

Biology of field bean pod borer, *Adisura atkinsoni* Moore under laboratory conditions on *Lablab purpureus* (L.)

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Abstract

The laboratory studies on biology of pod borer, *Adisura atkinsoni* was carried out during *rabi* 2023-24. The investigation on biology of *A. atkinsoni* revealed that the average egg incubation period was 3.23 ± 0.24 days indicating 93.01 ± 1.64 per cent egg hatching. The average fecundity of female moth was on an average 268.66 ± 58.94 eggs per female. The eggs were laid singly or in group ranging from one to 15 on flower buds, twigs and on tender pods of field bean. The pre-oviposition, oviposition and post-oviposition period lasted for 2.58 ± 0.37 , 7.33 ± 0.60 and 1.50 ± 0.35 days, respectively. The larva passed six instars with five moults with their respective durations of 2.46 ± 0.39 , 2.60 ± 0.32 , 2.71 ± 0.24 , 3.41 ± 0.32 , 3.68 ± 0.24 and 4.25 ± 0.26 days. The total larval period ranged from 17.25 to 21.75 days with an average in 19.11 ± 1.77 days. The larva prior to pupation undergone pre-pupal stage with average duration of 1.51 ± 0.35 days. In this stage the larva stopped feeding, all the body segments started to compress and body colour changed to pinkish brown. Then the larva undergone pupation inside soil in an earthen chamber. The average male and female pupal period were 16.42 ± 0.44 and 17.83 ± 0.51 days, respectively. The adult longevity of male and female moths were 12.42 ± 0.34 and 11.62 ± 0.66 days, respectively. The sex ratio was 1: 1.50. The total life cycle of male and female insect of *A. atkinsoni* was completed in an average of 52.74 ± 0.93 and 53.34 ± 0.90 days, respectively.

Keywords: *Adisura atkinsoni*, oviposition, biology, laboratory condition, egg, larva, pupa, adult

Introduction

Field bean is one of the important pulse cum vegetable crop, which is cultivated for its tender and mature pods, fodder, seeds and as a green manure crop. In India, the crop is grown mainly in Karnataka, Kerala, Andhra Pradesh, Tamil Nadu and Assam (Rekha, 2005)^[10]. The prevalence of many insect pests and diseases is one of the key cause of decrease in productivity of field bean.

The most significant of these are the pod borers, which regularly occurred and decreased crop yield up to the tune of 80-100 per cent (Katagihallimath and Siddappaji, 1962). Chakravarthy (1977)^[2, 5] documented eight pod borers on field bean, which included *Helicoverpa armigera* (Hubner), *Adisura atkinsoni* (Moore), *Maruca testulalis* (Geyer), *Etiella zinckenella* (Treitschke), *Sphenarches caffer* (Zeller), *Exelastis atomosa* (Walshingham), *Callosobruchus chinensis* (Linnaeus) and *Lampides boeticus* (Linnaeus). Among all these pod borers, *A. atkinsoni* is one of the important pod borer causing severe damage to field bean and less information is known about its biology. The larva is known to attack buds, flowers, seeds and pods. The nature of damage is shown by initially feeding on flower buds and flowers, later the larva completely bored into the pods and ate all the seeds, leaving the empty pod. Hence, it is important to study the biology of *A. atkinsoni*, as it helps to develop a successful pest control strategy, since it reveals most vulnerable and opportunistic stages of insect pest and it also helps in pest forecasting. Thus it helps to take management activities at right movement.

Materials and Methods

The laboratory investigations on the biology of field bean pod borer, *A. atkinsoni* were carried out at Department of Entomology, College of Agriculture, University of Agricultural Sciences, Dharwad during *rabi* 2023^[9]-24 at room temperature.

Rearing of *Adisura atkinsoni* Moore

Infested field bean pods in and around Dharwad formed the source of maintaining nucleus culture of the pod borer under laboratory condition. Petri dishes provided with wire screen of 10 cm diameter were used for individual larval rearing. Fresh tender pods were provided once in two days for the first and second instar larvae, whereas mature pods were provided daily for the subsequent instars. When the larvae completed their development, they were transferred to the petri plates filled with a thick layer of soil for pupation. After the larva undergone pupation, the petri plates containing pupae were kept inside the wire screen cages for emergence of adult moths.

Mating and Oviposition

Totally 10 pairs of newly emerged adults were releases in ratio of 1:1 \ for pairing separately in different rearing cages. After emergence of adult moths, they were provided with fresh twigs of field bean inflorescence. The twig of the inflorescence was dipped in water contained in a conical flask to prevent drying of the inflorescence, which served both as a source of egg laying site and adult food and these

twigs were replaced once in two days. The cotton swab dipped in 10 per cent honey solution was also provided in a glass vial as a source of adult food. Observations of incubation period, larval period, pupal period, adult life span, pre-ovipositional period, ovipositional period, post ovipositional period, fecundity and egg hatchability percentage were documented.

Morphometrics of egg, larva, pre-pupa, pupa and adult

The morphometric observations such as length and breadth of egg, larva, pre-pupa and pupa was recorded. Whereas adult wingspan and body length of male and female moth was recorded by using stereo-zoom binocular ocular meter (Leica).

Results and Discussion

Egg

The female moth was noticed laying the eggs in clusters varying from one to 15 or singly on flower buds, twigs of field bean inflorescence, tender pods and on the inner surface of walls in the glass cage, in laboratory conditions. The freshly laid eggs were observed to be creamy whitish to yellow in colour with ovoid to spherical in shape having a flat base (Fig1A). On the surface of eggs, opaque rib like structures were noticed connecting both the polar end of the eggs. The number of ribs present on each egg varied from 20 to 21. One day after oviposition, light pinkish to brownish disc appeared on upper half surface of fertilized eggs, whereas lower half surface remained whitish to yellow in colour. But, after two days of egg laying, the colour of egg was completely changed to light brownish and then turned to dark brown colour (Fig 1). The egg incubation period varied from 3.0 to 3.50 days with an average of 3.23 ± 0.24 days under laboratory conditions (Table 1). It is evident from the Table 2 that the length and breadth of the egg ranged from 0.45 to 0.49 mm and 0.48 to 0.52 mm respectively, with a mean of 0.46 ± 0.01 mm and 0.50 ± 0.01 mm, respectively.

Larva

The larva of *A. atkinsoni* undergone five instars with four moults (Fig 2). The total larval period under laboratory conditions varied from 17.25 to 21.50 days with an average of 19.11 ± 1.77 days (Table 1).

First instar

The freshly hatched first instar larva was initially dull whitish in colour, as the larva fed, the larva changed its colour to yellowish white. The transverse row of tubercles ending with black setae were present in thoracic region, whereas in abdominal region the setae were prominent and randomly distributed (Fig 2A). The duration of first instar larva was two to three days with an average of 2.46 ± 0.39 days (Table 1). The average length of first instar larva was 1.32 ± 0.03 mm and the breadth was 0.29 ± 0.01 mm (Table 2).

Second instar

The second instar larva was light cream to pale greenish in colour, with prominent lateral and longitudinal dorsomedian orange stripes on the body (Fig 2B). The duration of second instar larva ranged from two to three days, with an average of 2.60 ± 0.32 days (Table 1). The mean length and breadth of second instar caterpillar was 3.38 ± 0.03 mm and 0.55 ± 0.02 mm, respectively (Table 2).

Third instar

The third instar caterpillar was light greenish in colour and slender, with head, prothoracic shield and pro legs were brown in colour. Longitudinal dorsomedian dark green line was present, whereas whitish band was present on anterior and posterior region of the larva on both the sides in ventolateral region (Fig 2C). The duration of third instar larva ranged from 2.50 to 3.00 days, with an average of 2.71 ± 0.24 days (Table 1). The average length and breadth of third instar caterpillar was 7.88 ± 0.10 mm and 1.48 ± 0.09 mm, respectively (Table 2).

Fourth instar

The fourth instar larva was green in colour, with head light brown in colour (Fig 2D). The larval period of fourth instar ranged from 3.25 to 4.00 days with an average of 3.68 ± 0.24 days (Table 1). The average length and breadth of the larva was 16.80 ± 0.21 mm and 2.32 ± 0.06 mm, respectively (Table 2).

Fifth instar

On either side of the dorsomedian region, greenish to brownish stripes were prominent on fifth instar larva or the ventolateral white stripe was clearly visible. The larva became sluggish, stopped feeding and pinkish tinge developed all over the body (Fig 2E). The fifth instar larva occupied 4.00 to 4.50 days with an average of 4.25 ± 0.26 days (Table 1). The mean body length of fifth larval instar was 30.00 ± 0.41 mm and the breadth of the larva was 4.68 ± 0.26 mm (Table 2).

Pre-pupa

The fully matured larva before undergoing pupation, passed through pre-pupal stage, where the larva stopped feeding, became sluggish, all the body segments started to shrink and pinkish tinge developed all over the body (Fig 3A). The pre-pupal period occupied 1.00 to 2.00 days with an average of 1.51 ± 0.35 days (Table 1).

Pupa

The pupa was obiect type and initially it was light to transparent green in colour. Later it became light brownish and hard, with rounded cephalic end and pointed anal end. The pupal wing pads covered up to fourth abdominal segment in ventral region (Fig 3). The average length of male pupa was 13.73 ± 0.33 mm and 4.11 ± 0.18 mm in breadth, whereas female pupa measured on an average 14.41 ± 0.32 mm in length and 4.47 ± 0.32 mm in breadth (Table 2).

The sex differentiation of pupa was done based on the position of genital slit. The genital slit in female pupa, was present at eighth abdominal segment and it was very close to intersegmental line between eighth and ninth abdominal segment, hence in female pupa the genital slit was away from anal slit, located at tenth abdominal segment. In male pupa genital slit was present completely in ninth abdominal segment and it was very close to anal slit present at tenth abdominal segment. The genital slit in female pupa was less conspicuous, whereas in male pupa was more prominent (Fig 4 C and D). The male pupal period varied from 16.00 to 17.00 days with an average of 16.42 ± 0.44 days, whereas female pupal duration varied from 17.00 to 18.50 days with an average of 17.83 ± 0.51 days under laboratory conditions (Table 1).

Adult

The moth had setaceous antennae and the legs were light brown colour. Forewings of the moth were greyish to creamy brown in colour with randomly distributed black scales. Just below the sub terminal area of forewing, an oblique series of black spots were present, curving at center and finally meeting the posterior margin of the forewing. In female moths, the abdomen was stout compared to male moth and the tip of the abdomen was pointed. Whereas the male moths had slender abdomen which ended bluntly and in preserved

male specimens the genital valves were extruded compared to female moths (Fig 5). There was only slight difference between longevity of male and female moth. The longevity of male moth varied from 11.50 to 13.00 days with an average of 12.42 ± 0.34 days. Whereas the longevity of female moth varied from 10.75 to 12.00 days with an average of 11.62 ± 0.66 days (Table 1). The wingspan of male moth was on an average 13.84 ± 0.28 mm in length and 30.68 ± 0.33 mm in breadth. The average wingspan of female moth was 14.10 ± 0.31 mm in length and breadth was on an average 30.96 ± 0.33 mm (Table 2).

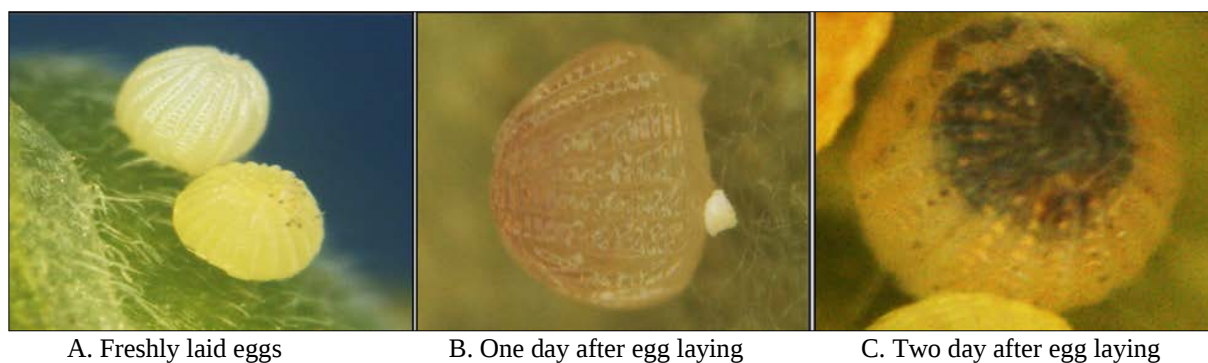


Fig 1: Development stages of *Adisura atkinsoni* Moore eggs

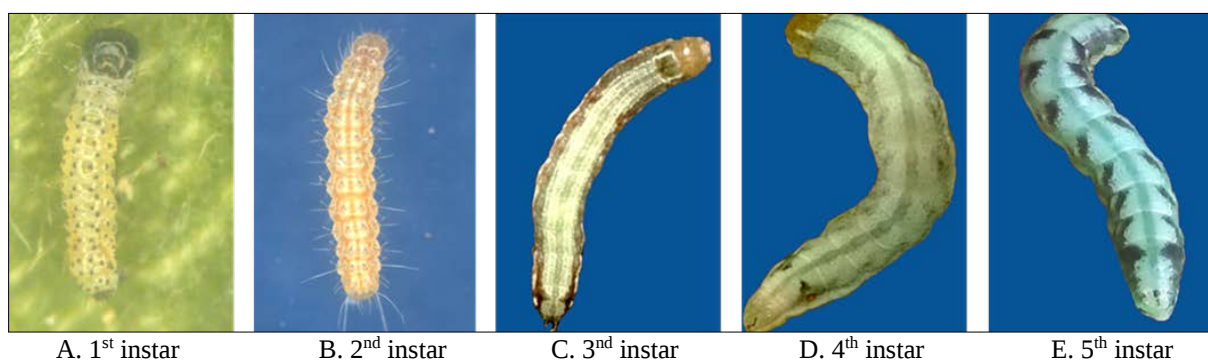


Fig 2: Different larval instars of *Adisura atkinsoni* Moore

Pre oviposition, oviposition and post oviposition period

The pre ovipositional period varied from 2.00 to 3.00 days, with an average of 2.58 ± 0.37 days. The ovipositional period ranged from 6.50 to 8.00 days, with an average of 7.33 ± 0.60 days, whereas the post ovipositional period ranged from 1.00 to 2.00 days with mean of 1.50 ± 0.35 days (Table 1).

Fecundity, egg hatchability per cent and sex ratio

The egg laying capacity of female moth varied from 181 to 342 eggs with an average of 268.66 ± 58.94 eggs per female in laboratory conditions. The per cent egg hatchability of *A. atkinsoni* varied from 90.71 to 95.01 per cent, with an average of 93.01 ± 1.64 per cent (Table 1). The adult moths were differentiated into separate sexes based on the morphological characters. Out of 20 moths emerged 12 were females and eight were males. The sex ratio of male to female moths was 1:1.50 (Table 1).

Table 1: Duration of different biological parameters of *Adisura atkinsoni* Moore reared on field bean pods

Insect stages	Duration (days)	
	Range	Mean $\pm$ SD
*Egg		
Incubation period	3.0 -3.5	3.23 ± 0.24
*Larval instars		
I instar	2.00 – 3.00	2.46 ± 0.39
II instar	2.00 – 3.00	2.60 ± 0.32
III instar	2.50 – 3.00	2.71 ± 0.24
IV instar	3.25 – 4.00	3.41 ± 0.32
V instar	4.00 – 4.50	4.25 ± 0.26
Total larval period	13.50 – 17.50	15.43 ± 1.53
**Pre – pupa	1.00 – 2.00	1.51 ± 0.35
**Pupa		
Male	16.00 – 17.00	16.42 ± 0.44

Female	17.00 – 18.50	17.83 ± 0.51
Average pupal period	16.50 – 17.75	17.12 ± 0.47
**Adult longevity		
Male	11.50 – 13.00	12.42 ± 0.34
Female	10.75 – 12.00	11.62 ± 0.66
Pre-oviposition period (days)	2.00 – 3.00	2.58 ± 0.37
Oviposition period (days)	6.50 – 8.00	7.33 ± 0.60
Post-oviposition period (days)	1.00 – 2.00	1.50 ± 0.35
Fecundity (number of eggs)	181 – 342	268.66 ± 58.94
*Egg hatching (%)	90.71 – 95.01	93.01 ± 1.64
*Sex ratio (Female : Male)	1: 1.50	
Total life span		
Male	51.50 – 55.00	52.74 ± 0.93
Female	52.25 – 54.5	53.34 ± 0.90

* Mean of fifteen observations ** Mean of six observations

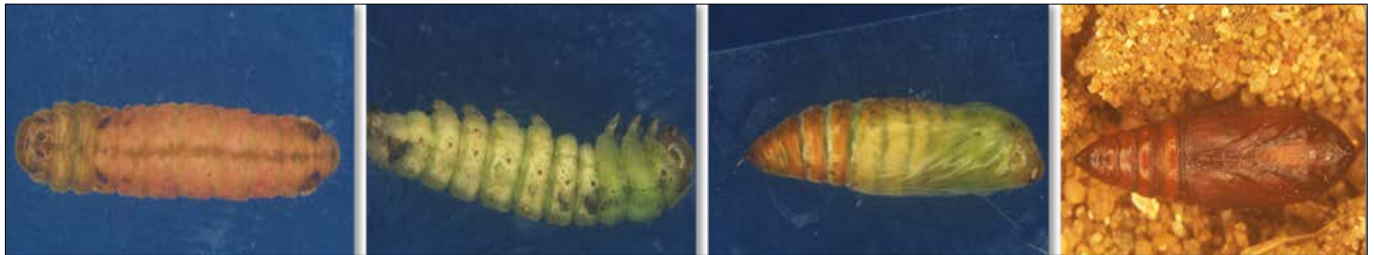


Fig 3: Colour changes in pupa of *Adisura atkinsoni* Moore



A. Male pupa

B. Female pupa

C-Female: genitalia present on intersegmental line of 8th and 9th abdominal segment

D-Male: genitalia present on 9th abdominal segment

Fig 4: Male and female pupal differentiation in *Adisura atkinsoni* Moore



Male moth

Female moth

Fig 5: Adult male and female moths of *Adisura atkinsoni* Moore

Total life cycle

The total life cycle of *A. atkinsoni* from egg to adult emergence of male moth varied from 51.50 to 55.00 days

with an average of 52.74 ± 0.93 days and that of female moth ranged from 52.25 to 54.50 days with an average of 53.34 ± 0.90 days under laboratory conditions (Table 1).

Table 2: Morphometry of life stages of *Adisura atkinsoni* Moore reared on field bean pods

Life stages	Length (mm)		Breadth (mm)	
	Range	Mean $\pm$ S.D	Range	Mean $\pm$ S.D
*Egg	0.45 - 0.49	0.46 $\pm$ 0.01	0.48 - 0.52	0.50 $\pm$ 0.01
*Larva				
I instar	1.28 – 1.35	1.32 $\pm$ 0.03	0.28 – 0.31	0.29 $\pm$ 0.01
II instar	3.34 – 3.42	3.38 $\pm$ 0.03	0.52 – 0.58	0.55 $\pm$ 0.02
III instar	7.75 – 8.02	7.88 $\pm$ 0.10	1.39 – 1.60	1.48 $\pm$ 0.09
IV instar	16.50 – 17.05	16.80 $\pm$ 0.21	2.29 – 2.40	2.32 $\pm$ 0.06
V instar	21.90 – 22.87	22.41 $\pm$ 0.35	3.41 – 3.64	3.52 $\pm$ 0.09
VI instar	29.4 – 30.5	30.00 $\pm$ 0.41	4.23 – 4.85	4.68 $\pm$ 0.26
**Pupa				
Male	13.25 – 13.52	13.37 $\pm$ 0.10	3.86 – 4.32	4.11 $\pm$ 0.18
Female	14.10 – 14.93	14.41 $\pm$ 0.32	3.99 – 4.87	4.47 $\pm$ 0.32
**Adult (wing expansion)				
Male	13.15 – 13.84	13.84 $\pm$ 0.28	30.21 - 31.10	30.68 $\pm$ 0.33
Female	13.80 – 14.81	14.10 $\pm$ 0.31	30.59 - 31.38	30.96 $\pm$ 0.33

*Mean of 10 observations

** Mean of 5 observations

Fewer studies have been conducted on the biology of *A. atkinsoni*. The present results are opined by Krishnamurthy and Appanna (1948)^[7] who reported that *A. atkinsoni* larva had six larval instars with five moults. Govindan (1974)^[4] who reported that egg incubation period was 3.0 to 4.0 days and larva of *A. atkinsoni* had six instars with five moults. The total larval period ranged from 19.41 to 21 days. The total pupal period varied from 10 to 18 days, but the pupal period of *A. atkinsoni* specifically reared on field bean pods was 17.29 days. The average adult male longevity ranged from 8 to 15 days and that of female moth varied from 9 to 13 days. The average fecundity of female moth varied from 145 to 364 eggs, which were similar with the present findings. The present findings were opined by Chakravarthy (1983)^[3] and Krishnamoorthy *et al.* (1986) who reported that eggs were laid by *A. atkinsoni* usually on tender pods and inflorescence of field bean. The present findings are in close consonant with Mallikarjunappa (1989)^[8] who reported that freshly laid eggs of *A. atkinsoni* were creamy whitish colour and later changed to dull brownish colour and revealed that newly formed pupa of *A. atkinsoni* was light green in colour and later the colour changed to dark brown colour. Pallavi *et al.* (2023)^[9] reported the male to female sex ratio was 1:1.4 and total larval period was 14.4 days which were approximately similar to the present findings.

Conclusion

The biology of *A. atkinsoni* was conducted in laboratory conditions during *rabi* 2023-24. The results from the present investigations were, the average incubation period was 3.0 to 3.5 days. The larva had six instars with five moults. The durations of individual larval instars from first to sixth instar were 2.46 $\pm$ 0.39, 2.60 $\pm$ 0.32, 2.71 $\pm$ 0.24, 3.41 $\pm$ 0.32, 3.68 $\pm$ 0.24 and 4.25 $\pm$ 0.26 days, respectively. The total larval period ranged from 17.25 to 21.75 days with an average of 19.11 $\pm$ 1.77 days. The pre-pupal period ranged from on an average 1.00 to 2.00 days. The male and female pupal period were 16.42 $\pm$ 0.44 and 17.83 $\pm$ 0.51 days, respectively. The adult male moth longevity was on an average 12.42 $\pm$ 0.34 days and that of female moth was 11.62 $\pm$ 0.66 days. The average fecundity of female moth was 268.66 $\pm$ 58.94 eggs per female. The egg hatchability percentage was 93.01 $\pm$ 1.64 and sex ratio of male to female moths were 1:1.50. Finally the total life cycle of male and female insect of *A. atkinsoni* were on an average 52.74 $\pm$ 0.93 and 53.34 $\pm$ 0.90 days, respectively.

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Conflict of Interest

Authors declare no conflict of interest

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