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Effect of Host Plants on the Biology of *Earias vittella* (Fab) (Noctuidae: Lepidoptera) Under Laboratory Conditions

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Abstract.- Studies were carried out to investigate the effect of host plants and temperature on the biology of *Earias vittella* (F.) under laboratory conditions. The host plants tested were, okra (*Abelmoschus esculantus* L), cotton (*Gossypium hirsutum* L.), China rose (*Hibiscus rosa-sinensis* L). and *Abutilon indicum* G.Den. The results indicated that incubation period varied from 2.3 to 5 days, on okra and Abutilon; larval period from 9.2 to 15.9 days on okra and china rose; pupal period from 8.6 to 14.4 on china rose and Abutilon, respectively; duration of life cycle ranged between 30.4 to 44.6 days on cotton and Abutilon, respectively (minimum and maximum values). Pre- copulation, pre-oviposition, oviposition and post oviposition periods of *E. vittella* adults varied when feeding on different host plants as larvae. Temperature variation affected all the above biological parameters *e.g.* the larval period of *E.vittella* on okra was recorded as 10.8 days at 34.12^{o}C, the same was 12.0 and 14.75 days on okra at 32.6 and 30.6^{o}C, respectively. The average fecundity of *E. vittella* females was 328.37 eggs and about 50% of eggs were laid on first two days of egg-laying. Fertility of eggs varied significantly ($P<0.01$) on different host plants and different days of egg- laying.

Key words: *Earias vittella*, Noctuidae, Okra plant.

INTRODUCTION

The spiny bollworm, *Earias vittella* (F.) (Noctuidae: Lepidoptera) is a very serious polyphagus insect pest on many economic crop plants of Malvaceae family. *E. vitella* apart from cotton (*Gossypuim* spp.) feeds on *Abutilon indicum* G.Den, okra (*Abelmoschus esculentus);* holly hock (*Althaea rosea*, Cav. Kenaf), *Hibiscus cannabinus* L., *H. vitifolius, Malvastrum tricuspidatum* Ait and Gray, shoeflower (*Hibiscuss rosa-sinensis* L.), Sonchal, (*Malva parviflora*) and other malvaceous plants (Nayar *et al.*, 1976; Ayyar, 1984). Arif and Attique (1990) suggested that the alternate host plants play important role in the carry over of *E. vittella*.

Earias vittella along with *E. insulana* are widely distributed in North Africa, Indo-Pakistan sub continent and other countries of the world. They are active almost throughout the year on different host plants under field conditions (Abdul-Nasr *et al.*, 1973; Arif and Attique, 1990). On cotton crop their initial attack is noticed in June and July. The attack on the bolls is generally higher than buds. Maximum infestation is recorded during August and September (Qureshi and Ahmed, 1991). As a result of attack the quality and quantity of cotton is adversely affected. A single larva can destroy several buds and bolls in its life. Among bollworms, *Earias* spp. are most abundant on cotton in Sindh as compared with other bollworm species (Leghari and Kalro, 2002) and cause 3.8 to 12.6% damage (Chang *et al.*, 2002), whereas Abro *et al.* (2003) have reported 1.79 to 2.38% infestation of cotton bolls due to *Earias* spp.

Earias spp. are also serious pests of okra. They attack growing points, but when fruiting bodies start to appear, feed mostly inside squares, flowers and fruits. The economic injury level of *Earias* spp. on okra is reported to be 5.3% damage (Krishnaiah *et al.*, 1978) and 36% of harvestable fruits are damaged by *Earias* spp. (Krishnaiah, 1980). Various authors have reported the damage caused by *Earias* spp. to okra crop, *e.g,* Srinivasan and Krishnakumar (1983) reported 9.3% infestation of *E. vittella*, Dhawan and Sindhu (1984) observed maximum damage of 67.75% caused to fruits and 25.04% to buds by *Earias* spp in late October. Tripathi and Singh (1990) studied the effect of different food plants on reproduction of *E. vittella*

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under laboratory conditions and revealed that okra was the most suitable food plant in terms of development, growth and reproduction. Srinivasaperuma *et al.* (1992) investigated life-table of *E. vittella* reared on three hosts. The rate of population increase was 0.124, 0.106 and 0.082 females/female per day on okra, cotton and Abutilon, respectively. Dongre and Rahalkar (1992) recorded the relative host plant preference and feeding behaviour of larvae of *E. vittella*. Out of five plants, okra was the most and *H. rosa-sinensis* the least preferred.

The pest status of an insect species depends on its ability to breed on a variety of host plants (Ananthakrishanan, 1977). The preferred hosts have a great influence on oviposition, fecundity, development period and longevity of adults of *Earias vittella* (Fab) and *E. insulana* (Boisd) (Khan and Rao, 1960). Mehta and Sexena (1973) reported that growth of *E. vittella* varies with the degree of conversion into body mass. Mani *et al.* (1986) studied the effects of food quality of okra and *Hibiscus rosa-sinensis* on output and viability of *E. vittella* eggs, whereas Sundararaj and David (1987) observed decrease in body weight, fecundity, percent of larvae becoming adults, adult longevity of both males and females and prolongation of larval period of *E. vittella* when reared on *A. indium* compared with okra and cotton which was due to less amount of reducing sugars, protein and free amino acids but high amount of non reducing sugars. In the present study effect of host plants and temperature on biology of *E. vittella* was studied under laboratory conditions and reported herein.

MATERIALS AND METHODS

Rearing techniques

E. vittella larvae were collected from okra (*Abelmoschus esculantus* L.) fields and were reared in Petri dishes (15 cm dia). Fresh okra fruits were provided daily till pupation. After adult emergence, insects were sexed and one male and one female were paired together for copulation and egg-laying in glass chimneys placed in Petri dishes. The open end of chimneys was covered with muslin cloth tied with rubber band. A cotton wool plug soaked in 5% sucrose solution was provided to adults. A twig of okra with tender leaves whose one end was dipped in water contained in small vial was provided in each chimney for egg-laying. After every 24 hours, okra twig was examined for presence of eggs and replaced with fresh one. Upon hatching of eggs, experiment was conducted on the affect of host plants on biology of *E. vittella*.

Effect of host plants on biology of E. vittella

Neonate larvae were reared in Petri dishes (15 cm dia) on different host plants namely, Okra (*Abelmoschus esculantus* L.), China rose (*Hibischus rosa-sinensis* L.) Cotton (*Gossypium hirsutum* L.) and *Abutilon indicum* G.D. Fifty larvae were released per host plant in a completely randomized design with five replicates per host plant. Fresh food (mostly flower buds and fruits) was provided daily and old food was removed. Observations were recorded on the larval and pupal periods on different host plants. After adult emergence, one male and one female was paired in glass chimneys for copulation and egg-laying. A host plant twig with tender leaves one end dipped in water contained in small vial and 5% (w/v) sucrose solution impregnated on to a cotton wool was provided for egg laying and adult feeding, respectively.

Experiment was laid out in a completely randomized design with ten host plants per replicate and recorded pre-copulation, copulation period, pre-oviposition, oviposition and post oviposition periods as well as manner and time of occurrence of copulation. The open ends of glass chimneys were covered with muslin cloth tied with rubber bunds. The numbers of eggs laid were recorded daily and kept separately for observing the fertility of eggs till cessation of egg- laying. When females stopped egg-laying, fecundity of females was determined and percentage of eggs laid on different days was also worked out. Observations were also made on the sex ratio and adult longevity. Percent eggs laid on different days of egg-laying were calculated by the formula:

$$\text{Percent eggs laid} = \frac{\text{Eggs laid on } n^{th} \text{ day}}{\text{Fecundity per female}} \times 100$$

Effect of temperature on biology of E. vittella

The present studies on *E. vittella* were initiated in the first week of July and continued till fourth week of November on different host plants. During this period, five life-cycles of *E. vittella* were studied. We present here the results of three life-cycles, keeping a difference of temperature regime of almost 2°C between different life-cycles, to show the effect of temperature on biology of *E. vittella*.

RESULTS AND DISCUSSION

Incubation period

Incubation period of eggs of *E. vittella* varied considerably due to host plants and temperature fluctuations during the period of study. The shortest incubation period of 2.30 days was recorded on okra and China rose, during the month of September when the average laboratory temperature was recorded as 32.6°C, while the longest incubation period of 5.0 days was recorded on Abutilon as host plant during the month of October with average temperature of 30.6°C (Table I). Al-Mehmmady (2000) reported incubation period of *E. vittella* as 2.42 days at 31.3°C during the month of September and 2.15 days during the month of August at 32.6°C.The present results are almost in agreement with those of Rehman and Ali (1981), Singh and Bichoo (1989) who recorded the incubation period of 3-4 days. Sundraraj and David (1987) also observed the incubation period of *E. vittella* as 4.57 days on okra.

Larval period

Considerable variation was also recorded in larval period of *E. vittella* feeding on different host plants and due to variation of temperatures. The shortest larval period of 9.16 and 9.6 days was recorded on okra and cotton, respectively during August, whereas the longest larval period of 14.9 days and 15.9 days was observed on Abutilon and china rose, respectively in the last week of October when the average laboratory temperature was 30.6°C. (Table I). Effect of host plants on larval duration of *E. vittella* recorded by Ambegankar and Billapate (1984) was 9.3 days on okra, and 11.3 days on cotton flowers. Similarly, Hiremath (1984) reported that development of *E. vittella* was fastest

Table I.- Effect of host plants and temperature on the different biological parameters of *Earias vittella* under laboratory conditions ($\bar{x}$ ± SD days.

Average Lab. (Temp.)	Host	Incubation period (days)	Larval period (days)	Pupal period (days)	Develop-mental time (days)	Pre-copulation (days)	Copulation hours	Pre-ovi-position (days)	Ovi-position (days)	Post ovi-position (days)	Adult longevity (days)		Duration of life cycle (days)
											Male	Female	
34.12°C	Okra	2.6±0.5	10.8±2.5	10±0.5	23.4	2.5±0.7	2.55±0.8	1.5±0.7	7.0± 1.4	10±4.2	14.2±1.7	13.9±2.2	37.3
	Cotton	3.87±1.3	11.5±1.1	9.84±0.7	25.21	3.5±0.7	2.7±0.8	1.33±0.5	8.0±0.0	3.0± 2.82	11.5±0.7	11.5±0.7	36.7
	China rose	3.3±0.5	11.1±1.1	9.66±0.7	24.06	2.0±0.0	2.25±1.1	1.0±0.0	8.0±0.0	4.0±0.0	11.0±0.0	10±0.0	34.1
	Abutilan	4.25±1.2	10.6±0.5	10.66±1.1	25.51	3.0±0.7	3.0±0.0	0.5±0.7	3±1.41	1.5±0.7	11.5±4.9	7.5±0.7	33.0
32.6°C	Okra	2.3±0.5	12±0.8	11.8±1.9	26.1	1.33±05	1.1±1.01	0.66±0.6	5.0±4.4	3.0±4.6	11.66±2.1	13.3±7.5	39.4
	Cotton	3.0±0.0	12..4±1.4	10.7±3.1	26.1	1.0±0.7	1.02±0.7	1.0±0.0	6.0±0.0	1.0±2.0	9.0±0.0	9.0±0.0	35.1
	China rose	2.3±0.5	10.3±3.8	11.28±4.6	23.88	2.0±0.0	3.0±1.1	1.0±0.0	8.0±0.0	4.0±0.0	9.5±3.5	10.5±4.9	34.4
	Abutilan	3.5±1.3	13.66±0.5	14.4 ± 0.5	31.56	2.0±1.4	1.85±0.4	2.0±0.0	5.5±4.1	3.5±0.7	12.6±4.0	13.6±2.6	45.2
30.6°C	Okra	3.5±1.7	14.75±1.9	11.16±1.9	29.41	1.0±0.7	1.85±0.5	1.75±0.9	4.5±4.0	2±1.41	11.8±5.0	8.0±5.8	37.4
	China rose	3.2±1.2	15.9±2.6	9.8±0.7	28.9	2.0±1.4	3.75±3.6	1.5±0.5	4±1.41	2.0±1.41	10±4.6	8.0±5.2	36.9
	Abutilan	5.0±0	14.90±1.7	11.8±1.4	31.7	2.0±0.0	5.0±0.0	2.0±0.0	8.0±0.0	2.0±0.0	13±1.4	8.0±5.6	39.7

on okra (23.50 days) followed by cotton as 25.4 and hollyhock as 27.5 days. Duration of larval stage recorded was 12.73, 13.76 and 18.33 days on okra, cotton and *A. indicum*, respectively by Sundraraj and David (1987). Rukhsana *et al.* (1995) found larval period of *E. vittella* on okra fruits took 18±0.88 days at 30.5°C, while Al-Mehmmady (2000) reported larval period of 11.39±3.13 days in October at 30.5°C and 11.28 days in August at 32.6°C.

Pupal period

The shortest pupal period of 9.66 days was observed on china- rose during the last week of July, while the longest pupal period of 14.4 days was recorded on Abutilon during the last week of September when average temperature was 32.6°C. Variable pupal periods of *E. vittella* have been reported in literature, which may be due to difference in climatic conditions or host plants. Rehman and Ali (1981) have reported 6 to 13 days, whereas Singh and Bichoo (1989) 6-14 days, Nayar *et al*. (1976) 7-10 days, Atwal (1984) 4-9 days. Pupal period on different hosts being 11.16, 12.36 and 13.03 days on okra, cotton and *A. indicum*, respectively (Sundraraj and David 1987). Al-Mehmmady (2000) reported pupal period of *E. vittella* during the month of August and October to be 6.45 and 7.78 days with an average temperature of 32.6 and 30.5°C, respectively.

Adult longevity

Male

Although male longevity did not follow a fixed trend, generally, male lived longer than females in the present study. The minimum adult male longevity was recorded as 9.5 days on cotton at 32.65°C, and the maximum longevity as 14.2 days on okra at 34.12°C (Table I). Contrary to the findings of present study Rehman and Ali (1981) have reported female adult longevity of 13.91 days and male longevity 9.25 days. While, Sundararaj and David (1987) reported male longevity of *E. vittella* as 10.76, 9.33 and 6.23 days on okra, cotton and *A. indicum*, respectively. Al-Mehmmady (2000) reported male longevity as 12.45 and 13.36 days in the months of August and October with an average temperature of 30.6 and 32.5°C, respectively.

Female

Host plants and temperature had marked effect on adult longevity. The minimum female longevity (7.5 days) was recorded during July on Abutilon, while the maximum of 13.9 days was observed on okra (Table I). Almost similar results have been reported on female longevity by Rehman and Ali (1981) and Sundraraj and David (1987) on okra, cotton and *A. indicum*, as 14.60, 14.13 and 9.90 days, respectively. While Al-Mehmmady (2000) reported 14.00 and 14.20 days female longevity in August and October with an average temperature of 32.6 and 30.5°C, respectively.

Duration of life-cycle

The life cycle of *E. vitella* varied on different host plants and at different temperature regimes in the present study. The minimum duration of life cycle of 33.00 days was observed on Abutilon compared with other host plants during the last week of July when the laboratory temperature was 34.12°C. Duration of life-cycle increased as the temperature decreased (Table I). Rehman and Ali (1981**)** reported a total life-span of 24 to 45 days at 36.7°C**.** Whereas Nayar *et al.* (1976) reported that the total life-cycle occupies 20 to 22 days. Sharma *et al.* (1985) recorded the duration of life cycle from 29 to 49 days. Sundararaj and David (1987) observed that the total development period of *E. vittella* on *A. indicum*, cotton and okra was 32.1, 27.9, and 26.9 days, respectively. While Al-Mehmmady (2000) reported the same to occupy 35.21 and 35.40 days in the month of October, respectively

Pre-copulation and copulation period

Pre-copulation period varied on different host plants from 1.5 to 3.50 days on Abutilon and cotton at 34.12°C. Temperature affected the pre-copulation period, pre-copulation period of *E. vittella* on okra was 2.5, 1.33 and1.0 days at 34.12, 32.6 and 30.6°C, respectively. The copulation period of *E. vittella* also varied due to host plants and temperature. At 30°C, the minimum copulation period (2.5 h) was recorded on okra and the maximum (5.0 h) on Abutilon (Table I). Rehman and Ali (1981) reported copulation period of 34 to 109 minutes.

Table II.- Effect of host plants on Fecundity and Fertility (%) of eggs of *E. vittella* under laboratory conditions.

Host Plants	Fecundity (Mean ± SD)	Eggs laid on different days					Mean ± SE
		1	2	3	4	5	
Okra	277.0±79.9a	62.5	55.1	39.2	31.3	5.5	38.7±9.98 a
Cotton	276.3±37.7a	72.21	66.0	46.8	30.41	5.6	44.20±12.14ab
China rose	256.7±60.5a	75.0	75.6	52.0	38.0	9.4	50.0±12.4b
Abutilan	114.6±11.2b	77.0	67.16	50.0	32.4	22.84	49.88±10.17b
Mean±SE		71.68±3.21d	65.96±4.21d	47.0±2.81c	33.03±1.71b	10.83±4.10a	

Pre-oviposition, oviposition and post ovipostion period

Pre-oviposition period of *E. vittella* females varied from 0.5 to 2. 0 days, while oviposition period varied from 3.0 to 11.00 days, whereas, post-ovipostion period spread over 1.5 to 10.0 days, respectively on cotton and okra (Table I). Rehman and Ali (1981) have reported 3.5, 5.83 and 4.75 days pre-oviposition, oviposition and post-oviposition periods, respectively.

Fecundity and fertility

Fecundity and fertility of eggs of *E. vittella* was recorded at 32.6°C under laboratory conditions. A total number of 25 pairs were kept under observation, and it revealed that on an average a female laid 328.37±17.33 (Mean ± SE) eggs over a period of 10-11 days. Almost 50% of eggs were laid during the first two days of egg-laying (Fig. 1). Egg-laying decreased gradually over a period of time and declined gradually. Anwar *et al.* (1973) reported that active ovipostion period was in the range of 2-7 days post emergence which agrees with present findings. Various workers have reported the fecundity of *E. vittella* females, Rehman and Ali (1981) as 82-378 eggs; Atwal and Dhaliwal (2005) as 200-400 eggs and Nayar *et al.* (1976) reported 385 eggs/female.

In the present study host plant exerted significant (F= 7.915. DF=3, 6; P<0.05) effect on egg laying capacity of females fed on different hosts as larvae.

The maximum number (277.0 eggs/female) of eggs was laid by females fed on okra as larvae followed by cotton during first five days of egg-laying. Females laid minimum (114.6 eggs /female) eggs fed on Abutilon as host. Sundararaj and David (1987) reported maximum (350.67 per female) number of eggs was laid by females fed on okra followed by cotton, while insects fed on Abutilon laid the minimum (135.0 eggs per female) number of eggs (Table II).

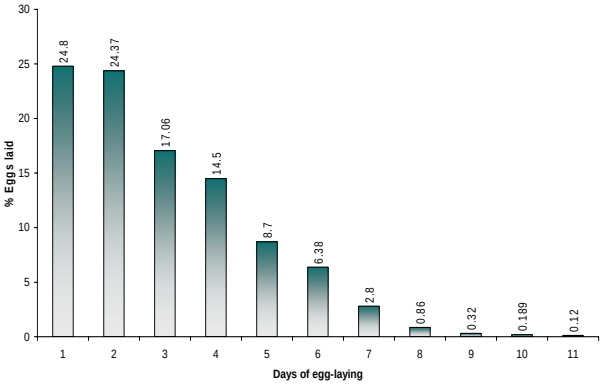

Fig. 1. Average eggs laid by *E. vittella* during different days of egg-laying.

The fertility of eggs of *E. vittella* varied significantly (F=126.65; DF=4.12, P<0.001) on different days of egg-laying and (F=7.448; DF=3, 12; P<0.001) due to feeding on different host plants. Eggs laid on the first two days showed maximum fertility 71.68 and 65.96% respectively, while eggs laid on fifth day had the minimum (10.83%) fertility of eggs (Table II).

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