

STUDIES ON BIOLOGY AND LIFE HISTORY OF OKRA SHOOT AND FRUIT BORER *EARIAS VITELLA* (FABRICIUS) UNDER LABORATORY CONDITION

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ABSTRACT : History of okra shoot and fruit borer, *Earias vitella* studied in laboratory revealed that female laid 158 - 191 eggs during her life span. The incubation period of different larval instars, pupal period and adult longevity have been observed to be 3-5 days, 11-16 days, 6-8 days and 4-9 days respectively. In life table study of *Earias vittella* showed maximum mortality at egg stage (16%) followed by 1st instar larvae (14.2%) and 2nd instar larvae (11.1%).

Key words : Biology, *Earias vitella*, laboratory condition.

INTRODUCTION

India has emerged out as the second largest producer of vegetables in the world. Vegetables constitute a substantial part of human diet supplying vitamins and minerals, in which other food materials are deficient. Among the different kinds of vegetables, okra (bhendi) *Abelmoschus esculentus* (L.) Moench. is the second largest cultivated one, a potential export earner and accounting for 60 percent of export of fresh vegetables (Peirce, 1987). In India major leading state in okra production is West Bengal, Andhra Pradesh, Odisha, Gujarat and Bihar with a production of 74.60, 74.25, 67.04, 65.66 and 59.24 thousand metric tones, respectively (NHB, 2013).

In Uttarakhand Dehradun, Udham Singh nagar, Pithoragarh, Tehri, Nainital, Haridwar and Chamoli are the major okra producing District.

Okra belongs to the family Malvaceae and grown all over the country during spring –summer and rainy season for its immature fruits. It is closely relative to cotton crop and thought to be native to tropical Africa extending from Ethiopia and Sudan (Peirce, 1987).

According to Zeven and Zhukovsky (1975) okra is believed to have originated in the Hindustani Centre of origin, chiefly India, Pakistan and Burma. It is adaptive to climates with relatively short rainy seasons, hence its special acceptance in north-east Brazil where it is considered as a crop that never fails. In India, okra is commercially grown in the states of Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Haryana, Punjab, Uttar Pradesh and Uttarakhand during

spring-summer and rainy season.

The edible portion of the okra crop is immature seed pod, which quickly loses its desirable characteristics as it matures. These tender okra pods/fruits are used as vegetable, a good source of vitamins (A, B and C), proteins, minerals and excellent source of iodine. Linoleic acid, an essential fatty acid, has also been reported to be present, abundantly in okra seed oil (Chin and Nushirwan, 1990) Okra mucilage is also used in clarification technique for producing quality jaggery (Mungare *et al*, 2000). Okra seed oil resembles a good grade of peanut oil. It is similar in composition with cotton oil. After the extraction of oil, the meal can be used as cattle feed. The whole seed and defatted flour of okra contained 23.56 and 60.06 per cent protein; 21.29 and 4.45 per cent oil; 16.66 and 5.44 per cent crude fibre; 4.46 and 8.19 per cent ash and 24.26 and 21.85 percent carbohydrate, respectively (Khalifa *et al*, 1998). Important limiting factors in the successful cultivation of okra is the damage due to insect pest, mainly fruit borers and sucking insects. The important species of fruit borers are *Earias vittella* (Fabricius) (Krishnaiah *et al*, 1978; Rawat and Sahu, 1973), *E. insulana* (Biodeval) (Tripathi and Singh, 1990). It causes upto 41.60% crop loss in different parts of India (krishnakumar and Srinivasan, 1987). However, according to Hiremath (1984) *Earias* spp. damage may reach as high as 60.68%. Besides fruits, it also damages growing shoots which adversely affects the overall health of plants and yield. Study on biology and life history of *Earias vitella* in okra crop.

METHODS AND MATERIALS

Biology and life history of okra shoot and fruit borer

The biology and life history of *Earias vittella*, the most predominant pest of okra, was studied in the laboratory. The immature stages of pest, collected from the field were allowed to rear in laboratory for adult emergence. After emergence, the male and female were allowed for mating and oviposition on polled okra plants in laboratory under room temperature. On hatching, the larvae were reared separately on potted okra plants in laboratory. The maximum-minimum temperature and relative humidity were also recorded while conducting the life history study of the insect. For life table study the various instars larvae were reared separately in petriplates providing regular food supply to the larvae.

RESULTS AND DISCUSSION

Biology, Life history and life table study of Okra shoot and fruit borer [*Earias vittella* (Fabricius)] (Tables 1, 2; Plate 1)

Earias vittella Fabricius (Lepidoptera: Noctuidae) is the most important and potential pest of okra throughout South East Asia damaging all stages of the crop thereby seriously affecting the yield. The study of biology and life history of an insect is an important aspect because it can guide operational and tactical strategy in insect pest management. However, meager information is available on the biology and life history of okra shoot and fruit borer from Tarai region of Uttarakhand. Therefore, the present study is aimed to work out the biology and life history of okra shoot and fruit borer, one of the most prevalent pest attacking okra in Uttarakhand. Keeping in mind the importance of okra crop and infestation level of *Earias* species in Tarai region an attempt has been taken to study the biology and life history of okra fruit and shoot borer, *E. vittella* at different temperatures under controlled condition in the laboratory to monitor the developmental rate of its different stages, which would be helpful in the management strategies of this pest.

The larvae of *Earias vittella* initially was observed to attack the tips of shoots of young plants when the crop was 30 days old. They bored into the shoot and caused withering and drying of shoot due to its feeding on plant tissue prevented further growth of affected shoot. The shoots infested with borer drooped downwards and dried up. In later stages of crop with the appearance of flowers and fruits, the larvae bore into the flower buds and fruits causing their premature shedding. The number of holes on the fruit varied from 1 to 3. The entrance holes exhibit the presence of excreta, excreted by the feeding larvae. The infested fruits got distorted, filled up

with excreta and they become unfit for human consumption with no marketable value. The pods thus obtained contained the deformed pods and damaged seeds, which resulted decrease in seed yield and its quality. Drying of shoot due to feeding resulted the larvae to move out so as to attack another shoot/fruit. Thus, a single larva was found infesting more than one shoot/fruit.

In okra field, fair population of moth resting on host plant was observed in the morning hours during the course of study. This is probably due to emergence of moth from the pupae which took place at late night. However, life history carried out in laboratory revealed that mating of moth occurred on the second day of adult emergence between 6:00 to 7:00 AM. During mating the male and female come in back to back position. The mating period was observed from 1-2 hours while the pre-oviposition period extended from 2-3 days.

Life history

Life history study of *Earias vittella* was carried out by collecting pupae from the field and rearing them in laboratory for adult emergence. Soon after adult emergence, the males and females were separated on the basis of secondary sexual characters and then each pair was released in the rearing jars for mating and oviposition. The rearing jars were supplied with fresh okra twigs and pods as the ovipositing site. The twigs and pods were removed and replaced by fresh twigs and pods every day in the morning and placed in rearing jars after examining the number of eggs laid by the pest. These eggs were reared in laboratory to study the life history and life table of *Earias vittella*.

Egg

In laboratory, the moth laid eggs singly on okra shoots and fruits appeared small, transparent and spherical. Under the field condition the oviposition also took place on the developing buds, flowers, fruits and shoots. Interestingly, the hairy parts of the plant were preferred for oviposition. Initially the eggs were transparent but later turned to light bluish in color just before hatching. A female laid 158 to 191 eggs (average 175.5 eggs) during her life span. The moth laid eggs during night. Freshly laid eggs were 0.54 to 0.78 mm in length (average 0.66mm) and 0.61 to 0.81 mm in width (average 0.71mm). The size of egg was slightly increased being 0.62 to 0.84 mm in length and 0.62 to 0.84 mm in width, just before hatching. A female moth deposited 2 or 3 eggs at a time. Incubation period ranged from 3 to 5 days (average 4 days) when range of temperature and relative humidity was 26.82 to 27.30°C and 73.52 to 74.32 percent respectively. Mehmmady (2000) reported the incubation



Plate 1 : Life stages of okra shoot & fruit borer of okra.

period of okra shoot and fruit borer from 3.03 ± 0.17 to 3.84 ± 0.68 days when temperature and relative humidity ranged from 23.2 to 24.5°C and 59 to 60.22 percent respectively whereas Singh and Bichoo (1989) reported that the incubation period lasted for 3-4 days when the range of temperature and relative humidity was 27.5 to 31.3°C and 58 to 67 per cent respectively. Although, $30 \pm 5^\circ\text{C}$ seems, an ideal temperature for incubation (lowest period) by most of the workers including our results, but Rukhsana (1995) reported the highest incubation period of 6.33 eggs ± 0.99 at $30 \pm 5^\circ\text{C}$ which appeared to be highest incubation period as reported by other researchers so far.

Larval instars

The first instar larva of *Earias vittella* passed through five successive larval instars. The larval instars seemed to be almost similar in their general morphological characters except slight variations such as size and colour etc. However, all the larval stages of this pest were observed very active. In later stages, third instar onwards the larva appeared stout, spindle shaped caterpillar. The body of the larvae appeared brownish with a median longitudinal stripe and numerous stout bristles and brown and milky white markings over the body. The duration of larval instars along with their morphometry is presented in Tables 1 and 2.

Moulting

Each larval instar on attaining its full growth casted its skin four times to complete its life cycle. During moulting, the larvae shed off their skin slowly into pieces

at intervals. Generally, the moulting took place inside the fruit or shoot but occasional shedding of skin was also observed outside on the plant parts. The larvae took 5 to 8 hours to moult however, the duration differed from instar to instar.

First instar larva

Newly hatched larva measured 2.31 to 3.40 mm in length (average 2.85 mm) and 0.33 to 0.44 mm (average 0.38 mm) in width but before moulting the length and width of larva slightly increased, being 2.7 to 3.7 mm (average 3.09 mm) in length and 0.38 to 0.53 mm (average 0.41 mm) in width. Freshly hatched first instar tiny larva appeared active, pale yellow in colour with a prominent brownish head. After hatching the larva moves actively in search of a suitable place (i.e. shoot/fruit), bore into the shoot or fruit for further development. The duration of first instar larvae varied from 2 to 3 days (average 2.4 days) when range of temperature and relative humidity were 26.72 to 27.25°C , 68.34 to 69.81% respectively.

Second instar larva

Second instar larva appeared light brown in colour which later on turned to darker brown before the second moult and the head turned almost black in colour. Just after moulting, the larva measured 4.04 to 4.28 mm (average 4.16 mm) in length and 0.70 to 0.85 mm (average 0.77 mm) in width. The duration of second instar larvae was 2 to 3 days (average 2.5 days) when range of temperature and relative humidity were 25.82 to 27.38°C and 68.83 to 69.65% , respectively.

Table 1 : Measurements of all life stages of *Earias vittella* Fab.

S. No.	Stage	Length (mm)			Breadth (mm)		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean
1.	Egg	0.54	0.78	0.66	0.61	0.81	0.71
2.	Larval stages						
	1 st instar	2.31	3.40	2.85	0.33	0.44	0.38
	2 nd instar	4.04	4.28	4.16	0.70	0.85	0.77
	3 rd instar	8.89	9.34	9.11	1.55	1.72	1.63
	4 th instar	12.41	13.22	12.81	2.88	2.98	2.93
	5 th instar	16.74	17.45	17.09	2.91	3.05	2.98
3.	Pupa	8.05	8.32	8.18	3.58	4.05	3.81
4.	Adult	9.85	10.16	10.00	3.78	4.32	4.05

Table 2 : Duration and different stages of life history of *Earias vittella* in laboratory.

S. No.	Stage	Duration (days)		
		Minimum	Maximum	Average
1.	Fecundity (eggs/female)	158	191	175.5
2.	Incubation period (days)	3	5	4
3.	Larval period (days)			
	1 st instar	2	3	2.4
	2 nd instar	2	3	2.5
	3 rd instar	2	3	2.5
	4 th instar	2	3	2.9
	5 th instar	3	4	3.7
4.	Total larval period	11	16	14
5.	Prepupal period	1	2	1.4
6.	Pupal period (days)	6	8	7.4
7.	Adult longevity (days)	4	9	5.5
9.	Oviposition period (days)	2	3	2.7
10.	Total life cycle (days)	27	43	35

Third instar larva

Third instar larva appeared light brown in colour which later on turned to dark brown. Soon after first moulting, the larva measured 8.89 to 9.34 mm (average 9.11mm) in length and 1.55 to 1.72 mm (average 1.63mm) in width. At this stage, many stout hairs on the larval body became prominent. The duration of third instar larvae was 2 to 3 days (average 2.5 days) when range of temperature and relative humidity were 25.87 to 27.47°C and 69.85 to 71.30%, respectively.

Fourth instar larva

Fourth instar larva appeared dark brown in colour with the white spots on the body and bristle. After moulting, the larva measured 12.41 to 13.22 mm (average

12.81mm) in length and 2.88 to 2.98 mm (average 2.93mm) in width. The duration of fourth instar larvae was 2 to 3 days (average 2.9 days) when range of temperature and relative humidity were 25.45 to 26.56°C and 69.30 to 70.81%, respectively.

Fifth instar larva

The last instar larva measured 16.74 to 17.45 mm (average 17.09 mm) in length and 2.91 to 3.05 mm (average 2.98 mm) in width. The larvae appeared brown in colour but with a median longitudinal stripe along with the bristles distributed over the body and prominent orange coloured markings on both the sides of the body. The duration of fifth instar larvae was 3 to 4 days (average 3.7 days) when range of temperature and relative humidity were 25.15 to 26.23°C and 69.88 to 70.10 % respectively.

Prepupal period

Fifth instar larva stopped feeding, become less active and start spinning the cocoon. On attaining full growth and development the larva comes out of the pod or shoot in search of a suitable site for pupation. Generally, prepupal period varied from 1 to 2 days.

Pupa

The prepupal stage was followed by the pupal stage, a resting stage in which development of moth takes place inside the pupal case. Before converting into pupae the full grown larvae stop feeding. Under natural conditions, the pupation took place among the fallen leaves or on the host plant itself. Whereas under laboratory condition, the full grown caterpillars after taking a short rest at the bottom of jars and Petri- dishes and then spin cocoon on plant parts. However, occasionally they also pupated on the muslin cloth which was used to cover the top of the rearing jars. Pupa measured 8.05 to 8.32 mm (average 8.18mm) in length and 3.58 to 4.05 mm (average 3.81 mm) in width and appeared almost boat shaped and

Table 3 : Life table of *Earias vittella* (okra shoot and fruit borer) in laboratory under control conditions (27-35 ± 1°C).

Life stages	No. of each stage for rearing	No. dying during each stage	Mortality (%)	Cumulative survival (%)
Egg	50	8	16	84
Larvae 1 st instar	42	6	14.2	69.7
Larvae 2 nd instar	36	4	11.1	58.6
Larvae 3 rd instar	32	2	6.2	52.2
Larvae 4 th instar	30	2	6.6	45.6
Larvae 5 th instar	28	1	3.5	42.1
Pupae	27	1	3.7	38.4
Adult	26	0	0	-

yellowish brown to light brown in colour. The cocoon made of tough silken threads, secreted by the pupating larvae. The pupal period lasted from 7 to 8 days (average 7.5 days) when range of temperature and relative humidity were 24.05 to 26.30°C and 71.24 to 72.33% respectively. Rukhsana *et al* (1995) observed the pupal period of *E. vittella* as 11±3.33 days at 30±5°C and 72±0.58% RH. While, Singh and Bichoo (1989) reported 6-14 days and Nayar *et al* (1976) reported 7-10 days.

Adult

The adult moth of *E. vittella* is small, distinctively creamy white in colour. The forewings appeared green with characteristic white streak in each wing. The moth appeared active during dark hours (nocturnal) and hides inside the leaves during day time. The adult longevity was observed from 4 to 9 days (average 5.5 days). Except the prominent, long ovipositor in females, the male and the females were morphologically very much identical to each other.

Sex ratio

During the course of study, on the basis of secondary sexual characters it was found that the number of laboratory emerged males was more than that of females. Thus out of fifteen replications, the number of emerged males were nine whereas the females were only six. Hence, the sex ratio of 3:2 (males: females) indicated a marked dominance of males in comparison to females.

Life table of *Earias viteella* under laboratory

Life table study of *Earias vittella* (Table 3) revealed that maximum mortality occurred at egg stage (16%) followed by 1st instar larvae (14.2%), 2nd instar larvae (11.1%), 4th instar larvae (6.6%), 3rd instar larvae (6.2%), pupa (3.7%) and 5th instar larvae (3.5%). Present findings are in close agreement with Shah *et al* (2012) who reported maximum larval mortality of okra shoot and fruit borer at 1st instar larvae as compared to mortality observed at 4th instar larvae and pupae (1.2 and 1.6 % respectively). recorded 8.13 percent mortality at egg stage

at 31.3 °C; Syed (2011) reported 71.68 % fertility of eggs. Cumulative percentage of survival showed that all adult remain live and survived till their natural life span.

CONCLUSION

The life history of okra shoot and fruit borer studied in laboratory revealed that female laid 158 to 191 eggs (average 175.5 eggs) during her life span on natural food. Freshly laid eggs were 0.54 to 0.78 mm in length (average 0.66mm) and 0.61 to 0.81 mm in width (average 0.71mm). Incubation period ranged from 3 to 5 days (average 4 days) on natural diet.

The larva of *Earias vittella* passed through five successive larval instars. Newly hatched first instar larva measured 2.31 to 3.40 mm in length (average 2.85 mm) and 0.33 to 0.44 mm (average 0.38mm) in width. Duration of first instar larvae varied from 2 to 3 days (average 2.4 days). Second instar larva measured 4.04 to 4.28 mm (average 4.16mm) in length and 0.70 to 0.85 mm (average 0.76mm) in width. The duration of second instar larvae was 2 to 3 days (average 2.5 days). Third instar larva measured 8.89 to 9.34 mm (average 9.11 mm) in length and 1.55 to 1.72 mm (average 1.63mm) in width. This stage of larvae was characterized by numerous hair like structure on larval body. The duration of third instar larvae was 2 to 3 days (average 2.5 days). Fourth instar larva measured 12.41 to 13.22 mm (average 12.81mm) in length and 2.88 to 2.98 mm (average 2.93 mm) in width. The fifth instar larva appeared brown in colour but with a median longitudinal stripe along with the bristles and both sides of the body having prominent markings of orange colour. The larvae measured 16.74 to 17.45 mm (average 17.09 mm) in length and 2.91 to 3.05 mm (average 2.98 mm) in width and larval duration was 3 to 4 days (average 3.7 days) observed.

The pupa measured 8.05 to 8.32 mm (average 8.18 mm) in length and 3.58 to 4.05 mm (average 3.81mm) in width. The pupa was boat shaped and yellowish brown to light brown in colour. The pupal period varied from 6

to 8 days (average 7.4 days).

The adult moth of *E. vittella* is small, distinctively creamy white in colour of forewings appeared green with characteristic white streak in each wing. The longevity of adult moth was observed from 4 to 9 days (average 5.5 days). On the basis of secondary sexual characters, it was revealed that the number of laboratory emerged males was more than that of females with sex ratio of 3:2 (males : females).

The life table study of *Earias vittella* under laboratory revealed that maximum mortality occurred at egg stage (16%) followed by 1st instar larvae (14.2%), 2nd instar larvae (11.1%), 4th instar larvae (6.6%), 3rd instar larvae (6.2%), pupae (3.7%) and 5th instar larvae (3.5%).

REFERENCES

- Chin A H G and Nurhirwan Z (1990) Properties of vegetable oils from unemployed source in Malaysia. *MARDI Res. J.* **18**, 261-265.
- Hiremath I G (1984) Host preference of spotted bollworm, *Earias* spp. *Entomology* **9**, 185-188.
- Khalifa A H, EI-Dengawy R A and Ramadan B R (1998) Evaluation and utilization of okra seeds. *Egyptian J. Food Sci.* **26**, 1-11.
- Krishnaiah K, Jagan Mohan N and Ramchander P R (1978) Economic Injury level and sequential sampling plan for okra fruit borer, *E. vittella* (Fab.) *Bull. Ent.* **19**, 114-118.
- Krishnakumar N K and Srinivasan K (1987) Efficacy and economics of pest control in okra with with conventional and synthetic pyrethroid insecticides. *Indian J. Plant Prot.* **15**, 81-83.
- Mehmady M Roqaya (2000) Biological studies on the okra moth, *Earias vittella* (F.) in Jeddah, Saudi Arabia. *Res. Bult.* **96**, *Res. Cent. Coll. of Agri., King Saud Univ.*, pp. 5-18.
- Mungare T S, Jadhav H D, Patil J P, Hasure R R, Jadhav B S, Singh J and Singh J (2000) Clarification Technique for producing quality Jaggary. *Cooperative Sugar* **32**, 283-285.
- Nayar K K, Ananthkrishnan T N and David B V (1976) *General and Applied Entomology*. Tata McGraw Hill publishing company limited. New Delhi. 268-269
- NHB (2013) www.hortibiziindia.org
- Peirce L C (1987) *Vegetables: characteristics, Production and Marketing*. John Wiley and Sons, Canada pp. 399-401.
- Rawat R R and Sahu H R (1973) Estimation of losses in growth and yield of okra due to *Empoasca devastans* (Dist.) and *Earias* spp. *Indian J. Ent.* **35**, 252-254.
- Rukhsana G I, Khan M F and Naquvi S N H (1995) Comparative study of *A. esculentus* (L.) Moench meth, Okra fruit and cotton leaves suitability for rearing and biology of *E. fabia* (Stoll.). *Pakistan J. Sci. Indus. Res.* **38**, 22-24.
- Shah M A, Memon N, Manan A and Shah N A (2012) Effect of different temperatures on the development of spotted bollworm, *Earias Vittella* (Fab.) (Lepidoptera: Noctuidae) in the laboratory. *Sindh Univ. Res. Jour. (Sci. Ser.)* **44**, 487-490.
- Singh Y and Bichoo S I (1989) Some biological and bionomical observations on *Earias fabia* Stoll. *Bull. Entomol.* **30**, 84-91.
- Syed T S, Abro G H, Khanum A and Sattar M (2011) Effect of host plants on the biology of *Earias vittella* (Fab) (Noctuidae: Lepidoptera) under laboratory conditions. *Pakistan J.Zool.* **43(1)**: 127-132.
- Tripathi S R and Singh A K (1990) Effects of food plants on development, growth and reproduction of *E. vittella* (Fab.). *Indian J. Ecol.* **17**, 83-85.
- Zeven A C and Zhukovsky P M (1975) *Dictionary of cultivated plants and their centres of diversity*. Centre for Agricultural publishing and Documentation, Wageningen. *The Netherlands* 219 p.