BIOLOGY OF PEARL MILLET EAR HEAD WORM [*Helicoverpa armigera* (Hubner)] UNDER LABORATORY CONDITION

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ABSTRACT

The biology of pearl millet ear head worm [Helicoperpa armigera (Hubner)] was studied under laboratory conditions at Department of Agricultural Entomology, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the year 2010. The results indicated that average length and breadth of egg was 0.48 ± 0.04 and 0.45 ± 0.05 mm, respectively. The eggs were shiny greenish, yellowish or waxy white in colour with dome shaped and flat. The shell has minute ribs, which radiate downward from the top to the base. Just before hatching, the colour of the egg turned to dark brown. The incubation period of eggs was 3.80 ± 0.82 days on pearl millet ear head. The average length and breadth of first, second, third, fourth, fifth and sixth instar larvae were 1.95 ± 0.56 and 0.29 ± 0.08, 5.36 ± 0.18 and 0.73 ± 0.04, 10.89 ± 0.92 and 1.33 ± 0.10, 17.02 ± 0.96 and 2.39 ± 0.34, 23.29 ± 0.18 and 2.90 ± 0.20 and 24.67 ± 0.26 and 3.07 ± 0.05 mm, respectively. The mean duration of the corresponding instars of larvae were 2.48 ± 0.51, 2.76 ± 0.72, 3.08 ± 1.08, 2.92 ± 0.90, 3.72 ± 0.94 and 4.24 ± 0.93 days, respectively. The total larval period varied from 17 to 22 days with an average of 19.20 ± 1.29 days. The average length and width of pre-pupal and pupal stage were 19.98 ± 0.63 and 3.74 ± 0.09 mm and 18.61 ± 0.37 and 4.48 ± 0.10 mm, respectively. The mean duration of the pre-pupal and pupal was 1.64 ± 0.49 and 12.48 ± 1.58 days, respectively. The average length and breadth of the adult male was 19.20 ± 0.42 mm and 38.73 ± 0.50 mm, respectively, while for adult female, it was 22.62 ± 0.66 and 45.36 ± 0.59 mm, respectively. The mean duration of male and female adult was 7.56 ± 1.29 and 9.52 ± 1.42 days, respectively. The sex ratio of male : female was 1 : 1.16. The average pre-oviposition, oviposition and post-oviposition period were 3.08 ± 0.91, 4.52 ± 1.01 and 1.92 ± 0.81 days, respectively. Female laid on an average 565 ± 196.39 eggs. The average longevity of male and female was 7.44 ± 1.29 and 9.52 ± 1.42 days, respectively. Similarly, Total life period from egg to death of adults ranged in between 41 to 48 (Av. 44.68 ± 2.23) days in male and 43 to 49 (Av. 46.64 ± 1.41) days in female.

KEY WORDS: *Biology, ear head worm, Helicoverpa armigera, pearl millet,*

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.], commonly known as pearl, cat tail, spiked or bulrush millet in English, which is world's sixth important and widely grown potential cereal food crop. In our country, it is known by many names in different languages, *Bajri* in Rajasthani, Gujarati and Marathi, *Sajje* in Kannada, *Kambu* in Tamil, *Bajra* in Hindi, Urdu and Panjabi and *Sajjalu* in

Telugu. The share of pearl millet in total food grain production of the country is to the tune of 10.7 per cent. Traditionally, it is used as porridge, but now a day, bakery products like cakes, muffins, cookies and biscuits are enhanced with pearl millet flour. In Gujarat, it occupied an area of 7.03 lakh hectares with a production of 9.61 lakh tones and productivity of 1370 kg / ha in *kharif* grown crop, while in *summer*, it was grown in 1.74 lakh hectares of area with 4261 tones of production and 2440 kg / ha productivity (Anonymous, 2010). Crop is attacked by a number of insect pests, *viz.*, Ear head worm, *Helicoverpa armigera* (Hubner); Gujarat hairy caterpillar, *Amsacta moorei*; Army worm, *Cirphis unipuncta* H.; Stem borer, *Chilo zonellus*; Blister beetle, *Cylindrothorax ruficolis* F.; Shoot fly, *Atherigona varia socata M.*; Surface grasshopper, *Chrotogonus brachypterous* B. and White grub, *Holotrichia consanguinea* B. (Patel *et al.,* 1970). Among various pests *Helicoverpa armigera* appeared in summer pearl millet might be due to adoption of *Bt*. cotton varieties in large scale area in the state. Very scanty information is available on biology of *H. armigera* on pearl millet crop and hence, the present investigation was planned.

MATERIALS AND METHODS

The biology of pearl millet ear head worm [*Helicoperpa armigera* (Hubner)] was studied under laboratory conditions at Department of Agricultural Entomology, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the year 2010. During the study period the average temperature and relative humidity was 17.50 ± 1.70 ^{0}C and 57.10 ± 9.42 per cent, respectively. Initially the larvae of *H. armigera* were collected from the infested field of pearl millet from the farmers' field. Each larva was kept in clean glass petri dish (15 cm diameter, 1.5 cm height) in the laboratory. Small pieces of freshly emerged ear head of pearl millet were provided as a food. The full grown larvae were transferred to the plastic jar (11 cm length x 9 cm width x 15 cm height) having one third part of the jar filled with moist soil to facilitate the pupation. After pupation the glass jar was kept as such and observed regularly to record the emergence of the adults. The adults emerged were utilized for further study on various aspects of biology. Newly emerged adults were paired and confined in an iron rearing cage. Fresh pearl millet ear head was provided inside the cage for egg laying purpose. A piece of 5 x 5 cm sized sponge submerged in 5 per cent honey solution was also provided for the food to the adults. The pearl millet ear head and piece of sponge were replaced every morning. The freshly laid eggs on ear head were located by close observation. The eggs were examined under microscope to study their colour and shape. The size of egg was measured with the help of ocular micrometer after calibrating with stage micrometer. To study the incubation period and hatching percentage of eggs, freshly laid eggs were transferred in petri dish and observed under microscope daily in the morning and evening till they hatched. Incubation period was calculated based on date of oviposition and hatching. Hatching percentage was also calculated from the number of eggs hatched out of the total number of eggs kept under observation. With a view to determine the number and duration of different larval instars and total larval period, the newly emerged larvae (first instar) were transferred individually in petri dishes (15 cm diameter ; 1.5 cm height) with the help of fine camel hair brush. Tender ear head pieces were provided as the food. The moulting was confirmed by presence of casted off head capsule and increased size of larva of subsequent instars. The larvae in each instar were closely observed for their colour, shape and size. Observations on number of instars, duration of each instar and total larval period were also

recorded separately. Measurement of first two instars was recorded under microscope, while the same for rest of instars measured by using graph paper. Various observations on pre-pupa and pupa were recorded critically. The adults were killed, pinned, dried and preserved for recording various observations. Fecundity, hatching per cent and total adult period for both the sex were also recorded.

RESULTS AND DISCUSSION

Freshly laid eggs of pearl millet ear head worm [*Helicoperpa armigera* (Hubner)] were shiny greenish, yellowish or waxy white in colour with dome shaped and flat. The shell has minute ribs, which radiate downward from the top to the base. Just before hatching, the colour of the egg turned to dark brown. The eggs were laid singly on the ear head of the pearl millet. The incubation period varied from 3 to 5 days with an average of 3.80 ± 0.82 days (Table 2) at an average temperature 17.50 ± 1.70 °C and relative humidity 57.10 ± 9.42 per cent. The length of eggs varied from 0.34 to 0.53 (Av. 0.48 ± 0.04) mm, however the breadth varied from 0.30 to 0.51 (Av. 0.45 ± 0.05) mm (Table 1). The present findings are in accordance with Trapsia *et al.* (2007).

Freshly emerged first instar larvae were semi-translucent, yellowish white in colour with yellowish orange longitudinal lines on dorsal surface of body. The head, thoracic, anal shields and legs were brown in colour. The length varied from 1.10 to 3.00 (Av. 1.95 ± 0.56) mm, while the width varied from 0.15 to 0.42 (Av. 0.29 ± 0.08) mm (Table 1). The duration of first instar larvae varied from 2 to 3 (Av. 2.48 ± 0.51) days (Table 2).

The colour of second instar larvae were reddish brown with dark brown hairs and pigments. The length varied from 5.00 to 5.80 (Av. 5.36 ± 0.18) mm, while the width varied from 0.64 to 0.80 (Av. 0.73 ± 0.04) mm (Table 1). The larval duration ranged between 2 to 4 days (Av. 2.76 ± 0.72) (Table 2). The above findings on colour, size and duration of second instar larvae of *H. armigera* are more or less similar to findings of Thakor *et al.* (2009). The colour of the third instar larvae turned pale brown. The skin showed granular appearance and body surface was covered with stiff hairs. The dorsal side consisted of a pale white strip. On lateral parts of the body broad light bands were seen in which the spiracles were clearly visible. The length of larvae varied from 8.00 to 12.10 (Av. 10.89 ± 0.92) mm, while the width varied from 1.20 to 1.50 (Av. 1.33 ± 0.10) mm (Table 1). The duration of third instar larvae ranged between 2 to 5 days (Av. 3.08 ± 1.08) (Table 2). The colour of the fourth instar larvae was greenish yellow. The body surface was covered with close set of minute tubercles. The narrow dark bands with varying colour appeared on the middle of the back. They may be broader and appeared as one stripe with a narrow line in the middle and the middle line may be broken and appeared as a series of light coloured dashes. The results (Table 1) revealed that the length varied from 16.00 to 19.20 (Av. 17.02 ± 0.96) mm, while the width varied from 2.00 to 2.90 (Av. 2.39 ± 0.34) mm. The duration of larvae ranged between 2 to 5 (Av. 2.92 ± 0.90) days (Table 2). These results on size, appearance and duration of fourth instar larvae of *H. armigera* are more or less are in confirmity with the finding of Trapsia *et al.* (2007). The body colour of the fifth instar larva was just similar to fourth instar larvae. The head was reddish yellow or light brown in colour. The results on measurement of fifth instar larva revealed that the length varied from 23.00 to 23.60 (Av. 23.29 ± 0.18) mm, while the width varied from 2.70 to 3.20 (Av. 2.90 ± 0.20) mm (Table 1). The larval duration varied from 3 to 6 (Av. 3.72 ± 0.94) days (Table 2). Full-grown larva of sixth instar was greenish with dark broken grey lines along the side of the body. These lines vary in width and in intensity of colour. Their colour was variable like green, straw, yellow and reddish brown or black. The head was greenish yellow. On each segment there were number of inconspicuous tubercles from

which a short hair arised. The length of full grown sixth instar larvae varied from 24.30 to 25.00 (Av. 24.67 ± 0.26) mm, while width varied from 3.00 to 3.15 (Av. 3.07 ± 0.05) mm (Table 1). The duration of sixth instar larvae varied from 3 to 6 (Av. 4.24 ± 0.93) days (Table 2). The results obtained from the above investigations revealed that the total larval period varied from 17 to 22 days with an average of 19.20 ± 1.29 days. The present results on total larval duration are more or less in confirmation with those reported by Doss (1979).

The sixth instar full grown larvae became sluggish, ceased feeding, contracted anterero-posteriorly in size assuming pre-pupal stage. It was cleared from (Table 1) that the length and width of pre pupa varied from 19.00 to 21.20 (Av. 19.98 ± 0.63) mm and 3.60 to 3.90 (Av. 3.74 ± 0.09) mm, respectively. The pre- pupal period was varied from 1 to 2 (Av. 1.64 ± 0.49) days (Table 2). The present observations on pre-pupal stage are in close agreement with the reports of Patel (1981) and Bapodra (1988). The freshly formed pupa was soft and pale brown or greenish in colour, smooth and shining. Within few hours it turned to dark brown colour. The length and width of pupal stage varied from 18.00 to 19.10 (Av. 18.61 ± 0.37) mm and 4.30 to 4.60 (Av. 4.48 ± 0.10) mm, respectively (Table 1). The pupal duration varied from 10 to 15 (Av. 12.48 ± 1.58) days (Table 2). The present results are in close agreement with the findings of Trapsia *et al.* (2007) on pearl millet.

The adults of *H. armigera* were extremely variable in colour and markings. In general, the colour of the adult varied from olive green to brown with a dark brown circular spot half way between the base and apex of the forewings and a smaller spot near the base. The hind wings were white with some dark spots and have strongly marked veins and a dark margin with two lighter. Forewing of the freshly emerged male moth was deep olive-buff or olive green with dark brown spot, while it was reddish brown with blackish brown spot in case of female adult. The shape of abdomen of female moth was broad and it was pointed in case of male moth. The length of the adult male varied from 18.00 to 19.50 (Av. 19.20 ± 0.42) mm and breadth varied from 37.00 to 39.00 (Av. 38.73 ± 0.50) mm, while the length of adult female ranged in between 21.50 to 23.50 (Av. 22.62 ± 0.66) mm and breadth varied from 44.50 to 46.00 (Av. 45.36 ± 0.59) mm (Table 1). The duration of male and female varied from 5 – 9 (Av. 7.56 ± 1.29) days and 8 – 13 (Av. 9.52 ± 1.42) days, respectively (Table 2).

The sex ratio of male : female of *H. armigera* reared on pearl millet found to be 1 : 1.16 under laboratory condition. In past, similar sex ratio of *H. armigera* has been reported by Trapsia *et al.* (2007). The pre-oviposition, oviposition and post-oviposition period of mated female varied from 2 to 5 (Av. 3.08 ± 0.91), 3 to 7 (Av. 4.52 ± 1.01) and 1 to 3 (Av. 1.92 ± 0.81) days, respectively, when adults obtained from larvae reared on pearl millet (Table 2). The present findings are in close conformity with the finding of Trapsia *et al.* (2007).

The egg laying capacity of the female of *H. armigera* varied from 360 to 956 (Av. 565 ± 196.39) eggs in pearl millet (Table 2). The longevity of male and female was 5 to 9 (Av. 7.44 ± 1.29) and 8 to 13 (9.52 ± 1.42) days, respectively. Thus, adult longevity of female was longer than that of male. In past, Nanda and Gujarati (2001) also observed more or less similar longevity of *H. armigera* adults on different hosts. Total life period from egg to death of adults ranged in between 41 to 48 (Av. 44.68 ± 2.23) days in male and 43 to 49 (Av. 46.64 ± 1.41) days in female (Table 2). Thus, female had a longer total life period than male. In past, Trapsia *et al.* (2007) reported the life span for male (43.00 ± 1.71 days) and female (44.80 ± 1.84 days) on pearl millet supports the present findings.

CONCLUSION

From over all findings of the present study, it is summarized that *H. armigera* is an International polyphagous pest. After large scale adoption of the *Bt*. Cotton in North Gujarat, the pest has diverted on bajara crop since last five years and started causing serious damage. The average length and breadth of egg was 0.48 ± 0.04 and 0.45 ± 0.05 mm, respectively. The incubation period of eggs was 3.80 ± 0.82 days on pearl millet ear head. The total larval period varied from 17 to 22 days with an average of 19.20 ± 1.29 days. The average length and width of pre-pupal and pupal stage were 19.98 ± 0.63 and 3.74 ± 0.09 mm and 18.61 ± 0.37 and 4.48 ± 0.10 mm, respectively. The mean duration of the pre-pupal and pupal was 1.64 ± 0.49 and 12.48 ± 1.58 days, respectively. The average length and breadth of the adult male was 19.20 ± 0.42 mm and 38.73 ± 0.50 mm, respectively, while for adult female, it was 22.62 ± 0.66 and 45.36 ± 0.59 mm, respectively. The mean duration of male and female adult was 7.56 ± 1.29 and 9.52 ± 1.42 days, respectively. The sex ratio of male : female was 1 : 1.16. The average pre-oviposition, oviposition and post-oviposition period were 3.08 ± 0.91, 4.52 ± 1.01 and 1.92 ± 0.81 days, respectively. Female laid on an average 565 ± 196.39 eggs. Total life period of male was slightly shorter than female.

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Table 1: Measurement of different stages of *H. armigera* reared on pearl millet

Stage	Length (mm)			Breadth (mm)		
	Min.	**Max.**	**Av. ± S.D.**	**Min.**	**Max.**	**Av. ± S.D.**
Egg	0.34	0.53	0.48 ± 0.04	0.30	0.51	0.45 ± 0.05
Larval instars						
I	1.10	3.00	1.95 ± 0.56	0.15	0.42	0.29 ± 0.08
II	5.00	5.80	5.36 ± 0.18	0.64	0.80	0.73 ± 0.04
III	8.00	12.10	10.89 ± 0.92	1.20	1.50	1.33 ± 0.10
IV	16.00	19.20	17.02 ± 0.96	2.00	2.90	2.39 ± 0.34
V	23.00	23.60	23.29 ± 0.18	2.70	3.20	2.90 ± 0.20
VI	24.30	25.00	24.67 ± 0.26	3.00	3.15	3.07 ± 0.05
Pupa						
Pre-pupa	19.00	21.20	19.98 ± 0.63	3.60	3.90	3.74 ± 0.09
Pupa	18.00	19.10	18.61 ± 0.37	4.30	4.60	4.48 ± 0.10
Adult						
Male	18.00	19.50	19.20 ± 0.42	37.00	39.00	38.73 ± 0.50
Female	21.50	23.50	22.62 ± 0.66	44.50	46.00	45.36 ± 0.59

Table 2: Duration of different stages of *H. armigera* reared on pearl millet

Sr. No.	Stage	Duration Range in Days (Average)
1.	**Egg**	3 – 5 (3.8 ± 0.82)
2.	**Larval instars**	
	I	2 – 3 (2.48 ± 0.51)
	II	2 – 4 (2.76 ± 0.72)
	III	2 – 5 (3.08 ± 1.08)
	IV	2 – 5 (2.92 ± 0.90)
	V	3 – 6 (3.72 ± 0.94)
	VI	3 – 6 (4.24 ± 0.93)
	Total larval period	17 – 22 (19.20 ± 1.29)
3.	**Pre-pupal**	1 – 2 (1.64 ± 0.49)
4.	**Pupal**	10 – 15 (12.48 ± 1.58)
5.	**Adult**	
	Male	5 – 9 (7.56 ± 1.29)
	Female	8 – 13 (9.52 ± 1.42)
	Pre-oviposion	2 – 5 (3.08 ± 0.91)
	Oviposition	3 – 7 (4.52 ± 1.01)
	Post-oviposition	1 – 3 (1.92 ± 0.81)
6.	**Total life period**	
	Male	41 – 48 (44.68 ± 2.23)
	Female	43 – 49 (46.64 ± 1.41)
7.	**Hatching percentage (%)**	90.89 %
8.	**Sex ratio(Male : Female)**	1:1.16
9	**Fecundity**	360 – 950 (565.00 ± 196.39)
10.	**Temperature (^{O}C)**	17.50 ± 1.70
11.	**Relative humidity (%)**	57.10 ± 9.42

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