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Biology of diamondback moth (*Plutella xylostella* Linn.) on cauliflower under laboratory condition

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Abstract

The present investigation entitled "Studies on the biology of diamond back moth, *P. xylostella* L. on cauliflower 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 13-22 with an average of 18.2 ± 0.55 . The average incubation, larval and pupal period were recorded as, 3.5 ± 0.11 , 9.8 ± 0.29 and 3.9 ± 0.12 days respectively under the laboratory condition.

Keywords: Biology, *Plutella xylostella* L.

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis*) is one of the most important winter vegetables grow in India. In India, cauliflower cultivation is done in almost all the states, but main states are Bihar, U. P., Orissa, Assam, M.P., Gujarat and Haryana. Cauliflower plays an important role in the human diet due to its attractive appearance, good taste, and its nutritive rich value. It is a rich source of protein, carbohydrates, vitamin-B, and C as well as various minerals which are necessary for the human health. Cauliflower is grown for its edible flowering head and consume as a vegetable in curries, soups, and pickles. In India, it is cultivated in an area of 4.26 lakh ha. with an average annual production of 8058 Mt and productivity of 19.2 Mt ha^{-1} (www.indiastat.com, 2014-15).

Productivity of cabbage and cauliflower in India is much lower attributing to many causes and among them insect pests are the major constraints. It has been estimated that insect herbivore alone causes 40% of the yield loss annually (Sood, 2007, Hasan and Ansari, 2010) [22]. The important insect pests are: diamondback moth (DBM), *Plutella xylostella* (Linn.), cabbage butterfly, *Pieris brassicae* (Linn.), cabbage borer, *Hellula undalis* (Fab.), leaf-eating caterpillar, *Helicoverpa armigera* (Hubner), *Spilarctia obliqua* (Walker), *Spodoptera littoralis* (Fab.), *S. litura* (Fab.), *S. exigua* (Hubner), leaf-webber, *Crociodomia binotalis* Zeller, cabbage looper, *Thysanoplusia orichalcea* (Fab.), *Plusia eriosoma* Doubleday, aphids: *Brevicoryne brassicae* (Linn.), *Lipaphis erysimi* (Kalt.), *Aphis gossypii* Glover, *Myzus persicae* (Sulzer), painted bug, *Bagrada cruciferarum* Krikaldy, *B. Maris*, leaf-eating beetle, *Phyllotreta cruciferae* (Goeze), *P. chotanica* Duviv., *P. birmanica* Harold. These insects are widely distributed in different agro-climatic conditions in India.

The diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) is an oligophagous pest of cruciferous crops (Thomsteinson, 1953). This pest is present wherever its host plants exist and is considered to be the widely distributed among all the Lepidoptera (Shelton, 2004) [21]. It is also because of the diversity and abundance of host plants, lack or distribution of its natural enemies, and high reproduction potential with up to 20 generation per year (Hui *et al.*, 2010) [10]. It has now been recorded from at least 128 countries or territories of the world (Talekar and Shelton, 1993) [24]. In India, DBM was first recorded on crucifer vegetables in 1914 (Fletcher, 1914) and now distributed all over India wherever crucifers grown.

The diamondback moth has become one of the most difficult pests to control in the past 50 years worldwide (Sarita *et al.*, 2010) [19] because of its intrinsic biology and ecology and also host range. The widespread and intensive use of insecticides and the genetic elasticity of DBM have led to serious problems including insecticide resistance (Mohan and Gujar, 2003, Shelton, 2004, Sarfraz *et al.*, 2005, Zhou *et al.*, 2011) [15, 18, 21, 27] and elimination of natural enemies (Kfir, 2002, Xu *et al.*, 2004) [13, 26].

Plant damage is caused by larval feeding. Although the larvae are very small, they can be quite numerous, resulting in complete removal of foliar tissue except for the leaf veins. This is particularly damaging to seedlings, and may disrupt head formation in cauliflower.

The female deposited eggs singly or in groups on the leaves. The eggs were yellowish in colour and 0.5mm in size (Abraham and Padmanaban, 1968)^[1]. The incubation periods of eggs as 1.5 to 5.4 days on cauliflower. (Kandoria *et al.*, 1994)^[11]. The larval period of *P.xylostella* L. was 10.5±0.32 days on cauliflower at 23±1° C temperature and 45±2 per cent relative humidity. (Devjani and Singh, 1999)^[5]. The larvae of diamondback moth passed through four instars. The average duration of first, second, third, and fourth instar was 2.50±0.50, 1.20±0.25, 1.84±0.34 and 2.04±0.24 days, respectively. The larval duration was 7.58±0.51 days. (Dhaduk, 2007)^[6]. The pre-pupal and pupal period of *P. xylostella* L. was 0.7 to 2.4 and 3.3 to 11.4 days on cauliflower. (Kandoria *et al.*, 1994)^[11]. The adult moth were small, slender, and brownish grey in colour with ochreous white head. The female moths were typically lighter in colour and marking on fore wing are less distinct than those of male moths. The abdominal end of the male is triangular in shape, rather pointed as compared to the female. The *longevity* of the adults *P.xylostella* L. on cauliflower as 16.7±2.95 days at 23±1° c temperature and 45±2 per cent relative humidity. (Devjani and Singh, 1999)^[5].

Materials and Method

Rearing technique

The larvae were reared in the laboratory on fresh leaves of cauliflower in petri plates. The fresh leaves of cauliflower were provided daily to the larvae of dbm as food in order to maintain proper hygienic condition. After sometimes pupae were sorted out carefully from the petri plates using forceps and transferred to another rearing cage covered with muslin cloth for adult emergence. After that, emerged adults were separated and provided 10 percent honey solution+ multi vitamin soaked in an absorbent cotton swab for feeding and cauliflower leaves for oviposition. Both were changed daily.

The male and female diamondback moth were determined by the colour pattern. The female moth was light in colour as compared to the male dbm. The end part of male was triangular in shape, as compared to female moth which was broader on the tip of abdomen. The male moth had brown band on the forewings which form the light coloured diamond on the back and hind wings are narrow, light grey in colour. After that, the male and female moth were transferred to another rearing cage. The leaves of the cauliflower were observed daily for egg laying of female moth.

Study on various stages of *P.xylostella* L.

To study the incubation period, the eggs were removed daily from the cauliflower leaves and kept in the petridishes in BOD incubator. The female laid eggs on the lower surface of the leaves mostly in singly or in groups. The eggs were collected till the death of female moth. Observation were noted to examine the egg period. To examine the larval periods, larvae of dbm were reared in petri dishes with cauliflower leaves. The larvae were carefully observed for the moulting process. The total number of instars, duration of each instars, and total larval period were recorded. Pre-pupal stage was observed when the larvae became matured, stop feeding, reduction in size before it turned to pupal stage. The

total duration, colour, size of the pupa were also recorded. To determine the total life span, the dbm was kept in rearing cage. Total development period was counted as the date of egg laying till the death of adult. Longevity of dbm was calculated 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 investigation on the biological parameters of diamondback moth. *P. xylostella* L. was studied on cauliflower under laboratory conditions in the laboratory, Department of Entomology, Abhilashi University, Mandi. The average temperature during the study was 25±3°C with relative humidity of 65 per cent. The results obtained are presented under following head:

Egg

Freshly laid eggs were oval in shape, pale yellowish and green in colour. The females laid eggs mostly singly about 150 to 200 on the lower surface of the leaves to protect them from rain, wind etc. Similar observations on egg shape appearance were reported by Ramegowda *et al.* (2006)^[17], Abraham and Padmanaban (1968)^[1], Gowri and Manimegalai (2016)^[8], Dhaduk (2007)^[6].

Earlier, the incubation period of eggs were found to be 2 to 4 days with an average of 3.5±0.11 days. Similarly other records was found to be 3.3 days (Chauhan *et al.*, 1997)^[3], 2.18 ± 0.12 days (Devjani and Singh, 1999)^[5], 2 to 3 days (Kapadia and Koshiya, 1999)^[12], 3 to 4 days (Kumar *et al.*, 1999)^[14], 3 to 4 days (Sharma *et al.*, 1999)^[20], 3.0 to 5.25 days (Ramegowda *et al.*, 2006)^[17], 3.33 0.42 days # (Dhaduk, 2007)^[6], 3 to 4 days (Gangurde and Wankhede, 2010)^[7], 2 days (Gowri and Manimegalai, 2016)^[8]. The results showed the earlier work done by others support the investigation. There were some variations due to duration of the experiment or weather condition.

Larva

There are four larval instars of diamondback moth.

1st instar

The first instar larvae were minute, white colour with brown head. The I instar occupies 2 to 3 days on an average of 2.7±0.08 days to complete its development.

Earlier, other records was given by Sharma *et al.* (1999)^[20], Kumar *et al.* (1999)^[14] and Dhaduk (2007)^[6] that the duration of first instar larva was found to be 2 to 3 days, 2 to 3 and 2.50 + 0.50 days, respectively and supports the present study.

2nd instar

The second larvae were freshly moulted and differed from the previous instar that is change in colour with yellowish green in appearance and the head were reddish brown in colour. The larval duration of the second instar 1.8±0.05 days to complete its development. Similarly, other results was to be found, 1-2 days with an average of larva was recorded 1 to 1.5 days by

Sharma *et al.* (1999) ^[20], 1 to 1.5 days by Kumar *et al.* (1999) ^[14] and 1.20 ±0.25 days by Dhaduk (2007) ^[6] respectively and supports the present study.

3rd instar

After the moulting process, the larvae were found to be light yellow in colour with light brown head. The third instar occupies 1 to 3 days with an average of 1.75 ± 0.25 days for its development.

Earlier, Sharma *et al.* (1999) ^[20], Kumar *et al.* (1999) ^[14] and Dhaduk (2007) ^[6] recorded the duration of third instar larva was found to be 1 to 2, 1 to 2 and 1.84 ± 0.34 days, respectively and supports the present study.

4th instar

The fourth instar were found to be dark green with light brown head. The larval body was covered with short erect hair all over the body. The 4th larval instar occupies 2-4 days with an average of 3.2±0.10 days for its development.

Similarly, other records was reported as 1.5 to 2.5 days (Sharma *et al.*, 1999) ^[20], 1.5 to 2.5 days (Kumar *et al.*, 1999) ^[14], and 2.04±0.24 days (Dhaduk, 2007) ^[6]. Thus the results of the earlier workers supports the present study.

Total larval period

The total larval period ranges from 7 to 12 days with an average of 9.8±0.29 days.

Similarly, the total larval period of the diamondback moth was recorded as 8 to 11 days by Patil and Porkharkar (1971) ^[16], 8 to 20 days by Vora *et al.* (1985) ^[25], 10 days in the hot and rainy seasons and 12 to 15 days in the cold season by Chelliah and Srinivasan, 1986) ^[4], 11 days by Chauhan *et al.* (1997) ^[3], 10.5 ± 0.32 days by Devjani and Singh (1999) ^[5], 9 to 10 days by Kapadia and Koshiya (1999) ^[12], 7.58 ± 0.51 days by Dhaduk (2007) ^[6] and 7 to 11 days by Gangurde and Wankhede (2010) ^[7]. The results of the earlier workers are in conformity with the present study.

Pre-pupal and pupal period

Two inactive phases occur in DBM i.e. pre-pupa and pupa. In prepupal stage, the larva showed some movement and reduces the feeding process which last stand for about 1-2 days with an average of 1.7±0.05 days for its development. Finally, the larvae entered in pupal stage.

Earlier, the pre-pupal period was recorded as 1 day (Stapathi, 1990), 0.7 to 2.4 days (Kandoria *et al.*, 1994) ^[11], 1 day (Kapadia and Koshiya, 1999) ^[12], 1.20 ± 0.13 days and 2 days (Gowri and Manimegalai, 2016) ^[8].

The pupation occurs in a loose silk cocoon, pale green in colour but it gradually became light yellow with brownish markings, usually found on lower side of the leaves. The duration of the pupal period varied from 3 to 5 days with an average of 3.9±0.12 days.

Earlier, the pupal period of *P. xylostella* was recorded as 3 to 7 days (Patil and Porkharkar, 1971) ^[16], 4 to 5 days (Vora *et al.*, 1985) ^[25], 4 days in the hot rainy season and 4 to 5 days in the cold season (Chelliah and Srinivasan, 1986) ^[4], 5 days (Stapathi, 1990), 3.3 to 11.4 days (Kandoria *et al.*, 1994) ^[11], 5.9 days (Chauhan *et al.*, 1997) ^[3], 6 to 7 days. (Kapadia and Koshiya, 1999) ^[12], 3 to 5 days (Sharma *et al.*, 1999) ^[20], 3.50 to 4.75 days (Ramegowda *et al.*, 2006) ^[17], 3 to 5 days (Dhaduk, 2007) ^[6].

Adult

Diamondback moth were small, slender and brownish grey in colour with white head. The moths had brown band on the fore wings which form the light coloured diamonds on the back and hind wings are narrow, light grey in colour.

Longevity

The duration from the date of emergence to death of adults was considered as the adult longevity. The adult longevity ranges between 3 days to 7 days on an average of 5.3 ± 0.16 days to complete its development.

Earlier, the longevity of the adults was reported as 6 to 13 days by Chelliah and Srinivasan, 1986) ^[4] and 3 to 4.27 days by Ramegowda *et al.*, 2006) ^[17].

Total development period

It is the duration of total life cycle, (the period between the date of egg laying to the date of death of adults). The total time taken by the *P. xylostella* to complete their life span on cauliflower under laboratory conditions varied from 13 to 22 days with an average of 18.2 ± 0.55 days.

Earlier, the total life cycle has been reported as 11.93 to 21.2 days (Abro *et al.*, 1992) ^[2] and 14 to 22 days as reported by Gangurde and Wankhede (2010) ^[7].

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

Life Stages		Winter	
		(November (2021) – January (2022))	
		Range Duration (in days)	Mean ± SE
Incubation period		02-4	3.5±0.11
	1 st Instar	02-3	2.7±0.08
	2 nd Instar	01-2	1.8±0.05
Duration of each instar	3 rd Instar	01-3	2.1±0.06
	4 th Instar	02-4	3.2±0.10
Total larval period (Days)		07-12	9.8±0.29
Pre-Pupal period		01-2	1.7±0.05
Pupal period		03-5	3.9±0.12
Total development period		17-22	18.9±0.57
Longevity		03-7	5.3±0.16
Total life cycle		13-22	18.2±0.55

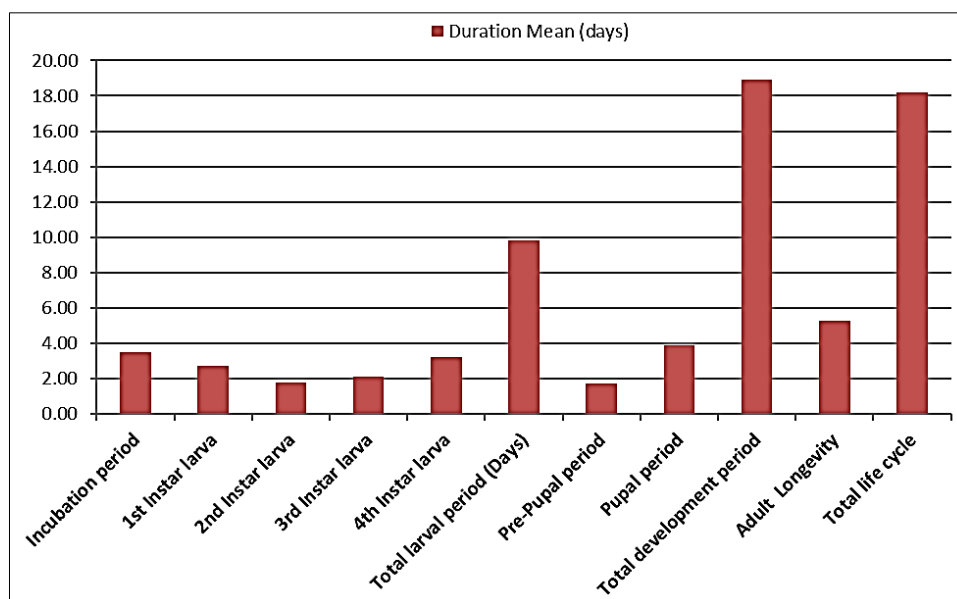


Fig 1: Biology of different life stages of diamond back moth, *P.xylostella* L. on Cauliflower under lab conditions.

Summary and Conclusion

Biology of *P. xylostella* L. on cauliflower under laboratory condition during 2021-2022 was carried out and it was recorded that the incubation period of *P. xylostella* ranges from 2-4 days with a mean of 3.5 ± 0.11 days during (March - April). The 1st, 2nd, 3rd and 4th instar ranged from 2 to 3, 1 to 2, 1 to 3, 2 to 4 days with mean average of 2.7 ± 0.08 , 1.8 ± 0.05 , 2.1 ± 0.06 and 3.2 ± 0.10 days, for their development. The pupal period occupied 3 to 5 days with an average of 3.9 ± 0.12 days in March-April. The adult longevity ranges from 3-7 days with an average of 5.3 ± 0.16 days, respectively. The total life cycle from egg to adult occupied 13 to 22 days with an average of 18.2 ± 0.55 days for its development.

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