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Biology of *Helicoverpa armigera* (Hubner) Reared in Laboratory on Natural Diet

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Abstract: *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) completed its larval stage in 17.325 ± 0.326 days passing through six instars under laboratory protocol, $26 \pm 1^\circ\text{C}$, 60-70% RH and 16 hours' daylight. The larvae moulted for 2nd instar, two days after hatching from eggs. Average stadiel periods for 2nd, 3rd, 4th, 5th and 6th instars were 2.07, 2.15, 2.48, 3.12, 3.55 and 3.95 days respectively. The last larval stage did not moult but was contracted and shortened into grub like pre-pupal stage. The average length measured for each instar (first to sixth) was 3.4, 4.6, 9.7, 17, 28.35, 36.85 mm respectively. The average pupal period was 13.2 days for female and 15.4 days for male. Fecundity of moths fed on sucrose solution was significantly higher than water fed females. The unfed females laid few eggs none was viable.

Key words: *Helicoverpa armigera*, biology, natural diet, stadiel period and larval instars

Introduction

Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae) is a cosmopolitan pest. It is variously known as gram caterpillar or pod borer, cotton bollworm, Corn earworm and tomato fruit worm. It does very serious damage to many cash crops and horticultural crops. The caterpillar (*H. armigera*) most frequently attacks cotton, grain sorghum, linseed, gram, Lucerne seed, maize and sweet corn, pea, tobacco and tomato (Goodyer, 1987). In India losses to pigeon pea and chickpea alone exceed 300 million US\$ (Reed and Pawar, 1981) and in Queensland (Australia) losses due to *Helicoverpa* spp. amount to be 25 million dollars (Twine, 1989). In Pakistan the polyphagous larvae have been recorded infesting cotton crop, pulses, sunflower, peas, wheat, tomato, tobacco, Lucerne, potato and other crops (Ahmad *et al.*, 1992). The pod damage to promising varieties of chickpea in different districts of Pakistan caused by *H. armigera* varies 3-34% (Ahmad and Hashmi, 1976). Ahmad and Ali (1979) has recorded its damage to gram crop upto 56% at Faisalabad. The pest causes severe damage to cotton crop feeding upon yield contributing parts (flower buds, flower heads and developing bolls) directly. Since, 1994 *H. armigera* has become major cause of substantial reduction in cotton yield (Ahmad *et al.*, 1997). Business Recorder daily reported (November 6, 1998), "American bollworm in Pakistan has become another challenge after leaf curl virus for the field and laboratory researchers of the silver crop. Bumper crop targets are not achieved only due to damage of the bollworm".

A study on biology of *H. armigera* is necessary to develop an efficient pest control program and IPM strategies. It will make possible, the application of right insecticide at right time. Moreover the knowledge of pest biology may help in construction of life table and in pest forecasting. The present study was designed to explore some aspects of the biology of *H. armigera* in laboratory conditions.

Materials and Methods

Stock rearing of *Helicoverpa armigera* was managed in laboratory at University College of Agriculture, Bahauddin Zakaraiya University, Multan. The laboratory conditions were maintained at $26 \pm 1^\circ\text{C}$ temperature, 60-70% RH and 16 hours day light. Natural lightening was obtained through a clear glass window.

Moths were sexed and paired. The pairs were kept in transparent plastic jars (30×15 cm) separately. The walls and lid of each jar were perforated to allow ventilation. A strip of cotton cloth toweling (6×17 cm) was hung

vertically inside each jar for egg collection. Sucrose based adult diet containing Honey 10%, water 90% %/iv (Topper, 1987) was provided in a 5 ml glass vial on cotton wool wick filling its mouth. The vials containing food were fixed in holes (dia. 2 cm) in the walls of jar near bottom. Fresh diet was provided after a regular interval of 24 hours. The eggs laid were collected daily. The eggs on the toweling were kept in a transparent polythene bag (40×25 cm) filled with air. The eggs from each pair were kept separately. After hatching, neonate larvae were transferred into petridishes (dia. 15 cm). Fresh cotton squares and small bolls were used as larval food. The larvae were transferred into vertically, one larva per cell (4×4×4 cm) before completion of 2nd instar to avoid cannibalism. Glass plates from top and bottom covered the cells.

Average length of caterpillar, average period for each stadium, larval, pre-pupal and pupal stages were calculated at CI 95% from the 40 randomly selected specimens.

To study fecundity of moths, three adult rearing jars were prepared containing five pairs of *H. armigera* in each. The moths in one unit were kept without feeding, in 2nd fed on only water and in 3rd fed on 10% sucrose solution. The eggs from each jar were collected daily until all females died. The experiment was replicated thrice. Average number of eggs laid per female and percent viability of the eggs from each treatment was calculated. The significance of the difference in these values was found out with the help of DMR test (Steel and Torrie, 1980).

Results and Discussion

The eggs of *H. armigera* were pale yellow and about 0.5 mm in diameter. A fertile egg has developed brown ring on second day, the whole egg turned brown and it was black before hatching. The eggs hatched in 3-5 days after laying. Those not hatched after five days were discarded. Infertile eggs were yellowish becoming increasingly yellow and shriveled after 3 days. The neonate ate some or the entire empty eggshell. Newly hatched larvae were translucent yellowish white, with faint darker longitudinal lines and brown head capsule. Thoracic shield, thoracic legs, setae, tubercles and spiracles were also brown to black giving a spotted appearance to the larva. The larvae changed their body patterns with age. Pro-legs were present on 3rd, 4th, 5th, 6th and 10th abdominal segments. The insect pass through larval, pre-pupal and pupal stages (Table 1). It completed its larval stage in 17.32 ± 0.326 days and passed pre-pupal stage with grub like appearance in 2.1 ± 0.158 days. The pupae were mahogany brown, smooth-surfaced, round both at anterior and posterior sides.

Nasreen and Mustafa: *Helicoverpa armigera*, biology, natural diet, stadiel period

Table 1: Duration to complete larva, pre-pupa and pupa stages of *H. armigera* at C.I.95%

Stage of insect	No.	Duration (days)	C.I. 95%	Range (Days)
Larva	40	17.325 ± 0.326		15-19
Pre-pupa	40	2.1 ± 0.158		1-4
Pupa Male	20	15.4 ± 0.50		14-17
Female	20	13.2 ± 0.458		12-15

Table 2: Stadiel period and larval length of *H. armigera* at each instar

Developmental Stages	No	Stadiel Period C.I. 95% (days)	Length of Larva C.I. 95% (mm)
1st Instar	40	2.075 ± 0.085	3.40 ± 0.229
2nd Instar	40	2.150 ± 0.115	4.60 ± 0.344
3rd Instar	40	2.475 ± 0.162	9.65 ± 0.744
4th Instar	40	3.125 ± 0.165	17.00 ± 0.710
5th Instar	40	3.550 ± 0.161	28.35 ± 0.698
6th Instar	40	3.950 ± 0.176	36.85 ± 0.759

Table 3: Effect of adult feeding on fecundity and egg viability of (*H. armigera*)

Treatment	Eggs/female	Egg viability
Unfed	7.37 c	0.00 c
Water fed	248.55 b	44.00 b
Sucrose fed	795.02 a	75.00 a

Pupa has two tapering parallel spines at posterior tip. Twenty pupae for each sex were selected by observing the position of gonophore and the shape and size of terminal segment. The female moths emerged 2-3 days before male moths because of shorter pupal period for females. Similar results were reported by Armes *et al.* (1992) at 20-25°C. The average pupal period of *H. armigera* ranged 13.2 to 15.4 which differ by Jayaraj (1982) who studied it 10.5 to 13.6 days. He did not mention the temperature conditions of his experiment.

Stadiel period for each larval instar: *H. Armigera* completed its larval period passing through six distinct developmental stages of larva. After completion of each developmental stage (instar), the larva underwent moulting to provide a spacious exo-skeleton for further body growth. During first instar the colour of all larvae was more uniform and movement was less. The first instar was completed in 2.075 ± 0.085 days. The larvae in second instar were much similar to the first except slight darkening of body colour. The sclerotized parts of head capsule, thoracic shield and thoracic legs appeared lighter. Second instar was last for 2.15 ± 0.115 days. Third instar was passed in 2.475 ± 0.162 days in which head capsule was brown and ground colour was gray brown. Stadiel periods 3.125 ± 0.165 and 3.55 ± 0.161 days were noted at fourth and fifth instars respectively which were darker in body colour. At sixth instar the larvae had attained a characteristic granular appearance due to close arrangement of minute tubercles. Head capsule was light brown, pro-thoracic and anal plates were pale brown. Setae became dark, spiracles and claws were black. Body underside of caterpillars was uniformly pale. Colour pattern of body was appeared in white and yellowish bands. At sixth instar it stopped feeding after 3.95 ± 0.176 days and entered into pre-pupa stage. The results supported the studies of Reed (1965) and contradicted the studies of Singh and Moore (1987) who reported five larval instars. The variation in results may be due to the effect of prevailing temperature and diet on which the insect was reared (Armes *et al.*, 1992) (Table 2).

Larval size at each instar: The Larvae of *H. armigera* were observed increasing in size with age. After attaining a particular size larvae moulted into next instar. Very small first instar larvae had attained body length 3.4 ± 0.229 mm. The length of caterpillar was measured for 2nd, 3rd, 4th, 5th and 6th developmental stages as

4.6 ± 0.344, 9 ± 0.74, 17 ± 0.71, 28.35 ± 0.698 and 36.85 ± 0.759 mm respectively. The results slightly differ by Goodyer (1987). It may be due to the temperature difference as he maintained temperature constant at 25°C (Table 2).

Adult moths: Female adults started to emerge two days before the male. Immediately after emerging from pupal case, moths climbed up a nearby vertical surface of jar. The sex of newly emerged adults was determined by the colour of forewings, In male, the forewings were greenish whilst in female the wings were brown.

Fecundity of female moths was highly variable when fed on different diets. It was reflected by average number of eggs laid by female moths and percent number of eggs hatched out (Table 3). The results with regard to eggs laid by female moths and viability of eggs were significantly different in all the three treatments. The eggs laid by females fed on 10 percent sucrose solution was highest (795.02 eggs per female) it was 248.55 eggs per female in case of water fed females that is higher than the unfed females who laid only 7.37 eggs per female on an average. Similarly the percent viability of eggs was the highest (75%) in case of females fed on sucrose whereas it was 44% in case of water fed females. The unfed females laid no viable egg. These results support the studies of Topper (1987) and Kelvin (1990) who stated that sugar based diet is a pre-requisite for egg maturation and causing female to become refractory to mating.

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