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Biology of Spotted Pod Borer, *Maruca vitrata* (Fabricius) (Lepidoptera: Crambidae) on Cowpea, *Vigna unguiculata* (L.) under Laboratory condition

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ABSTRACT: The laboratory investigation on biology of spotted pod borer, *Maruca vitrata* (Fabricius) on cowpea was carried out during the year 2021 at the Department of Agricultural Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand. A female laid on an average 36.36 eggs singly or in batches on flower buds and tender pods with 3.2 days incubation period and 84 percent egg hatching. The larval development passed through five instar and completed within 13.24 days. Each larval instar of *M. vitrata i.e.*, 1st to 5th instar took 1.52, 2.67, 2.76, 2.81 and 3.48 days, respectively. The pre-pupal and pupal stage completed within 1.43 and 7.95 days, respectively. The pre-oviposition, oviposition and post-oviposition period lasted for 2.0, 3.91 and 2.18 days, respectively. In case of adult stage of *M. vitrata*, sex ratio of male: female was 1: 1.10 with longevity of male and female was 5.10 and 8.09 days of male and female, respectively and growth index was 7.55. The total life span of male and female *M. vitrata* was completed within 29.82 and 32.36 days, respectively. The *Apanteles taragamae* larval parasitoids, which kill larvae and larvae feed inside the pods, are the main challenges of studying this pest, so when changing the food, be careful and critically observe all the pods before throwing them away.

Keywords: Biology, cowpea, instar, *M. vitrata*, spotted pod borer.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) is well adapted to the drier portions of the tropics, where other food legumes do not perform well, as a drought tolerant and warm-weather crop. Some literature shows that the cowpea evolved in the Savannah region of west and central Africa during Vedic times (Colby and Steele, 1976). It was introduced from Africa to India approximately 2000 to 3500 years ago. Chola, choli, chavli, lobia, bobbarlu, southern pea and black-eyed bean are all popular names of cowpea. In India, cowpea cultivated in 0.07 million hectares with a production of 0.04 million tonnes and a productivity of 0.63 t/ha (CMIE, 2020). Attack of insect-pests on cowpea is considered as one of the major constraints of low yield. As many as 21 insect-pests of different orders have been recorded to damage the cowpea crop from germination to maturity. Among these, the spotted pod borer, *Maruca vitrata* (Fabricius) has been considered as one of the serious pests of cowpea and other legumes in tropical and subtropical regions of the world because of its varied host range, destructiveness and distribution (Taylor, 1967). It is widely distributed in Asia, Africa, Australia and the Americas infesting 40 host plants including pigeonpea, cowpea, green gram, lablab and common bean (Taylor, 1978). It starts attack on crop right from pre-flowering stage and lasts upto pod maturing stage. It forms a web by using flower buds, flowers as well as pods and through webbing it continues feeding inside it. The larva Damage to the reproductive parts of the plant contributes to major yield loss of the crop. This pest is single major factor responsible for heavy loss (about 42 to 80%) in cowpea. Understanding the biology of the pest on the crop, helps to identify its most damaging stages, weak point as well as the particular time to start management practices against the pest, which will be beneficial for strategizing the management options of the pest. Hence, the present investigation has been carried out to study the biology of *M. vitrata* on cowpea under laboratory condition.

MATERIALS AND METHODS

The present study was carried out at Department of Agricultural Entomology laboratory. The larvae of spotted pod borer, *M. vitrata* were collected from the infected field in plastic vials and brought to the laboratory and these collected larvae were placed in the plastic vials individually along with fresh cowpea pods. The larva was picked up with fine camel hair brush and put in new plastic vials with fresh cowpea pods, which were changed daily in the morning. Sanitation was

maintained to decrease the mortality of larvae. After pupation, pupae were collected with sanitized forceps and placed in a Petri plate which was then kept in a wooden cage (30 × 30 × 45 cm) for adult emergence. A twig of cowpea along with few pods was kept in conical flask filled with water to avoid desiccation and then placed inside the cage for oviposition. A cotton swab dipped in 5 per cent honey solution was also placed inside the cage as food for the emerging adults. Thus, initial laboratory culture of spotted pod borer was maintained and eggs were used to study the biology of the pest. The biology of spotted pod borer was started with 25 eggs.

Observations on egg hatching percentage, incubation period, larval, pre-pupal, pupal, adult, pre-oviposition, oviposition and post oviposition period in days; fecundity, sex ratio (male: female) and total life cycle (days) were recorded. The time period between adult emergence to oviposition by female moth was considered as pre-oviposition period. Total time period of egg laying was considered as oviposition period. The total number of eggs laid during whole life span of female moth was considered as its fecundity. For the purpose, records on the eggs laid by the females were maintained every day. Time period after completion of oviposition period to the death of female moth was considered as post-oviposition period.

RESULTS AND DISCUSSION

The biology of *M. vitrata* was carried out at an average temperature and relative humidity were maintained as 26 ± 1 °C and 60 ± 10 per cent, respectively. Thus, the time range for different growth stages expressed in days along with the mean value, fecundity (No. of eggs laid per female) of spotted pod borer, *M. vitrata* on cowpea under laboratory condition are presented in Table 1.

Table 1: Duration of various life stages of spotted pod borer, *M. vitrata* under laboratory condition.

Life stages	Duration in day(s)			Sample size (n)
	Minimum	Maximum	Mean ± SD	
Egg hatching (%)	84 (%)			25
Incubation period	2	4	3.29 ± 0.64	25
Larval period				
I instar	1	3	1.52 ± 0.68	21
II instar	2	3	2.67 ± 0.48	21
III instar	2	4	2.76 ± 0.70	21
IV instar	2	3	2.81 ± 0.40	21
V instar	3	4	3.48 ± 0.51	21
Total larval period	11	16	13.24 ± 1.34	21
Pre-pupal period	1	2	1.43 ± 0.51	21
Pupal period	7	9	7.95 ± 0.80	21
Pre-oviposition period	1	3	2.00 ± 1.03	11
Oviposition period	3	5	3.91 ± 1.24	11
Post-oviposition period	2	3	2.18 ± 0.90	11
Fecundity (Eggs/ female adult)	33	40	36.36 ± 10.69	11
Adult period				
Male	4	6	5.10 ± 0.74	10
Female	7	9	8.09 ± 0.83	11
Total life span				
Male	30	36	29.82 ± 1.33	10
Female	31	34	32.36 ± 0.81	11
Sex ratio (Male: Female)	1: 1.10			
Growth index	7.55			

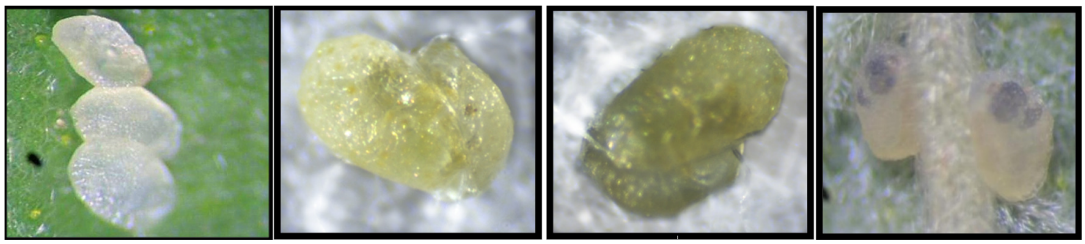
Note: SD = Standard Deviation

A. Egg hatching (%)

The freshly laid eggs were whitish in colour, translucent, lightly sculptured and oblong in shape. The colour of the eggs then changed to yellowish and before hatching *i.e.* mature eggs were changed into light brown colour (Fig. 1). The female moth of *M. vitrata* laid the eggs in singly or in groups of 2 to 3 on reproductive parts like flower buds, flowers or tender pods of cowpea plant, with 84 ± 16.7 per cent hatching. The current findings for egg laying are consistent with those of Ghorpade *et al.* (2006); Pandit *et al.* (2021); Shelke *et al.* (2021), while for egg hatching (%) Shukla *et al.* (2008); Rachappa *et al.* (2016); Shinde *et al.* (2017) as well as Mahankuda and Tiwari (2020) have also reported similar results.

B. Incubation period

It is evident from the data that incubation period of the eggs laid by female *M. vitrata* moths rearing on cowpea was with an average 3.29 ± 0.64 days (Table 1). Past results are meagre in cowpea but in other crops like in green gram by Sravani and Mahalakshmi (2016), in dolochos bean by Shinde *et al.* (2017), in pigeon pea by Jahantaj (2018); Shelke *et al.* (2021) in dolichos bean results obtained were in close agreement with present findings.



Freshly laid eggs | Colour changed in eggs | Matured eggs

Fig. 1. Eggs of spotted pod borer, *M. vitrata.*

C. Larval Period

In order to determine the larval instars, the individual larva was observed daily for the shedding of exuviae as well as head capsule by the larvae and it was revealed that larvae under goes through five instars and form to the prepupal stage (Fig. 2).

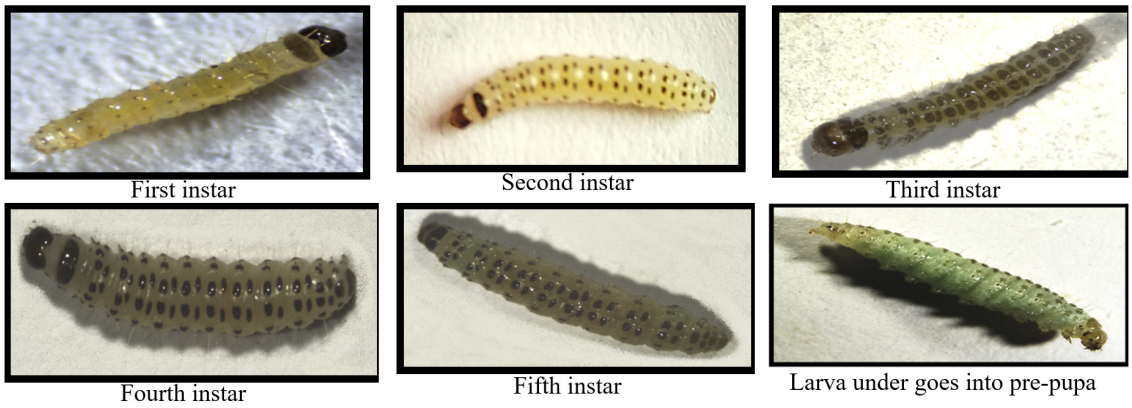


Fig. 2. Different larval instars of *M. vitrata.*

First instar. First instar (neonate) larva appeared yellowish white with a light brown head, short hairs on black warts all over the body and two long white hairs present in the caudal end of the larva. The microscopic view showed six rows of dark brown spots all over the body which are not visible to naked eyes. First instar period of *M. vitrata* reared on cowpea was with an average of 1.52 ± 0.68 days along with minimum period of 1 day and maximum of 3 days (Table 1).

Second instar. In this stage, larval size was increased and head seemed to turn slightly dark brown in colour. The larva was very active, whitish yellowish in colour with dark brown spot on all over the body were visible to naked eyes. The period of *M. vitrata* second instar larval stage reared on cowpea was 2.67 ± 0.48 days.

Third instar. The third instar larva was recognized from another instar by the presence of prominent brownish black spots on the mid dorsal line and whitish yellowish in colour. The head and prothoracic shield were darker. The larval duration ranged from 2 to 4 days with an average of 2.76 ± 0.70 days (Table 1).

Fourth instar. The fourth instar larvae were similar to the third instar except in size. Further, it has more distinctive brownish black spots on dorsal side of the body and sparse hairs was present around the brown spot on the body. As per the data presented in Table 1, fourth instar larval period of *M. vitrata* was 2.81 ± 0.40 days.

Fifth instar. The mature larvae were creamy white to brownish green in colour with a brown colour dark spot on whole body. Further, this instar larvae also showed aggressive behavior when disturbed. Fifth instar larval period of *M. vitrata* was on an average of 3.48 + 0.51 days to with a range of 3 to 4 days (Table 1). Similar results were also obtained by Naveen *et al*. (2009) on cowpea and Shejulpatil *et al.* (2020) on pigeon pea.

Total larval period. The data presented in Table 1 indicated that the larval stage of *M. vitrata* passed through five instars and was completed between 11 to 16 days with a mean of 13.24 ± 1.34 days. In accordance to the above findings, Panickar and Jhala (2007) had reported a total larval period of 13.71 days while Shejulpatil *et al.* (2020) observed the same spanning 12 to 15 days with an average of 13.75 ± 0.64 for *M. vitrata.*

D. Growth index

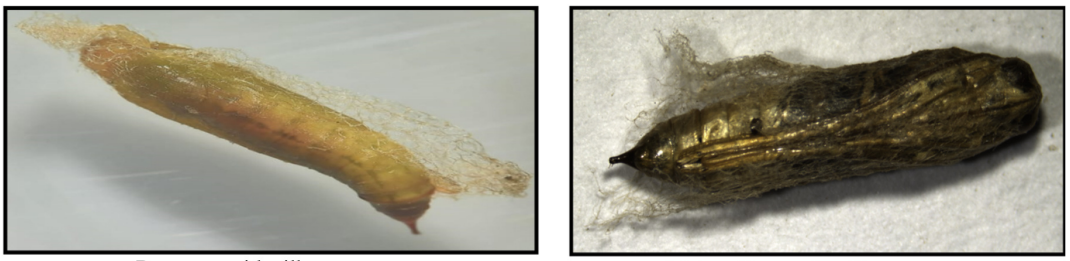
The growth index (7.55) was calculated using data from Table 1 and was calculated by dividing the percent of larvae that pupated by the entire mean larval duration in days.

Experiment regarding growth index has not been conducted by many empiricists except Panickar and Jhala (2007) who appraised 5.71 and 2.82 growth index of *M. vitrata* on cowpea and pigeon pea, respectively which vary with the results of present study. The variation might be due to the long duration of total larval period.

E. Pre-pupal period

The period starting from larval feeding cessation to pupal stage initiation was considered as pre-pupal period and body size gradually reduced. Pre-pupal stage was greenish in colour (Fig. 3). Full grown larvae spun silken thread in a net like fashion around its body on the plant

parts or at the bottom of plastic vial to transform into a pre-pupa. The pre-pupa sheds its larval skin which remains attached to the caudal end of pre-pupa. Pre-pupal period lasted for 1.00 to 2.00 days with an average of 1.43 ± 0.51 days (Table 1). The present findings are in close proximity with the findings of Panickar and Jhala (2007); Shejulpatil *et al.* (2020).



Pre-pupa with silken cocoon Mature Pupa with silken cocoon

Fig. 3. Age wise changes in pupa of *M. vitrata.*

F. Pupal period

The pupation took place within the silken webbings made either on the side of plastic vial or on the pods. The pupa was obtect type, broader anteriorly and tapering posteriorly. The pupa removed from the silken webbing was initially green or pale yellow in colour but gradually it became brownish green and finally turned in to dark brown (Fig. 3). In past, Sravani and Mahalakshmi (2016); Hanabar and Hegde (2018); Shejulpatil *et al.* (2020) and Mahankuda and Tiwari (2020) found that *M. vitrata* took pupation inside the webbed flowers, leaflets and immature pods or sometimes in rearing containers under laboratory conditions. Thus, the above observations made by different researchers are closely in accordance with the present finding.

The data presented in Table 1 exhibited that the pupal period of *M. vitrata* ranged from 7 to 9 days with an average of 7.95 ± 0.80 days. In accordance with the past, Naveen *et al.* (2009); Chaitanya *et al.* (2012); Sravani and Mahalakshmi (2016); Shejulpatil *et al.* (2020); Shelke *et al.* (2021) had also recorded more or less same pupal period.

Male and female pupae were distinguished under a stereo binocular microscope and differentiated based on the morphology of genital aperture.

Male Pupae: The genital aperture is present away from the anterior margin of the last abdominal segment and located on 8th abdominal segment.

Female Pupae: The aperture of the oviduct and bursa copulatrix is present adjacent to anterior margin of the last abdominal segment and situated on the 9th abdominal segment. Further, twelve hooks were seen at the tip of the tenth abdominal segment, among them six were long and six were shorter hooks. This sex differentiation of *M. vitrata* based on the morphology of the genital aperture also confirmed with the report of Jahantaj (2018).

G. Adult Longevity

Sexual dimorphism was clearly evident in the adult moths. The adult moth had medium brown wings and creamy white to brown body with long legs. Forewings were small in size with semitransparent bands and the hind wings were silver white in colour with brown spots at the apical margin across the wings. The data on adult longevity are presented the Table 1 indicated that the Male adult longevity ranged from 4 to 6 days with an average of 5.10 ± 0.74 days, whereas female adult longevity ranged from 7 to 9 days with an average of 8.09 ± 0.83 days. Male and female moths could be clearly distinguished by the abdominal shape.

Male Adult: Abdomen tapered towards the end [Fig. (4A)].

Female Adult: The tip of the female abdomen was long, slightly bulged and provided with two opening [Plate (4B)]. These findings are more or less in accordance with the results of Sravani and Mahalakshmi (2016) on green gram, Shinde *et al.* (2017) on dolichos bean, Hanabar and Hegde (2018) as well as Shejulpatil *et al.* (2020) on pigeon pea for adult longevity and morphological differentiation of adults.

H. Pre-oviposition, Oviposition and Post-oviposition Period

Pre-oviposition period. Pre-oviposition period of *M. vitrata* reared on cowpea was on an average of 2.00 ± 1.03 days with a minimum pre-oviposition period was 1 day while, maximum pre-oviposition period was 3 days (Table 1).

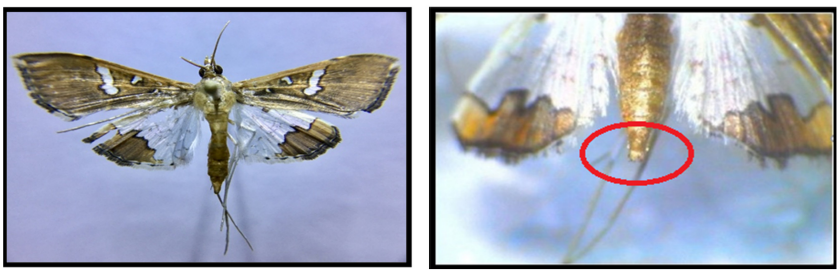


Fig. 4A. Male adult with tapered abdomen towards the end.

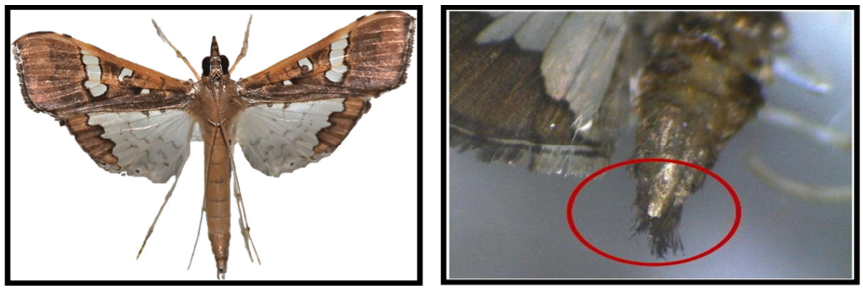


Fig. 4B. Female adult with long abdominal tip with two openings.

Oviposition period. The oviposition period of *M. vitrata* was observed from 3 to 5 days with an average of 3.91 ± 1.24 days on cowpea (Table 1).

Post-oviposition period. The data presented in Table 1 indicated that *M. vitrata* raised on cowpea had on an average 2.18 ± 0.90 days post-oviposition period with a minimum of 2 days and a maximum of 3 days.

In past, Panickar and Jhala (2007) on pigeon pea, Naveen *et al.* (2009) on cowpea, Rachappa *et al.* (2016) on pigeon pea, Shinde *et al.* (2017) on dolichos bean and Shelke *et al.* (2021) also on dolichos bean recorded more or less same pre-oviposition, oviposition and post-oviposition period.

I. Fecundity and Sex ratio

The fecundity (No. of eggs laid per female adult) of female was observed during study and was varied from 33 to 40 eggs with an average of 36.36 ± 10.69 eggs. During the study, sex ratio of male and female was observed 1: 1.10 (Table 1).

The outcome of the present finding was in close agreement with Ghorpade *et al.* (2006); Shukla *et al.* (2008); Rachappa *et al.* (2016); Sravani and Mahalakshmi (2016); Mahankuda and Tiwari (2020) for fecundity while, Shinde *et al.* (2017); Shelke *et al.* (2021) for sex ratio.

J. Total Life Cycle

The data on total life cycle of the respective sex of *M. vitrata* from eggs to adult are presented in Table 1 indicated that the male adult moth from egg to emergence of moth under laboratory condition on cowpea ranged from 30 to 36 days with an average of 29.82 ± 1.33 while, female adult moth ranged from 31 to 34 days with an average of 32.36 ± 0.81 days (Fig. 5). The present results are in accordance with Sravani and Mahalakshmi (2016) on green gram, Shinde *et al.* (2017) on dolichos bean, Hanabar and Hegde (2018) on groundnut, Shejulpatil *et al.* (2020); Shelke *et al.* (2021).

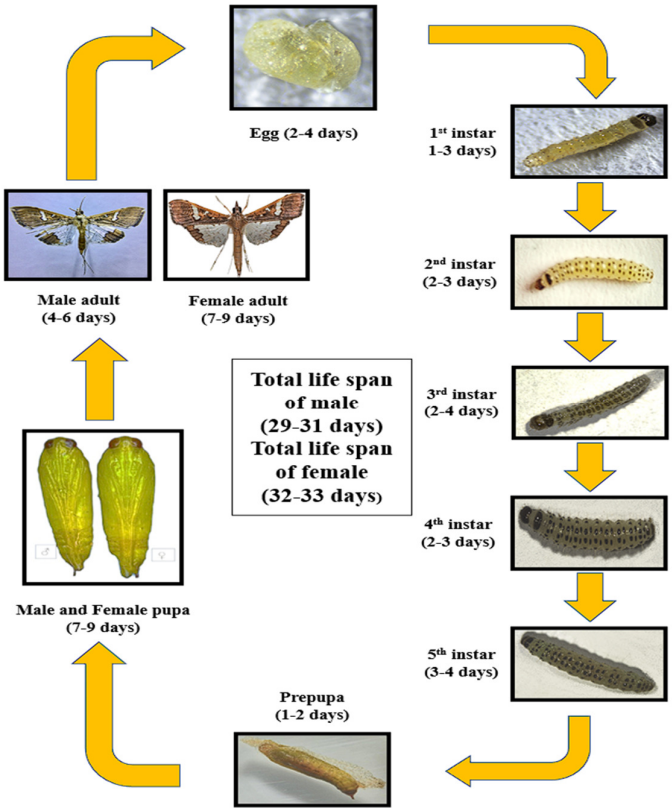


Fig. 5. Life cycle along with duration of each life stages of *M. vitrata.*

CONCLUSIONS

The biology of spotted pod borer on cowpea during *kharif* season revealed that the total life cycle of spotted pod borer was completed in 29.82 and 32.36 days of male and female, respectively and the mean fecundity of this pest was recorded as 36.36 eggs per female. Moreover to this, the larval period is about 11 to 16 days, hence one can consider it as a weak point of the pest and control measures can be taken during this period.

FUTURE SCOPE

Differences in crop phenology and agroclimatic conditions may influence the biology and life cycle of *M. vitrata*. Therefore, understanding the biology of the pest in the crop is most important for formulating IPM strategies for effective management of the pest. Controlling this pest became difficult due to its nature of feeding inside the web. Therefore, effective management strategies have to be developed to reduce the losses caused by the pest as well as to protect the crop. Identification of weak points for control amongst all the life stage and the sequence of management practices can be formulated by using this study. More research works on varied hosts and different agro-climatic zones should be carried out to generate good amount of data as well as to understand its biology under varied agro ecosystem.

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Conflict of Interest. None.

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