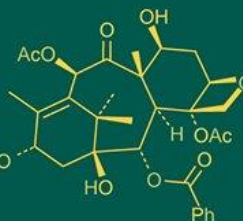
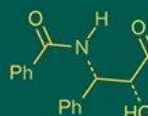


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Biology and morphometric characterization of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) on field pea under laboratory conditions

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Abstract

The present study aimed to investigate the biology and morphometrics of *Helicoverpa armigera* (Lepidoptera) on field pea under laboratory conditions. The experiment was conducted in the Department of Entomology, CCS Haryana Agricultural University, Hisar. The study revealed that a single female laid 397 to 507 eggs (Mean $\pm$ SD 456.00 $\pm$ 43.28 eggs), preferably singly on pods, flowers and leaves of field pea. The incubation period of eggs ranged from 3.69 to 4.07 days (Mean $\pm$ SD 3.91 $\pm$ 0.16 days). After hatching, the larvae passed through six instars. The total larval and pupal periods averaged 22.50 $\pm$ 2.28 days and 10.04 $\pm$ 1.23 days, respectively. The average longevity of male and female adults was 8.70 $\pm$ 0.48 days and 10.80 $\pm$ 0.79 days, respectively. *Helicoverpa armigera* completed its total life cycle within 40 to 51 days under laboratory conditions.

Keywords: *Helicoverpa armigera*, field pea, biology, morphometrics, life cycle, developmental stages

1. Introduction

Field pea, *Pisum sativum* L. (Family: Leguminosae), is an important grain legume crop cultivated during the Rabi season throughout the world and is believed to have originated in Western Asia and Europe (Bijur and Verma, 1997) [2]. Fresh green peas (100 g edible portion) contain 44 calories, 75.6% moisture, 6.2 g protein, 0.4 g fat, 16.9 g carbohydrates, 2.4 g fibre, 0.9 g ash, 32 mg calcium, 102 mg phosphorus, 1.2 mg iron, 6 mg sodium, 350 mg potassium, 405 μ g beta-carotene equivalent, 0.28 mg thiamine, 0.11 mg riboflavin, 2.8 mg niacin and 27 mg ascorbic acid. In contrast, dried peas contain 10.9% moisture, 22.9% protein, 1.4% fat, 60.7% carbohydrates, 1.4% fibre and 2.7% ash per 100 g (Duke, 1981; Hulse, 1994) [8]. During 2024, field pea occupied about 7.72 lakh hectares in India, producing 10.67 lakh metric tonnes with an average productivity of 1.38 tonnes ha⁻¹ (FAO, 2024). In Haryana, the crop is grown over 4.1 thousand hectares with a production of 3.2 thousand tonnes and an average productivity of 780 kg ha⁻¹. Crop productivity is adversely affected by inadequate crop management practices as well as various abiotic and biotic stresses. Among the biotic factors, insect pests are considered one of the major causes of yield losses. Among them, *Etiella zinckenella* and *Helicoverpa armigera* attack the crop during flowering and pod development stages and are regarded as important constraints responsible for reduced productivity and deterioration in grain quality. The early instars of *H. armigera* initially feed on leaves and flowers and subsequently bore into the pods, feeding on developing seeds while keeping a part of their body outside the pod. A single larva is capable of damaging several pods during its development. Singh *et al.* (2004) [20] reported that pod damage caused by pod borers in field pea varied from 1.0 to 4.0 percent. Knowledge of biological parameters such as fecundity, egg hatchability, duration of larval stages, larval and pupal mortality, and adult emergence can help identify the most vulnerable stages of the insect and facilitate the adoption of timely and effective management strategies.

2. Materials and Methods

2.1 Laboratory Culture of *H. armigera*

Studies on different biological parameters of *Helicoverpa armigera* were conducted under laboratory conditions in the Department of Entomology at a temperature of 28 $\pm$ 1 °C and

relative humidity of 60-70 percent using field pea cv. HFP-1428. For establishing the culture, an adequate number of fully grown larvae of *H. armigera* were collected from field pea plots during January, 2024. Since the larvae exhibit cannibalistic behaviour, they were maintained individually in glass tubes of 7 × 2.5 cm dimensions. Tender leaves and pods of field pea cultivar HFP-1428 were provided as food to 100 individually reared larvae. The glass tubes were plugged with cotton and fresh, unsprayed leaves and pods collected from the field were supplied daily by replacing the old food material. The larvae completed their development and pupated inside the soil provided in the glass tubes. After adult emergence, male and female moths were paired and released into glass jars measuring 15 × 10 cm. The openings of the jars were covered with muslin cloth and fastened securely with rubber bands. Two folded paper strips were hung inside each jar to provide resting sites for the moths. Fresh twigs of field pea were placed inside the jars to encourage oviposition. To prevent desiccation and maintain leaf freshness, the cut ends of the twigs were wrapped with water-soaked cotton swabs. Cotton swabs dipped in 10 percent sugar solution were provided as food for the adults. Females laid eggs on the leaves, muslin cloth and inner surface of the jars. The eggs were carefully collected with the help of a moist camel hair brush and transferred to Petri dishes for recording the incubation period and egg viability.

2.2 Egg

Ten pairs of freshly emerged male and female moths were maintained separately in specimen jars containing fresh field pea twigs for oviposition in order to record the pre-oviposition, oviposition and post-oviposition periods. The twigs were replaced every day. A cotton swab soaked in 10 percent honey solution was squeezed and suspended inside each specimen jar to serve as a food source for the moths, and fresh swabs were provided daily. The females used for recording the oviposition period were also observed to determine their total fecundity. For fecundity studies, leaves bearing eggs from the twigs were detached and the eggs present on them were counted. A field pea twig containing a known number of eggs was placed on blotting paper inside a Petri dish. A moist cotton swab was wrapped around the petiole of the leaf to maintain adequate humidity and to prevent desiccation of both the eggs and the leaf. Egg hatching was observed at 24-hour intervals in five such replicates. The number of eggs hatched each day was recorded and converted into percentage hatchability, and observations were continued until completion of hatching. The mean incubation period was calculated from these egg batches.

2.3 Larva

To determine the number and duration of larval instars, twenty newly hatched larvae were reared individually in separate specimen tubes. Fresh field pea twigs bearing pods were provided regularly as food for the developing larvae. The duration of each larval instar was determined by observing the cast exuviae. The exuviae of the early instars were examined daily under a stereoscopic binocular microscope, whereas those of the later instars were detected either with the help of a hand lens or by naked eye observations.

2.4 Pupa

For studying the pupal period, five groups (replications) of pupae, each consisting of ten individuals, were maintained

separately in Petri dishes and examined daily for adult emergence. The pupal duration was calculated based on the number of days taken for adult emergence from the pupae, and adult emergence was subsequently expressed as percentage.

2.5 Adult

Twenty newly emerged adults were paired individually (one male and one female) and each pair was maintained in a separate specimen jar. A cotton swab soaked in 10 percent honey solution was provided as food, along with fresh field pea twigs bearing pods. The adults were examined daily and their mortality was recorded to determine adult longevity. For estimating the sex ratio, five batches of pupae, each comprising ten individuals, were maintained and observed for adult emergence. The emerged adults were killed in a killing bottle and sexed on the basis of their morphological characteristics. The total life cycle of *H. armigera* was determined by recording the time interval from egg laying to adult emergence. These observations were made in ten replications.

2.6 Morphometrics

The length and width of different developmental stages were recorded during the first generation using an ocular micrometer and a stage micrometer. Measurements were taken for ten individuals of each stage, including egg, first to sixth larval instars, pupa, and adult males and females, with the aid of a stereoscopic zoom binocular microscope.

2.7 Statistical Analysis

The data generated during the present investigation were subjected to statistical analysis. The observations recorded on various biological parameters of *Helicoverpa armigera* were analyzed by computing the mean and standard deviation for each parameter.

3. Results and Discussion

The data presented in Table 1 were examined to study the various biological parameters of *Helicoverpa armigera*, which are described below:

3.1 Pre-oviposition, Oviposition and Post oviposition Period

The data presented in Table 1 revealed that the pre-oviposition, oviposition and post-oviposition periods of *H. armigera* varied from 2 to 4 days (Mean ± SD 2.70±0.82 days), 5 to 6 days (Mean ± SD 5.50±0.53 days) and 1 to 2 days (Mean ± SD 1.50±0.53 days), respectively. The present findings are in close agreement with those reported by Singh *et al.* (2023) ^[21], who observed pre-oviposition, oviposition and post-oviposition periods ranging from 2-3 days (average 2.46±0.29 days), 5-8 days (average 6.33±0.14 days) and 1-2 days (average 1.67±0.14 days), respectively. Similar results were also obtained by Sharma *et al.* (2019) ^[18], who recorded mean durations of 2.56±0.50, 5.80±0.86 and 2.40±0.50 days for pre-oviposition, oviposition and post-oviposition periods, respectively.

3.2 Fecundity and Adult Longevity of *H. armigera*

Observations on the eggs revealed that females deposited eggs on the muslin cloth, paper strips and also on the plant parts provided as food inside the cage. Eggs were generally laid singly, predominantly on pods, flowers and leaves of field pea. Freshly laid eggs of the gram pod borer were

spherical and creamy white in colour, which gradually turned dark brown prior to hatching. A single female deposited 397 to 507 eggs during her lifetime, with an average fecundity of 456.00 ± 43.28 eggs (Table 1). The present findings corroborate those of Shinde *et al.* (2022) ^[19], who reported an average fecundity of 453.19 eggs per female. Similar results were obtained by Sharma *et al.* (2019) ^[18], who recorded an average of 490.20 ± 77.87 eggs per female. Comparable observations were also reported by PuRabiya *et al.* (2024) ^[16], who observed a fecundity ranging from 424 to 631 eggs with a mean of 544.85 ± 63.89 eggs per female.

The longevity of male and female moths ranged from 8 to 9 days (Mean $\pm$ SD 8.70 ± 0.48 days) and 10 to 12 days (Mean $\pm$ SD 10.80 ± 0.79 days), respectively, indicating that females survived longer than males (Table 1). These findings are in close conformity with those reported by Gadhiya (2014) ^[10], who observed the longevity of mated male and female moths to range from 7 to 8 days (average 7.64 ± 0.49 days) and 8 to 10 days (average 9.08 ± 0.70 days), respectively. Similar observations were also made by PuRabiya *et al.* (2024) ^[16], who recorded adult longevity ranging from 8 to 10 days (average 9.04 ± 0.78 days) for males and 9 to 12 days (average 10.54 ± 0.99 days) for females.

3.3 Incubation Period and Hatchability of Eggs

The incubation period of *H. armigera* eggs ranged from 3.69 to 4.07 days, with an average duration of 3.91 ± 0.16 days (Table 1). The present findings are in close agreement with those of Chauhan *et al.* (2018) ^[4] and Sharma *et al.* (2019) ^[18], who reported an incubation period varying from 3 to 5 days. Likewise, Shinde *et al.* (2022) ^[19] observed the maximum incubation period on soybean (3.20 days), followed by sunflower (3.10 days), maize (2.69 days) and sorghum (2.54 days). Egg hatchability varied from 78 to 86 percent, with a mean hatchability of 80.80 ± 3.35 percent (Table 1). Similar results were reported by Chauhan *et al.* (2018) ^[4], who recorded 87.65 percent egg hatchability on chickpea. The present observations are also in close accordance with those of Shinde *et al.* (2022) ^[19], who reported the highest hatchability on sunflower and maize (90.00%), followed by sorghum (89.00%) and soybean (87.00%).

3.4 Larval Period

The present investigation showed that *H. armigera* passed through six larval instars and completed the larval period in 19 to 26 days, with a mean duration of 22.50 ± 2.28 days. Similar findings were reported by Shinde *et al.* (2022) ^[19], who recorded a larval period of 22.20 days on soybean, followed by sunflower (20.54 days), sorghum (19.52 days) and maize (18.87 days). The duration of the first instar ranged from 2 to 3 days, with an average of 2.55 ± 0.51 days. The second instar, which was reddish-brown in colour and possessed dark hairs, remained active for 3 to 4 days (average 3.40 ± 0.50 days) before moulting. The third instar lasted for 3 to 4 days, with a mean duration of 3.55 ± 0.51 days. The fourth instar persisted for 3 to 5 days and averaged 3.75 ± 0.85 days. The fifth instar continued for 4 to 5 days, with an average duration of 4.40 ± 0.50 days. The

sixth and final instar remained active for 4 to 6 days and recorded a mean duration of 4.90 ± 0.81 days before entering the pupal stage (Table 1). These findings are in close conformity with those of Chauhan *et al.* (2018) ^[4], who reported that the durations of the first, second, third, fourth, fifth and sixth larval instars varied from 2-3 days (average 2.48 ± 0.51 days), 2-4 days (average 2.76 ± 0.72 days), 2-5 days (average 3.08 ± 1.08 days), 2-5 days (average 2.92 ± 0.90 days), 3-6 days (average 3.72 ± 0.94 days) and 3-6 days (average 4.24 ± 0.93 days), respectively, before moulting.

3.5 Pupal Period

Pupation was observed on the inner surface of the glass jars, soil, muslin cloth and tissue paper in all five observations. The pre-pupal period of *H. armigera* ranged from 1.70 to 2.10 days, with an average duration of 1.92 ± 0.18 days (Table 1). Similar findings have been reported by several researchers. Ali *et al.* (2009) ^[1] observed a pre-pupal period of 1 to 3 days, with a mean duration of 2.15 ± 0.16 days. Rabari *et al.* (2017) ^[17] recorded a pre-pupal period varying from 1 to 3 days with an average of 1.93 ± 0.69 days, whereas Sharma *et al.* (2019) ^[18] reported duration of 1 to 2 days with a mean of 1.48 ± 0.50 days. The pupal period varied from 8.30 to 11.60 days and averaged 10.04 ± 1.23 days. These findings are in agreement with those of Ali *et al.* (2009) ^[1], who reported a pupal duration ranging from 10 to 14 days with an average of 13.15 ± 0.27 days. Similarly, Baikar and Naik (2016) ^[13] recorded a pupal period of 13 to 15 days with a mean duration of 13.8 ± 0.84 days, while Sharma *et al.* (2019) ^[18] observed a pupal period ranging from 11 to 15 days with an average of 13.48 ± 1.29 days.

3.6 Adult Emergence

Adult emergence ranged from 80 to 100 percent, with an average emergence of 88.00 ± 8.37 percent (Table 1). The present findings are in close agreement with those of Goyal and Rathore (1988) ^[11], who observed 100 percent adult emergence when *H. armigera* larvae were reared on gram leaves and pods under laboratory conditions at 30 ± 1 °C. Similar results were reported by Srivastava and Srivastava (1990) ^[22], who recorded adult emergence ranging from 80 to 90 percent on different chickpea genotypes under laboratory conditions.

3.7 Sex Ratio

Male and female moths were distinguished on the basis of forewing colouration. The forewings of male moths were greenish-brown, whereas those of females were orange-brown. The percentage of male and female moths varied from 37.50 to 60.00 (Mean $\pm$ SD 47.28 ± 8.38) and 40.00 to 62.50 (Mean $\pm$ SD 52.72 ± 8.38), respectively. The sex ratio (female: male) ranged from 1.0:0.6 to 1.0:1.5, with an average of 1.0:0.94, indicating a slight predominance of females (Table 2). The present findings are in accordance with those reported by earlier workers. Dahegaonkar and Mohite (2014) ^[6] observed a sex ratio of 1:0.66 (F:M) in *H. armigera*. Similarly, Baikar and Naik (2016) ^[13], Rabari *et al.* (2017) ^[17], and PuRabiya *et al.* (2024) ^[16] reported sex ratios of 1:0.78 (F:M), 1:0.87 (F:M), and 1:0.76 (F:M), respectively.

Table 2: Sex ratio of *Helicoverpa armigera*

Pupae observed	Total no. of adult emerged	Males (No.)	Females (No.)	Males (%)	Females (%)	Sex ratio
Mean $\pm$ SD	44	21	23	47.28 $\pm$ 8.38	52.72 $\pm$ 8.38	1.0 :0.94

3.8 Total Life Cycle

The data presented in Table 1 revealed that the total life cycle of *H. armigera* ranged from 40 to 51 days, with an average duration of 46.2 $\pm$ 3.55 days. The present findings are in close agreement with those of Gadhiya (2014) [10], who reported that the total life cycle of *H. armigera* varied

from 40 to 61 days (average 49.40 $\pm$ 5.21 days) in males and from 43 to 65 days (average 52.40 $\pm$ 7.03 days) in females. Similar observations were made by Singh *et al.* (2023) [21], who recorded the average total life span of male and female adults as 50.30 $\pm$ 7.51 days and 53.50 $\pm$ 7.93 days, respectively.

Table 1: Developmental period of different life stages of *Helicoverpa armigera*

Sl. No.	Parameters observed		Range	Mean $\pm$ SD
1.	Pre-oviposition period (days)		2-4	2.70 $\pm$ 0.82
2.	Oviposition period (days)		5-6	5.50 $\pm$ 0.53
3.	Post-oviposition period (days)		1-2	1.50 $\pm$ 0.53
4.	Fecundity		397-507	456.00 $\pm$ 43.28
5.	Incubation period (days)		3.69-4.07	3.91 $\pm$ 0.16
6.	Hatchability (%)		78-86	80.80 $\pm$ 3.35
7.	Larval instar period (days)			
	1 st instar		2-3	2.55 $\pm$ 0.51
	2 nd instar		3-4	3.40 $\pm$ 0.50
	3 rd instar		3-4	3.55 $\pm$ 0.510
	4 th instar		3-5	3.75 $\pm$ 0.85
	5 th instar		4-5	4.40 $\pm$ 0.50
	6 th instar		4-6	4.90 $\pm$ 0.81
8.	Total larval period (days)		19-26	22.50 $\pm$ 2.28
9.	Total pupal period (days)		8.30-11.60	10.04 $\pm$ 1.23
10.	Adult emergence		80-100	88.00 $\pm$ 8.37
11.	Adult longevity			
	Under laboratory conditions	Female	10-12	10.80 $\pm$ 0.79
		Male	8-9	8.70 $\pm$ 0.48
12.	Sex-ratio (Male:Female)		1.0:0.6-1.0:1.5	1.0 :0.94
13.	Total life cycle		40-51	46.2 $\pm$ 3.55

3.9 Morphometrics of Various Developmental Stages

Egg

Freshly deposited eggs of *H. armigera* were spherical in shape and creamy white in colour, which gradually changed to a darker shade before hatching. The egg length varied from 0.34 to 0.52 mm, with an average of 0.44 $\pm$ 0.06 mm, whereas the width ranged from 0.41 to 0.62 mm, averaging 0.51 $\pm$ 0.06 mm (Table 3). The present observations are in close agreement with those of Chavan *et al.* (2014) [5], who reported the mean length and breadth of eggs as 0.48 $\pm$ 0.07 mm and 0.50 $\pm$ 0.07 mm, respectively. Similar findings were also recorded by Jat *et al.* (2020) [14], who observed average egg dimensions of 0.51 $\pm$ 0.06 mm $\times$ 0.46 $\pm$ 0.37 mm on an artificial diet and 0.52 $\pm$ 0.03 mm $\times$ 0.48 $\pm$ 0.62 mm on a natural diet (pigeon pea), which are comparable with the present results.

3.9.2 Larva

The larval stage of *H. armigera* comprised six instars, with body dimensions increasing progressively after each moult. The first instar larvae were relatively small, measuring 1.20 to 1.82 mm in length and 0.36 to 0.50 mm in width, with mean values of 1.52 $\pm$ 0.18 mm and 0.44 $\pm$ 0.05 mm, respectively. The second instar larvae attained a length ranging from 3.40 to 5.10 mm (average 4.12 $\pm$ 0.57 mm), whereas the width varied from 0.52 to 0.74 mm with an average of 0.64 $\pm$ 0.07 mm. In the third instar, the larvae measured 7.18 to 9.23 mm in length (average 8.14 $\pm$ 0.75 mm) and 0.79 to 0.87 mm in width (average 0.83 $\pm$ 0.03

mm). The fourth instar larvae exhibited a length ranging from 10.48 to 17.82 mm, with a mean of 14.53 $\pm$ 2.10 mm, while the width varied from 0.96 to 1.21 mm, averaging 1.10 $\pm$ 0.10 mm. The fifth instar larvae measured 18.21 to 25.63 mm in length (average 21.35 $\pm$ 3.01 mm) and 1.82 to 2.61 mm in width (average 2.22 $\pm$ 0.29 mm). The sixth and final instar was the largest, with a body length ranging from 28.33 to 33.85 mm and an average of 31.17 $\pm$ 1.96 mm, whereas the width varied from 2.80 to 3.22 mm, with a mean of 3.04 $\pm$ 0.16 mm (Table 3). Similar findings were reported by Parmar (2006) [15], who observed larval lengths and breadths of 1.74 $\pm$ 0.12 and 0.30 $\pm$ 0.01 mm, 4.85 $\pm$ 0.42 and 0.49 $\pm$ 0.02 mm, 8.46 $\pm$ 0.47 and 1.01 $\pm$ 0.17 mm, 17.42 $\pm$ 0.75 and 2.21 $\pm$ 0.10 mm, and 28.76 $\pm$ 1.05 and 3.56 $\pm$ 0.14 mm for the respective larval instars. These results are in conformity with the present findings.

3.9.3 Pupa

Based on morphological characteristics, freshly formed pupae were soft and pale brown to greenish in colour, which gradually changed to dark brown within a few hours. Sex differentiation at the pupal stage was carried out on the basis of the distance between the genital and anal openings. In male pupae, the genital opening was situated on the ninth abdominal segment, whereas in female pupae it was located on the eighth abdominal segment. In both sexes, the anal opening was present on the tenth abdominal segment. Consequently, the distance between the genital and anal openings was greater in female pupae than in male pupae.

Female pupae measured 16.65 to 22.05 mm in length, with an average of 19.22 ± 1.76 mm, while the width ranged from 5.85 to 7.55 mm, averaging 6.74 ± 0.64 mm (Table 3). Male pupae were comparatively smaller, with lengths varying from 14.54 to 18.93 mm (Mean $\pm$ SD 16.32 ± 1.64 mm) and widths ranging from 5.22 to 6.34 mm (Mean $\pm$ SD 5.72 ± 0.37 mm). Similar observations were reported by Jat *et al.* (2020) [14], who recorded average dimensions of male pupae as 18.82 ± 1.19 mm $\times$ 3.58 ± 1.29 mm on an artificial diet and 20.33 ± 0.05 mm $\times$ 4.79 ± 1.63 mm on a natural diet (pigeon pea). The corresponding measurements for female pupae were 19.23 ± 1.58 mm $\times$ 4.86 ± 1.22 mm on an artificial diet and 19.41 ± 1.33 mm $\times$ 4.94 ± 1.50 mm on a natural diet. These findings are in close agreement with the present investigation.

3.9.4 Adult

The adults of *H. armigera* were stout-bodied moths possessing a broad thorax. Their antennae were filliform, non-sexually dimorphic and covered with fine hairs. Male and female moths could be easily distinguished by the colouration of their forewings. The forewings of males were

greenish-brown, whereas those of females varied from orange-brown to dark brown. In both sexes, the hind wings were dull creamy in colour and possessed a broad dark-brown band at the apical margin, which was interrupted by a pale patch. Female moths measured 18.89 to 20.78 mm in body length, with an average of 19.94 ± 0.56 mm, and exhibited a wingspan ranging from 38.81 to 41.59 mm, averaging 40.12 ± 1.04 mm. In comparison, male moths were smaller, with body lengths varying from 17.46 to 18.47 mm (Mean $\pm$ SD 17.86 ± 0.32 mm) and wingspans ranging from 34.08 to 36.68 mm (Mean $\pm$ SD 35.41 ± 0.85 mm) (Table 3). Similar observations were reported by Deepa and Srivastava (2010), who described male moths as greenish-grey in colour, while females were orange-brown. They also recorded pre-emergence periods of 9.25 ± 0.19 days in males and 11.08 ± 0.38 days in females. Comparable findings were documented by Herald and Tayde (2018) [12], who observed an average body length of 17.94 ± 0.52 mm and a wingspan of 36.22 ± 0.94 mm in male moths, whereas female moths recorded an average body length of 19.38 ± 0.73 mm and a wingspan of 40.26 ± 0.87 mm. These observations are in close conformity with the present findings.

Table 3: Morphometric measurement of different developmental stages of *Helicoverpa armigera*

Number observed	Developmental Stage	Length (mm)	Range	Width(mm)	Range
10	Egg	0.44 ± 0.06	0.34-0.52	0.51 ± 0.06	0.41-0.62
Larva					
10	1 st instar	1.52 ± 0.18	1.20-1.82	0.44 ± 0.05	0.36-0.50
10	2 nd instar	4.12 ± 0.57	3.40-5.10	0.64 ± 0.07	0.52-0.74
10	3 rd instar	8.14 ± 0.75	7.18-9.23	0.83 ± 0.03	0.79-0.87
10	4 th instar	14.53 ± 2.10	10.48-17.82	1.10 ± 0.10	0.96-1.21
10	5 th instar	21.35 ± 3.01	18.21-25.63	2.22 ± 0.29	1.82-2.61
10	6 th instar	31.17 ± 1.96	28.33-33.85	3.04 ± 0.16	2.80-3.22
Pupa					
10	Female pupa	19.22 ± 1.76	16.65-22.05	6.74 ± 0.64	5.85-7.55
10	Male pupa	16.32 ± 1.64	14.54-18.93	5.72 ± 0.37	5.22-6.34
Adult					
10	Female	19.94 ± 0.56	18.89-20.78	40.12 ± 1.04	38.81-41.59
10	Male	17.86 ± 0.32	17.46-18.47	35.41 ± 0.85	34.08-36.68

4. Conclusion

Therefore, the information generated on the biology, behaviour and developmental characteristics of *H. armigera* in the present study may be utilized for developing effective management strategies by targeting the most vulnerable stages of its life cycle, thereby ensuring efficient pest suppression while promoting the conservation of biodiversity.

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6. Competing Interests

The authors declare that they have no competing interests.

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