

An Overview on the life cycle of *Plutella xylostella* (Lepidoptera:Plutellidae) with special reference *Brassica oleraceae* var. *botrytis*

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ABSTRACT: *Plutella xylostella* (L.) (Lepidoptera: plutellidae) is one of the major pest of crucifers. The crops that belong to crucifer family are cabbage, cauliflower, radish, beetroot, broccoli etc. Among these, due to the presence of its juicy and succulent leaves, the most vulnerable to pest are cauliflower (*Brassica oleraceae* var. *botrytis*) and cabbage (*Brassica oleraceae* var. *capitata*) in particular. *P. xylostella* (DBM) is a cosmopolitan pest and is widely present throughout the world. It is observed that DBM can survive even in extreme climatic conditions. Damage caused by the pest accounts to 30-90% of crop loss and it results in huge economic loss to the farmers. In order to develop a successful pest management strategy, as a researcher it is utmost necessary to have a complete knowledge of the pest. Keeping this in view, the present study was undertaken to study the biology and life-cycle of *P. xylostella* with special reference to cauliflower crop.

The results revealed that the incubation period of eggs averages $3.12 \pm .83$ days. Adult *P. xylostella* develops after passing from four larval instars. I, II, III and IV instar larvae survived on average for 1.9, 3.33, 5.0 and 4.25 days respectively in laboratory conditions at a temperature: $22 \pm 5^{\circ}\text{C}$, whereas total mean duration period for pupal + prepupal stages was 5.5 days.

Female *Plutella xylostella* lived for 16.64 (± 1.73) days as compared to males which lived for about 13.96 (± 1.57) days. The total life span recorded ranged between 35 to 38 days.

KEYWORDS: *Plutella*, biology, life-cycle, instar.

I.INTRODUCTION

The **adult** *Plutella xylostella* is a small grayish sometimes pale brown coloured moth. It measures about 8-12 mm in length. In rest position its wings are seen folded roof-like over its body. When the wings are folded three pale whitish diamond-shaped pattern is observed on the back of the forewing in male moth, it is because of this, it is called DBM (Diamondback Moth). Knodel and Ganeshwarachchi, (2008) reported wing tips are fringed with long hairs. Wing expanse measured about 12-15 mm. Abraham and Padmanaban (1968), Butani and Jotwani (1985), Ganpathy (1990) and Vadodaria (1993) also gave similar description of *P. xylostella*. Whereas Powell and Opler, (2009) reported that the forewing could be 5.5-7.5 mm long.

The life cycle of DBM comprises of egg - four larval instars- pupa - adult Moth. The larval instars cause the maximum damage to the crop. They feed on the juicy leaves of the crucifer crop, as well as its inflorescence. In the present study, the larvae were fed with leaves of cauliflower (*Brassica oleraceae* var. *botrytis*) and the duration of the larval instars and other biological parameters was observed. Cauliflower is a major vegetable crop of crucifer family and is highly vulnerable to insect-pests that cause about 20 to 30% yield loss (Estruch et al., 1997).

DBM is reported to reproduce throughout the year, making it possible for 13-14 generations in a year in different parts of India (Jayarathnam, 1997). At peak infestation as much as 16 to 17 larvae per plant could be observed causing 90 % of crop loss, resulting in unmarketable crop and a heavy loss to farmers (Khan and Dewanda, 2015). Similarly, Srinivasan, (1984) reported 90 - 92% crop loss if not taken any protective measures by farmers against pest attack. The crop faces high risk from DBM, right from the seedling stage and renders it untransplantable (Shelton, 2004). In order to protect the crops, farmers switch to chemical pesticides to combat with this problem. World-wide the annual cost of control measures of Diamondback moth is approximately one million US dollar (Talekar and Shelton, 1993). In a study conducted in India, on a cultivated area (501,700 ha) of cabbage, the losses due to *P. xylostella* infestation was calculated to be US\$ 16 million annually. (Mohan and Gujar, 2003).

Keeping in view, the aforesaid and with the aim of understanding the biology of the pest, for developing a proper management strategy and a line of action to control DBM, the present study was undertaken.

II. METHOD**2.1. Rearing of *Plutella xylostella*:**

3rd and 4th *P. xylostella* larvae were sampled and collected from the major fields of cauliflower of Ajmer city. They were carried to laboratory of Zoology Department in S.P.C Govt. College, Ajmer, in labeled and sufficient ventilated plastic containers. Here the larvae were reared using 'Rearing Method' as adopted by Dela Mondedji et al., (2015) with slight modifications. The larvae were reared on cauliflower plants (6-8 weeks old) in large transparent buckets, provided with proper ventilation. When the larvae moulted to adults, in order to provide them with food, cotton swabs, dipped into 10% honey solution were hanged in these rearing buckets. After 22-24 days, mated females were collected from these rearing buckets.

2.2. Study of the total development period of *Plutella xylostella* larval instars:

For assessing the development period of *Plutella*, right from the egg stage to the post pupal stage, an untreated leaf disc was used. Freshly excised cauliflower leaves were obtained from plants of the same age (± 6 weeks after transplant). These leaves were washed with water and then cut into leaf disc (± 8 cm diameter). Each leaf disc was placed on a petri-dish on a filter paper. One egg was placed on each of the leaf disc. In order to avoid escape of the larva, each petri-dish was covered by a muslin cloth fastened with a rubber-band. The incubation period and the development duration were noted for all the four instars L1, L2, L3 and L4 of *Plutella xylostella*. The pre-pupal and the post-pupal period was also observed and analysed. An average of the total development duration taken by each instar, for each treatment was calculated. The leaf disc was replaced by the fresh one after every 48 hours. The experiment was replicated 10 times. The complete study was carried out at temperature $22 \pm 5^\circ\text{C}$ and relative humidity $70 \pm 5\%$.

2.3 Study of fecundity of female moth:

For finding out the fecundity of Female *Plutella* moths, 80 eggs were placed in containers, each container contained properly water-washed cauliflower leaves. After the emergence of 1st instar larvae from the leaf mines, the leaves were replaced with the fresh treated leaves. The larvae were fed the respective treated leaves unless and until adult moths emerged. After mating each mated female moth was transferred to another glass container which contained a cauliflower leaf (Patel, 2000). After every 48 hours, the leaves were collected with the help of a hair brush, and were counted. The eggs laid on the walls of the container were also counted. The counting process continued till no further oviposition took place. The complete oviposition duration was also noted. For calculating the fecundity, total no of eggs from five female moths were obtained. Further the mean count of the eggs (laid per female moth) and standard deviation was calculated. The experiment was replicated 3 times. These eggs were further used for biological studies of *P. xylostella*.

III. OBSERVATIONS

Biological studies of <i>Plutella xylostella</i>	Mean of days taken to develop
I INSTAR	1.90 \pm .737
II INSTAR	3.33 \pm 1.49
III INSTAR	5.0 \pm 2.21
IV INSTAR	4.25 \pm 1.85
PRE- PUPAL	2.00 \pm .69
PUPAL	3.5 \pm 0.55
Total of Mean of larval period	14.48
Total of Mean of Pupa period	5.50
Total of Mean of larval duration period	19.98
Incubation period	3.12 \pm .83
Oviposition period	7.8 \pm 1.38
Fecundity of adult female moth	106.17
Longevity of Adult male moth	13.96 \pm 1.57
Longevity of Adult female moth	16.64 \pm 1.73
The study was done in laboratory conditions at room temperature: $22 \pm 5^\circ\text{C}$ and relative humidity: $70 \pm 5\%$.	

Graph showing duration of different developmental stages of *Plutella xylostella*

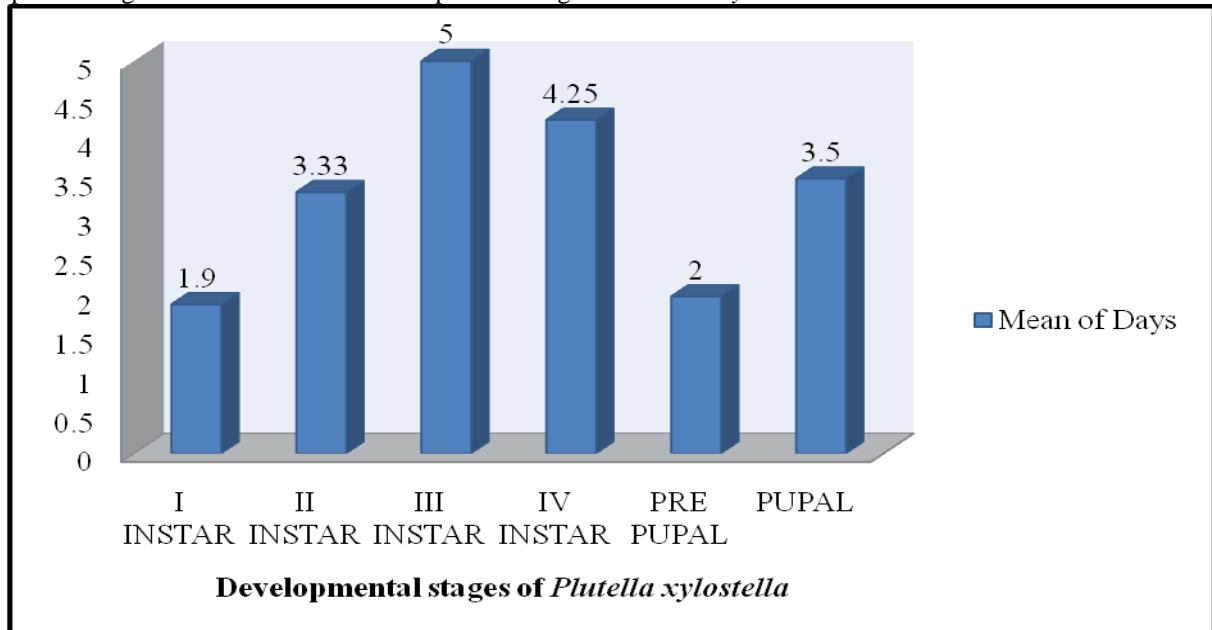


FIGURE: 1 SHOWING LIFE CYCLE OF *Plutella xylostella*



IV. RESULT AND DISCUSSION

The outcome of the biological studies conducted on *P. xylostella* are as follows:

4.1. Egg: During the study, it was observed that total time taken for the adult moth to develop from the egg was 22 to 24 days at room temperature of $22 \pm 5^\circ\text{C}$, the results differ slightly from Oke, (2008) who reported that DBM requires around 32 days (at $20\text{--}22^\circ\text{C}$) to develop from an egg to an adult. Incubation period was recorded 3.12 days, which can be corroborated with similar findings - (3.2 - 4.3 days) Ramzan, M. et al., (2019).

It was observed in the study that female moths lay pale yellow coloured, pin head sized eggs either in cluster (ranging from 5 to 40 eggs) or singly. They prefer the undersurface of the leaves or crevices of the mid vein for laying eggs. The results hold well in the light of the findings of (Oke, 2008) that revealed that eggs are laid singly or in groups of 2 to 8 on the upper or under the surface of the leaves. Vadodria (1993) reported that the female lay oval shaped eggs, which are yellowish-white in color, and becomes dark just before hatching.

It was also observed that mating occurs mainly in the evening, when the light is low. The mating takes place for 60-120 minutes, immediately afterwards which oviposition starts. The oviposition lasted for around 7.8 ± 1.38 days (8-10 days reported by Harcourt 1957). The average number of eggs laid per female moth observed during the study was 106.17. Whereas, the count of eggs laid per female moth was 200 – 210 eggs as reported by Ramzan et al., (2019) and Harcourt, (1957) reported 18-356 eggs, on an average 159 eggs. Probably the difference in the total number of eggs oviposited per female moth and the difference in the oviposition period lies in fact that it depends much on the temperature, atmospheric conditions and exposure to light, age of the moth and the quality of food on which the larvae was fed (Harcourt 1957).

4.2. Larval instars: Four larval instars were observed (as shown in figure: 1) namely I, II, III and IV larval instar. Just after hatching, the I instar larvae mine the host leaves and stay there for around 1.90 days, the succeeding stage -II instar larvae comes out of the leaf mines and starts feeding on the host leaves. They were creamish white in colour, the head and the body capsule properly demarcated. Fine hairs are visible throughout the body length. After on an average 3.33 days the II instar larvae moult to III instar. The III and IV instars are active feeders and voraciously chew the soft parts of the crop causing the maximum damage to it, at this stage. The duration of the III larval instar recorded was 5.0 days and the colour of the body becomes dark yellow while the head region appears dark brown. The ultimate larval stage, the IV instar is clearly visible due to its dark green colour, body length measuring upto 4.5 mm to 5.1 mm in length. Total mean duration for the larvae to reach the pre-pupal stage, when fed on *Brassica oleraceae* var. *botrytis* was 14.48 days (on an average), whereas the total mean pupal duration was 5.50 days. Hence in total the larvae took just 19.98 days to complete its journey from I instar to an adult *Plutella*. The results can be correlated with the findings of Ho Thian Hua (1965), Patel (1968), Butani and Jotwani, (1985) and Chauhan, et al., (1997) that the larva emerge from the egg passes through four instars to finally develop into an adult moth. Incubation period last for 2 to 8 days, larval period ranged between 8 to 16 days and the pupal period averages 5-8 days. The duration recorded in this study, slightly varied with the findings of Harcourt, 1954. He conducted his study during summer in Ontario, Canada and reported the average duration of the larval instars was 4.0, 4.0, 5.0, and 5.6 days for I, II, III, IV larval instars respectively. It also differed to some extent with the studies of Ramzan, M., (2019), who reported duration for the I II, III, IV larval instars at 26°C temperature, 3-5, 3, 1-4 and 2-3 days respectively, and the pupal and pre-pupal duration was 5-3 days respectively.

4.3. Longevity of adult male and female moth: An adult moth emerges from loosely spun, white coloured pupa. The study revealed that (in laboratory conditions and diet given 10 % honey solution) females lived for a longer life span ie. 16.64 (± 1.73) days as compared to males which lived for about 13.96 (± 1.57) days. The total life span recorded ranged between 35 to 38 days. These results are similar to study where total life span of male and female *Plutella* reported by Patel, V. J. (2000) was 23 to 35 days and 25 to 38 days, respectively. The results varied slightly with the findings where adult DBM male and female moth longevity as reported by Asman et al., 2001 was 9.0 ± 0.69 and 13.0 ± 0.73 days, respectively. Yadav et al., (1983) reported 27.46 days at room temperature $25 \pm 3^\circ\text{C}$

V.CONCLUSION

It can be concluded that *Plutella xylostella* is a serious threat to the cole crops. The larval stage of it causes maximum damage to the crop resulting in heavy economic loss. The larval instars duration and the longevity of adult moth, depends greatly on the temperature, and humidity. It also depends on the availability and variety of host plant. The observed details of biological parameters of DBM will be helpful in checking the infestation rate of the pest and also in developing a successful pest management strategy.

VI. ACKNOWLEDGEMENT

I thank S.P.C., Govt. College, Ajmer, India, for providing facilities in the Department of Zoology, during this study. We gratefully acknowledge Research Fellowship provided by the University Grants Commission for this research work.

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