Investigation on biology of *Helicoverpa armigera* (Hubner) on chickpea under laboratory condition

Abstract

The *Helicoverpa armigera* (Hubner) is a polyphagous pest which is found throughout world. Due to its damaging nature, it causes quantitative as well as qualitative loss and finally over all economic loss in agricultural crop production. So present investigation was done byrearing of *H. armigera* on chickpea under laboratory condition. The study revealed that this pest has four distinct stages i.e., egg, larva, pupa and adult for completing its life cycle. The total life cycle of male and female was completed in 49-50 days and 52.30-53.00 days, respectively.Whole life period was divided as incubation period takes 4-5 days, larval stage was completed in 20.00-20.50 days by passing through six instars under laboratory conditions at temperature of 27±1^{0}C with 70±5 % relative humidity in 12 hours light. The last larval instar did not moult and its contracted into a grub like pre-pupal stage which lasted for 2-3 days and pupal period 13-14 days. The adult period of male and female insects was completed in 8.50-9.00 and 12.00-12.50 days, respectively. The female moths had a pre-oviposition period of 3-4 days that included sexual maturity period. The oviposition and post-oviposition period recorded were 5-6 days and 2 days, respectively. A single female produced on an average 992.50-1085 eggs throughout her entire life span. The average hatching percentage of eggs recorded on 63.00-67.50 percent.

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

Introduction

Helicoverpa armigera (Hubner)commonly known as the cotton bollworm or chickpea pod borer, is a polyphagous pest belongs order lepidoptera family noctuidae. *Helicoverpa armigera* are typically dull light brown in color with a wing expanse of 30-45 mm. Fore wings of the moth are with a series of irregular, a pale band near the margin. Hind wings are pale with a dark broad outer margin with a pale patch in it. Lifecycle of *H. armigera* take 4-6 weeks from egg to adult in summer and 8-12 weeks in spring or autumn.The lifecycle stages are egg, larva, pupa and adult. The female moths lay eggs on tender parts of the plant, a single moth can lay up to500-890 eggs. The freshly laid eggs are yellowish-white in colour. The apical area of egg is smooth and the rest of the surface sculptured in the form of longitudinal ribs. Larva had six distinct instars in chickpea (Ali *et al.,* 2009). Thus, it causes significant damage to various crops due to having a wide and large diverse range of host plant in major agricultural crops, including chickpea.

In India Chickpea (*Cicer arietinum* L.) is an important legume pulse crop (family: Fabaceae)andalso known as king of pulses, Ceci bean, Bengal gram, Garbanzo bean, Chana and

Sanagalu bean. This is rich source of protein among the food crops grown in India so it is also known as poor man' meat. India is the largest producer and consumer of pulses which constitutes about 27 per cent of Indian diet. It is most important pulse crop of the world, cultivated in an area of 13.84 million hectares with a production of 13.65 million tonnes. In India chickpea, is grown in an area of 9.85 million hectares with production of 11.99 million tonnes. In India, Rajasthan is the largest chickpea growing state with an area of 2.46 million hectares with production of 2.66 million tonnes followed by Maharashtra and MP. Uttar Pradesh is the 4th largest producer with an area of 0.62 million hectares with production of 0.85 million tonnes (Anonymous, 2021).Chickpea pods in raw form are consumed as both whole fried or boiled and salted. It is made into split pulse (Chana dal) which is cooked and eaten and as flour (Besan) out of which a variety of dishes like snacks and sweets are made. Fresh green leaves and grains are used as vegetables (Chhole). It is being used increasingly as a substitute for animal protein. The straw of chickpea is an excellent source of fodder for cattle besides both husk and bits of the 'Dal' serve as valuable cattle feed. Chickpea seed contains 18.22 per cent protein, 16-62 per cent total carbohydrate, 47 per cent starch, 5 percent fat, 6 per cent crud fibre, 6 per cent soluble sugar and 3 per cent ash (Jukanti *et al.*, 2012). Although pulses have been consumed for thousands of years for their nutritional qualities (Kerem *et al.*, 2007).Then what? is this sentence complete?

Understanding the reproductive biology of *Helicoverpa armigera* on chickpea is equally imperative. Studies delve into aspects such as mating behavior, fecundity, fertility, and oviposition preferences of adult moths reared on chickpea plants in laboratory conditions. Observations of egg-laying patterns and the number of eggs laid per female provide insights into the reproductive potential and population dynamics of this pest species. In laboratory settings, researchers conduct comprehensive studies to elucidate the various aspects of *Helicoverpa armigera* life cycle, behavior, and interactions with chickpea plants. These studies typically encompass several key elements that shed light on the dynamics of this pest species.You don't go for control measures? What is your last goal?

Materials and Methods

The present studyentitled "Investigationonbiology of *Helicoverpa armigera* (Hubner) on chickpea under laboratory condition" were carried out at the Department of Entomology C. S. Azad University of Agriculture and Technology, Kanpur during rabi season 2021-22 and 2022-23. The culture of *Helicoverpa armigera* was reared in laboratory of the Department of Entomology at the constant temperature of 27±1°C and 70±5% relative humidity and 12 hours light. A pure culture of *Helicoverpa armigera* was developed by collecting its larvae from the field and their rearing in laboratory to get the sufficient adult emergence, which were held in glass jars of 20x15cm size and offered 10 percent glucose solution in cotton swab as food to them. Folded papers were kept in the jar to serve as substrate for resting and egg laying.

The eggs were laid singly on marking cloth. These eggs as well as pupae were treated along with the cloth in sodium hypochloride solution to prevent the viral infection in culture, the

larvae on hatching, were transferred to glass vial (10x2.5cm) containing approximately 10g of artificial diet as described by Sri *et al*. (2010). They were fed on the artificial diet, having chickpea flour (100g), agar-agar (12.8g), yeast (30.0g) methyl-para-hydroxy benzoate (2.0g), sorbic acid (1.0g), ascorbic acid (3.2g), Wesson salt mix (7.2g). streptomycin sulphate (40g), vitamin supplement (2.0ml), choline chloride (10% 7.2ml), formaldehyde (40% 1.0ml), carbendazim (0.500g), water (720ml) and covered with black cloth on attaining the second instar (1.5 to 2 cm long) the larvae were transferred to individual vials (7.5x2.5 cm) to avoid cannibalism. As soon as pupation takes place inside the vials, it was separated 2-3 days after pupation to avoid damage by Armes *et al*. (1992).

Results and Discussion

The freshly laid eggs were hemispherical in shape with a flat base and yellowish white in colour and changed to deep yellow after a day and then changed to dark or grey black a day before hatching. The average incubation period was recorded as 5.00 ±1.41 and 4.00 ±1.41 days during 2021-22 and 2022-23(Table-1&2). The average hatching percentage of eggs recorded on 63.00±7.07 and 67.50±7.78 percentat respective years (Table-3&4). These findings are in accordance with the results of earlier workers, Baikar and Naik (2016), Chaitanya *et al*. (2014), Chakravarty *et al*. (2018), Choudhury *et al*. (2013),Nunes *et al*. (2017) and Sharma *et al*. (2019).If such a result is there, what is the purpose of studying then? Is it important to study again? What is you justification?

The larva passed through six instars. Freshly emerged first instar larvae were translucent and yellowish white in colour with black head, while, second instar larva was yellowish green in colour with black thoracic legs. The full-grown larva was brownish or pale green brown lateral strips and distinct dorsal stripe and it was long and ventrally flattened but convexdorsally. The average larval period of first, second, third, fourth, fifth and sixthinstar larva were 3.50±0.71, 2.50±0.71, 2.50±0.71, 3.50±0.71, 4.00±1.41 and 4.50±2.12,at respectivedays during 2021-22 (Table-1).During 2022-23, the average larval period of first, second, third, fourth, fifth and sixth instar larva were2.50±0.71, 3.00±1.41, 2.50±0.71, 3.50±0.71, 4.00±1.41 and4.50±2.12,at respective days. (Table-2). Total larval development period was on an average of 20.50±6.36 and 20.00±7.07 days in during 1st and 2ndyear(Table-1&2).The present findings also supported by Baikar and Naik (2016), Chakravarty *et al*. (2018),Deepa and Srivastava (2010), Jaykumar *et al*. (2005), Nunes *et al*. (2017) and Sharma *et al*. (2019).Then what?

In this stage, the full-grown larva becomes sluggish, wrinkled and suspended feeding and movement. The average of pre-pupal stage was 2.00±1.41 and 3.00±1.41 days, respectively during 1st and 2ndyear (Table-1&2).In agreement of our findings, Acharya *et al*. (2007), Baikar and Naik (2016), Chaitanya *et al*. (2014), Chakravarty *et al*. (2018), Nunes *et al*. (2017), Sharma *et al*. (2019) and Singh and Yadav (2009).Do you think this sentence is complete?

Freshly formed pupa was light green yellowish in colour but later on turned into dark brown prior to emergence of moth. The pupa was object type, broadly rounded interiorly and tapered posteriorly. The average duration pupal stage was 13.00±4.24 and 14.00±2.83 days at respective year (Table-1&2).Insupport of our findings, Acharya *et al*. (2008), Baikar and Naik (2016), Chaitanya *et al*. (2014), Chakravarty *et al*. (2018), Nunes *et al*. (2017) andSharma *et al*. (2019) also found.Do you think this sentence is grammatically correct?

The adult moth was brownish colour, forewing was pale brown with a series of dots on margins and a black kidney shaped mark on the underside of each forewing. Hind wings were lighter in colour with dark patch at the apical end. The female moth was slightly bigger than male moth and was identified by the presence of tuft of hair on the tip of the abdomen. The average time duration male stage was 8.50±2.12 and 9.00±1.41 days and female stage was 12.00±2.83 and 12.50±3.54 days,respectively during 1st and 2nd year (Table-1&2).The present findings also supported by Baikar and Naik (2016), Chakravarty *et al*. (2018), Nunes *et al*. (2017) and Sharma *et al*. (2019).I am afraid the English construction is not correct?

Table-1: Period of various stages of gram pod borer, *Helicoverpa armigera* (Hubner) reared on chickpea in laboratory condition during *Rabi* 2021-22.

Sl. No.	Stage	Period (days)		
		Min.	Max.	Av. ± S.D.
1	Incubation period	4	6	5.00±1.41
2	Larval period			

	I instar	3	4	3.50±0.71
	II instar	2	3	2.50±0.71
	III instar	2	3	2.50±0.71
	IV instar	3	4	3.50±0.71
	V instar	3	5	4.00±1.41
	VI instar	3	6	4.50±2.12
	Total larval period	16	25	20.50±6.36
3	Prepupa period	1	3	2.00±1.41
	Pupal period	10	16	13.00±4.24
4	Adult period			
	Male	7	10	8.50±2.12
	Female	10	14	12.00±2.83
5	Total life period			
	Male	38	60	49.00±15.56
	Female	41	64	52.50±16.26

My advice to the chief editor is to thoroughly review the manuscript for unacceptable mistakes before sending it to reviewers, as it is poorly constructed and contains numerous elementary grammatical errors.

Table-2: Period of various stages of gram pod borer, *Helicoverpa armigera* (Hubner) reared on chickpea in laboratory condition during *Rabi* 2022-23.

Sl. No.	Stage	Period (days)		
		Min.	Max.	Av. ± S.D.
1	Incubation Period	3	5	4.00±1.41
2	Larva Period			
	I instar	2	3	2.50±0.71
	II instar	2	4	3.00±1.41
	III instar	2	3	2.50±0.71
	IV instar	3	4	3.50±0.71
	V instar	3	5	4.00±1.41
	VI instar	3	6	4.50±2.12
	Total larval period	15	25	20.00±7.07
3	Prepupa period	2	4	3.00±1.41
	Pupal period	12	16	14.00±2.83
4	Adult period			
	Male	8	10	9.00±1.41
	Female	10	15	12.50±3.54
5	Total life period			
	Male	40	60	50.00±14.14
	Female	42	65	53.50±16.26

Pre-oviposition, oviposition and post-oviposition periods:

The average number of eggs laid by a female of *Helicoverpa armigera* was 992.50±505.58 and 1085.00±615.18 respectively both years. The average pre-oviposition period was noticed 3.00±1.41 and 4.00±1.41 day respectively both years. The average oviposition and

post-oviposition periods were 6.00±1.41 and 2.00±1.41 days during first and during second year, 5.00±1.41 and 2.00±1.41 days, respectively. The average hatching percentage of eggs was 63.00±7.07 and 67.50±7.78 days during 1st& 2nd year (Table-3&4).Ali *et al*. (2009), Gadhiya *et al*. (2014) and Patel *et al*. (2011). For what are these citations, already a period is there?

The total life period (egg to death of adult) of *Helicoverpa armigera*an averageof49.00±15.56and 50.00±14.14 days in males and females was52.50±16.26 and 53.50±16.26 days in during 1st and 2nd year (Table-1&2). Clearly indicating that *Helicoverpa armigera*females have longer average life that the males Deepa and Srivastava (2010), Choudhury *et al*. (2013) and Parmar (2006).Very difficult to understand. Sentences end up with …

The present findings also supported by Bhatt and Patel (2001) studied biology of *Helicoverpa armigera* at room temperature during December 1998 to February 1999. There were six larval instar and larval period was 20.60±1.78 days while pupal period was 16.21±1.40 days. The average longevity of male was 9.15±0.90 days, whereas that of female was 11.40±0.91 days. The duration of total life span (egg to death of adult) for male was 50.9±4.89 days while, for female it was 53.90±5.41 days. The average number of eggs laid by female was 990.70±127.40. The hatching percentage of eggs was 90.89±5.23. The pre-oviposition, oviposition and post oviposition periods were 2.85±0.65, 7.5±0.86 and 1.10±0.54 days, respectively. Khandwe and Gujrati (2002) reported the biology of the pod borer, *Helicoverpa armigera*, on pigeon pea was studied in the laboratory. The female moth laid eggs on buds, flowers and leaves of pigeon pea, in small batches of 1 to 10. The average incubation, larval, pre-pupal and pupal period lasted for 3.93+ or -0.85, 18.06+ or - 0.77, 2.26+ or -0.44 and 16.66+ or -1.24 days, respectively. The average adult longevity was 10.8+ or -1.46 days for males and 13.4+ or -1.08 days for females. Average life cycle lasted for 40.51+ or - 3.30 days. Hossain *et al*. (2007) the pre-oviposition, oviposition and post- oviposition periods were 2.25+ or -0.19, 3.45+ or -0.23 and 1.15+ or -0.08 days, respectively. Females laid 680-1620 eggs singly or 2-6 eggs in a cluster at night during 3.45 days of oviposition period. The hatching percentage of eggs was 85.77+ or -5.19. The incubation period of egg ranged from 2-4 days. The larva passed through six instars and the durations of 1st, 2nd, 3rd, 4th, 5th and 6th instar larvae were 2-4, 2-4, 2-3, 1-3, 1-3 and 1-2 days, respectively. The length and breadth of full-grown larvae ranged 25.0-36.0 mm and 4.0-5.5 mm, respectively. A period of 10-15 and 9-14 days were required to complete larval and pupal stages, respectively. The longevity of male and female ranged 3-5 and 4-9 days, respectively. The male and female completed its life span (egg to death of adult) between 28-33 days and 29-36 days, respectively.

Table-3: Pre-oviposition, oviposition, post-oviposition, fecundity and hatching percentage of gram pod borer, *Helicoverpa armigera*in laboratory condition during *Rabi* 2021-22.

Sl. No.	Stage	Period (days)		
		Min.	Max.	Av. ± S.D.

1	Pre- oviposition period (days)	2	4	3.00±1.41
2	Oviposition period (days)	5	7	6.00±1.41
3	Post-Oviposition period (days)	1	3	2.00±1.41
4	Fecundity	635	1350	992.50±505.58
5	Hatching percentage	58	68	63.00±7.07

Table-4: Pre-oviposition, oviposition, post-oviposition, fecundity and hatching percentage of gram pod borer, *Helicoverpa armigera*in laboratory condition during *Rabi* 2022-23.

Sl. No.	Stage	Period (days)		
		Min.	Max.	Av. ± S.D.
1	Pre- oviposition period (days)	3	5	4.00±1.41
2	Oviposition	4	6	5.00±1.41
3	Post-Oviposition	1	3	2.00±1.41
4	Fecundity	650	1520	1085±615.18
5	Hatching percentage	62	73	67.50±7.78

Conclusion

The average incubation period of egg was recorded as 5.00±1.41 and 4.00 ±1.41 days during 1st and 2nd year.The average larval period of first, second, third, fourth, fifth and sixth instar larva were 3.50±0.71, 2.50±0.71, 2.50±0.71, 3.50±0.71, 4.00±1.41 and 4.50±2.12, at respective days during 1st year.During 2nd year the average larval period of first, second, third, fourth, fifth and sixth instar larva were 2.50±0.71, 3.00±1.41, 2.50±0.71, 3.50±0.71, 4.00±1.41 and 4.50±2.12, at respective days.Total larval development period was on an average of 20.50±6.36 and 20.00±7.07 days in during 1st and 2nd year. The average of pre-pupal stage was 2.00±1.41 and 3.00±1.41 days, respectively during 1st and 2nd year. The average duration pupal stage was 13.00±4.24 and 14.00±2.83 days at respective year. The average time duration male stage was 8.50±2.12 and 9.00±1.41 days and female stage was 12.00±2.83 and 12.50±3.54 days, respectively during 1st and 2nd year. The average number of eggs laid by a female of *Helicoverpa armigera* was 992.50±505.58 and 1085.00±615.18 respectively both years. The average pre-oviposition period was noticed 3.00±1.41 and 4.00±1.41 day respectively both years. The average oviposition and post-oviposition periods were 6.00±1.41 and 2.00±1.41 days during first year. During second year 5.00±1.41 and 2.00±1.41 days, respectively. The average hatching percentage of eggs was 63.00±7.07 and 67.50±7.78 percent respectively both years.The total life period (egg to death of adult) of *Helicoverpa armigera* on an average of 49.00±15.56 and

50.00±14.14 days in males and females was 52.50±16.26 and 53.50±16.26days in during 1st and 2nd year. Clearly indicating that *Helicoverpa armigera*females have longer average life that the males.

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