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Biology of shoot and fruit borer, *Earias vittella* Fabricius (Noctuidae, Lepidoptera) on okra

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ABSTRACT: The biology of fruit and shoot borer (*Earias vittella* F.) was studied under the natural conditions in the instructional farm of Uttar Banga Krishi Viswavidyalay in *pre-kharif*, *kharif* and *post-kharif* on okra. The study revealed that the egg incubation in *pre-kharif, kharif and post-kharif* revealed that the egg incubation were 3.18±0.40, 3.61±0.70 and 4.25±0.67 and larval period were 11.00±0.88, 11.00±0.82 and 13.01±1.81 during corresponding seasons respectively. The pupal period in *pre-kharif, kharif and post-kharif* were 13.01±1.81; 11.00±0.82; 10.97±2.15 days respectively. The adult male longevities observed were 3.64±0.67, 5.60±0.70 and 7.33±0.97 during *pre-kharif, kharif* and *post-kharif.* On the other hand female longevities observed were about 7.45±1.57; 8.87±1.10; 9.41±1.51 days in corresponding seasons respectively. The female fecundity during *pre-kharif, kharif* and *post-kharif* were 91.55±10.93, 117.55b±10.60 and 132.04±5.83 eggs in their lifetime. The pre-oviposition during *pre-kharif, kharif* and *post-kharif* were 1.64±0.50, 1.52±0.53 and 1.88±0.57 and the oviposition periods in corresponding seasons were 2.73±0.47, 3.22±0.79 and 4.32±0.52. While post-oviposition periods in *pre-kharif, kharif* and *post-kharif* were 3.09±0.70, 4.14±0.63 and 3.23±0.92 respectively. Its total life-cycle was completed in 27.45±1.57, 31.60±1.90 and 41.35±2.55 days during *pre-kharif, kharif* and *post-kharif* respectively. Higher fecundity may lead to faster population growth that may surpass the economic threshold level (ETL), even though the shoot and fruit borer's life cycle is longer in *kharif* and *post-kharif*. Thus, it may be said that the *kharif* and *pos-kharif* seasons are the most susceptible to shoot fruit and shoot borer infestation.

KEY WORDS : Life cycle, seasons, susceptability, population growth

Okra, *Abelmoschus esculentus* (L.) is a native of tropical or sub-tropical Africa and belongs to the Family Malvaceae. In India, okra is cultivated around the year in *pre-kharif*, *kharif* and *post-kharif* seasons. Okra is attacked by several species of insect pests and infected by a few diseases from seedling to harvesting. Economic losses depend on the degree of damage, pest density, environmental condition, stage of growth and the plant part damaged by the pest. Studying the life cycle of insect pests is vital for effective pest management, sustainable agriculture, environmental protection, and reducing the economic impact of pest damage. It serves as the cornerstone for making well-informed decisions about pest control tactics and aids in balancing the need for pest control with

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ecological and economic considerations. Among different insect pests infesting okra in the terai region of West Bengal, fruit borer and jassid are considered key pests since they are causing regular menace to okra in huge amounts. Therefore, an attempt has been made to study the biology of the fruit and shoot borer *(Earias vittella F.)* as influenced by the seasons.

A laboratory culture of *E. vittella* was started with several infested okra pods collected from the field which were transferred into plastic jars covered with muslin cloth and kept in laboratory conditions till pupation and adult emergence. After mating adults were shifted to potted okra plants with young fruit and covered with net for egg laying. The egg masses were examined daily and the incubation period was recorded. On hatching, the larva was monitored until the end of the last instar. The full-grown larva bores a large exit hole, leaves the okra pod, spins a cocoon and pupates on the outer surface of the fruit. The duration of the larval and pupal stages was determined. For studying adult longevity, 10 pairs of newly emerged males and females were maintained in glass vials with 10% sugar solution in absorbent cotton. The time elapsed between the emergence of each moth and its death was recorded as the longevity of such an individual. The duration of each generation was estimated based on the average length of the life cycle. The duration of pre-oviposition, oviposition, and post-oviposition were recorded for the female. The cage was opened daily and the leaves and fruits were observed for oviposition with the help of magnifying lens and this was continued till the last egg was laid. SAS software (ver. 9.2) was used for data analysis. One-way ANOVA was performed for each of the parameters and separation of the means was done using the Least Significant Difference (LSD) test at 5% significant level.

A. Incubation period

The incubation period varied in different crop seasons. The highest incubation period of 4.25±0.67 days was recorded in *post-kharif* followed by 3.61±0.67 days in *kharif* and the shortest duration (3.18±0.40 days) was recorded in *pre-kharif.* This result is in agreement with Rehman and Ali (1981) in January to March; Singh and Bichoo (1989) in September to October; Raju (2016) in *kharif* and Nishi (2016) in March-April who reported that the incubation period lasted for 3 to 4 days. The incubation period was 3.27 and 3.67 days as reported by Kumar *et al.* (2014) during July-August and October-November supports our study. At par with the present result for the *post-kharif* season, Das and Chaudhuri (2012) recorded 4.50 days of incubation period in October-November. A similar observation of 4.57 days and 5.00 days was also observed by Sundraraj and David (1987) and Suryawanshi *et al.* (2001). Bhat *et al.* (2005) recorded 2.60-3.80 days during June-August and 4.40-4.80 days during September-November which supports the present observation. The results under present studies as well as other reports as discussed above contradict Al-Mehmmady (2000) who found shorter incubation of 2.15 and 2.42 days in August and September. In line with Al-Mehmmady (2000) and Syed *et al.* (2011) also found 2.30 days of incubation period.

B. Larval period

The larva is the most injurious stage and therefore, their growth and development is very important, as it directly affects fruit production. Caterpillar passed through five stages. The duration of different larval instars varied with seasons. Total larval periods of 11.00±0.88; 12.25±1.20 and 17.90±1.17 days were recorded in *pre-kharif, kharif* and *post-kharif* respectively. In conformity with the present study during *post-kharif* Rukhsana *et al*. (1995), Suryawanshi *et al.* (2001) and Das and Chaudhuri (2012) also recorded larval periods of 18.00±0.88, 19.00 and 16.66-23.33 days respectively. Other workers reported similar result where the period lasted for 9.30 days (Ambegankar and Billapate, 1984); 12.73 days (Sundraraj and David, 1987); 11.28-11.39 days (Al-Mehmmady, 2000); 10-12 days (David, 2002); 7-15 days (Srivastava, 2003); 9.20-11.20 days (Dhillon and Sharma 2004); 8.20-9.00 days in June-August and 9.80-12.20 days in September to November (Bhat *et al*., 2005); 9.16 days (Syed *et al*., 2011); 8.00 days in March-August (Shah *et al*., 2012); 11.79 days in July-

Table 1: Duration of different developmental stages of *Earias vitella* on okra over seasons

	Pre-kharif	*Kharif*	*Post-kharif*
Mean temperature (Min-max)	25.08°C (20.60-31.55 °C)	28.08 °C (23.65-32.50 °C)	27.37 °C (21.92-32.82 °C)
Mean RH (Min-Max)	74.28% (72.97-79.71 %)	84.26% (78.69-87.83 %)	78.45% (74.73-82.16%)

Life stages	Duration in days (Mean±SD)						
	Pre-Kharif	*Kharif*	*Post-Kharif*	Average	F	Pr>F	LSD
Incubationperiod	3.18±0.40b	3.61±0.70b	4.25±0.67a	3.68±0.57	8.58	0.0020	0.539
Larval period							
1st instar	1.09±0.30c	1.60±0.52b	2.15±0.42a	1.61±0.56	17.69	<.0001	0.370
2nd instar	2.00±0.09b	2.03±0.20b	3.04±0.57a	2.36±0.64	30.07	<.0001	0.318
3rd instar	2.18±0.40b	2.34±0.48b	3.61±0.67 a	2.71±0.85	21.84	<.0001	0.494
4th instar	2.36±0.50c	2.85±0.42b	4.76±0.32a	3.32±1.36	68.11	<.0001	0.454
5th instar	3.36±0.50b	3.43±0.70b	4.35±0.52a	3.71±0.59	17.45	<.0001	0.387
Total Larva	11.00±0.88b	12.25±1.20b	17.90±1.17a	13.80±3.94	51.74	<.0001	1.508
Pupal Period	8.91±0.54c	11.00±0.82b	13.01±1.81a	10.97±2.15	32.63	<.0001	1.059
Adult longevity							
Male	3.64±0.67c	5.60±0.70b	7.33±0.97a	5.52±1.91	58.27	<.0001	0.714
Female	7.45±1.57b	8.87±1.10a	9.41±1.51a	8.58±2.05	7.10	0.0047	1.231
Life cycle	27.45±1.57a	31.60±1.90b	41.35±2.55a	33.46±1.70	67.10	<.0001	2.568
Fecundity	91.55±10.93c	117.55b±10.60b	132.04±5.83a	113.72±21.33	54.71	<.0001	8.183
Pre-oviposition	1.64±0.50a	1.52±0.53a	1.88±0.57a	1.68±0.42	1.42	0.2648	0.458
Oviposition	2.73±0.47	3.22±0.79	4.32±0.52	3.42±0.56	20.47	<.0001	0.528
Post-oviposition	3.09±0.70b	4.14±0.63a	3.23±0.92a	3.48±0.19	5.51	0.0124	0.717

** Within row means followed by the same letter(s) are not significantly different at 5% level*

August and 11.15 days in October-November (Kumar *et al*., 2014) and 11.50±1.08 days in March-April (Nishi, 2016). The newly hatched larvae wandered about for few hours before boring into the fruit. The period of different larval instars were 1.09±0.30, 2.00±0.09, 2.18±0.40, 2.36±0.50 and 3.36±0.50 days in *pre-kharif*; 1.60±0.52, 2.03±0.20, 2.34±0.48, 2.85±0.42 and 3.43±0.70 days in *kharif*; 2.15±0.42, 3.04±0.57, 3.61±0.67, 4.76±0.32 and 4.35±0.52 days in *post-kharif* season respectively. The average duration of different larval stages in the three seasons were 1.61±0.56, 2.36±0.64, 2.71±0.85, 3.32±1.36 and 3.71±0.59 days. This finding was at par with Sewak (2016) where the average duration of 1st, 2nd, 3rd, 4th and 5th larval instars was 1.60±0.52, 2.00±0.00, 2.50±0.53, 2.50±0.53 and 3.00±0.00 days respectively. In support of the present finding during *post-kharif,* Das and Chaudhuri (2012) recorded 3.33, 3.00, 3.00, 3.33 and 4.00 days of development period of different larval instars during October-November.

C. Pupal period

At the end of its development, the larva leaves the fruits and settles down to spin their cocoons at different places outside the okra fruits. Pupation occurred in a dirty white boat-shaped cocoon. The average pupal period was 10.97±2.15 days in three seasons. The longest period was observed in *post-kharif* (13.01±1.81 days) followed by *kharif* (11.00±0.82 days) and the shortest (8.91±0.54 days) was in *pre-kharif*. In support of the present findings other workers recorded a period of 6-14 days (Rehman and Ali, 1981 and Singh and Bichoo, 1989); 11.16 days (Sundraraj and David, 1987); 6.45 and 7.78 days during August-October (Al-Mehmmady, 2000); 10.00 days (Suryawanshi *et al.,* 2001); 7-10 days (David, 2002); 7.8-8.6 days during June-August and 9.8-10.2 days during September-November (Bhat *et al.*, 2005); 10.00 in July and 11.80 days in September (Syed *et al.*, 2011) and 8.0±0.82 days (Nishi, 2016). The pupal period lasted for 8.50-9.50 days in October-November as reported by Das and Chaudhuri (2012) deviates from the present work, particularly for *post-kharif* crop.

D. Adult stage

The duration of different stages of *Earias* adult life is presented (Table 1). The adult longevity was highest in *post-kharif* (7.33±0.97 days for males and 9.41±1.51 days for females) and it was supported by the findings of Suryawanshi *et al.* (2001) where it was 10 days and Das and Chaudhuri (2012) with 9.16 days of adult longevity. The male and female adults during *kharif* lived for 5.60±0.70 and 8.87±1.10 days and it was 3.64±0.67 and 7.45±1.57 days in *pre-kharif* confirms the report of Shah *et al*. (2012) and (Nishi, 2016) who recorded the period as 6-12 days and 9-14 days and 4.2 days and 9.5 days for male and female respectively. The average life span of male and female moths in three generations was 5.52±1.91 days and 8.52±2.05 days respectively. However, longer male and female adult longevity was recorded by different workers and the duration was 9.25 and 13.91 days (Rehman and Ali, 1981); 10.76 and 14.60 days (Sundraraj and David, 1987); 12.45 and 14.00 days during August and 13.36 and 14.20 days during October (Al-Mehmmady, 2000) and 13.9 and 14.2 days in July, 11.66 and 13.3 days in September and 8.0 and 11.8 days in October (Syed *et al*., 2011). This might be due to variations in regional climatic conditions influencing the activity of the insect.

The pre-oviposition, oviposition and post-oviposition period were 1.64±0.50, 2.73±0.47 and 3.09±0.70 days in *pre-kharif*; 1.52±0.53, 3.22±0.79 and 4.14±0.63 days in *kharif* and 1.88±0.57, 4.32±0.52 and 3.23±0.92 days in *post-kharif* with an average of 1.68±0.42, 3.42±0.56 and 3.48±0.19 days respectively. Das and Chaudhuri (2012) also recorded the 1.00-2.00 days of pre-oviposition, 5.00-5.15 days of oviposition and 2.00-2.05 days of post-oviposition period in October-November. The earlier work by Bhat *et al*. (2005) revealed that the pre-oviposition period varied from 1.8 to 2.44 days in August to 3.6 ± 0.54 days in November, whereas the oviposition and post-oviposition period ranged from 2.2±0.44 (August) to 4.2 ± 0.44 in November and 8.4 ± 0.54 in June to 12.2 ± 0.83 in November. However, Suryawanshi *et al.* (2001) recorded a longer oviposition period of 7 days and the post-oviposition period was only 1.00 days. In support of *the pre-kharif* result, Nishi (2016) also obtained 1.8±0.78, 2.8±0.79 and 4.5±0.53 days of pre-oviposition, oviposition and post-oviposition period during March-April while Rehman and Ali (1981) reported 3.5, 5.83 and 4.75 days respectively. The corresponding values were 1.5, 7.0 and 10.0 in July, 0.66, 5.0 and 3.0 in September and 1.75, 4.5 and 2.0 in October respectively as recorded by Syed *et al*. (2011). However, Shah *et al*. (2012) reported 6-8 days of egg laying period.

E. Life cycle

The duration of the life cycle varied with the seasons. In *post-kharif*, the duration was longest (41.35±2.55 days) followed by kharif (31.60±1.90 days) and shortest (27.45±1.57 days) in *pre-kharif*. The present findings are in close conformity to Al-Mehmmady (2000) who reported life cycle of 39.00 to 49.40 days, 31.82 to 36.59 days and 35.40-39.64 days during February-May, June-August and September to December. Sharma *et al.* (1985) recorded the duration ranged from 29 to 49 days which supports the present result. The period of 32.50±3.24 days as reported by Nishi (2016) during March-April also confirms the present result. Rehman and Ali (1981) reported a total life span of 24-45 days at 36.7°C. However, a shorter period was recorded by Nayar *et al.* (1976) (20-22 days);

Butani and Jotwani (1984) (22 to 25 days) and Sundraraj and David (1987) (26.9 days). Sharma *et al.* (1985) found that dry and cold weather prolongs the duration of the different stages resulting in prolonged duration of generation, whereas humid and warm weather is considered favorable for the growth and development of this insect as it completes its generation in a shorter time. It could be concluded that temperature influences the development of the moth which is inversely proportional to it (Table 1).

F. Fecundity

The longevity of adult female is an important factor in the realization of its oviposition potential. The fecundity was highest in *post-kharif* 132.45±5.83 eggs/female followed by *kharif* (117.55±10.60 eggs/female) and *pre-kharif* (91.55±10.93 eggs). In support of the present result Das and Chaudhuri (2012) reported that the adult female of the October-November generation laid 135 eggs. However, a higher fecundity of 200-400 eggs/female was recorded by Atwal and Dhaliwal (2005); Panwar (2002) and Srivastava (2003). David (2002) also recorded higher fecundity of 385 ggs/female. According to Bhat *et al.* (2005) highest fecundity was recorded during September (206.40 eggs/female) and the lowest in June (187.4 eggs/female). In support of Bhat *et al.* (2005), Kumar *et al.* (2014) also revealed that the fecundity was 196 eggs during July-August as compared to 203 eggs during October-November. Nishi (2016) found that the fecundity was 199±34.3eggs in March-April. Each female laid about 277 eggs and 150-250 eggs singly as reported by Syed *et al.* (2011) and Shah *et al.* (2012). Although, the fecundity of fruit borer in aforesaid works is not in conformity with the present investigation trends in seasonal variation are at par with the results present study.

Shoot and Fruit borer life cycles were shorter during *pre-kharif* (27.45 days), indicating that there were more numbers of generations, but because of the low fecundity (91.00 eggs/female), population expansion may have been slower. The Fruit and Shoot Borer took 31.60 days in *kharif,* which is longer than in *pre-kharif*, but its higher fecundity (117.55 eggs/female) may lead to a large population expansion. The longest life cycle was recorded in *post-kharif* season (44.10 days) but higher fecundity (133.00 days), may lead to higher population growth than in the *pre-kharif* and *kharif* seasons. It can be concluded *post-kharif* seasons is most vulnerable to okra fruit and shoot bore followed by *kharif* and *pre-karif*.

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