigs both of which are rough surfaced. In the laboratory, it was evident that BSFB female prefers to deposit its eggs in a place of rough surface. The fine meshed net was found to be a preferred surface for egg deposition of BSFB. Generally oviposition started during the next night after emergence and mating. On an average 47.05±2.88% female were found to start egg laying in the first night and 23.11±2.88% were in the second night (Table 2). Egg laying always occurred during the night and from the observation it was found to start egg laying just after sunset. Maximum percentage of (86.62±2.53) egg laying occurred at first half of the night and rest of them were in the second half of the night (Table 1). The egg laying frequency of BSFB at different hours during the first half of the night was shown in Figure 2. Maximum percentage (60.00%) of eggs were laid from 20.00 to 22.00 hours followed by 24.34% and 15.66% at 18.00 to 20.00 and 22.00 to 24.00 hours, respectively. The oviposition period was 2.70±0.04 days while the preoviposition period was 1.10±0.52 days (Table 3). The egg laying continued for 4 days. The egg laying pattern of female BSFB was shown in Figure 3. The number of eggs

laid in different days varied significantly ($p \geq 0.01$). The number of eggs laid daily decreased with the day followed by. The highest number of eggs was laid on the first day (139.14). A certain decrease of egg laying was found in the second day. Then it showed a similar trend with the third day. Thereafter a sharp decrease of egg laying occurred at 4th day reaching a few (21.50) number of eggs. On the second and third day, the female laid on an average of 68.50 and 67.67 eggs, respectively which were statistically similar. Only a few (21.50) number of eggs were laid on the 4th day. Almost 50% of the total fecundity was found on the first day. Although females were found to survive about a week but effective egg laying period was first three days. On an average 275.00 eggs were laid by a female. The eggs were distributed in mass or singly in a scattered form. A range of 40-60 eggs were found in a mass.

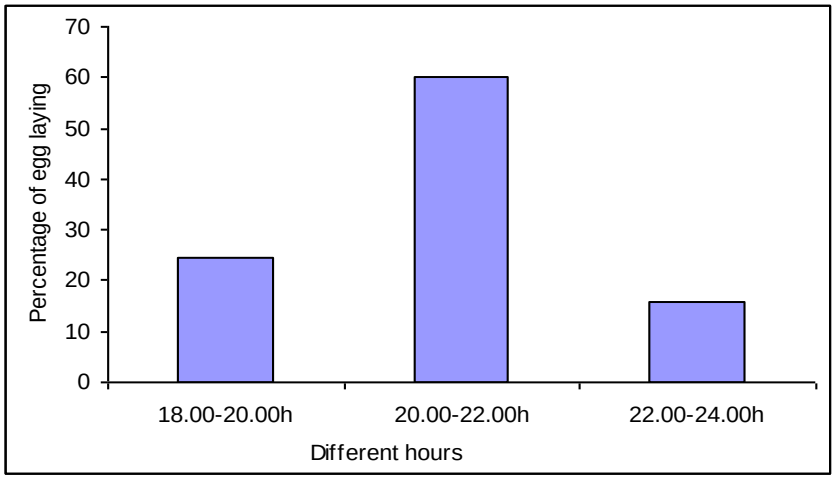

Fig. 2. Egg laying frequency of brinjal shoot and fruit borer at different hours in the first half of the night.

Singh and Singh (2001b) reported that the female laid eggs within a day or second day after the mating. Singh and Singh (2001a) reported that the laying of eggs started on the same day of mating and continued till fourth day with an average preoviposition and ovipositional period 1.35 and 2.09 days, respectively. The number of eggs gradually decreased by each day. The egg laying activities of the female was reported by Prabhat and Johnsen (2000), Alam *et al*. (2003) and Rahman (2005). Rahman (2005) reported that eggs were laid during the later part of the night to the early hours of the morning. Gupta and Kauntey (2007) reported that the average oviposition periods of BSFB was 2.46 days. Harit and Shukla (2003) expressed the similar opinion indicating that the female BSFB moth starts laying eggs on the same day or a day after mating and has an average oviposition period of 2.1±0.171 days.

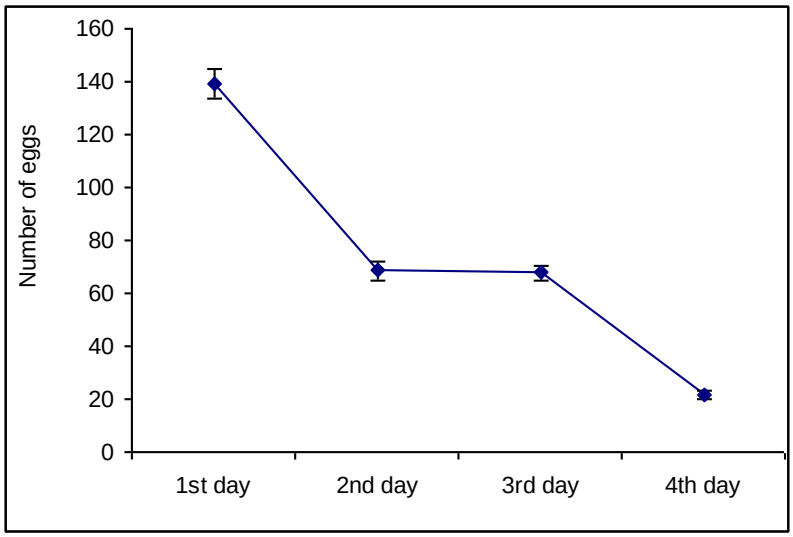

Fig. 3. Egg laying pattern of BSFB female at different days after emergence. Vertical bars represent number±SE.

The findings of the above authors are similar with the results of the present study. However, the findings of Rahman (2005) is different. The present findings on the oviposition time is not in full agreement with the findings of Rahman (2005). No females laid eggs in the late hours of night or in the early morning while Rahman (2005) indicated that egg laying occurred during the period mentioned. On an average the mean oviposition period was observed in this study was 2.70 days. But Gupta and Kauntey (2007) reported it as 2.46 days. Harit and Shukla (2003) reported the oviposition period of BSFB as 2.1 days. A little difference in the oviposition period found in the present study and the two authors might be due to variation of environmental condition. However, all the findings showed that the oviposition period of BSFB is very short. This indicates that the female emerged with full compliment of eggs which are deposited in short time starting as early as possible.

Preference of egg laying site

BSFB was found to deposit its eggs on different parts of brinjal plant such as leaf, petiole, calyx and stem. The females preferred to lay eggs on the leaves (Fig. 4). It is noted that the moth showed higher preference for tender leaves as oviposition site. Maximum eggs (90.51%) were recorded from the leaf of brinjal plant. Only a few eggs were found in stem, calyx and petiole. There was no significant difference among the number of eggs laid on stem, calyx and petiole. A distinct preference was also observed for deposition of eggs on two surfaces of the leaves. The ratio of the eggs laid on upper and lower surface of the leaf was 1:2.74.

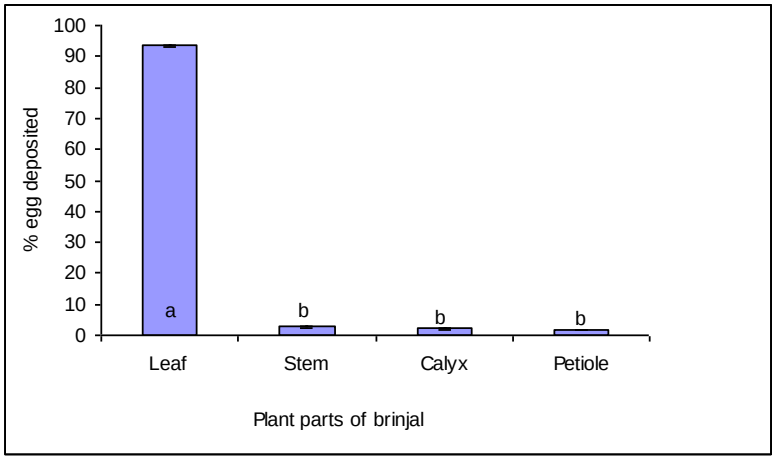

Fig. 4. %Egg deposited of BSFB moth at different plant parts of brinjal. Vertical bars represent number± SE. Same letter(s) within the bars do not differ significantly.

Ardez *et al*. (2008) showed that the eggs were mostly found on the lower leaf surface of top most open and middle leaves although few were also deposited on the upper leaf surface and petiole. The preference of egg laying in the present study is similar to the findings of Ardez *et al*. (2008). Alam *et al*. (2003) reported that eggs were laid singly on the lower surface of the young leaves, green stems, flower buds or calyces of the fruits. Rahman (2005) reported that eggs were laid singly on shoots, flower buds, near the peduncle of fruits and on the lower surface of the leaves. The present findings are in agreement with the report of above authors.

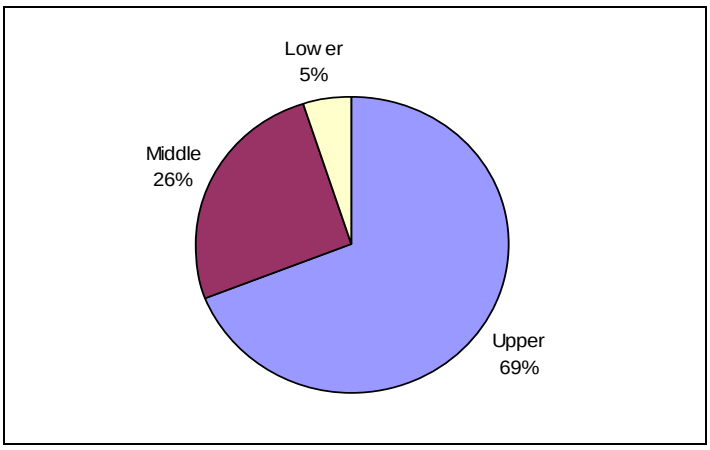

Fig. 5. Distribution of eggs of BSFB at three different plant canopies. A plant was divided into three vertical sections. Each section was considered as a level of canopy.

Distribution of BSFB eggs at different plant canopies

Percentage of egg deposition by BSFB at three different plant canopies varied significantly ($p \geq 0.01$) and was shown in Figure 5. The highest percentage (69%) of eggs was deposited in the upper plant canopy and lowest (5%) was in the lower canopy. Twenty six percent egg deposited was in the middle part of the plant. Upper canopy had a higher number of young leaves, shoots, flower buds, calyces of the fruits than the middle and lower canopy which explained the reasons for deposition of higher number of eggs in upper canopy.

Fecundity and viability

After mating the female moth of *L. orbonalis* laid on an average 241.50±2.32 eggs (Table 3). The overall mean percentage of egg hatching was 77.43±0.30 (54-88). The egg hatching period was 3.52±0.53 days (3-5). It is important to note that eggs were hatched early in the morning. Usually in the morning 87.41% eggs were hatched at 7.0-9.0 AM. Rest of the eggs were hatched at 9.0 AM-2.0 PM. Egg laying was started just after sunset and no egg was laid during day time.

Singh and Singh (2001a) reported that on an average 174.95 eggs were laid by a female and the viability of eggs was 82.61%. Alam *et al*. (2003) reported that the number of eggs laid by a female varies from 80 to 253. An adult female laid as few as 8 to as many as 295 eggs during its lifetime with an average of 118 eggs (PhilRice, 2007). Kavitha *et al.* (2008) reported that the average number of eggs laid by an individual female was 170.

The number of eggs laid per female and %egg hatching reported by the above authors were more or less same found in the present study. The similarity and difference found in the present study and reports of the above authors could be for the variation of environmental conditions. Environmental conditions influence the biology of many insects including the fecundity. It is clearly reflected from the fecundity data of BSFB in the present study. A large variation (8 to 295 eggs) in the egg laying of BSFB reported by PhillRice (2007) might be related to the environmental variations.

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