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Systematic Studies, Life History and Infestation by *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) on Tomato in Semi Arid Region of Rajasthan

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ABSTRACT : The detailed systematic studies, life history and infestation done by *Helicoverpa armigera* (Hubner) on tomato in semi arid region of Rajasthan were conducted from 1999-2010. The pre-oviposition, oviposition and post oviposition periods ranged from 2.15-3.21, 5.25-6.60 and 1.12-1.33 days, respectively in different generations. The fecundity/ female ranged from 256.60-490.66 eggs and percentage hatchability ranged between 77.80-89.0 percent in different generations. The longevity of male and female moths was 2.44-5.89 and 8.79-11.33 days, respectively. In the first two generations the ratio of male was higher than female (1:0.76 and 1:0.67) but in the next generation the ratio of female was higher than males (1:1.22). The incubation period was 5-7, 5-6 and 4-6 days in the Ist, IInd and IIIrd generation. The larvae passed through five instars with 21.25-38.24 days of total larval period in different generations. The mean pre-pupal period and pupal period ranged from 4.04-4.75 and 13.78-24.38 days in different generations. *H. armigera* completed three generations in semi arid region of Rajasthan from October to May.

Keywords : Helicoverpa armigera, life history, tomato, Rajasthan.

INTRODUCTION

Tomato (*Lycopersicon esculentum Mill.*) is a profitable vegetable, cultivated widely in the semi arid region of Rajasthan. Among the various insect-pests responsible for lowering the yield of tomato crop, the fruit borer, *Helicoverpa armigera* (Hubner), is a highly destructive pest causing serious damage (Srinivasan, 1959; Krishnamoorthy and Mani, 1996). The monetary loss due to this pest in the country has been estimated over rupees one thousand crores per year (Jayraj *et al.*, 1994). A thorough knowledge of life history of insect and its status as a pest provide an important basis for developing efficient pest management strategies. Climatic conditions, particularly temperature, humidity, rainfall, agronomic practices and cropping pattern of the region appear to be the principal controlling factors. Therefore, the present studies were undertaken to study the biology of *H. armigera* on tomato in semi arid region of Rajasthan.

MATERIALS AND METHODS

Studies on the biology of the tomato fruit borer, H. armigera were made in the field and laboratory of the Department of Entomology, S.K.N. College of Agriculture, Jobner, Rajasthan; College of Technology and Agricultural Engineering, MPUAT, Udaipur and identification and measurement work of different stages of insect conducted at Department of Entomology, S.K.N. College of Agriculture, Jobner and Zoological Survey of India, Desert Regional Centre, Jodhpur, Rajasthan from 1999-2010.

(*i*) Rearing of *H. armigera:* For studying the life history of the *H. armigera* a large number of tomato fruit borer larvae were collected from the tomato crop, during September- October. Each larva was reared separately in a plastic tube (10 × 2.5cm) at the room temperature. Fresh tomato leaves were served as food for the larvae. Each tube was closed with the help of a cotton plug. The grown up larvae pupated in the tube. The newly emerged moths from these tubes were released in pairs in the glass chimneys for getting the eggs. The upper end of the chimney was kept closed with a piece of muslin cloth fastened with rubber band. The bottom of the chimney was placed intact in a petridish containing a filter paper. Two folded paper stripes were suspended inside the chimney, which served as a resting place for the moths. Fresh tomato twigs were used for egg lying. The cut ends of these twigs were wrapped in water soaked cotton swabs, which were covered with polythene pieces. This was done to avoid the loss of water from the twigs so as to keep them turgid. Ten per cent honey solution, put on the cotton swabs, was provided to adults as food. The female moths laid eggs on the leaves, walls of the chimney and on muslin cloth. These eggs were removed gently with the help of a moist camel hairbrush.

(*ii*) Duration of larval instars: For determining the durations of the five larval instars, 0-24 hour old larvae were taken. Thirty larvae were reared singly in plastic specimen (10 × 2.5cm) tubes. Each tube was kept closed with the help of the cotton plug. Food in each tube was changed daily by bringing fresh leaves from the field.

Observations on moulting were recorded daily. To detect exuviae and heads of the 1st and 2nd instar larvae, a binocular microscope was used. The exuviae of subsequent instars were, however, visible with naked eye. Thus, the durations of different larval instars were recorded.

(*iii*) Pre-pupal and pupal duration: Pre-pupal (time elapsed between cessation of feeding and shedding of the last larval skin) and pupal (the time of pupation and the emergence of moths) durations were determined. A total of 30 newly hatched larvae were taken for further observations. Weight of each pupa was recorded within 24 hours of its formation.

(*iv*) Studies on some aspects of adult life: The newly emerged moths were separated as males and females to work out sex- ratio. For studying the pre-oviposition, oviposition and post-oviposition durations, the newly emerged moths were released, in pairs, in glass chimneys. The period from the emergence of female moth to the laying of first egg was considered as pre-oviposition period. The period from laying of the first to the last egg was considered as the oviposition period. The duration from laying of the last egg to the death of the moth was considered as post-oviposition period. In these studies, cotton swab soaked in 10 per cent honey solution were placed in the chimney to serve as food for the moths. These swabs were changed daily. The duration from emergence of a moth to its death was considered as longevity.

For studying the fecundity, each mated female moth was kept in a glass-chimney. Each chimney was provided with a 10 cm long tomato twig to facilitate egg laying. The twigs bearing the eggs were replaced daily by fresh twigs. The eggs on each twig were counted daily. This process was continued till the female died. Some times eggs were laid on the walls of the chimney and on the muslin cloth. In such cases, these were counted directly without removing them from these surfaces. Fifty eggs obtained from females were placed in a petridish (5 cm. diameter) to study their viability and incubation period

RESULTS AND DISCUSSION

The results of detailed systematic studies, life history and infestation done by *Helicoverpa armigera* (Hubner) on tomato in semi arid region of Rajasthan were as given below.

(*a*) Egg: It is spherical in shape with a flattened base. The colour in the beginning was yellow-white, which become dark brown before hatching. They measured 0.47 + 0.04 mm × 0.48 + 0.05 mm. in length and breadth, respectively. The above observations are in agreement with those of Lefroy (1906), Neunzing (1964), Edwards and Heath (1964) and Singh and Singh (1975).

(*b*) Larva: The larva passed through five instars before becoming pupa and the size of first, second, third, fourth and fifth instar larva was 1.44 × 0.49 mm, 3.43 × 0.78 mm, 8.30 × 0.07 mm, 17.8 × 0.34 mm and 32.40 × 5.20 mm in length and breadth, respectively. The newly hatched larva was semi translucent and creamy in colour with yellowish orange longitudinal lines on the dorsal surface of the body. The head, thoracic, anal shields and legs were of brown colour. The setae present were dark in colour. These findings are similar to those of Neunzig (1964) and Singh and Singh (1975). The second instar larva was yellowish brown in colour and head was some what darker as compared to the body colour. In the third instar, the colour turned yellowish white with many black spots from anterior to posterior side of the body. In the forth instar the change in body colour was apparent having dorsal side pale yellow with grayish longitudinal lines. The head become dark brown in the fifth instar with pale green body having broken stripe along each side of the body. These findings are in conformity with those of Neunzig (1964) and Singh and Singh (1975).

(*c*) Pre-pupal stage: The fully-grown larva stopped feeding before entering into pupal stage. The pre-pupa measured 24.40 + 2.83 mm in length and 4.85 + 0.65 mm in breadth, however the colour became darker with less prominent stripes. These findings are supported by Neunzig (1964).

Table 1: Measurement of different stages of tomato fruit borer, *Helicoverpa armigera*.

S.No.	*Stage*	*Length (mm)*	*Breadth (mm)*	*Weight (mg)*
1.	Egg	0.47 + 0.04	0.48 + 0.05	-
2.	Larva			
	Ist instar	1.44 + 0.03	0.49 + 0.02	-
	IInd instar	3.43 + 0.44	0.78 + 0.29	-
	IIIrd instar	8.3 + 0.07	2.95 + 0.51	-
	IVth instar	17.8 + 0.34	2.99 + 0.31	-
	Vth instar	32.40 + 0.92	5.20 + 0.02	-
3.	Pre-pupa	24.40 + 2.83	4.85 + 0.65	-
4.	Pupa			
(A)	Male	22.25 + 0.94	5.98 + 0.24	130.60 + 2.50
(B)	Female	18.20 +0.45	6.42 + 0.54	138.15 + 1.80
5.	Adult			
(A)	Male	Body length	18.42 + 0.58	-
		Wing expanse 38.30 + 0.35	-	-
(B)	Female	Body length	19.82 + 0.75	-
		Wing expanse 42.15 + 0.65	-	-

Data based on measurement of 15 individuals

(*d*) Pupa: The male pupa measured 22.25 + 0.94 mm in length, 5.98 + 0.24 mm in breadth. It weighed 130.60 + 2.50 mg but the female measured 18.20 + 0.45 mm in length, 6.42 + 0.54 mm in breadth with 138.15 + 1.80 mg weight. It was broadly rounded anteriorly but tapering posteriorly. The freshly formed pupa was light green yellowish in colour. It become light brown and got further darkened prior to the

Table 2: Biological parameters of tomato fruit borer, *Helicoverpa armigera Hubner*.

S. No.	Parameter	1st week of	1st week of October to last wee of November 2008	1st week of December 2008 to 2nd week of	April to 2nd week of may 2009 February 2009
1.	*Pre- oviposition period (days)*		2.24 (1-4)	3.21 (3 - 4)	2.15 (2-3)
2.	*Oviposition period (days)*	5.56 (5- 6)	6.60 (6 - 8)	5.25 (5 - 6)	
3.	*Post oviposition period (days)*	1.22 (1-2)	1.33 (1-2)	1.12 (1-2)	
4.	*Fecundity (number of eggs/female)*	433.55 (420-470)	256.60 (220 - 2700	490.66 (460-480)	
5.	*Percentage hatchability*	87.8 (63-90)	77.80 (65 - 80)	89.0 (83-90)	
6.	*Longevity of adults (days)*				
	i. Male	4.33 (4-5)	5.89 (6-8)	2.44 (3-5)	
	ii. Female	9.78 (8-11)	11.33 (9-13)	8.79 (9-10)	
7.	*Sex ratio*				
	Male: Female	1: 0.76	1: 0.67	1: 1.22	

Data based on 10 pairs of individuals; Digits in parenthesis indicates range.

Table 3: Development period of different stage of tomato fruit borer, *Helicoverpa armigera Hubner.*

Generation	Period of study	Incubation period (days)	Larval duration in days larval instars					Total larval duration in (days) range (Av.)	Pupal stage (days) range (Av.)	Pupal on in (days) range (Av.)	Total life cycle duration on (days) range (Av.)
			Range (Av.)	Range (Av.)	Range (Av.)	Range (Av.)	Range (Av.)				
I	1st week of October to last week of November 1999	5.05 5-7	8.36 8-9	9.0 9-10	4.30 4-5	4.0 4-0	4.70 4-6	30.39 29-32	4.17 4-5	21.25 19-23	56.69 53-62
II	1st week of December 1999 to 2nd week of February 2000	5.08 5.06	9.25 9-10	9.22 9-10	6.75 6-8	6.22 6-7	6.80 6-8	38.24 36-43	4.04 3-5	24.38. 22-28	65.23 63-77
III	1st week of April to 2nd week of May 2000	4.85 4-6	5.60 5-6	3.10 3-4	3.10 3-4	3.90 3-4	4.30 4-5	21.25 23-28	4.75 4-5	13.78 13-16	44.25 40-50

Data based on 10 individuals; Digits in parenthesis indicates range.

emergence of moth. The abdomen was distinctly marked into ten segments with spiracles located on fourth and ninth segments. These findings are in conformity with those of Nachiappan and Subramanium (1974) and Singh and Singh (1975).

(*e*) Adult: The adult was brownish gray in colour. The body of the male measured 18.42 + 0.58 mm in length with 38.30 + 0.35 mm wing expanse, while female had 19.82 + 0.75 mm body length with 42.15 + 0.65 mm wing expanse. The forwings were pale brown with a marginal series of black dots, having black kidney shaped mark on under side. The hind wings were lighter in colour with a dark patch present at the outer end. However, the tip of abdomen of females was marked by a tuft of hair. These findings are similar to those of Ewing *et al.* (1947) and Singh and Singh (1975).

(*f*) Pre-oviposition period: The pre-oviposition period ranged from 2.15 to 3.21 days and these results are in agreement with those of Patel *et al.* (1968) and Singh and Singh (1975).

(*g*) Oviposition period: The oviposition period varied from 5-25 to 6-60 days, and this observations corroborate with those of Patel *et al.* (1968) and Singh and Singh (1975).

(*h*) Post oviposition period: The average post-oviposition period was 1.22, 1.33 and 1.12 days during October, December and April, respectively. Singh and Singh (1975) also recorded similar post oviposition period of 1-2 days, which support the present findings.

(*i*) Fecundity: There was significant variation in the fecundity of female (256.60 to 490-66 eggs/female) during different months. Similar variation in the fecundity was also observed by Ongoren *et al.* (1977) who reported that each female laid about 423 to 603 eggs.

(*j*) Percent hatchability: The per cent hatchability of egg was very much influenced by the temperature prevailing in the laboratory 89.0 per cent (during April), 87.8 per cent (during October) and 77.80 per cent (during November). Singh and Singh (1975) also reported similar hatchability of 63 to 90 per cent and support the present investigation.

(*k*) Longevity of adult: The average longevity of male moth during December to February, October to November and April to May was reported to be 5.89, 4.33 and 2.44 days, respectively. The respective longevity of female was recorded to be 11.33, 9.78 and 8.79 days. In all the three generations and the females lived longer than males. The longevity of adult was also reported to vary from 1 to 29 days (Wilcox et al., 1956), 20 days (Hsu *et al.*, 1960), 11 days (Reed, 1965) and 1 to 16 days (Singh and Singh, 1975).

(*l*) Sex ratio: The Sex-ratio (male: female) varied from 1: 0.67 to 1: 1.22 in different generations. Similar results have been reported earlier by Nachiappan and Subramanium (1973) and Singh and Singh (1975).

(*m*) Durations of different developmental stages:

(*i*) *Incubation period:* The incubation period ranged from 5-7, 5-6 and 4-6 days in the first, second and third generations, respectively. These findings are in agreement with those of Singh and Singh (1975), Ismail and Swailem (1976) and Ongoren *et al.* (1977).

(*ii*) *Larval instar and their duration:* The life stages passed through five larval instars. The average duration of first, second, third, fourth and fifth instars took 8.39, 9.0, 4.30, 4.0 and 4.70 days, respectively with a total larval period of 30.39 days in the first generation. However, it was 9.25, 9.22, 9.75, 6.22 and 6.80 days in first, second, third, fourth and fifth instars, respectively in the second generation with a total larval duration of 38.24 days. But larval period was 5.6, 3.10, 3.10, 3.90 and 4.30 days for first, second, third, fourth and fifth instars, respectively with a total larval duration of 23-28 days in the third generation. Similar results were obtained by Srivastava and Saxena (1958), Singh and Singh (1975) and Wicox *et al.* (1956), support the present findings.

(*iii*) *Pre-pupal period:* Before pupal forming, the fully fed caterpillar spent 4.17, 4.04 and 4.75 days as pre-pupal period during different generations. These findings are in agreement with those of Singh and Singh (1975), Ongoren *et al.* (1977) and Nachiappan and Subramanium (1974).

(*iv*) *Pupal period:* The pupal period was reported to be influenced by the rearing temperature, being 21.25, 24.38 and 13.78 days in October to November, December to February and April to May, respectively. Similar observations were recorded by Singh and Singh (1975), Sharma (1978) and Ongoren *et al.* (1977) and also support the present investigation.

(*v*) *Life cycle:* It took minimum of 44.25 days in third generation during first week of April to second week of May and maximum of 65.25 days in second generation during first week of December to second week of February. In first generation during first week of October to last week of November, however the life cycle was completed in 56.69 days. The present findings are in agreement with those of Nachiappan and Subramanium (1974), Singh and Singh (1975), Vaish and Agarwal (1978) and Sharma (1978).

The pest completed three generations from October to May on tomato. These results are in partial agreement with that of Singh and Singh (1975) who reported two generations on tomato in Punjab. Contrary to the present investigations Tripathi and Singh (1993) reported five generation under laboratory as well as under field in a year in Madhya Pradesh. The number of generations varies from place to place and rearing foods. The present study provided the detailed information on Helicoverpa armigera, so that it will helpful in planning strategy for Integrated Pest Management programs to the control of pests and for the higher productivity of crop.

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