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## Biology and morphometry of diamondback moth, *Plutella xylostella* on cabbage

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#### Abstract

Biological studies were conducted during *rabi* 2020-21 at laboratory of Department of Agricultural Entomology, VNMKV, Parbhani. Study revealed that the incubation period ranged from 1 to 3 days, with a mean of  $2\pm 0.56$  days. The larvae went through four instars and three moults. The mean duration of larvae from first to fourth instar were  $2.2\pm 0.41$ ,  $2.15\pm 0.36$ ,  $2.55\pm 0.51$  and  $2.9\pm 0.78$  days, respectively. From first to fourth instar, the mean length of larvae was  $1.31\pm 0.04$ ,  $2.52\pm 0.13$ ,  $4.63\pm 0.45$  and  $5.15\pm 0.61$  mm, while the breadth was  $0.17\pm 0.02$ ,  $0.26\pm 0.02$ ,  $0.42\pm 0.04$  and  $0.56\pm 0.07$  mm. The duration of total larval period was  $9.8\pm 0.89$  days. The pre pupal period ranging from 1 to 2 days with a mean of  $1.65\pm 0.48$  days whereas, pupal period lasted for  $4.4\pm 0.50$  days. Pre-oviposition, oviposition and post-oviposition period were  $1.6\pm 0.51$ ,  $7.95\pm 1.25$  and  $5.6\pm 1.17$  days respectively. The average fecundity of female was  $161.7\pm 9.70$  egg per female. The total developmental period ranging between 25 to 30 days with mean of  $27.1\pm 1.94$  days.

**Keywords:** Biology, cabbage, duration, egg, larvae, adult

#### 1. Introduction

Crucifers particularly cabbage and cauliflower are most important among all vegetables because of their nutritional and economical values from producer and consumer point of view. Among the winter vegetables, cole crops have the superiority over other crops and are grown throughout the country.

Cabbage (*Brassica oleracea* var. *capitata* Linn.) is a major cole crop grown commercially in India as a leafy vegetable. Cabbage is a cold-loving plant native to the Mediterranean. It is grown for its edible enlarged terminal buds known as the head. India is the second largest producer of vegetables in the world next only to China. In India, area under cultivation of cabbage is around 4.03 lakh hectares with an annual production of 93.69 lakh metric tonnes during the year 2019-20.

Cabbage production is limited by attacks of insects' pests (Meena and Sharma, 2003) [11]. DBM was first reported in India on cruciferous vegetables in 1914 (Fletcher, 1914) [6], and it is now found throughout the country. Among the lepidopterous pest, diamondback moth (DBM), *Plutella xylostella* (L) (Lepidoptera: Plutellidae), is the most serious and widely distributed pest of cruciferous crops worldwide (Bonnemaïson, 1965). *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) is one of the most damaging cosmopolitan insect pests of cruciferous plants in the world. Sometimes the percentage of damage reached up to 90%. (Verkerk and Wright, 1996) [15]. The marketable yield loss due to diamondback moth infestation estimated about 52 percent (Kumar *et al.* 1983) [10].

#### 2. Materials and Methods

The field collected larvae were reared in the laboratory on cabbage in round clean plastic boxes. To facilitate aeration, the open ends of plastic boxes were covered with perforated lids. After removing excreta and partially eaten leaves from plastic boxes, a sufficient amount of fresh cabbage leaves were provided to the diamond back moth larvae every day until the larvae grew to pupal form. All pupae obtained were held in separate boxes for adult emergence. Regular collections began as soon as adult moths emerged from pupae and continued until the last adult emerged.

A pair of newly emerged male and female moths were carefully transferred in an oviposition plastic jar for egg laying. To maintain the turgidity of the leaves, cut ends of fresh cabbage leaves were dipped in a conical flask filled with fresh water.

The conical flask with leaves was placed inside the plastic jar, which was covered with muslin cloth and secured in place with a rubber band. As a comfort food for the adults, 5% honey solution was provided. Female egg laying was observed on cabbage leaves on a daily basis. The eggs were removed from the leaves, and fresh leaves were provided on a regular basis. Freshly laid eggs were used in further research. On cabbage, observations on the number of instars, duration of instars, and total larval period were counted manually. Vernier caliper was used to record measurements of morphometrics of different stages.

### 3. Results and Discussion

Observations regarding biological parameters were presented in Table 1 and morphometrical parameters were presented in Table 2.

#### 3.1 Egg

They laid their eggs mostly singly or in small groups on the lower surface of the cabbage leaves along the midrib and radiating veins of cabbage as well as on the container walls. The freshly laid eggs ranged in colour from yellowish white to yellowish green and were cylindrical to oblong in shape. As the stage matured, the colour darkened just before hatching. Similar observations were made by Abraham and Padmanaban (1968) [1] on cabbage and cauliflower, Bhalla and Dubey (1986) [4].

The average length and breadth of egg was ranging between 0.41 to 0.51mm and 0.22 to 0.30mm with mean value of 0.46±0.03 and 0.25±0.02mm respectively. Similar findings were made by Ashwini (2014) [3] who reported the length and breadth of egg was 0.45±0.02 and 0.28±0.03mm respectively. Study revealed that the incubation period of diamondback moth on cabbage varied from 1 to 3 days with an average of 2±0.56 days. The present findings were closely conformity with previous findings like Gowri and Manimegalai (2016) [7] who reported the incubation period of egg was 2 days, Mala (2006) reported the egg period was ranging between 1 to 3 days with an average of 2.16 ± 0.62 days.

#### 3.2 Larva

According to the data, the larva consisted of four distinct instars.

##### 1<sup>st</sup> instar

The first instar larvae were tiny, white, and had a dark brown head. The newly emerged larvae moved around the leaf surface for a while, then settled in one spot, bore into the epidermis, and mined the leaf tissues. The duration of first instar ranged between 2-3 days with an average of 2.2±0.41days. The present findings are strongly supports with Kumar *et al.* (1999) [9] who observed the duration of 2-3 days on cabbage and Alizadeh *et al.* (2011) [2] observed an average of 2.18±0.17 days. The average length and breadth of first instar varied from 1.25 to 1.36 and 0.15 to 0.22mm respectively with mean value of 1.31±0.04 and 0.17±0.02 respectively. Similar findings were made by Bhalla and Dubey (1986) [4] who reported the length and breadth of first instar as 1.30±0.03 and 0.18±0.04mm respectively.

##### 2<sup>nd</sup> instar

The colour of the larva was yellowish green with light brown head. The larvae feed by forming irregular patches on the lower surface of the leaves. The duration of second instar

larvae recorded as 2-3 days with an average of 2.15±0.36days respectively. The present results were closely conformity with Alizadeh *et al.* (2011) [2] who reported the average duration of 2.06±0.28 days and Harika *et al.* (2019) [8] recorded the duration of second instar as 2 days. The average length and breadth of second instar ranging between 2.32 to 2.67mm and 0.22 to 0.29mm respectively with mean value of 2.52±0.13 and 0.26±0.02mm respectively (Table 4.15). The present results were more or less in conformity with Bhure *et al.* (2020) [5] who reported the average length and breadth was 2.5±0.12 and 0.3±0.03mm respectively.

##### 3<sup>rd</sup> instar

The third instar larvae were longer than second instar larvae and were light green in colour with pale colour head. The duration of third instar larvae was ranging between 2-3 days with an average of 2.55±0.51days. The present investigations were more or less indirection with Gowri and Manimegalai (2016) [7] who reported each larval duration lasted for 2-3 days and Alizadeh *et al.* (2011) [2] reported the average duration of 2.14±0.14 days. The average length and breadth of third instar ranging between 4.01 to 5.45mm and 0.36 to 0.46mm respectively with mean of 4.63±0.45 and 0.42±0.04mm respectively. The present results were close conformity with Bhalla and Dubey (1986) [4] who recorded the average length and breadth to be 4.67±0.88 and 0.4±0.03mm respectively.

##### 4<sup>th</sup> instar

The fourth instar larvae was light green in colour. The larvae of the fourth instar were light green in colour. Green with a light coloured head, moderately stout with short, scattered bristle hair. The larvae were observed to be feeding on leaf lamina tissues leaving the hard veins. The duration of fourth instar larvae recorded as 2 to 4 days with an average of 2.9±0.78days. The present results were close conformity with Bhure *et al.* (2020) [5] who recorded it as 2 to 4 days with an average of 2.92 ± 0.81days. The average length and breadth of fourth instar varied from 4.41 to 6.01mm and 0.48 to 0.68mm respectively with mean of 5.15±0.61 and 0.56±0.07mm respectively. Bhure *et al.* (2018) recorded the length and breadth of fourth instar to be 5.01±0.45 and 0.5±0.03mm respectively.

#### 3.3 Total larval period

The duration to complete four larval instars were ranging between 9 to 12 days with an average of 9.8±0.89 days respectively. Results were more or less in conformity with previous findings like Bhure *et al.* (2020) [5] who observed the total larval period as 8 to 12 days with an average of 10.32 ± 1.22 days where as Ramzon *et al.* (2019) [14] observed as 12 – 17 days with an average of 15.89 days.

#### 3.4 Pre pupa and pupa

Larvae showed sluggish movement and reduced feeding during the pre-pupal stage. At this stage the final instar larva started constructed a silken cocoon on leaves of cabbage near the edges and veins or on old leaves of the plant as well as in the lid of plastic containers. The duration of pre pupal stage lasted for 1 to 2 days with an average of 1.65±0.48 days. The present findings were closely conformity with Harika *et al.* (2019) [8] who reported the average pre pupal period ranging between 1 to 2 days with an average of 1.5 ± 0.5 days.

Pupation takes place on leaves and also on the walls of rearing plastic jars. The pupae had a thin, flimsy silken

cocoon that started out pale green but eventually turned light yellow with brownish markings. The pupal period was recorded as 4-5 days with an average of  $4.4 \pm 0.50$  days. The results were more or less indirection with previous findings such as Alizadeh *et al.* (2011) [2] who reported it was  $4.23 \pm 0.23$  days.

The average pupal length and breadth was ranging between 4.49 to 5.65mm and 1.11 to 1.34mm respectively with mean value of  $5.09 \pm 0.46$  and  $1.22 \pm 0.09$  mm respectively. The present findings were close confirmity with previous workers such as Bhalla and Dubey (1986) [4] who reported the average pupal length and breadth to be  $5.15 \pm 0.15$  and  $1.17 \pm 0.33$ mm respectively.

### 3.5 Pre-oviposition, oviposition and post-oviposition period

The pre-oviposition period lasted for 1 to 2 days with an average of  $1.6 \pm 0.51$  days. The present results were more or less in confirmation with the earlier reports of Mala (2006) reported the pre-oviposition period to be 1 to 3 days with an average of  $1.86 \pm 0.74$  days. The oviposition period ranging from 7 to 11 days with an average of  $7.95 \pm 1.25$  days. Results has close conformity with Alizadeh *et al.* (2011) [2] who reported it as  $7.20 \pm 0.13$  days while Kumar *et al.* (1999) [9] observed it as 6-7 days.

According to results obtained by present findings, the post-oviposition period ranging between 4 to 7 days with an average of  $5.6 \pm 1.17$  days. The results were close confirmation with Mala (2006) who reported it as ranging between 4 to 8 days with an average of  $5.93 \pm 1.22$  days.

### 3.6 Adult

The forewings of the moths have a brown band that is constricted to form light-coloured diamonds on the back, and the hind wings are narrow and light grey in colour. Males and females could be distinguished by their darker and slender bodies, as opposed to the female's lighter and moderately stout body. The wing expanse of female and male varied from 12.05 to 13.01mm and 11.65 to 12.30mm with an average of  $12.65 \pm 0.44$ mm and  $11.77 \pm 0.21$ mm respectively. Similar comparable findings were obtained by Bhalla and Dubey (1986) [4] who reported the average female and male wing expansion of  $13.06 \pm 0.17$  and  $12.97 \pm 0.16$ mm respectively.

### 3.7 Adult longevity

The longevity of male was recorded as 7 to 9 days with an average of  $7.7 \pm 0.82$  days. Males have a shorter lifespan than females. The present findings are thus close confirmation with the findings of Kumar *et al.* (1999) [9] who reported the longevity of male as 6 to 9 days. The longevity of female ranging from 8 to 11 days with an average of  $10 \pm 1.33$  days respectively. The present findings are thus more or less similar with those of Ashwini (2014) [3] who observed the female longevity on average of  $10.17 \pm 0.68$  days whereas, Abraham and Badhmanaban (1968) [1] reported it as 6 to 13 days.

### 3.8 Fecundity

The egg laying capacity of the female ranging between 145 to 173 eggs with an average of  $161.7 \pm 9.70$  eggs per female. Thus the present findings has close conformity with of Gowri and Manimegalai (2016) [7] who reported it to be 140 to 175 eggs under laboratory condition.

### 3.9 Total life cycle

The total life cycle from egg to adult ranged between 25 to 30 days with an average of  $27.1 \pm 1.94$  days. There are almost similar findings were observed by Bhure *et al.* (2020) [5] who reported the total life cycle of male as  $28.87 \pm 3.40$  days. Bhalla and Dubey (1986) [4] reported it to be 25.30 days in male and 29.50 days in female this results also supporting with present findings.

**Table 1:** Biological parameters of diamondback moth, *Plutella xylostella* L. reared on cabbage leaves (N=20)

Sr. No.	Particular	Range	Mean $\pm$ SD
1	Incubation period (days)	1-3	$2.0 \pm 0.56$
2	Larval period (days)		
	1 <sup>st</sup> instar	2-3	$2.2 \pm 0.41$
	2 <sup>nd</sup> instar	2-3	$2.15 \pm 0.36$
	3 <sup>rd</sup> instar	2-3	$2.55 \pm 0.51$
	4 <sup>th</sup> instar	2-4	$2.9 \pm 0.78$
3	Total larval period	9-12	$9.8 \pm 0.89$
4	Pre pupal period (days)	1-2	$1.65 \pm 0.48$
5	Pupal period (days)	4-5	$4.4 \pm 0.50$
6	Adult longevity (days)*		
	Male	7-9	$7.7 \pm 0.82$
	Female	8-11	$10 \pm 1.33$
7	Pre-oviposition period (days)*	1-2	$1.6 \pm 0.51$
8	Oviposition period (days)*	7-11	$7.95 \pm 1.25$
9	Post-oviposition period (days)*	4-7	$5.6 \pm 1.17$
10	Fecundity (No. of eggs/female)*	145-173	$161.7 \pm 9.70$
11	Total developmental period (days)	25-30	$27.1 \pm 1.94$

\*Mean of ten observations

**Table 2:** Morphometry of various stages of diamondback moth *Plutella xylostella* L. reared on cabbage leaves (N=10)

Life stages	Length (mm)		Breadth (mm)	
	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD
Egg	0.41-0.51	$0.46 \pm 0.03$	0.22-0.30	$0.25 \pm 0.02$
Larval instars				
1 <sup>st</sup> instar	1.25-1.36	$1.31 \pm 0.04$	0.15-0.22	$0.17 \pm 0.02$
2 <sup>nd</sup> instar	2.32-2.67	$2.52 \pm 0.13$	0.22-0.29	$0.26 \pm 0.02$
3 <sup>rd</sup> instar	4.01-5.45	$4.63 \pm 0.45$	0.36-0.46	$0.42 \pm 0.04$
4 <sup>th</sup> instar	4.41-6.01	$5.15 \pm 0.61$	0.48-0.68	$0.56 \pm 0.07$
Pupa	4.49-5.65	$5.09 \pm 0.46$	1.11-1.34	$1.20 \pm 0.09$
Adult (Breadth at wing expanse)				
Female	12.05-13.01	$12.65 \pm 0.44$	-	-
Male	11.65-12.30	$11.77 \pm 0.21$	-	-

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