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Biology of *Plutella xylostella* Linn. On cabbage leaf under laboratory condition

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Abstract

The present investigation entitled "Studies on the biology of diamond back moth, *P. xylostella* L. on cabbage crop" was conducted under laboratory condition at the research farm of School of Agriculture, Abhilashi University Mandi, during the year 2021-2022. The total life cycle of diamond back moth, *Plutella xylostella* was completed in 25-35 days and 27-40 days in case of male and female respectively. The average incubation larval and pupal period were recorded as, 2.50 ± 0.044 , 12.72 ± 0.038 and $7.44 \pm$ days respectively under laboratory condition.

Keywords: Biology, *Plutella xylostella* L.

Introduction

India is second largest producer of vegetable in the world next only to China. More than 40 kinds of vegetables belonging to different groups namely solanaceous, cucurbitaceous, root crops and leafy vegetables etc. are grown in India. Cole crops like cabbage, cauliflower, broccoli, Sprouts etc. are grown in hills and plains of India. Among them cabbage and cauliflower are economically more important vegetables in India. Cabbage (*Brassica oleracea* L.) is most important Cole crop origin from Cyprus and Mediterranean region. It belongs to the genus Brassica of the family Brassicaceae. Cabbage is one of the most popular winter vegetables grown in India. The total production of Cabbage in India was 9,606.21 Tonnes in 2021-22. The major cabbage producing states are Uttar Pradesh, Orissa, Bihar, Assam, West Bengal, Maharashtra & Karnataka. Among these states West Bengal contributed 2,341.87 Tonnes of cabbage almost 24.38% share of the total production of cabbage. In Himachal Pradesh the total production of cabbage was 146.66 Tonnes almost 1.53% share of the total production of cabbage in India (APEDA, 2021-2022).

Although the crop has got huge domestic demand, a number of limiting factors have been attributed for its low productivity and one of the chief constraints in the production of cabbage is damaged caused by pest complex right from germination till harvesting. Cabbage is an input intensive crop, which is prone to many insect pests especially to diamond back moth. This is one of the most serious and widely distributed pests of the cruciferous crops in many countries including India. Though, the moth originated in Mediterranean area, it has surpassed all the natural barriers and is believed to become a cosmopolitan pest (Meyriche, 1928) [7]. DBM is one of the most destructive pests of cruciferous vegetables in the world and has been reported from at least 128 countries and in recent years, DBM acquired serious dimension and has become major limiting factor in successful cultivation of Cole crops in India too (Saxena *et al.*, 1989 and Srinivasan and Krishnamoorthy, 1992) [12].

Diamondback moth eggs are oval and are yellow or pale green in colour, and are deposited singly or in small groups of two to eight eggs in depressions on the surface of foliage, or occasionally on other plant parts. The diamond back moth has four instars. Throughout their development, larvae remain quite small and active. The larvae are colourless in the first instar, but thereafter are green. The body bears relatively few hairs, which are short in length, and most are marked by the presence of small white patches. The young larva of *Plutella xylostella* L. feeds by scrapping the epidermal tissue and producing typical white patches, while in advanced stage, larvae bite the hole in leaves and produce a poor-quality head.

The extent of damage due to diamond back moth was reported 31.9% on cabbage (Abraham and Padmanaban, 1968) [1]. The diamond back moth, *P. xylostella* L. alone is capable of reducing cabbage yield up to 100% (Sachan and Srivastava, 1972) [10].

It damages the crop by feeding on the foliage. Population of four or more medium sized larvae (3rd and 4th instars) could render a seedling un-transplantable. Attack by a large number of larvae hinders the growth of plant leading to significant reduction in yield. The damage is caused by small green larvae, which crawl to under side of the leaves, penetrate the epidermis and feed on leaf tissues by making windows or holes of through it and which results in heavy yield losses of the cabbage crop. It is found to be the most devastating pest on the Cole crops.

The population of the insect remains low during the vegetative stage but increases the crop mature (Raju and Srinivasam, 1989) [8]. This fact makes the pest more serious as the marketable product is damaged heavily and fetch no monetary value in the market. Another important fact with diamond back moth is that, it was the first insect pest in which resistance to DDT was recorded (Salines, 1975) [11]. In India DBM was first recorded in 1914 on crucifer vegetables (Fletcher, 1914) [4]. Now the pests have been noticed all over India where plants belonging to family Brassicaceae are grown (Devi *et al.* 1995) [3].

Materials and Method

Rearing technique

The larvae were reared in the laboratory on respective host in transparent petri-plates. Everyday fresh leaves of cabbage were provided as a food to the larvae of diamond back moth after removing excreta and partially eaten leaves from petri-plates till the larvae grew to pre-pupal form. All the pupae obtained were kept in separate rearing cages for adult emergence. As soon as the adult moths emerged from the pupae they were collected daily until each and every adult emerged out.

The sexes of diamond back moth were determined by the colour pattern. The female moth was lighter in colour with markings on fore wings and less distinct than those of male DBM. The male and female can also be distinguished by abdominal tips. The end of male was triangular in shape, as compared to female moth which was broader on the tip of abdomen. For egg laying, a pair of male and female moths were transferred in rearing cages. Combination of glucose and protein and honey solution (10%) soaked in cotton swabs provided as food. The leaves of cabbage were daily observed for egg laying by female moth.

Study on various stages of *P. xylostella*

To study the incubation period, the eggs laid on the leaves were picked up carefully and transferred to the glass petri-plates. The eggs were also examined under the microscope, to study the shape, size and colour of the eggs. Usually, the female of DBM preferred egg laying at the lower surface of the leaves. The female mainly deposited eggs singly or in the batches on cabbage. In order to determine the number of larval instars, the size of individual larva was observed daily. The larvae were reared in glass petri-plates. The moulting was confirmed by the increased size of the head capsule of the larva of subsequent instar. Total number of instars, duration of each instar and total larval period were recorded on cabbage. Measurements of different instar stages were recorded under the microscope. Pre-pupal was observed when the larva became fully matured, stopped feeding and became sluggish before it turned to pupa. The pre-pupa developed from each larva was kept in petri-plates along with infested

leaves. Every pupal duration, colour and size were also recorded. To determine the life span, a pair of male and female was kept in rearing cage. The total life span of DBM was counted from the date of egg laying till death of adult. Longevity of male and female was calculated separately and from the recorded data longevity was calculated.

Statistical analysis

Data of each experiment will be subjected to suitable statistical methods of analysis. The statistical methods followed in the experiments are Analysis of Variance (ANOVA) technique in CRBD (Panse and Sukhame, 1967) and 't' test (Snedecor and Cochran, 1989). Transformation of data will be done whenever necessary.

Result and Discussion

The results obtained during the present investigation are presented and discussed in this chapter under following headings.

Biology of diamond back moth, *P. xylostella* L. on cabbage

The study on the biological parameters of diamond back moth, *Plutella xylostella* L. on cabbage was carried out at Laboratory, Department of Entomology, School of Agriculture, Abhilashi University, Chail-Chowk during March to April, 2022. The results obtained are presented.

Incubation period

The incubation period revealed that the incubation period of eggs was 2.50 ± 0.044 and range varied from 1 to 3 days. In past various workers also reported incubation period of *P. xylostella* on different hosts. Yadav *et al.* (1983) reported 2.21 days on cauliflower at room temperature. Ramegowda *et al.* (2006) [9] recorded 3 to 5.25 days on mustard and ranged from 1 to 4 days with an average of 2.40 ± 0.97 days on cabbage as studied by Meena and Singh (2012) [6].

Larva

In order to study the various larval instars of *P. xylostella*, newly hatched larvae were reared on leaves of the cabbage till pupation. The measurement and duration of different instars are presented in Tables. The data indicated that the larva passed through four distinct instars. Thus, the present investigation is in close confirmation with Meena and Singh (2012) [6].

First instar

The freshly emerged larvae were creamy white in colour with a dark brown head. There was no pigmentation on the body, however, two brown spots were conspicuous on both sides of the mid-dorsal region of the prothoracic shield of the dorsal setae. Feeding resulted in appearance of numerous scarring of white markings on leaves. The larva passed its first instar into the mine.

Second instar

The freshly emerged second instar larva was light yellow in colour with dark brown head. The patches on prothorax were in form of numerous spots. The larvae found to feed by making irregular patches on lower surface of leaves. The mean duration of second instar was 2.44 ± 0.016 and range varied 1-3 days.

Third instar

The third instar larvae were longer than second instar larvae and were light green in colour with pale coloured head. The mean duration of third instar was 2.44 ± 0.017 and range varied from 2 to 4 days. In past, Mala (2006) [5] reported that the average length and breadth of third instar was 4.28 mm and 0.38 mm on cabbage. While in reports of Meena and Singh (2012) [6], it was 3.80 to 4.78 mm in larval length and 0.33 to 0.43 mm in breadth on cabbage. The duration of third instar larva ranged from 2 to 4 days with an average of 2.88 ± 0.78 days on cabbage.

Fourth instar

The fourth instar larva was light green in colour. Later changed to green with light coloured head, moderately short, scattered bristle hair. They remained outside of the mine and mostly found on lower side of the leaves of cabbage. The mean duration of fourth instar larva was 2.44 ± 0.018 and ranged from 2-4 days.

Adult female of *P. xylostella* preferred lower surface of the leaves for egg laying mainly along the midrib and radiating veins in cabbage. At a time, eggs were also observed to be laid on side wall of rearing glass jar as well as on muslin cloth used for covering the jar. The female deposited eggs singly or in the batches of 2 to 16 on cabbage.

The total larval period of *P. xylostella* ranged from 7 to 13 days on cabbage with mean average of 12.72 ± 0.038 . Earlier workers reported that the total larval period was 8.44 days on cabbage (Raghuwanshi *et al.* 2010). Similar pattern of larval period was reported by Meena and Singh 2012 [6]. According to Meena and Singh the total larval period of *P. xylostella* was 7 to 13 days with average of 10.00 ± 1.56 days on cabbage.

Pre-pupa and Pupa

In order to study the pre-pupal and pupal stages of *P. xylostella* the results on these aspects are presented under following sub headings:

Pre-pupa

When the larva became fully grown, it reached to pre pupal stage. At this stage the final instar larva constructed a silken cocoon on leaves of the cabbage near the edges and veins or on old leaves of the plant and also the walls of rearing petri-plates. The duration of pre pupal period of *P. xylostella* ranged from 1 to 3 days. The present findings are thus more or less similar with those of Meena and Singh (2012) [6] who reported the duration of pre pupal period ranged from to 3 days with an average of 2.20 ± 0.79 days.

Pupa

In laboratory, pupation took place on leaves and also on the walls of rearing plate. The pupa was formed in transparent silken cocoon which was opened at both. Ends. The pupa when first formed was pale green in colour but it gradually turned to light yellow with brown markings. The pupal period revealed that it ranged from 6 to 10 days with an average of 7.44 ± 0.025 days. According to Mala (2006) [5], the pupal

period was 5 to 10 days on cabbage. Whereas, Meena and Singh (2012) [6] recorded the pupal period which ranged from 5 to 9 days with an average 7.60 ± 1.35 days on cabbage crops, which is more or less in agreement with the present findings.

Adult

The moth was small, and greyish in colour with white head and pale whitish narrow forewings. The front wings were closely applied to the sides of the body. The creamy yellow dorsal band extending from the base to torn us was separated by an irregular border that had three distinct markings on hind margins of each forewing, which appeared like the diamond shape, when the wings were closed. The hind wings were dark grey in colour. The colour of the female moth was typically lighter and markings were less distinct than those of male moth. The abdominal end of male was triangular in shape and rather pointed as compared to that of female.

The longevity of male ranged from 14-17 days with an average of 16.44 ± 0.018 . Similarly in case of female the longevity ranged from 18 to 22 days, while the mean duration was 18.16 ± 0.019 . Thus, it clearly indicated that the female was longer than male in size. Almost similar observations were also reported by Mala (2006) [5].

Total development period

The total development period from incubation period, larval period and pupal period with an average 53.33 ± 0.003 days in male and female total larval period

Total life cycle

The total life cycle from egg to death of male ranged from 25 to 35 days with an average of 41.44 ± 0.008 days, while in case of female, total life cycle ranged from 27 to 40 days with an average of 43.11 ± 0.018 days. Thus, the total life cycle of female was longer than that of male. The present findings are thus more or less similar with the findings of Meena and Singh (2012) [6] who recorded total life cycle of male moth ranged from 29 to 47 days with an average of 38.60 ± 3.79 days while in case of female moth it ranged from 30 to 49 days with an average of 40.10 ± 4.35 days on cabbage.

Table 1: Biology of different life stages of diamond back moth, *P. xylostella* L. on Cabbage under lab conditions.

Life Stages	Winter March (2022) -April (2022)	
	Range Duration (in days)	Range Duration (in days)
Incubation period	1-3	2.50 ± 0.044
Duration of each instar	1st Instar	2.44 ± 0.015
	2nd Instar	2.44 ± 0.016
	3rd Instar	2.44 ± 0.017
	4th Instar	2.44 ± 0.018
Total larval period (Days)	7-13	12.72 ± 0.038
Pupal period	6-10	7.44 ± 0.025
Male longevity	14-17	16.44 ± 0.018
Female longevity	18-20	18.16 ± 0.019
Total life cycle of Male	25-35	41.44 ± 0.008
Total life cycle of Female	27-40	43.11 ± 0.018

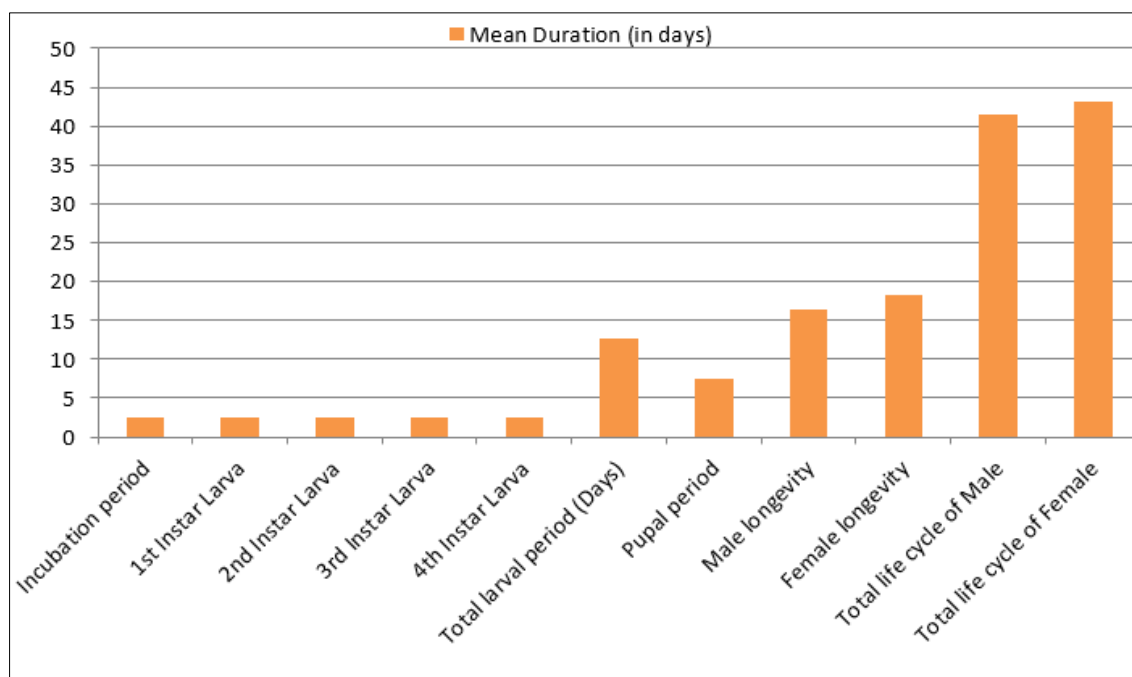


Fig 1: Biology of different life stages of diamond back moth, *P. xylostella* L. on Cabbage under lab conditions

Summary and conclusion

Biology of *p. xylostella* on cabbage under laboratory condition during 2021-2022 was carried out and it was recorded that the egg period of *P. xylostella* varied from 1-3 days with a mean of 2.50 ± 0.044 days during (March-April). The 1st, 2nd, 3rd and 4th instar ranged from 1 to 3, 2 to 4, 2 to 4, 2 to 4 days with mean 2.44 ± 0.015 , 2.44 ± 0.016 , 2.44 ± 0.017 and 2.44 ± 0.018 days, respectively. The pupal period occupied 6 to 10 days with an average of 7.44 ± 0.025 days in March-April. During the month from March to April when the adults were provided with food, the male lived for 14 to 17 days with mean of 16.44 ± 0.018 days and female for 18 to 20 days, with mean of 18.16 ± 0.019 days, respectively. The total life cycle from egg to adult occupied during March to April while it occupied 25 to 35 days in males with mean of 41.44 ± 0.008 days and 27 to 40 days in females with mean of 43.11 ± 0.018 days.

The study on the biology of *P. xylostella* L. concluded that the adult longevity of female was higher than the male.

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