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BIOLOGY AND MORPHOMETRIC STUDY OF OKRA SHOOT AND FRUIT BORER *EARIAS VITELLA* (F.)

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ABSTRACT

Investigations on biology of shoot and fruit borer (*Earias vitella*) on okra revealed that the freshly laid eggs were spherical, bluish green and finally become brownish. These measured 0.52± 0.02 x 0.51± 0.02 mm. The incubation period was 3.35± 0.76 days, and larval stage passed through four instars. The first, second, third and fourth instar was 2.16± 0.71, 1.43± 0.50, 2.26± 0.73 and 3.30±1.02 days, respectively with the total larval period of 9.13± 1.71 days. These were measured 1.77± 0.28, 2.60± 0.40, 6.45± 0.56 and 14.15± 2.12 mm long respectively and 0.27± 0.03, 0.36± 0.08, 1.24± 0.07 and 3.23± 0.51 mm, respectively in breadth. The pre-pupa lasted for 1.43± 0.50 days. The male and female pupa measured 9.78± 0.46 mm and 3.14± 0.31 mm, 10.14± 0.69 mm and 3.37± 0.09 mm, respectively, with duration of 7.90± 0.92 and 7.53± 0.50 days, respectively. The adult male measured 9.13± 0.41 mm in length and 21.02± 0.98 mm in breadth with expanded wings. Whereas, female 10.71± 1.14 mm in length and 22.30± 1.48 mm in breadth with expanded wings. The preoviposition, oviposition and post-oviposition periods were 1.50± 0.68, 6.00± 1.33 and 4.30± 1.53 days, respectively. The fecundity was 265.00± 86.75 eggs/ female. The total lifecycle of male was 30.51± 6.00 days, while in female it was 32.60± 5.59 days.

Key words: Okra, shoot and fruit borer, biology, fecundity, morphometrics, instars, incubation period, longevity, lifecycle, oviposition,

Okra, *Abelmoschus esculentus* (L.) is one of the most important vegetable (Jan et al., 2021; Nagachandrabose, 2022); (Khanzada and Khanzada, 2018; Kumar and Das, 2021). In India, it is cultivated on 5.1 lakh ha with an annual production of 6094 thousand mt and a productivity 12.00 mt/ ha. Major okra growing states are Gujarat, West Bengal, Bihar, Andhra Pradesh, Assam and Orissa (Anonymous, 2018a). In Gujarat, it is mainly cultivated in Junagadh, Vadodara, Surat, Bhavnagar, Valsad and Anand districts on 75.27 thousand ha with total production of 921.72 thousand MT and a productivity of 12.28 mt (Anonymous, 2018b). Several biotic and abiotic factors are responsible for low yield in the okra crop, and among them, incidence of insect pests is important. Shoot and fruit borer *Earias vitella* and *E. insulana* (Ahmed et al., 2012; Tanni et al., 2019) are the most serious as it. *Earias vitella* being predominant (Kathiriya et al., 2007; Kumar et al., 2014); (Dongarjal and Bhamare, 2016). In India, an estimated loss of 69% is observed (Sharma et al., 2010; Kedar et al., 2014). Keeping in view the economic importance of *E. vitella* in okra, studies on biology and its morphometric were done.

MATERIALS AND METHODS

The study was carried out in the laboratory of Department of Entomology, C P College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during August 2019 to October 2019. Biology was studied on okra variety Gujrat Okra-5 at 26.81± 1.53°C and 67.82± 08.13% RH. To raise the initial culture of *E. vitella*, infected fruits were collected from college farm and brought to the laboratory. These were kept in circular galvanized trays and as soon as pupae were formed these were removed to glass jar (20 x 14 cm). The top of glass jar was covered with pieces of muslin cloth with the help of rubber bands and kept in oviposition cage for emergence of adults. On emergence of male and female tender shoots and fruits were provided for oviposition. Egg, larvae, pupa and adult were observed Size of eggs were measured under the microscope with ocular micrometer and size of larvae, pupa and adult was measured with graph paper. The number and duration of larval instar was determined on the basis of exuviae casted off. Incubation period was calculated from laying to hatching and hatching % was calculated. Sex of the adult was identified from the pupa

on the basis of marking on genitalia and anal opening of the pupa. The newly emerged male and female were used to study the preoviposition, oviposition and post-oviposition periods. Number of eggs laid by each female was recorded daily till the death of the female, to observed the fecundity. Longevity of male and female were also calculated. The period from egg laying to the death of adult was considered as a total lifecycle. The data on various biological parameters were subjected to analysis in software SPSS.

RESULTS AND DISCUSSION

It was observed that *E. vitella* did not lay eggs on leaf surface. In laboratory conditions, the eggs were laid singly in a small group of 2 to 3 on surface of the tender shoot and hairy part of fruits. Kathiriya et al. (2007) reported similar observation. The freshly laid eggs were spherical, bluish green which projected upward and gave it crowned appearance. Later, eggs turned into dark green and finally became creamy brown and after emergence of the larvae, the egg shell became transparent with a tiny emergence hole made by the larva. Vennila et al. (2007) and Patel et al. (2010) corraborate. Maximum mortality was observed in egg stage and first larval instars was observed while minimum was in the fourth larval instar (Shah et al., 2014). The length of eggs varied from 0.52± 0.02 mm, while the breadth 0.51± 0.02 mm. Patel et al. (2010) reported it was 0.52± 0.02 x 0.51± 0.02 mm. The incubation period varied from 3.35± 0.76 days; it was 2.8 to 3.5 days by Dhillon and Sharma (2004); 3.66± 0.75 days by Kathiriya et al. (2007); 3.33± 0.48 days by Patel et al. (2010); 2.30 days by Syed et al. (2011) and 2.97± 0.30 days by Sahito et al. (2019). The hatching of eggs varied from 73.27± 3.56%, similar with the findings of Dhillon and Sharma (2004), Kathiriya et al. (2007), Patel et al. (2010) and Sahito et al. (2019).

The larva was observed to pass through four larval instars. Kathiriya et al. (2007) and Patel et al. (2010) observed four larval instars on cotton genotypes the larval period was from 8.2 to 9.2 days on buds and 9.2–12.2 days on bolls with the pre-oviposition period of 2.42 days (Dhillon and Sharma, 2004). The freshly hatched larvae were light creamy white, possessed hairs on dorsal and lateral side with black dots and also with dark brown head capsule; and later on it turned black. After feeding it turned into pale brown. The larva had three pairs of thoracic legs on each thoracic segment and five pair of prolegs on third to sixth and tenth abdominal segment. Patel et al. (2010) reported that length and breadth of first instar of *E. vitella* larva was on an average 1.75± 0.29 mm and 0.26±0.04 mm. Thus, the present findings are in conformation with those reported in past. The duration of first instar larva varied from 1 to 3 days with a mean of 2.16± 0.71 days (Table 1). Shitole and Patel (2010) and Sahito et al. (2019) reported that the average duration of first instar larva of *E. vitella* was 2.51± 0.61 days and 2.50± 0.22 days, respectively when reared on okra. Thus, the above findings are more or less corroborating with present findings.

Morphometrics of larval instars are given in Table 1. These observations and those on larval period almost corroborate with those of earlier workers (Kathiriya et al., 2007; Patel et al., 2010; Shitole and Patel (2010); Sahito et al., 2019; Sayed et al., 2011.

The fourth instar larva became sluggish, stopped

Table 1. Morphometry and biology of *E. vitella*

Sl.No.	Life stage	Period (Days)			Length (mm)			Breadth (mm)		
		Min.	Max.	Mean± S.D.	Min.	Max.	Mean± S.D.	Min.	Max.	Mean± S.D.
1.	Egg	2	5	3.35± 0.76	0.5	0.54	0.52± 0.02	0.5	0.55	0.51± 0.02
2.	Larva									
	I instar	1	3	2.16± 0.71	1.34	2.16	1.77± 0.28	0.23	0.32	0.27± 0.03
	II instar	1	2	1.43± 0.50	1.86	3.1	2.60± 0.40	0.24	0.49	0.36± 0.08
	III instar	1	3	2.26± 0.73	5.6	7.23	6.45± 0.56	1.13	1.36	1.24± 0.07
	IV instar	2	5	3.30± 1.02	10.7	17.04	14.15± 2.12	2.45	4.13	3.23± 0.51
3.	Pupa									
	Male	7	8	7.53± 0.50	9.1	10.8	9.78± 0.46	2.82	3.64	3.14± 0.31
	Female	7	9	7.90± 0.92	9.36	11.13	10.14± 0.69	3.24	3.51	3.37± 0.09
4.	Adult									
	Male	27	44	32.60± 5.59	8.45	9.68	9.13± 0.41	19.8	22.7	21.02± 0.98
	Female	22	39	30.51± 6.00	9.1	12.49	10.71± 1.14	20.4	24.56	22.30± 1.48

feeding and contracted. The contracted larva has darker brown colour with white and orange spots on the dorsal and lateral side. The duration of pre-pupal stage was 1.43± 0.50 days. Dhillon and Sharma (2004) observe pre-pupal period of 19.8 to 23.7 hours and Patel et al. (2010) was 1.4± 0.33 days. Sex differentiation in pupa was done on the basis of female and male genitalia. In female, sex organs were present on 8th and 9th segments of abdomen and in male it was present on 9th abdominal segment. Anal slit present on 10th abdominal segments of pupa in both sexes. Kathiriya et al. (2007) reported that the pupa was dirty white to light brown, silken, boat shaped cocoon and pupated inside it. The female pupa measured 10.14± 0.69 x 3.37± 0.09 mm, male pupa measured 9.78± 0.46 x 3.14±0.31 mm (Table 1). Patel et al. (2010) observed similar more or less morphometrics. The duration of pupal stage varied from 7.53± 0.50 and 7.90± 0.92 days in female and male, respectively. The present finding are in close agreement with those of Patel et al. (2010) and Shitole and Patel (2010).

The male and female moths were pale white with green longitudinal wedge-shaped band in the middle of the forewings. Hind wings were pale white and smaller than forewings. Head was smaller than thorax. Antennae were filiform and yellowish grey with creamy white hair. Eyes were black. Abdomen was cylindrical, long with pale hairs. The male was distinguished from the female by the presence of tuft of hair on the last abdominal segment. The present findings on sex differentiation are in close agreement with those of Kathiriya et al. (2007) and Patel et al. (2010). The measurements of adults agree with those of earlier workers (Kathiriya et al., 2007; Patel et al., 2010). The preoviposition period was 1.50± 0.68 days. Patel et al. (2010) reported it as 1.45± 0.49 days. The oviposition period was 6.00± 1.33 days found to agree with Patel et al. (2010).

The post-oviposition period lasted 4.30± 1.53 days. Patel et al. (2010) observed it as 4.40± 1.68 days. The fecundity of female varied from was 265.50± 86.75 eggs/ female (Table 1). Patel et al. (2010) observed 228± 8.10 eggs/ female Mishra et al. (2016) gave similar results. The longevity of male was 8.70± 2.11 days, while in female it similar more or less morphometrics. The duration of pupal stage varied from was 11.16± 2.62 days. Patel et al. (2010) observed that the female survived longer than male similar to the present study. The total lifecycle was 30.51± 6.00 days in male and 32.60± 5.59 days in female (Table 1). Patel et al. (2010) observed that the total life cycle of female and male was 34.18± 4.68 and 29.90± 3.62 days, respectively.

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AUTHOR CONTRIBUTION STATEMENT

Ankur has conducted the entire work under the guidance of Ravindra Kumar Patel and Mohan Lal Tetarwal. Tanmaya Kumar Bhoi has analysed the data. Ipsita Samal has given constructive suggestions while writing this manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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