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BIOLOGY OF GRAM POD BORER, *Helicoverpa armigera* (hubner) HARDWICK (LEPIDOPTERA: NOCTUIDAE) ON CHICKPEA (*Cicer arietinum* L.)

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ABSTRACT

Studies on the biology of gram pod borer, *Helicoverpa armigera* (Hubner) Hardwick on chickpea were conducted under laboratory conditions at the Department of Entomology, Anand Agricultural University, Anand, Gujarat, India during *rabi*, 2025-26. The insect completed its life cycle through 4 distinct stages: egg, larval, pupal and adult stages. The incubation period of eggs averaged 3.32 ± 0.80 days with an egg hatchability of 83.33%. The larva passed through six instars with a mean total larval duration of 21.28 ± 1.93 days, followed by pre-pupal and pupal periods of 1.88 ± 0.78 and 13.40 ± 1.08 days, respectively. The mean pre-oviposition, oviposition and post-oviposition periods were 2.58 ± 0.90, 6.42 ± 1.00 and 1.83 ± 0.72 days, respectively. The fecundity ranged from 421 to 713 eggs per female with a mean of 563.58 ± 87.34 eggs/female. Female moths lived longer (10.83 ± 1.27 days) than males moths (8.92 ± 0.76 days) resulted in a greater total life span of 50.67 ± 2.06 days in females compared to 48.85 ± 2.48 days in males. The male to female sex ratio was recorded as 1:1.08.

Keywords **:** Biology, *Helicoverpa armigera*, Chickpea, Lifecycle, Fecundity.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated worldwide and serves as a major source of dietary protein particularly in developing countries. It is an economically important protein-rich dietary legume containing considerable amounts of protein (17-22%), carbohydrates (51–70%), fats, vitamins and minerals, especially calcium, iron and phosphorus (Begum *et al*., 2023). India is the world's largest producer of chickpea, contributing nearly 75 per cent of the global production (Gaur *et al*., 2019). Besides its nutritional importance, chickpea is also beneficial in improving soil fertility through atmospheric nitrogen fixation and fits well into various cropping systems (Zhang *et al*., 2024). Despite its importance, chickpea productivity is considerably constrained by insect-pests infestations. More than 60 insect-pests species have been reported attacking chickpea, among which gram pod borer, *Helicoverpa armigera* (Hubner) Hardwick (Lepidoptera: Noctuidae) is regarded as the most destructive pest causing severe economic losses (Sharma *et al*., 2007). The young larvae initially feed on tender foliage and subsequently bore into the developing pods resulting in to yield losses ranging from 50 to 60 per cent under severe infestation conditions (Khare and Ujagir, 1977). In India, *H. armigera* has been reported to feed on 181 cultivated and uncultivated plant species belonging to 45 botanical families, indicating its highly polyphagous nature (Veer *et al*., 2021). Owing to its high reproductive potential, migratory behaviour, adaptability to diverse agro-climatic conditions and ability to develop resistance against several insecticides, it is considered one of the most destructive insect-pests and has been designated as a national pest (Sarwar *et al*., 2009). Therefore, detailed knowledge of the biology of *H. armigera* is fundamental for understanding its life history and developing effective integrated pest management strategies.

Materials and Methods

The present investigation on the biology of gram pod borer, *Helicoverpa armigera* (Hubner) Hardwick, was carried out during *rabi*, 2025-26 at the Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India. The chickpea variety Gujarat Gram 5 (GG 5) was used as the host plant throughout the study.

Maintenance of initial culture

An initial culture of *H. armigera* along with fresh larval food consisting of chickpea leaves with immature pods was collected from an unsprayed chickpea crop grown at the Entomology Farm, BACA, AAU, Anand. The field collected larvae were brought to the laboratory in plastic vials (5.5 × 4.5 cm) and maintained individually in plastic vials provided with perforated lids to facilitate aeration. Individual rearing was adopted to avoid larval cannibalism. Fresh chickpea leaves with immature pods were provided daily as larval food and replaced every morning with fresh food. After pupation, the pupae were collected using sanitized forceps and transferred to insect rearing cages (30 × 30 × 30 cm) for adult emergence. A small chickpea plant placed in a water-filled conical flask (250 mL) was placed into the cage to prevent desiccation and provide a suitable substrate for oviposition. Adult moths were supplied with a cotton swab soaked in 5 per cent honey solution as food. The eggs thus obtained from the laboratory culture were used for biological studies.

Methodology

Egg

The biology of *H. armigera* was studied using thirty eggs collected from the initial laboratory culture. For recording egg hatchability and incubation period, the eggs were mounted on six glass slides at the rate of five eggs per slide using a small amount of gum and a fine camel hair brush. Each slide was placed separately in a Petri plate (diameter: 90 mm) and observed daily during morning hours until hatching.

Larva

Immediately after hatching, neonate larvae were transferred individually into plastic vials (5.5 × 4.5 cm) using a fine camel hair brush. The vials were provided with perforated lids to ensure proper ventilation. Fresh young chickpea leaves with immature pods were supplied daily as food. Observations on larvae were recorded daily to determine the number of larval instars, duration of each instar and total larval period. Moulting was confirmed by the presence of shed head capsules and exuviae. The total larval period was considered from egg hatching until cessation of feeding.

Pupa

The interval between cessation of feeding and pupation was recorded as the pre-pupal period, whereas the pupal period was measured from pupation until adult emerged. The pupae were examined daily during the morning hours to record the duration of pupal development and adult emergence accurately. Sex differentiation of pupae was done based on morphological characteristics, wherein females possessed a greater distance between the genital slit and anal slit than males. The sex ratio was calculated based on the number of male and female adults emerged.

Adult

Freshly emerged adults were paired (male: female) and maintained separately in insect rearing cages (30 × 30 × 30 cm). A small chickpea plant in a water-filled conical flask (250 mL) and a cotton swab soaked in 5 per cent honey solution were provided as oviposition substrate and adult food, respectively. The chickpea plant and food source were replaced daily. The duration between adult emerged and oviposition was considered as the pre-oviposition period. The total period of egg laying was recorded as the oviposition period, whereas the period from completion of oviposition until female death was considered as the post-oviposition period. Fecundity was determined by counting the total number of eggs laid by each female during its lifetime. Adult longevity was recorded separately for males and females and the total life cycle was calculated from egg laid to the adult death.

Results and Discussion

Egg Stage

The eggs of *H. armigera* were spherical to dome-shaped with a flattened base and a sculptured surface bearing distinct longitudinal ridges [Fig.1(A)]. Freshly laid eggs were yellowish white in colour and gradually turned dark brown to blackish prior to hatching. Under laboratory conditions, 83.33 per cent egg hatchability was recorded (Table-1). The present findings on egg hatchability are in close agreement with the reports of Hossain *et al.* (2007), who observed 85.77 ± 5.19 per cent hatching of *H. armigera* on chickpea. Further, Kumawat *et al.* (2025) recorded 78.61 ± 9.73 per cent egg hatchability on chickpea.

The incubation period ranged from 2 to 5 days with an average duration of 3.32 ± 0.80 days (Table-1). The present findings are in close agreement with those of Hossain *et al.* (2007), who reported an incubation

period of 3.60 days; Rabari *et al.* (2017), who observed 3.73 days; Chakravarty *et al.* (2018), who recorded 3.66 days; and Kumar *et al.* (2022), who reported 3.62 days on chickpea.

Larval Stage

The larvae passed through six distinct instars before entering the prepupal stage. The first instar neonate larvae were yellowish white with a black head capsule and fed initially on the egg chorion immediately after hatching [Fig.1(B)]. The duration of the first instar larvae reared on chickpea ranged from 2 to 3 days with a mean duration of 2.48 ± 0.51 days (Table-1). The present findings are comparable with those of Ali *et al.* (2009), Deepa and Srivastava (2010), Chakravarty *et al.* (2018), Purabiya (2022) and Gusain *et al.* (2023), who recorded first instar durations of 2.27 ± 0.08, 2.52 ± 0.10, 2.28 ± 0.18, 2.54 ± 0.50 and 2.66 ± 0.33 days, respectively on chickpea.

The second instar larvae resembled the first instar morphologically but were comparatively larger, light brown in colour with a dark black head capsule and thoracic legs [Fig.1(C)]. The duration of the second instar ranged from 2 to 4 days with a mean duration of 2.96 ± 0.73 days (Table-1). The present findings are comparable with those of Deepa and Srivastava (2010), Chakravarty *et al.* (2018), Sharma *et al*. (2019) and Gusain *et al.* (2023), who reported second instar durations of 2.48 ± 0.10, 2.46 ± 0.11, 3.40 ± 0.50 and 2.66 ± 0.33 days, respectively.

The third instar larvae were comparatively larger and darker than the preceding instar with body colour varying from yellowish green to light brown. The body was convex dorsally and comparatively flat ventrally, bearing a distinct dorsal longitudinal line and a whitish lateral band [Fig.1(D)]. The duration of the third instar ranged from 2 to 5 days with a mean duration of 3.36 ± 0.81 days (Table-1). Ali *et al.* (2009) reported a mean third instar duration of 2.67 ± 0.07 days. Subsequently, Chakravarty *et al.* (2018) observed an average period of 2.72 ± 0.17 days. More recently, Kumar *et al.* (2022) documented a mean duration of 4.40 ± 0.13 days on chickpea, whereas Purabiya (2022) recorded an average duration of 4.04 ± 0.88 days.

In the fourth instar, the larvae were comparatively darker with body colour ranged from yellowish to light brown and bearing a reddish-brown head capsule. Yellowish-white lateral stripes were distinctly visible on the body, whereas the dorsal stripes appeared either continuous or discontinuous [Fig.1(E)]. The duration of the fourth instar varied from 3 to 5 days with a mean period of 3.76 ± 0.78 days (Table-1). Similar findings were reported by Chakravarty *et al.* (2018), Kumar *et al.* (2022) and Purabiya (2022), who reported an average duration of 3.18 ± 0.23, 3.80 ± 0.11 and 4.24 ± 0.77 days, respectively on chickpea. More recently, Gusain *et al.* (2023) documented a mean fourth instar period of 3.66 ± 0.88 days.

The fifth instar larvae were greenish-brown in colour with distinct fragmented dorsal stripes and continuous whitish lateral stripes. Fine setae were observed throughout the body surface included the head capsule [Fig.1(F)]. The duration of the fifth instar larvae reared on chickpea ranged from 3 to 6 days with a mean period of 4.16 ± 0.80 days (Table-1). Comparable observations were made by Chakravarty *et al.* (2018), who reported an average fifth instar duration of 3.86 ± 0.18 days. Kumar *et al.* (2022), Purabiya (2022) and Gusain *et al.* (2023) documented relatively longer periods of 4.40 ± 0.13, 4.50 ± 0.51 and 4.33 ± 0.66 days, respectively.

The sixth instar larvae exhibited considerable colour polymorphism with body colour varied from pale green and light greenish to reddish brown and greenish brown. The body appeared dorsally convex and ventrally flattened bearing distinct black longitudinal dorsal stripes and continuous whitish lateral stripes. Fine hairy setae were distributed throughout the body surface included the head capsule [Fig.1(G)]. The duration of the sixth instar larvae ranged from 4 to 6 days with a mean period of 4.56 ± 0.71 days (Table-1). Comparable observations were reported by Chakravarty *et al.* (2018), who recorded a mean sixth instar duration of 3.80 ± 0.14 days. Similar findings were also documented by Purabiya (2022) and Gusain *et al.* (2023), who observed mean durations of 4.92 ± 0.80 and 4.33 ± 0.88 days, respectively.

The total larval duration of *H. armigera* reared on chickpea ranged from 16 to 29 days with a mean developmental period of 21.28 ± 1.93 days (Table-1). Similar findings were reported by Bhatt and Patel (2001), who recorded a mean total larval duration of 20.60 ± 1.78 days on chickpea. Comparable observations were made by Rabari *et al.* (2017) and Chakravarty *et al.* (2018), who reported 22.97 ± 1.10 and 18.30 ± 0.54 days, respectively on chickpea. More recently, Purabiya (2022) and Gusain *et al.* (2023) documented average larval periods of 23.12 ± 1.83 and 20.00 ± 3.21 days, respectively.

Pre-pupal and Pupal Stage

The pre-pupal stage was characterized by cessation of feeding, reduction in body length and sluggish movement. The body gradually became wrinkled and lighter in colour [Fig.1(H)]. The prepupal period ranged from 1 to 3 days with a mean duration of

1.88 ± 0.78 days (Table-1). The present findings are in close conformity with those of Ali *et al.* (2009), Rabari *et al.* (2017), Chakravarty *et al.* (2018), Kumar *et al.* (2022) and Purabiya (2022), who reported prepupal durations of 2.15 ± 0.16, 1.93 ± 0.69, 2.12 ± 0.08, 1.80 ± 0.05 and 1.64 ± 0.69 days, respectively on chickpea.

Pupae were obtect, tapering posteriorly, smooth and cylindrical. Fresh pupae were light green and gradually changed to reddish brown [Fig.1(I)]. The pupal duration ranged from 12 to 16 days with an average of 13.40 ± 1.08 days (Table-1). These results are in close conformity with Ali *et al.* (2009), who reported a pupal duration of 13.20 days; Kumar *et al.* (2022), who observed 13.60 days; and Purabiya (2022), who recorded 13.45 days.

Adult Stage

Adults were stout-bodied moths with females appeared comparatively larger than males and possessed a tuft of hairs at the tip of the abdomen. Adult longevity of *H. armigera* reared on chickpea varied between sexes [Fig.1(J&K)]. Male moths survived for 8 to 10 days with a mean longevity of 8.92 ± 0.76 days, whereas females lived relatively longer ranged from 7 to 15 days with an average longevity of 10.83 ± 1.27 days. The present findings are in close conformity with Ali *et al.* (2009), Rabari *et al.* (2017), Sharma *et al.* (2022) and Purabiya (2022), who reported male longevities of 8.10 ± 0.31, 8.87 ± 0.83, 8.60 ± 0.89 and 9.20 ± 1.13 days and female longevities of 10.20 ± 0.37, 10.53 ± 1.06, 10.80 ± 1.02 and 11.40 ± 1.24 days, respectively.

Sex differentiation and Sex ratio

The pupal sex was differentiated based on the position of the genital opening and the distance between the genital opening and the anal slit. The genital opening was located on the ninth abdominal segment in male pupae, whereas in female pupae it was situated on the eighth abdominal segment. The distance between the genital opening and the anal slit was comparatively greater in female pupae than in male pupae. The male to female sex ratio was recorded as 1:1.08 indicated a slightly higher proportion of females than males (Table-1). Similar findings were reported by Solanki (2013), who recorded a sex ratio of 1:1.04. Comparable observations were also made by Gadhiya *et al.* (2014) and Chakravarty *et al.* (2018), who reported male to female sex ratios of 1:1.20 and 1:1.28, respectively.

Pre-oviposition, Oviposition and Post-oviposition period

The pre-oviposition period ranged from 1 to 4 days with a mean duration of 2.58 ± 0.90 days (Table-1). Similar findings were reported by Hossain *et al.* (2007) and Ali *et al.* (2009), who recorded mean pre-oviposition periods of 2.25 ± 0.19 and 2.45 ± 0.08 days, respectively.

The oviposition period varied from 5 to 8 days with a mean duration of 6.42 ± 1.00 days (Table-1). Similar findings were reported by Ali *et al.* (2009), who recorded a mean oviposition period of 5.33 ± 0.12 days. Comparable observations were also made by Kumar *et al.* (2022) and Purabiya (2022), who reported durations of 6.10 ± 0.21 and 6.64 ± 1.28 days, respectively.

The post-oviposition period ranged from 1 to 3 days with a mean duration of 1.83 ± 0.72 days (Table-1). Similar findings were reported by Ali *et al.* (2009), who recorded a mean post-oviposition period of 2.00 ± 0.05 days. Comparable observations were also made by Kumar *et al.* (2022) and Purabiya (2022), who reported mean durations of 1.80 ± 0.08 and 2.12 ± 0.60 days, respectively.

Fecundity

Female moths deposited eggs mostly singly and occasionally in groups of two to three on tender chickpea plant parts during night hours and the fecundity ranged from 421 to 713 eggs per female with a mean of 563.58 ± 87.34 eggs per female (Table-1). The present findings are more or less comparable with those of Ali *et al.* (2009), Kumar *et al.* (2022) and Purabiya (2022), who reported mean fecundities of 413.00 ± 1.89, 409.20 ± 12.28 and 689.60 ± 91.54 eggs per female, respectively on chickpea.

Total Life Cycle

The total life span of *H. armigera* reared on chickpea ranged from 39 to 63 days in males and from 38 to 68 days in females with mean durations of 48.85 ± 2.48 and 50.67 ± 2.06 days, respectively (Table-1). The present findings are in close conformity with those of Rabari *et al.* (2017), who reported total life spans of 46.53 ± 2.16 and 49.27 ± 2.43 days in male and female moths, respectively. Similarly, Chakravarty *et al.* (2018) observed total life spans of 47.20 ± 2.57 days in males and 48.70 ± 2.79 days in females, while Purabiya (2022) recorded 48.80 ± 2.63 and 51.40 ± 2.95 days in male and female moths, respectively on chickpea.

Table 1: Duration of different life stages of gram pod borer, *H. armigera* on chickpea

Life stages	Particulars	Duration (days)			Sample size (n)
		Min.	Max.	Mean ± SD	
Egg Hatching (%)	83.33				30
Egg		2	5	3.32 ± 0.80	30
Larva	First instar	2	3	2.48 ± 0.51	25
	Second instar	2	4	2.96 ± 0.73	25
	Third instar	2	5	3.36 ± 0.81	25
	Fourth instar	3	5	3.76 ± 0.78	25
	Fifth instar	3	6	4.16 ± 0.80	25
	Sixth instar	4	6	4.56 ± 0.71	25
	Total	16	29	21.28 ± 1.93	25
Pupa	Pre-pupa	1	3	1.88 ± 0.78	25
	Pupa	12	16	13.40 ± 1.08	25
Adult	Pre oviposition	1	4	2.58 ± 0.90	13
	Oviposition	5	8	6.42 ± 1.00	13
	Post oviposition	1	3	1.83 ± 0.72	13
	Longevity (M)	8	10	8.92 ± 0.76	12
	Longevity (F)	7	15	10.83 ± 1.27	13
Male	**Total life span**	39	63	48.85 ± 2.48	12
Female		38	68	50.67 ± 2.06	
Sex-ratio (male: female)		1:1.08			25
Fecundity (no. of eggs/female)		421	713	563.58 ± 87.34	13

Conclusions

The present study generated comprehensive information on the biology of *H. armigera* reared on chickpea under laboratory conditions. The insect completed its life cycle through four distinct developmental stages with six larval instars and a mean total larval duration of 21.28 ± 1.93 days. Female moths exhibited a longer mean total life span (50.67 ± 2.06 days) than males (48.85 ± 2.48 days). The biological parameters recorded during the present investigation provide valuable baseline information for laboratory mass rearing and the development of timely and effective integrated pest management strategies against *H. armigera* in chickpea.

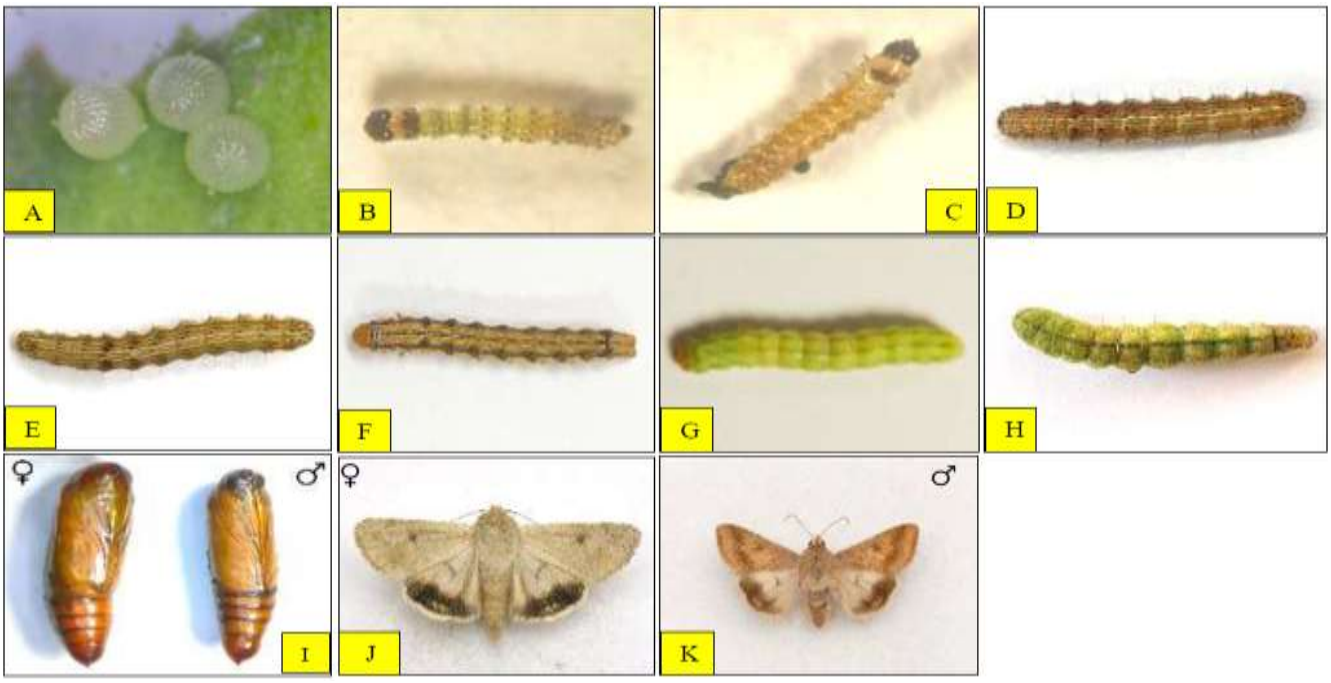

Fig.1: Life stages of *H. armigera,* A) Eggs, B) First instar, C) Second instar, D) Third instar, E) Fourth instar, F) Fifth instar, G) Sixth instar, H) Pre-pupa, I) Female(Left) and Male(Right) Pupa, J) Female moth, K) Male moth

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