



# Studies on the Life Stages and External Morphology of Gram Pod Borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae)

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## Abstract:

Life history studies of *Helicoverpa armigera* were conducted on artificial diet under laboratory conditions at room temperature. The incubation period of egg was  $3.42 \pm 0.40$ , varies from 2 to 5 days. The size of the egg was 0.50 mm in length and about 0.48 mm in breadth. The total larval period of all six instars varies from 18 to 26 days and the length of first to sixth instar larvae were  $2.58 \pm 0.01$ mm,  $3.93 \pm 0.08$ mm,  $8.73 \pm 0.18$ mm,  $12.03 \pm 0.15$ mm,  $22.67 \pm 0.43$ mm and  $35.99 \pm 0.89$ mm, respectively. There was variation in colour within larval instars. Full fed larvae pupated by constructing earthen cells in the soil. The pre-pupal period was  $3.11 \pm 0.27$ days, varies from 1-4 days. Average pupal period was  $13.80 \pm 2.87$ , varies from 10 to 16 days. The males were recorded greenish-grey in colour, while females were orange-brown and the longevity of male and female was 7 to 10 (average  $8.70 \pm 0.55$ ) days and 9 to 13 (average  $11.80 \pm 0.72$ ) days, respectively. The males outnumbered the females in the laboratory as they comprised 60% of the population. The fecundity varies from 557 to 739 eggs per female. Egg-laying usually begins 3 days after the emergence and were always laid singly.

## Key words:

Life history, external morphology, *Helicoverpa armigera*

## Introduction:

*Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is an economically important polyphagous pest in India. This pest is reported to attack a wide range of agricultural crops causing substantial losses every year (Sharma, 2001). It causes 24 to 68% losses of cotton (Vadodaria *et al.*, 1998) and 28 to 40% losses of pulses (Srivastava *et al.*, 2005) at a national level. A comprehensive account on the biology of *Helicoverpa armigera* has been given by Tripathi and Sharma (1984), Kyi and Zalucki (1991), King (1994), Akasheet *al.* (1997), Saito (1999). Recently, Bhatt and Patel (2001), Reddy *et al.* (2004), Pandey and Kumar (2007) and Ali *et al.* (2009) studied the biology of *Helicoverpa armigera*. The present study broadly confirms their findings but a number of variations have been recorded in the present work. The conformation on biological studies is available for Punjab and Uttar Pradesh but not Vidarbha region of Maharashtra where the climatic conditions are quite different from those of the other places at which the biology of the insect has been worked out. Hence, the present work has been undertaken to determine the variations, if any, in the biology of insect of Vidarbha region.





## Materials and methods:

A colony of *H. armigera* was initiated from late instar larvae collected from the cotton fields of Central Institute for Cotton Research, Nagpur and reared on the agar-based chickpea diet (Nagarkatti and Prakash, 1974) at room temperature with a photoperiod of L: D 14: 10. Rearing of life stages was based on the techniques as described by Mohite *et al.* (2009). Adult moths were kept in specially prepared cages provided with fine wire grills from the sides. The top of the cage was provided with movable glass to study the reproductive and ovipositional behaviour of the adults. The adult moths were fed with 10% sucrose solution and honey mixture (3:1). Incubation period of eggs and time required for moulting of larval instars as well as pupal period and adult longevity has been recorded. The data regarding the life span of developmental stages and male and female were based on the factual observations of ten samples during rearing in the laboratory conditions. Eggs were measured with the help of an ocular micrometer calibrated with a stage-micrometer. Morphological observations were done under the stereoscopic binocular microscope and the measurements of different stages were also taken, which were based on average of ten observations. Labomed Digi-3 microscope was used for microphotography of eggs, first and second instar larvae.

## Results and discussion:

The life history of the moth *Helicoverpa armigera* comprises the adult, the egg, I to VI instar larvae and Pupa. Average life span and size of the body of various developmental stages have been depicted in table 1.

The eggs (Fig. 1) were about the size of small pin-head with a flat base. The height of the egg was 0.50 mm and width about 0.48 mm. It was ornamental in appearance with pigmented ribs. Before hatching, it assumed a dark colour. Freshly laid eggs were shiny and faintly yellow in colour, but within a couple of days with the embryonic development, the colour became yellow. For a short time before hatching, a large dark spot appears near the top of the egg, this spot being the head of the embryo. Infertile eggs soon became conical and finally shrivel up. As per findings of the present work the average incubation period was  $3.42 \pm 0.40$ , varies from 2 to 5 days (under laboratory condition) but Singh and Singh (1975) reported the same to vary from 2.6 to 3.6 days.

However, present observations are in agreement with those of Srivastava and Saxena (1958), Hsu *et al.* (1960), Tripathy and Sharma (1984) and Pandey and Kumar (2007) since they reported incubation period to vary from 2 to 5 days. King (1994), Fowler and Lakin (2001) and CAB (2003) reported the egg stage last for 3-14 days. This difference in the incubation period appears to be





due to difference in temperature and relative humidity, because it was well analyzed fact that the incubation period was affected by temperature and relative humidity. *Helicoverpa armigera* eggs hatch in about 3 days at 25°C, but at lower temperatures, hatch may take up to 11 days.

Immediately after hatching (Fig. 2), the newly hatched larva was very sluggish and negatively photo tactic. Newly hatched larvae typically consume their egg shells (Fig. 3). Although feeding on the egg shell by the first instar larvae in Lepidoptera seems to be common feature (Hinton, 1946), it has been reported in few cases. They became active 2 - 4 hours and began searching for suitable food. Length of first instar larva (Fig. 4) was 1.4 – 1.6 mm; head, thoracic shield, thoracic legs and anal shields were shiny black. The newly hatched larva was pale and translucent. It became opaque and creamy after feeding. All the segments of the body were distinct. Great variations in colour and size occurred within and between larval instars. Main larval characteristics changed at the time of each shedding of integument. Length of second instar larva (Fig. 5) was 3.4 – 4 mm; head and thoracic legs were black. The second instar resembles the first in appearance, but the dermal spinulation was more pronounced. Length of third instar larva (Fig. 6) was 7.0–8.2 mm; head pale brown with two short white lateral stripes, thoracic legs, thoracic and anal shields were black. Body was convex dorsally but flat ventrally. Length of fourth instar larva (Fig.7) was 9 – 11.4 mm; head, thoracic and anal shields were pale brown. Appearance of fourth instar was the same as the one of third instar. The colour of larva was brownish green. Length of fifth instar larva (Fig. 8) was 17.6 – 20 mm; head brown with fine pale setae.

Length of sixth instar larva (Fig. 9 & 10) was 30 – 40 mm; head thoracic and anal shields were dark brown. It resembles with fifth instar in appearance. The full grown sixth instar larva had reddish brown head. Its prothorax was more brownish in comparison with meso-and metathorax; short white bristles were scattered all over the body. The larva showed more pronounced individual variations in the nature of markings. They exhibit body colour polymorphism.

The longitudinal lines on the dorsal side were light brownish and they remains continuous but the lateral longitudinal lines were broken at places. The duration of this instar was from 6.4 to 8.1 days with an average of  $6.98 \pm 0.87$  days. When full grown, the larva was flattened ventrally but convex dorsally. Each thoracic segment possesses one pair of 3-jointed legs. Abdomen was 10 segmented. One pair of spiracles was present on the pleural side of the thorax. Likewise, each of first eight abdominal segments bears a pair of spiracles laterally. Each of the 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup> and 10<sup>th</sup> abdominal segments bears a pair of thick and conical prolegs, with flat chrochets. In the present study, normally only six larval instars were recorded in the laboratory rearing on artificial diet. Larvae may complete up to 7 instars, though generally there





were between 5 and 7 instars (Twine, 1978; King, 1994; Fowler and Lakin, 2001). The complete larval period (all instars combined) in the present laboratory study varies from 18 to 26 days, but on the contrary, Tripathi and Sharma (1984) reported the same to vary from 24 to 30 days, while Bhatt and Patel (2001) and Fowler and Lakin (2001) found the complete larval period lasts between 12–36 days. The time required to complete each larval stage varies considerably depending on host plant, temperature and other factors. The cannibalism in *Helicoverpa armigera* was very prevalent.

Newly hatched larvae, however, were not cannibalistic. But as larvae become longer, they developed a voracious appetite. If larvae happens to meet, they immediately attacked each other and either both were killed. If one happens to kill other, it will immediately begin eating the dead one. The pre-pupal stage lasted 2-4 days, and during this time larval activity decreases. Once feeding was completed, larvae moved below the soil surface to pupate. They were observed to pupate at a depth of 3–5 cm. in earthen cells.

Pupa (Fig. 11) was of the obtect type, broadly rounded anteriorly and tapering posteriorly measuring about  $20.64 \pm 0.64$  mm in length and about  $5.37 \pm 0.08$  mm in breadth at the widest across the dorsum. Its head and thorax were pale green in the beginning but they became light brown within 20 – 24 hrs. The first portion of body to darken was head and the dorsal region of thorax and abdomen, prior to emergence of moth, the colour of pupa darkens further. Its abdomen had ten distinct segments. Each of the 4<sup>th</sup> – 9<sup>th</sup> segments possesses a pair of spiracles and the terminal segment had a pair of dark brown spines. In the present study, average pupal period was  $13.80 \pm 2.87$ , varies from 10 to 16 days and this finding of the present work was at variance with Singh and Singh (1975) who recorded the same from 5 to 8 days. However, it was difficult to determine pupal periods exactly when larvae have transformed in the soil, because of the disturbance of pupal cells and the danger of preventing the emergence of moths. Depending on temperature the pupal stage lasted between 6–33 days, unless the insect goes into diapause, in which case pupation may required several months (King, 1994; Akashe *et al.*, 1997; and Bhatt and Patel, 2001).

Adults (Fig. 12 & 13) emerged from the pupae in between dusk and midnight, climb vertical structures and dry their wings for a period of 2 or more hours. Present observations are in agreement with King (1994) and CAB (2003). The male moth was recorded greenish-gray in colour, whereas, female with orange-brown. Males were  $18.65 \pm 0.73$  in length but smaller than females. Forewings were with marginal series of dots. The underside of each forewing had bean-shaped black markings. Hind wings were lighter in colour. Females possess a tuft of hairs at the posterior extremity of the body. The males outnumbered the females in the laboratory as they comprised 60% of





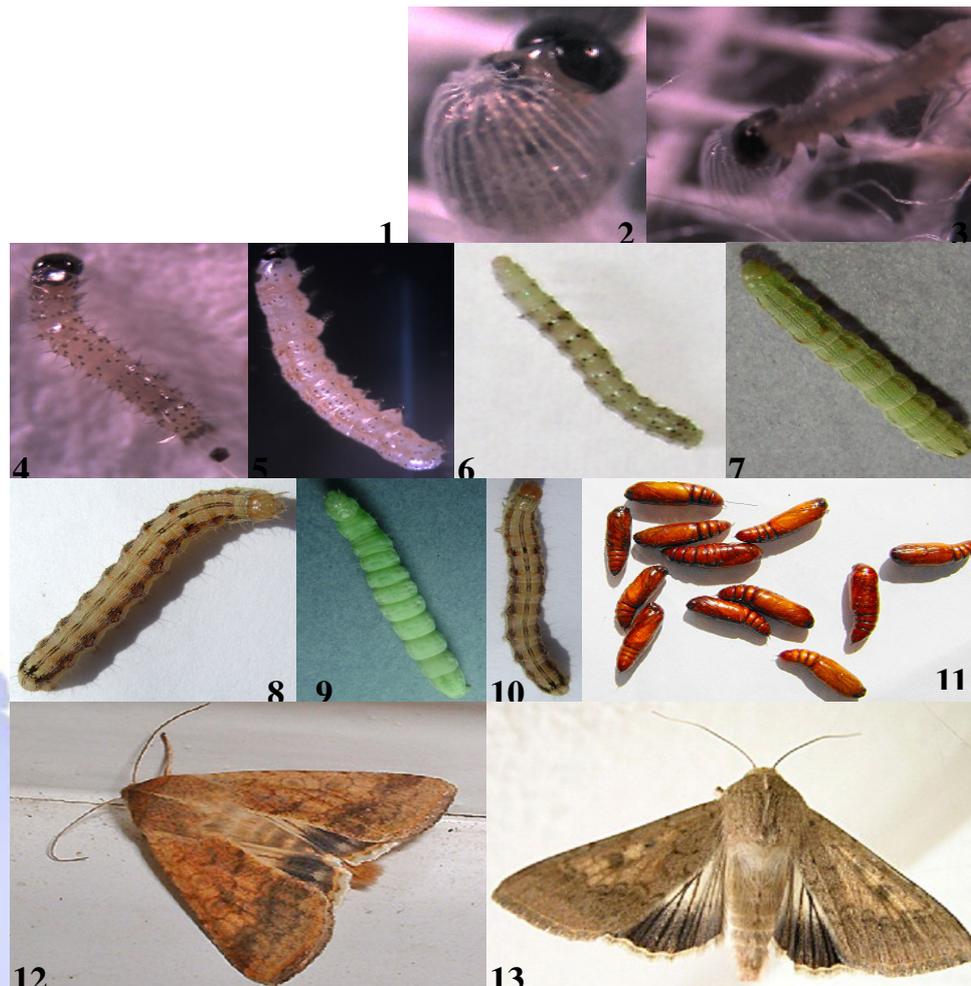
the population. Moths were active during the night only and they were attracted to the light. Flight usually begins just before dark and continues throughout the night. Females lived slightly longer than the males. The longevity of male and female was 7 to 10 (average  $8.70 \pm 0.55$ ) days and 9 to 13 (average  $11.80 \pm 0.72$ ) days, respectively. King (1994) reviewed several adults longevity studies and reported a range in adult life span of 5 to 36 days. Adult longevity depends on several factors including pupal weight, food supply, temperature, etc. (King, 1994).

Egg-laying usually begins 3 days after the emergence. The oviposition starts usually at dark and may continue till midnight. A few females oviposit during the whole night. No oviposition was noticed during the day time. Eggs were always laid singly. Unfed females laid few eggs. The present findings on fecundity were at variance with those of previous workers. Singh and Singh (1975) reported 53 and 40 eggs for female; Hsu *et al.* (1960) reported 1000 eggs per female. Reed (1965) observed that the fecundity varied from 198 eggs in June-July to a maximum of 1226 in May-June. Patel (1968), Reddy *et al.* (2004) and Pandey and Kumar (2007) reported 510-1402 eggs per female. In the present study, the fecundity varied from 557 to 739 eggs in response to rearing on artificial diet, which are in agreement with those of King (1994), Fowler and Lakin (2001) and CAB (2003).

**Table. 1-** Larval body length, body width and average life span of various developmental stages of *H. armigera* (\*with expanded wings)

Stage	Body length (mm)	Body width (mm)	Average life span (days)
1 <sup>st</sup> instar	$2.58 \pm 0.01$	$0.34 \pm 0.01$	$3.81 \pm 0.23$
2 <sup>nd</sup> instar	$3.93 \pm 0.08$	$0.65 \pm 0.01$	$2.63 \pm 0.18$
3 <sup>rd</sup> instar	$8.73 \pm 0.18$	$0.91 \pm 0.01$	$2.26 \pm 0.16$
4 <sup>th</sup> instar	$12.03 \pm 0.15$	$1.06 \pm 0.01$	$2.79 \pm 0.59$
5 <sup>th</sup> instar	$22.67 \pm 0.43$	$2.12 \pm 0.03$	$3.14 \pm 0.33$
6 <sup>th</sup> instar	$35.99 \pm 0.89$	$2.65 \pm 0.01$	$3.87 \pm 0.37$
Prepupa	$39.73 \pm 0.16$	$3.12 \pm 0.01$	$3.11 \pm 0.27$
Pupa	$20.64 \pm 0.64$	$5.37 \pm 0.08$	$13.80 \pm 2.87$
Adult male	$18.65 \pm 0.73$	$34.32 \pm 0.59^*$	$8.70 \pm 0.55$
Adult female	$20.08 \pm 0.31$	$38.87 \pm 0.55^*$	$11.80 \pm 0.72$





**Figure :** Life stages of *Helicoverpa armigera* (Hübner). **1:** Freshly laid eggs (x10), **2:** Egg hatching (x40), **3:** Newly hatched larva consuming egg shell (x40), **4:** First instar larva (x40), **5:** Second instar larva (x40), **6:** Third instar larva, **7:** Fourth instar larva, **8:** Fifth instar larva, **9 & 10:** Sixth instar larva (Body colour polymorphism), **11:** Pupae, **12:** Adult female, **13:** adult male.

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