



BIOLOGY OF FRUIT BORER, *HELICOVERPA ARMIGERA* (HUBNER) ON CHILLI UNDER LABORATORY CONDITIONS

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Abstract

The studies on the biology of fruit borer, *Helicoverpa armigera* (Hubner) recorded that the mean preoviposition, oviposition and postoviposition period on chilli lasted for 3.1 ± 0.74 , 5.5 ± 0.53 and 1.3 ± 0.48 days, respectively. A female laid on an average 381.4 ± 86.88 eggs. The incubation period and hatching percentage were observed to be 3.2 ± 0.79 days and 91 ± 3.16 on chilli, respectively. The first instar larva was very active with head breadth of 0.25 ± 0.03 mm, body length of 1.62 ± 0.24 mm and body breadth of 0.44 ± 0.03 mm. The larval development completed within 21.8 ± 0.79 days. The duration of each instar on chilli was found to be 2.4 ± 0.52 , 2.7 ± 0.48 , 3.8 ± 0.42 , 4.3 ± 0.48 , 4.5 ± 0.53 and 4.1 ± 0.32 days, respectively. The full grown larva measured 2.76 ± 0.06 mm in head breadth, 31.26 ± 1.35 mm in body length, 2.92 ± 0.07 mm in body breadth and 207 ± 14.05 mg body weight. The pupa was obtect type with mahogany-brown colour. The mean pre pupal period lasted for 2.2 ± 0.45 days on chilli. The mean pupal period lasted for 13.8 ± 0.84 days. Longevity of adult ranged from 6 to 8 days with an average of 6.9 ± 0.74 days in males, while the longevity of female moths ranged from 8 to 10 days with an average of 9.0 ± 0.66 days. The male moth measured 17.84 ± 0.59 mm in length, 36.04 ± 1.24 mm in breadth (with wing expanded) and the female moth measured 19.34 ± 0.75 mm in length, 40.20 ± 0.84 mm in breadth (with wing expanded) on chilli. The sex ratio for male and female was 1 : 0.78 on chilli. The generation from egg to death of male and female *i.e.* total life cycle was found to be completed within 42 to 55 days with an average of 47.9 days and 44 to 57 days with an average of 50.0 days, respectively on chilli.

Key words : Biology, fruit borer, *Helicoverpa armigera*, chilli, laboratory.

Introduction

Chilli (*Capsicum annum* L.) is one of the most important commercial spices of India. It is grown almost throughout the country. There are more than 400 different varieties of chillies found all over the world. It is also called as hot pepper, cayenne pepper, sweet pepper, bell pepper, etc. Among the spices consumed per head, dried chilli fruits constitute a major share. Some varieties of chillies are famous for red colour because of the pigment 'capsanthin' (Anonymous, 2012a). In India, chilli contributes 22.70 per cent share among total spices. India has produced around 1448.20 million tonnes of chilli with area of 793.92 million ha. during 2011-12. Maharashtra State constitutes 71.75 million tonnes production of chilli from 34.64 million ha. area, which is 4.4 per cent of the total area of country under chilli (Anonymous, 2012b). The most important chilli growing states in India are Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu, which together constitute nearly 75 per cent of the total

area. In Indian subcontinent, chillies are cultivated throughout the year; however, it grows best at 20–30°C. The growth and yield suffer when temperatures exceed 30°C or drops below 15°C for extended periods. The crop can be grown over a wide range of altitudes from sea level upto 2100 meter. Fresh chilli peppers are very rich in vitamin C with 111.0 mg, which makes them very effective as immune system stimulants and healing agents especially for cellular damage. Many folk remedies recommend chilli pepper in wound cleaning preparations for gangrene and open sores and even as a styptic, though more modern sources generally advise against using chilli on broken skin. While drying, chilli loses most of its vitamin C; it increases the vitamin A content by 100 times. Vitamin A is powerful anti-oxidant and anti-inflammatory agent. Chilli preparations have been used as a gargle to treat sore throat and laryngitis. Surprisingly, it has been shown that chillies do not aggravate or cause stomach ulcers. In fact, they have a preventative effect, as

stomach ulcers are mostly caused by bacteria and its antibacterial action kills such bacteria. In folk-medicine they have also long been used to treat worms. Chilli has beneficial effect on the circulatory system. Studies have shown that it counteract on cholesterol build up and reduces platelet aggregation, thus reducing the risk of heart attacks and strokes. It also lowers high blood pressure and increases peripheral circulation. (Anonymous, 2009). Chilli is attacked by various major pests like thrips, *Scirtothrips dorsalis* (Hood); aphid, *Aphis gossypii* (Glover) and *Myzus persicae* (Sulzer); fruit borer, *H. armigera* and *Spodoptera litura* (Fabricius) and mite, *Polyphagotarsonemus latus* (Bank) from seedling to fruiting stage. The damage caused by *H. armigera* during flowering and fruit formation is the most concern. The young larvae of *H. armigera* feed on flower buds and young fruits by making a circular hole. Later, the larvae feed on internal contents usually with its head inside the fruit and rest of the body outside.

Chilli is one of the important spice crops and severely infested by fruit borer, *H. armigera*. Since few years, considerable research work on biology of fruit borer, *H. armigera* infesting chilli has been done in abroad and India, but comparatively less work has been carried out under Konkan region of Maharashtra. Hence, the present investigation was planned and conducted at the Biocontrol laboratory, Department of Agricultural Entomology, College of Agriculture, Dapoli.

Materials and Methods

The biology of fruit borer, *H. armigera* on chilli was studied in the Biocontrol Laboratory, Department of Agricultural Entomology, College of Agriculture, Dapoli from September to November, 2014. A brief account of techniques employed in the present study is described below:

The initial culture of pest was obtained by collecting larvae from Botany Farm, College of Agriculture, Dapoli, during the month of September. The individual larvae were reared in the small plastic vials to avoid cannibalism. Fresh buds, tender leaves and shoots were provided daily as a food for first and second instar larvae. Further, tender and green fruits of chilli were provided daily as a food for third to sixth instar larvae till pupation. Freshly formed pupae were kept individually in small sized plastic jar containing dry soil, the top of which was covered with muslin cloth and secured firmly with rubber band. The freshly emerged moths were collected and ten pairs of freshly emerged male and female adult were confined individually into the glass jar. The cotton swab soaked in

10 per cent honey solution was kept suspended in the jar from the top as food for newly emerged adults. The swab soaked in honey solution was changed daily. The inner side of the glass jar was wrapped with black coloured paper to observe egg laying. The top of the jar was covered with muslin cloth and secured firmly with rubber band. Dates of pre-oviposition, oviposition and post oviposition period were recorded.

Pre-oviposition period

The period required from the emergence of female moth from pupa to the commencement of egg laying was recorded for ten females. On this basis, average pre-oviposition period was worked out.

Oviposition period

To work out the oviposition period, dates of first and last egg laid by female moth was recorded. The period between those two dates was considered as oviposition period. Such oviposition period was recorded for ten females and mean oviposition period was worked out.

Post-oviposition period

The period from cessation of oviposition by female moth till death was recorded for ten females. On this basis average post oviposition period was worked out.

Site of oviposition

Microscopic observations on the site of oviposition under captivity were made while working out the oviposition period. The paper surface, glass jar surface, cotton swab surface and muslin cloth were observed critically for the eggs.

Fecundity

To study the fecundity, total numbers of eggs laid by each female during its life span were counted. Such ten females were observed and mean fecundity was worked out.

Egg morphometrics

The morphometrics of eggs were recorded by using "computerized micrometer". The average length and breadth was recorded on the basis of ten eggs.

Incubation period

To study the incubation period, the number of days from egg laid till the hatching of egg was recorded as incubation period. A set of hundred eggs was kept under observation.

Larval instars, morphometrics and period

For this study, fifty plastic vials containing single larva in each were kept in the laboratory and provided with fresh buds of chilli, daily. For recording larval instars, the

larva in each vial was observed daily for moulting. The number of moultings was determined on the basis of casted head capsule. The period between each moulting was recorded as period for corresponding instar. The linear measurements on head width and body length were recorded using “computerized micrometer scale” for ten larvae. Thus, the data obtained were averaged out and presented.

Pre-pupal period

The period required from full development of larva as indicated by cessation of feeding till complete formation of pupa was recorded for ten larvae and average pre-pupal period was worked out and data are presented.

Pupal period

To record pupal period, ten freshly formed pupae were kept under observation in plastic jars till emergence of adult and on this basis the average pupal period was worked out. The mean length and breadth of pupa were also recorded by using “millimeter scale” on the basis of measurements taken for ten pupae.

Adult longevity

Newly emerged adults were separated for their sexes and released in a separate glass jar and cotton swab soaked in ten per cent honey solution was kept suspended in the jar as food for moth. To record the longevity of adult moths without food, ten newly emerged male and female moths were released in another jar without ten per cent honey solution. The top of all the jars were covered with muslin cloth and secured firmly with rubber band. The longevity of ten males and females was recorded by observing the duration between emergence and the death of adult. The data thus obtained were used to calculate average longevity of male and female moths with food as well as without food.

Adult morphometrics

The measurements on body width, body length and wing expanse were recorded by using “millimeter scale” for ten adults of both the sexes separately. The body width was recorded by spreading the wing completely and measured horizontally. The data thus obtained were averaged out and presented.

Sex ratio

To calculate sex ratio, hundred pupae obtained from the egg mass of a female were kept under observation separately. The adults emerged from them were separated according to their sexes and sex ratio was worked out on the basis of number of male and female adults emerged from total number of pupae.

Life cycle

The total period for the completion of life cycle was worked out based on the duration of egg, larval, pre-pupal, pupal and adult stage.

Results and Discussion

The results obtained are presented and discussed hereunder:

Pre-oviposition, oviposition and post-oviposition period

The pre-oviposition, oviposition and post-oviposition period were recorded and the results are presented in table 1.

It was revealed that the pre-oviposition period varied from 2 to 4 days with an average of 3.1 ± 0.74 days. The oviposition period ranged between 5 to 6 days with an average 5.5 ± 0.53 days. The post-oviposition period was recorded only for 1 to 2 days with a mean of 1.3 ± 0.48 days. These observations are in conformity with the findings of Bhatt and Patel (2001), who reported that the pre-oviposition, oviposition and post-oviposition periods were 2.85, 7.5 and 1.10 days, respectively on chickpea. Pandey and Kumar (2007) also reported that pre-oviposition, oviposition and post-oviposition period lasted for 3.12 ± 0.66 , 9.8 ± 0.54 and 1.22 ± 0.36 , respectively on chickpea. Sharma *et al.* (2011) also reported that pre-oviposition, oviposition and post-oviposition periods were 2.15 – 3.21, 5.25 – 6.60 and 1.12 – 1.33 days, respectively.

Fecundity

The data recorded on fecundity of fruit borer, *H. armigera* revealed that the total number of eggs laid by female in her life span varied from 260 to 495 with an average of 381.4 ± 86.88 (table 1). The observations are in accordance with Sharma *et al.* (2011), who reported that the female of *H. armigera* laid 256.60 to 490.66 eggs.

Eggs

The freshly laid eggs were yellowish or creamy white in colour and spherical in shape. The colour of eggs changed gradually from yellowish to brownish towards hatching. The eggs measured 0.41 mm to 0.62 mm in length with an average of 0.51 ± 0.070 mm and 0.38 mm to 0.56 mm in breadth with an average of 0.46 ± 0.062 mm (table 2).

The present findings regarding eggs of *H. armigera* are in conformity with Rao and Abraham (1956), who reported that newly laid eggs of *H. armigera* were white and before hatching, their colour turned yellowish to brownish. Ali *et al.*, (2009) also reported that the size of

Table 1 : Pre-oviposition, oviposition, post-oviposition period and fecundity of *H. armigera* on chilli.

S. no.	Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)	Fecundity
1	3	5	2	460
2	3	6	2	495
3	2	5	1	302
4	3	5	1	351
5	4	6	1	448
6	3	5	2	260
7	4	6	1	380
8	4	6	1	286
9	2	5	1	342
10	3	6	1	490
Range	2-4	5-6	1-2	260-495
Mean	3.1	5.5	1.3	381.4
S.D.±	0.74	0.53	0.48	86.88

Table 2 : Morphometrics of eggs of *H. armigera* on chilli.

S. no.	Length (mm)	Breadth (mm)
1	0.55	0.43
2	0.46	0.44
3	0.62	0.56
4	0.51	0.48
5	0.58	0.52
6	0.41	0.38
7	0.47	0.45
8	0.49	0.40
9	0.58	0.54
10	0.43	0.40
Range	0.41 - 0.62	0.38 - 0.56
Mean	0.51	0.46
S.D.±	0.070	0.062

eggs varied from 0.42 mm to 0.60 mm in length and 0.40 mm to 0.55 mm in breadth.

Incubation period and hatching percentage

The data regarding incubation period and hatching percentage are presented in table 3. It was evident from the data that the incubation period ranged from 2 to 4 days with mean of 3.2 ± 0.79 days. Hatching percentage ranged from 90 to 100 with an average of 91 ± 3.16 .

The present observations are in close conformity with reports of Bhatt and Patel (2001), who recorded hatching percentage of eggs as 90.89. Pandey and Kumar (2007) reported that the incubation period varied from 2 to 4

days and with 90.25 per cent egg hatching. Ali *et al.* (2009) reported that the incubation period of egg was 3.37 days.

Larval development

During present studies it was observed that there were six larval instars. The observations on larval instars and larval period are given in table 4. The development period of larvae ranged from 21 to 23 days with an average of 21.8 ± 0.79 days. During this period, larvae moulted five times. The instar wise description of larva is presented hereunder.

The present observations are in accordance with reports of Bhatt and Patel (2001), who recorded larval period of 20.60 days on chickpea. Ali *et al.* (2009) reported the larval period of 16.96 days on chickpea. Nasreen and Mustafa (2000) also reported that the larval development was completed within 17.325 ± 0.326 days.

First instar

The first instar lasted for 2 to 3 days with mean of 2.4 ± 0.52 days (table 4). Newly hatched larva was tiny, active and yellowish white to reddish brown with dark brown to black head capsule. The morphometrics of first instar larvae of *H. armigera* are given in Table 5. The breadth of head capsule ranged from 0.20 mm to 0.29 mm (mean 0.25 ± 0.03 mm). The larva measured 1.24 mm to 1.90 mm (mean 1.62 ± 0.24 mm) in length and 0.40 mm to 0.50 mm (mean 0.44 ± 0.03 mm) in breadth.

Second instar

The second instar lasted for 2 to 3 days with mean of 2.7 ± 0.48 days (table 4). The second instar larva was very active. The breadth of head capsule varied from 0.46 mm to 0.54 mm (mean 0.50 ± 0.03 mm). The larva measured 3.54 mm to 4.96 mm (mean 4.22 ± 0.51 mm) in length and 0.65 mm to 0.75 mm (mean 0.69 ± 0.04 mm) in breadth (table 6).

Third instar

The third instar larva lasted for 3 to 4 days with an average of 3.8 ± 0.42 days (table 4). The head capsule measured 0.60 mm to 0.70 mm (mean 0.64 ± 0.03 mm) in breadth. The larva measured 6.96 mm to 9.40 mm (mean 8.17 ± 0.76 mm) in length and 0.79 mm to 0.85 mm (mean 0.82 ± 0.02 mm) in breadth. The weight of larva was in the range of 30 mg to 50 mg (mean 39.2 ± 6.09 mg) (table 7).

Fourth instar

The fourth instar lasted for 4 to 5 days with an average of 4.3 ± 0.48 days (table 4). The head capsule measured 1.10 mm to 1.26 mm (mean 1.16 ± 0.05 mm) in breadth.

Table 3 : Incubation period and hatching percentage of *H. armigera* on chilli.

S. no.	No. of eggs observed	No. of eggs hatched (days)				Total eggs hatched	Hatching percentage	Average incubation period
		1	2	3	4			
1	10	-	-	5	4	9	90	3
2	10	-	-	4	5	9	90	3
3	10	-	-	4	5	9	90	4
4	10	-	-	5	5	10	100	3
5	10	-	-	6	3	9	90	4
6	10	-	3	6	-	9	90	2
7	10	-	4	5	-	9	90	2
8	10	-	-	5	4	9	90	3
9	10	-	-	4	5	9	90	4
10	10	-	-	5	4	9	90	4
Range						9-10	90-100	2-4
Mean						9.1	91	3.2
S.D. ±						0.32	3.16	0.79

Table 4 : Larval development period of *H. armigera* on chilli.

S. no.	Duration of larval instars (days)						Total larval period (days)
	I	II	III	IV	V	VI	
1	2	3	4	4	5	4	22
2	3	2	3	4	5	4	21
3	2	3	4	5	4	4	22
4	2	3	4	4	5	5	23
5	2	3	3	5	4	4	21
6	3	2	4	4	4	4	21
7	3	2	4	4	5	4	22
8	2	3	4	4	4	4	21
9	3	3	4	4	5	4	23
10	2	3	4	5	4	4	22
Range	2-3	2-3	3-4	4-5	4-5	4-5	21-23
Mean	2.4	2.7	3.8	4.3	4.5	4.1	21.8
S.D. ±	0.52	0.48	0.42	0.48	0.53	0.32	0.79

The larva measured 10.30 mm to 16.40 mm (mean 12.86 ± 1.92 mm) in length and 0.95 mm to 1.10 mm (mean 1.02 ± 0.05 mm) in breadth. The weight of larva was in the range of 50 mg to 60 mg (mean 53.1 ± 3.38 mg) (table 8).

Fifth instar

The fifth instar lasted for 4 to 5 days with an average of 4.5 ± 0.53 days (table 4). The head capsule measured 2.40 mm to 2.50 mm (mean 2.45 ± 0.03 mm) in breadth. The larva measured 18.10 mm to 24.50 mm in length (mean 21.67 ± 2.18 mm) and 1.98 mm to 2.50 mm in breadth (mean 2.23 ± 0.17 mm). The weight of larva was in the range of 115 mg to 130 mg (mean 121 ± 4.78 mg) (table 9).

Sixth instar

The sixth instar lasted for 4 to 5 days with an average of 4.1 ± 0.32 days (table 4). The head capsule measured 2.70 mm to 2.90 mm (mean 2.76 ± 0.06 mm) in breadth. The larva measured 29.00 mm to 33.00 mm in length (mean 31.26 ± 1.35 mm) and 2.80 mm to 3.00 mm in breadth (mean 2.92 ± 0.07 mm). The weight of larva varied from 190 mg to 230 mg (mean 207 ± 14.05 mg) (table 10).

The present findings are in close conformity with Bhatt and Patel (2001) who reported that the larval period was 20.60 days. Naseri *et al.* (2009) also reported that the average larval period ranged from 17.30 to 26.20 days on soybean. The morphometrics of larval instars is in accordance with reports of Ali *et al.* (2009).

Table 5 : Morphometrics of first instar larvae of *H. armigera* on chilli.

S. no.	First instar larva		
	Head breadth (mm)	Body length (mm)	Body breadth (mm)
1	0.23	1.56	0.42
2	0.22	1.88	0.49
3	0.28	1.26	0.41
4	0.20	1.24	0.40
5	0.25	1.52	0.42
6	0.29	1.76	0.44
7	0.24	1.81	0.46
8	0.29	1.90	0.50
9	0.22	1.72	0.47
10	0.26	1.60	0.44
Range	0.20-0.29	1.24-1.90	0.40-0.50
Mean	0.25	1.62	0.44
S.D. ±	0.03	0.24	0.03

Table 6 : Morphometrics of second instar larvae of *H. armigera* on chilli.

S. no.	Second instar larva		
	Head breadth (mm)	Body length (mm)	Body breadth (mm)
1	0.47	3.92	0.66
2	0.48	3.98	0.66
3	0.52	4.12	0.69
4	0.46	3.54	0.65
5	0.53	4.58	0.71
6	0.54	4.96	0.75
7	0.47	3.81	0.66
8	0.52	4.82	0.73
9	0.52	4.73	0.72
10	0.47	3.76	0.66
Range	0.46-0.54	3.54-4.96	0.65-0.75
Mean	0.50	4.22	0.69
S.D. ±	0.03	0.51	0.04

Pupation

The observations on the development period of prepupa and pupa are presented in table 11.

Prepupal period

The full grown larva before pupation passed through a prepupal stage, it stopped feeding and gradually shrunk in length and became sluggish. The prepupal period lasted for 2 to 3 days with an average of 2.2 ± 0.45 days.

Table 7 : Morphometrics of third instar larvae of *H. armigera* on chilli.

S. no.	Third instar larva			
	Head breadth (mm)	Body length (mm)	Body breadth (mm)	Weight (mg)
1	0.64	7.82	0.81	33
2	0.65	8.40	0.83	40
3	0.62	7.12	0.81	35
4	0.60	6.96	0.79	30
5	0.63	7.92	0.82	35
6	0.70	9.40	0.85	50
7	0.64	8.56	0.83	42
8	0.63	8.12	0.81	40
9	0.67	9.02	0.84	46
10	0.64	8.45	0.82	41
Range	0.60-0.70	6.96-9.40	0.79-0.85	30-50
Mean	0.64	8.17	0.82	39.2
S.D. ±	0.03	0.76	0.02	6.09

Table 8 : Morphometrics of fourth instar larvae of *H. armigera* on chilli.

S. no.	Fourth instar larva			
	Head breadth (mm)	Body length (mm)	Body breadth (mm)	Weight (mg)
1	1.14	12.44	1.02	52
2	1.14	12.58	0.98	52
3	1.13	11.72	1.05	50
4	1.10	10.30	0.95	50
5	1.12	11.45	0.97	51
6	1.26	16.40	1.10	60
7	1.17	13.18	1.08	51
8	1.14	12.04	1.05	53
9	1.15	12.52	1.03	54
10	1.23	15.98	1.04	58
Range	1.10-1.26	10.30-16.40	0.95-1.10	50-60
Mean	1.16	12.86	1.02	53.1
S.D. ±	0.05	1.92	0.05	3.38

Pupal period

The pupa was obiect type with mahogany-brown colour. The surface was smooth and it rounded both anteriorly and posteriorly, with two tapering parallel spines at the posterior tip. The duration of pupal period ranged from 13 to 15 days with an average of 13.8 ± 0.84 days (table 11). The pupa measured from 18.9 mm to 19.4

Table 9 : Morphometrics of fifth instar larvae of *H. armigera* on chilli.

S. no.	Fifth instar larva			
	Head breadth (mm)	Body length (mm)	Body breadth (mm)	Weight (mg)
1	2.43	22.14	2.22	120
2	2.43	22.96	2.10	118
3	2.42	21.25	2.20	118
4	2.40	18.10	1.98	115
5	2.42	20.08	2.10	117
6	2.50	24.50	2.50	130
7	2.41	19.38	2.10	120
8	2.42	20.41	2.40	120
9	2.46	23.56	2.30	125
10	2.47	24.30	2.40	127
Range	2.40-2.50	18.10-24.50	1.98-2.50	115-130
Mean	2.45	21.67	2.23	121
S.D. ±	0.03	2.18	0.17	4.78

Table 10 : Morphometrics of sixth instar larvae of *H. armigera* on chilli.

S. no.	Sixth instar larva			
	Head breadth (mm)	Body length (mm)	Body breadth (mm)	Weight (mg)
1	2.73	30.42	2.90	198
2	2.75	32.15	2.85	220
3	2.72	30.49	2.99	197
4	2.70	29.00	2.80	190
5	2.75	31.56	2.85	194
6	2.90	33.00	3.00	230
7	2.80	32.81	2.90	222
8	2.72	30.18	3.00	200
9	2.73	30.35	2.95	206
10	2.82	32.60	3.00	220
Range	2.70-2.90	29.00-33.00	2.80-3.00	190-230
Mean	2.76	31.26	2.92	207
S.D. ±	0.06	1.35	0.07	14.05

mm in length with an average of 19.12 ± 0.17 mm and the breadth ranged from 4.9 mm to 5.3 mm with an average of 5.1 ± 0.12 mm. The weight of pupa varied from 202 mg to 265 mg (mean 225 ± 19.75 mg) (table 12).

Ali *et al.* (2009) reported prepupal period of 2.15 ± 0.16 days and pupal period 13.15 ± 0.27 days. Sharma *et*

Table 11 : Prepupal and pupal period of *H. armigera* on chilli.

S. no.	Prepupal period (days)	Pupal period (days)
1	2	13
2	2	14
3	2	13
4	3	15
5	2	14
Range	2-3	13-15
Mean	2.2	13.8
S.D. ±	0.45	0.84

Table 12 : Morphometrics of pupae of *H. armigera* on chilli.

S. no.	Length (mm)	Breadth (mm)	Weight (mg)
1	19.0	5.0	230
2	19.1	5.0	212
3	19.2	5.2	232
4	18.9	4.9	218
5	19.0	5.1	205
6	19.4	5.3	230
7	19.0	5.1	202
8	19.0	5.0	265
9	19.3	5.2	210
10	19.3	5.2	246
Range	18.9-19.4	4.9-5.3	202-265
Mean	19.12	5.1	225
S.D. ±	0.17	0.12	19.75

Table 13 : Longevity of adults of *H. armigera* on chilli.

S. no.	Without food (days)		With food (days)	
	Male	Female	Male	Female
1	1	1	7	10
2	1	2	7	8
3	2	2	7	9
4	1	1	6	8
5	1	3	7	9
6	2	2	8	10
7	2	1	6	9
8	2	1	6	9
9	1	3	7	9
10	2	2	8	9
Range	1-2	1-3	6-8	8-10
Mean	1.5	1.8	6.9	9.0
S.D. ±	0.53	0.79	0.74	0.66

Table 14 : Morphometrics of adults of *H. armigera* on chilli.

S. no.	Female		Male	
	Body length (mm)	Body breadth (mm)	Body length (mm)	Body breadth (mm)
1	19.8	40.2	18.0	36.2
2	19.0	39.8	17.0	34.3
3	20.4	41.5	18.5	37.5
4	19.0	40.3	18.2	36.8
5	18.5	39.2	17.5	35.4
Range	18.5-20.4	39.2-41.5	17.0-18.5	34.3-37.5
Mean	19.34	40.20	17.84	36.04
S.D. ±	0.75	0.84	0.59	1.24

Table 15 : Sex ratio in *H. armigera* on chilli.

S. no.	No. of adults examined	Female moth	Male moth
1	10	5	5
2	10	4	6
3	10	5	5
4	10	3	7
5	10	6	4
6	10	4	6
7	10	5	5
8	10	3	7
9	10	3	7
10	10	6	4

Sex ratio – Male : Female

56 : 44

1 : 0.78

al. (2011) also reported prepupal and pupal period of 4.04 - 4.75 and 13.78 – 24.38 days. The weight of pupa was 130.60 - 138.15 mg.

The findings regarding length and breadth of pupa are in close conformity with Ali *et al.* (2009), who recorded the length of pupa as 19.00 ± 0.30 mm and breadth of 5.72 ± 0.08 mm with pupal period of 13.15 ± 0.27 days.

Adult longevity

The adult longevity was studied for both the sexes with and without food and the observations are presented in table 13. It was noticed that male moth was short lived. They lived without food for 1 to 2 days with an average of 1.5 ± 0.53 days, while females lived without food for 1 to 3 days with an average of 1.8 ± 0.79 days. However, when fed with 10 per cent honey solution, the adult longevity increased considerably and ranged from 6 to 8

Table 16 : Life cycle of *H. armigera* on chilli.

S. no.	Particulars	Duration (days)		
		Minimum	Maximum	Mean
1	Egg period	2	4	3.2
2	Larval period			
	1 st instar	2	3	2.4
	2 nd instar	2	3	2.7
	3 rd instar	3	4	3.8
	4 th instar	4	5	4.3
	5 th instar	4	5	4.5
	6 th instar	4	5	4.1
	Total larval period	19	25	21.8
3	Pre-pupal period	2	3	2.2
4	Pupal period	13	15	13.8
5	Life cycle (egg to adult emergence)	36	47	41.0
6	Pre-oviposition period	2	4	3.1
	Oviposition period	5	6	5.5
	Post- oviposition period	1	2	1.3
7	Adult longevity			
	Male (with food)	6	8	6.9
	Female (with food)	8	10	9.0
	Male (without food)	1	2	1.5
	Female (without food)	1	3	1.8
8	Total life cycle			
	Male (with food)	42	55	47.9
	Female (with food)	44	57	50.0

days with an average of 6.9 ± 0.74 days in males, while the longevity of female moths ranged from 8 to 10 days with an average of 9.0 ± 0.66 days.

Sharma *et al.* (2011) recorded the longevity of male and female was 2.44 to 5.89 and 8.79 to 11.33 days, respectively. Bhatt and Patel (2001) obtained the mean adult longevity of 9.15 and 11.40 days for males and females, respectively. Ali *et al.* (2009) recorded the mean adult longevity of 9.17 ± 0.42 and 11.74 ± 0.51 days for males and females, respectively.

Adults

The adult moth of *H. armigera* was stout bodied with broad thorax. The forewings had a series of dots on the margins. However, the hind wings were lighter in

colour with a broad dark-brown border at the apical end. They had yellowish margins and strongly marked veins. There was distinguished colour pattern between male and female moths. Males were greenish-grey in colour, whereas females were orange-brown in colour with tuft of hair on the tip of abdomen. Almost similar description of adult moth has been given in by Ali *et al.* (2009).

The length and breadth (with wing expanded) of female moth ranged from 18.5 mm to 20.4 mm (average 19.34 ± 0.75 mm) and 39.2 mm to 41.5 mm (average 40.20 ± 0.84 mm), respectively. The male moth was 17.0 mm to 18.5 mm (average 17.84 ± 0.59 mm) in length and 34.3 mm to 37.5 mm (average 36.04 ± 1.24 mm) in breadth (with wing expanded) (table 14). The observations are in accordance with Ali *et al.* (2009), who recorded the average length of male and female moth from head to tip of abdomen as 17.65 ± 0.18 mm and 20.08 ± 0.37 mm, respectively. The average breadth (with wing expanded) of male and female moth was 34.73 ± 0.59 mm to 40.93 ± 0.55 mm, respectively. Sharma *et al.* (2011) also reported that the length of male and female moth as 18.42 ± 0.58 mm and 19.82 ± 0.75 mm, respectively. The breadth (with wing expanded) of male and female was 38.30 ± 0.35 mm and 42.15 ± 0.65 mm, respectively.

Sex ratio

The sex ratio was worked out by examining 100 adults and presented in table 15. Out of 100 adults examined, 56 were observed to be males and 44 were females. The male and female ratio was 1:0.78.

The present observations are closely matched with Pandey and Kumar (2007), who recorded the sex ratio of 1: 0.76. Sharma *et al.* (2011) reported that the sex ratio (Male : Female) varied from 1: 0.67 to 1: 1.22 in different generations.

Life cycle

The observations pertaining to life cycle are presented in table 16. The total period required to complete life cycle from eggs to emergence of adult varied from 36 to 47 days with an average of 41.0 days, whereas the generation from eggs to death of male and female *i.e.* total life cycle was found to be completed within 42 to 55 days with an average of 47.9 days and 44 to 57 days with an average of 50.0 days, respectively.

The present findings are in conformity with the findings of earlier research workers. Shivanna *et al.*

(2012) recorded total life span from egg to death of adult for male and female was 47.40 ± 0.80 and 50.13 ± 1.23 days, respectively. Bhatt and Patel (2001) observed total life span from egg to death of adult for male and female was 50.9 and 53.90 days, respectively. Pandey and Kumar (2007) also recorded the total life span for male and female was 52.8 ± 3.56 and 58.6 ± 4.52 days, respectively.

References

- Ali, A., R. A. Choudhury, Z. Ahmad, F. Rahman, F. R. Khan and S. K. Ahmad (2009). Some biological characteristics of *Helicoverpa armigera* (Hubner) on chickpea. *Tunis. J. Plant Prot.*, **4(1)**: 99-108.
- Anonymous (2009). *Post harvest profile of chilli*. Directorate of Marketing and Inspection Head Office, Nagpur. pp. 8-10.
- Anonymous (2012a). *Manual on good agricultural practices for chilli*. Directorate of Marketing and Inspection Head Office, Nagpur. pp. 1-2.
- Anonymous (2012b). Statistics, Spices Board India, www.indianspices.com
- Bhatt, N. J. and R. K. Patel (2001). Biology of chickpea pod borer, *Helicoverpa armigera* (Hubner). *Indian J. Entomol.*, **63(3)**: 255-259.
- Naseri, B., Y. Fathipour, S. Moharramipour and V. Hosseininaveh (2009). Comparative life history and fecundity of *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) on different soybean varieties. *Entomol. Sci.*, **12**: 147-154.
- Nasreen, A. and G. Mustafa (2000). Biology of *Helicoverpa armigera* (Hubner) reared in laboratory on natural diet. *Pakistan J. Biol. Sci.*, **3(10)**: 1668-1669.
- Pandey, K. and P. Kumar (2007). Studies on biology of chickpea pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera : Noctuidae) on chickpea. *Lucknow J. Sci.*, **4(1)**: 37-46.
- Rao, N. K. R. and E. V. Abraham (1956). The gram caterpillar a serious pest of jowar in Madras state. *Plant Prot. Bull.*, **8**: 19-20.
- Sharma, K. C., S. C. Bhardwaj and G. Sharma (2011). Systematic studies, life history and infestation by *Helicoverpa armigera* (Hubner) (Lepidoptera : Noctuidae) on tomato in semi arid region of Rajasthan. *Biological Forum-An International Journal*, **3(1)**: 52-56.
- Shivanna, B. K., M. R. Girish, H. Shruthi, M. E. Shilpa, H. M. Vikas, G. B. Mallikarjuna, S. Harishbabu, S. Shivanna and M. K. Basavaraj (2012). Bioecology and management of budworm, *Helicoverpa armigera* (Hubner) on FCV tobacco. *Int. J. Sci. Nat.*, **3(4)**: 892-899.