

Biology of Field Bean Pod Borer, *Adisura atkinsoni* (Moore) (Lepidoptera : Noctuidae) on Dolichos Bean under Laboratory Condition

K. PALLAVI, M. THIPPAIAH. R. MANJUNATH AND B. SHIVANNA

Department of Agricultural Entomology, College of Agriculture, UAS, GKVK, Bengaluru - 560 065

e-Mail : reddy.pallavi2011@gmail.com

AUTHORS CONTRIBUTION

K. PALLAVI:

Conceptualization, investigation, analysis and draft preparation;

M. THIPPAIAH :

Framing research proposal, data curation and draft correction;

B. SHIVANNA :

Data curation and draft correction;

R. MANJUNATH :

Supervision and draft correction

Corresponding Author :

K. PALLAVI

Department of Agricultural Entomology, College of Agriculture, UAS, GKVK, Bengaluru

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ABSTRACT

The studies on the biology of field bean pod borer, *Adisura atkinsoni* (Moore) on field bean pods was carried out in the Department of Entomology, College of Sericulture, Chintamani under laboratory condition during 2021-22. The mean pre-oviposition, oviposition and post-oviposition period on field bean pod lasted for 2.2 ± 0.78 , 6.4 ± 3.02 and 2.2 ± 1.22 days, respectively. The females laid on an average of 343.9 ± 232.4 eggs in her life time. The incubation period and hatching percentage were observed to be 3.6 ± 0.51 days and 94 ± 6.99 , respectively. The mean length and breadth of eggs was reported about 0.609 ± 0.03 mm and 0.405 ± 0.01 mm, respectively. The mean total larval duration observed to be 14.4 ± 1.42 days. The fully grown larva measured 1.83 ± 0.03 mm & 26.34 ± 1.51 mm with respect to head width and body length. The pupal period lasts for 15.3 ± 1.25 days. The male pupa measures about 12.22 ± 0.12 mm and 4.09 ± 0.064 mm with respect to length and breadth. Whereas, the mean length and breadth of female pupae observed to be 13.24 ± 0.34 mm and 4.35 ± 0.08 mm, respectively. The male moths measured 11.8 ± 0.2 and 2.59 ± 0.11 mm with respect to body length and width. The average body length and breadth of female moth was 12.8 ± 0.14 and 2.78 ± 0.13 mm, respectively. Whereas, the wing expansion with respect to male and female moth reported was 26.7 ± 0.388 mm and 27.74 ± 0.50 mm. The sex ratio of male and female was 1:1.4.

Keywords : *Adisura atkinsoni*, Field bean, Morphometrics, Sex ratio, Life cycle

THE field bean (*Dolichos lablab* L.) is an important pulse-cum-vegetable crop in India popularly known as hyacinth bean, dolichos bean, country bean, butter bean and poor-man's bean. Field bean is cultivated for its tender and matured pods, seeds and also as fodder. The foliage of the crop provides hay, silage and green manure. The crop is cultivated in dry tropical parts of Asia, Africa, East and West Indies, South Central America and China. In India, it is being cultivated in Karnataka, Tamil Nadu, Andhra Pradesh, Kerala and Assam. In Karnataka, *Dolichos* bean is cultivated in 0.77 lakh hectares with an annual production of 0.17 lakh tonnes with a productivity rate of 183 kg/ha (Anonymous, 2019). Though the crop is cultivated in almost all regions of

Karnataka, it is largely grown as a mixed crop with finger millet and sorghum mainly in many parts of Karnataka. However, it is also grown as a pure crop under rain fed as well as irrigated conditions.

On local cultivars, more than ten species of pod borers embracing Lepidoptera, Coleoptera and Diptera are recorded. Among the several pests infesting this crop, pod borer complex comprising of *Helicoverpa armigera* (Hubner), *Adisura atkinsoni* (Moore), *Maruca vitrata* (Geyer) and *Exelastis atomosa* (Walshingham) found to be major cause for the severe yield loss (Rashmi *et al.*, 2019).

After 1990's, the plant breeders were successful in evolving photo-insensitive varieties, like the *Lablab*

plants which bloom throughout the year and this caused the change in the seasonal occurrence, relative abundance and composition of species of pod borers on *Lablab* cultivars. Interestingly, species of pod borers like webworm, *Maruca* and polyphagous pod borer, *Helicoverpa* increased in abundance and their occurrence extended to the entire year. Hence, wherever photo insensitive cultivars and varieties are being sown there the seasonal occurrence and relative abundance of *Adisura* is declining (Chakravarthy and Rajendraprasad, 2016).

The pod borer, *A. atkinsoni* is a dominant and specific insect pest of field bean occurring from August to March under field conditions which coincides with flowering and pod formation stage of the crop. It was found feeding only on the flowers and pods of field bean.

Adisura is a specific, locally adapted, economically important pod borer on *Lablab* beans. The life cycle of the pod borer appears to have co-evolved with the life cycle of the plant. Understanding the biology of the pest in the crop will help to identify its most damaging stages as well as the particular time to carry management practices against the pest, which will be beneficial for strategizing the management options of that particular pest. Hence, present investigation has been carried out to study the biology of field bean pod borer on field bean pods under laboratory conditions.

MATERIAL AND METHODS

The present study was carried out at College of Sericulture, Chintamani during 2021-22. The detailed biology was studied in Insect rearing laboratory, Department of Entomology, College of Sericulture, Chintamani.

Collection and Rearing of Field Bean Pod Borer *Adisura Atkinsini*

The initial inoculum culture of insect was collected from field bean (HA4 variety) crop. Collected larvae were reared on field bean pods in the laboratory. The temperature of 25 ± 2 °C and relative humidity of $69 \pm 5\%$ was maintained during the study. The pupa

obtained during rearing were sex separated and kept separately in plastic containers for adult emergence.

Mating and Oviposition

The adults emerged within 12 to 15 days after pupation. The newly emerged adults (males and females) were collected and about 10 pairs were allowed for pairing in the ratio of 1:1. Each pair provided with individual mating cages with a cotton swab dipped in 1:1 solution (honey: water) for adult feeding. A fresh inflorescence of field bean was arranged for egg laying (Plate 1). The inflorescence was maintained in water filled container to maintain the turgidity. Inflorescence was changed daily and examined for the eggs/ egg masses. The collected eggs/ egg masses were kept separately in plastic containers. The black head stage eggs were provided with fresh young field bean pods and were changed regularly at an interval of one- two days throughout the study.

Observations on incubation period, larval instars and duration, pupal duration, adult emergence, adult longevity, fecundity and hatching percentage were recorded. Larval instars were determined based on exuviae.

Morphometric Study

Starting from the egg stage, *A. atkinsoni* undergoes four moultings *i.e.*, five larval instars followed by pupation and adult stage. Changes in length and breadth during different developmental stages of larva were noticed. Diameter of eggs, instar wise larval measurements, pupal and adult measurements were recorded by using computerized micrometer (Leica).

RESULTS AND DISCUSSION

Pre-oviposition, Oviposition and Post-oviposition Period

The observation on pre-oviposition, oviposition and post-oviposition period revealed that, the pre oviposition period varied from 1 to 3 days with an average of 2.2 ± 0.78 days. The oviposition period ranged between 1 to 10 days with an average of 6.4 ± 3.02 days. The post-oviposition period ranged between 1 to 4 days with an average of 2.2 ± 1.22 days (Table 1). These observations are almost close

TABLE 1

Pre-oviposition, oviposition, post-oviposition period and fecundity of *A. atkinsoni* on field bean pod.

Observation	Minimum	Maximum	Mean±SD
Pre-oviposition period (days)	1	3	2.2 ± 0.78
Oviposition period (days)	1	10	6.4 ± 3.02
Post-oviposition period (days)	1	4	2.2 ± 1.22
Fecundity	7	648	343.9 ± 232.4

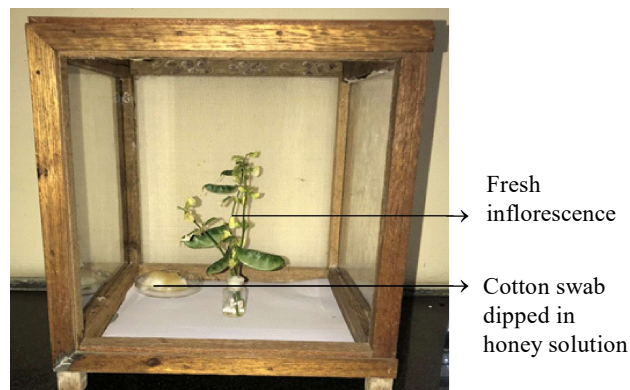


Plate 1: Mating and oviposition cage

to the findings of Govindan (1974), who reported that the pre-oviposition, oviposition and post-oviposition was 2 to 3 days, 7 to 10 days and 1 to 2 days, respectively.

Fecundity

The observations on fecundity of *A. atkinsoni* revealed that, the female moth laid an average of 343 ± 232.4 eggs, ranging from 7 to 648 eggs (Table 1). The observations are in accordance with Govindan (1974), who reported female laid eggs ranging from 145 to 364 with an average of 272 eggs on field bean pod. Sunil and Mohan observed that *Phthorimaea absoluta* laid 125.5 eggs per day on tomato in captivity. The present findings are on corroboration with these reports.

Eggs

The freshly laid eggs were creamy whitish in color and spherical or ovoid in shape with flat base. The color of eggs changed gradually from yellowish to brownish towards hatching with the mean hatching percentage was 94 ± 6.99 , which was ranging from

80 to 100 per cent. The incubation period occupied between 3 to 4 days with an average of 3.6 ± 0.51 days under laboratory conditions (table 2). The present findings are in conformity with observations of Govindan (1974) and Ramachandra rao (1918), who recorded average incubation period of *A. atkinsoni* on field bean pod was 3.5 and 3 days, respectively.

The morphometrics of egg stage was recorded. The mean length of eggs were 0.60 ± 0.032 mm and ranging from 0.56 to 0.68mm. Whereas, the mean breadth of eggs 0.40 ± 0.10 mm which ranges from 0.39 to 0.42 mm as shown in table 3. According to Govindan (1974), egg measures 0.46 mm in height and 0.49 mm in diameter, these observations are varying with present observations may be due to nutrient contents.

Larva

The development period of larva ranged from 12 to 18 days with an average of 14.4 ± 1.42 days during this period, larvae moulted 4 times with 5 instars (Table 2). According to Ramachandra rao (1918) and Krishnamurti and Appanna (1948), the larval period of *A. atkinsoni* occupied from 13 to 15 days and 17 to 18 days, respectively with five instars. The larval duration of *A. atkinsoni* in the present study was coinciding with the results of Nunes *et al.* (2017), who reported a *Helicoverpa armigera* mean larval duration of 14.54 days.

The mean duration of 1st larval instar was 3.3 ± 0.48 , which ranges from 3 to 4 days. The mean 2nd larval instar duration was 2.4 ± 0.51 days, which was ranging from 2 to 3 days. After 2nd instar the three remaining instars (III, IV and V) were look similar except size. The mean 3rd, 4th and 5th instar larval duration was 2.2 ± 0.42 days, 2.3 ± 0.48 days and

TABLE 2
Duration (days) of different developmental stages of *A. atkinsoni* on field bean pod

Growth stage	No. of individuals observed	Period (in days)		
		Minimum	Maximum	Mean±SD
Egg (incubation period)	10	3	4	3.6 ± 0.51
<i>Larval duration</i>				
1 st instar	10	3	4	3.3 ± 0.48
2 nd instar	10	2	3	2.4 ± 0.51
3 rd instar	10	2	3	2.2 ± 0.42
4 th instar	10	2	3	2.3 ± 0.48
5 th instar	10	3	5	4.2 ± 0.63
Total larval duration		12	18	14.4 ± 1.42
<i>Pupal duration</i>				
Pre-pupa	10	2	3	2.3 ± 0.48
Pupa	10	12	14	12.8 ± 0.78
Total pupal duration		14	17	15.3 ± 1.25

4.2 ± 0.63 days, which were ranging from 2 to 3 days, 2 to 3 days and 3 to 5 days, respectively (table 2). The present findings are matching with the recordings of Govindan (1974), who reported the mean 1st, 2nd, 3rd, 4th and 5th larval instar durations was 2.6 days, 2.8 days, 2.75 days, 3.8 days and 4.7 days and ranged from 2 to 3 days, 2.5 to 3 days, 2 to 3 days, 3 to 4 days and 4 to 5 days, respectively.

The larval morphometrics of *A. atkinsoni* recorded from first instar to fifth instar, which was reared on field bean pod and the larval size increased with each moulting (Plate 2).

The morphometrics of different larval stages was given in table 3. The mean head width of 1st, 2nd, 3rd, 4th and 5th larval instar was 0.299 ± 0.02 mm, 0.69 ± 0.014 mm, 1.137 ± 0.02 mm, 1.46 ± 0.03 mm and 1.83 ± 0.03 mm, respectively. Which, ranges from 0.27 to 0.35 mm, 0.68 to 0.71 mm, 1.1 to 1.19 mm, 1.41 to 1.5 mm and 1.75 to 1.86 mm with respect to 1st, 2nd, 3rd, 4th and 5th larval instars. Govindan (1974) showed the mean head width was 0.5 mm, 0.75 mm, 1.0 mm, 1.25 mm and 1.9 mm with respect to 1st, 2nd, 3rd, 4th and 5th instars, while except for first instar the observations were in accordance with present study observations.



Plate 2: Change in larval size and colour from first instar to fifth instar

The mean body length of 1st, 2nd, 3rd, 4th and 5th larval instars was 2.42 ± 0.23 mm, 10.02 ± 0.52 mm, 12.37 ± 0.42 mm, 18.65 ± 0.58 mm and 26.34 ± 1.51 mm, respectively. The body length of 1st, 2nd, 3rd, 4th and 5th larval instars was ranging from 2.1 to 2.7 mm, 9.3 to 11 mm, 11.9 to 13 mm, 18 to 19.5 mm and 24 to 28 mm, respectively (table 3). The host nutrition and temperature could be the reason for variation in larval body size. The body length of different larval stages of *A. atkinsoni* on field bean showed by Govindan (1974) was ranging from 2.0 to 2.5mm, 4.5 to 5.5mm, 7 to 10mm, 14 to 16mm and 21.5 to 23.0mm with respect to 1st, 2nd, 3rd, 4th and 5th larval instars and the present findings are in accordance with these results.

Pupa

The fully grown caterpillar stop feeding wandered for some time and entered into the soil. It prepares an oval earthen cell within which the caterpillar become inactive and body shrunk. The skin ruptured along the mid-dorsal line and pupation occurred. The caterpillar was also found to pupate inside the pod even in absence of the soil. The pre-pupal duration ranged from 2 to 3 days with an average of 2.3 ± 0.48 days (table 2). Mahakunda and Tiwari (2020) also reported pre-pupal period from 2 to 3 days in *M. vitrata* on pigeon pea and the present results are in agreement with the above reports.

The freshly formed pupa is light-green in color and soft and later become brown and hard (Plate 2). The mean pupal period of *A. atkinsoni* was 12.8 ± 0.78 days which ranged from 12 to 14 days (table 2). The present results are in contradiction with the reports of Govindan (1974), who recorded pupal period of *A. atkinsini* varied from 10 to 18 days on field bean

under laboratory condition and variation of pupal period may be depending on light hours.

The mean length of male pupa was 12.22 ± 0.12 mm and ranged from 11.95 to 12.29 mm in which, the width ranged from 4.01 to 4.19 mm with an average of 4.09 ± 0.06 mm. The female pupa length ranged from 12.6 to 13.6 mm with an average of 13.24 ± 0.34 mm whereas; the mean width of female pupa was 4.35 ± 0.08 mm, which ranged from 4.1 to 4.4 mm (Table 3).



Plate 3: Colour changes observed in pupa of *A. atkinsoni*

TABLE 3
Morphometrics of different stages of *A. atkinsoni* on field bean pod

Growth stage	Parameter(mm)	No. of individuals observed	Minimum(mm)	Maximum(mm)	Mean± SD
Egg	Length	10	0.56	0.68	0.609 ± 0.03
	Breadth		0.39	0.42	0.405 ± 0.01
<i>Larval stages</i>					
1 st instar	Head width	10	0.27	0.35	0.299 ± 0.02
	Body length		2.1	2.7	2.42 ± 0.23
2 nd instar	Head width	10	0.68	0.71	0.69 ± 0.01
	Body length		9.3	11	10.02 ± 0.52
3 rd instar	Head width	10	1.1	1.19	1.137 ± 0.02
	Body length		11.9	13	12.37 ± 0.42
4 th instar	Head width	10	1.41	1.5	1.46 ± 0.03
	Body length		18	19.5	18.65 ± 0.58
5 th instar	Head width	10	1.75	1.86	1.83 ± 0.03
	Body length		24	28	26.34 ± 1.51
<i>Pupal stages</i>					
Male	Length	10	11.95	12.29	12.22 ± 0.12
	Width		4.01	4.19	4.09 ± 0.06
Female	Length	10	12.6	13.6	13.24 ± 0.3
	Width		4.1	4.4	4.35 ± 0.08

TABLE 4
Morphometrics of adult moths of *A. atkinsoni*

Adult	Parameter	Minimum (mm)	Maximum (mm)	Mean± SD
Male	Body length	11.5	12.1	11.8 ± 0.2
	Body width	2.4	2.8	2.59 ± 0.11
	Wing expansion	26.1	27.1	26.7 ± 0.38
Female	Body length	12.6	13	12.8 ± 0.14
	Body width	2.6	3	2.78 ± 0.13
	Wing expansion	27.1	28.5	27.74 ± 0.50

Adult

The body length of male and female was ranged from 11.5 to 12.1 mm and 12.6 to 13 mm with an average of 11.8 ± 0.2 mm and 12.8 ± 0.14 mm, respectively. The mean body width of male and female moths was 2.59 ± 0.11 mm and 2.78 ± 0.13 mm, which ranged from 2.4 to 2.8 mm and 2.6 to 3 mm, respectively. The wing expanse of male and female moth ranged from 26.1 to 27.1 mm and 27.1 to 28.5 mm with an average of 26.7 ± 0.38 mm and 27.74 ± 0.50 mm, respectively (Table 4).

Sex Ratio

The male and female moths did not show any distinct sexual dimorphism (Plate 4). Whereas in dry preserved male specimen, the tip of abdominal genital valvae are seen extruded, but in case of female, the abdomen is somewhat stout and the tip is pointed. The sex ratio of laboratory reared culture was found to be 1:1.4 (male: female). Out of 100 adults examined, 41 observed to be males and 59 were females. Govindan

(1974) observed sex ratio of lab reared culture was found to be 5:4 (male: female) out of 10 specimens.

The present study indicated the biology of *A. atkinsoni* on field bean under laboratory conditions. Since, *A. atkinsoni* is the major pest of field bean crop having enough potential to cause severe damage to the crop and yield. The larval size increased in each instar. The mean larval duration of 5th instar is more compared to other instars. The pupal and adult female body is increased compared to male body. Differences in crop phenology and agroclimatic conditions may influence the biology and life cycle of *A. atkinsoni*.

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Plate 4: Male and Female moths of *A. atkinsoni*

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