



Studies on the Effect of Abiotic Factors on the Larval Population of Diamondback Moth (*Plutella xylostella* L.) on Cauliflower

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiments on the effect of abiotic factors on larval population of Diamondback Moth was conducted at research field of Khanpur, block Pataudi of district Gurugram, Haryana during two rabi seasons i.e., 2017-2018 and 2018-2019. Data revealed that the Diamondback Moth, *P. xylostella*

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population (0.33) appeared in first week of October (41st standard week) and gradually reached up to maximum level of 8.33 Diamondback Moth larvae/05 plants during third week of December (50th standard week) during 2017-2018 however it appeared in second week of October (42nd standard week) (1.33) and gradually reached up to maximum level of 8.67 Diamondback Moth larvae/05 plants during second week of December (49th standard week) during the year 2018-2019.

Keywords: Abiotic factors; cauliflower; diamondback moth; relative humidity; temperature; rainfall.

1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* Linn.) is an important vegetable crop of Cyprus and Mediterranean origin and introduced in India for first time in 1822. Now it is grown more or less in all the states of our country. It contains proteins and minerals such as potassium, sodium, iron, phosphorous, calcium and magnesium. It is low in fat and high in dietary fiber and water content. It also has anticancerous value [1] due to glucosinolates which are helpful in detoxifying human blood. Apart from abiotic factors, there are certain biotic factors cause complete failure of the crop. It is subject to be attacked by number of insect pests i.e., Tobacco caterpillar (*Spodoptera litura*), Diamondback Moth (*Plutella xylostella* L.), Cabbage butter fly, Cabbage leaf webber, Cabbage semi looper, Painted bug, Mustard saw fly, Flea beetle and Aphids [2].

The present investigation was undertaken to study the effect of abiotic factors like temperature, relative humidity, extent and distribution of rainfall, etc. on the Diamondback Moth larval population.

2. MATERIALS AND METHODS

Gurugram is situated between 28.45⁰N' latitude and 77⁰ 02 E' longitude at an altitude of 217 meters above mean sea level just south west of New Delhi. The district Gurugram falls under northern plains of upper Gangetic plains. The total geographical area of 732 km² is covered by this district in Haryana. Gurugram district is listed in semi-arid and sub-tropical climatic regions and is characterized by hot summers and cold winters. During summer maximum temperature reaches up to 45°C whereas minimum temperature is 4-5°C during winter season. The average annual rainfall is about 714 mm of which about 75-80 percent is received through south west monsoon during the month of July to September. Few rain showers occur in the winter and summer seasons. The meteorological information of Gurugram, Haryana were obtained from the meteorological laboratory of the Krishi Vigyan Kendra, Gurugram, Haryana.

Field Preparation: The experimental field was ploughed by tractor drawn harrow to expose the immature larval stage of soil borne insect pests. The field was ploughed deep (20-25 cm). Thereafter, cross harrowing (2-3) was also done to make soil friable and loose. Planking (1-2) was done for making the surfaces smooth and leveled.

Transplanting: Nursery beds was irrigated just one day before transplantation to soften the soil. Twenty-five days old cauliflower seedlings were transplanted in the third week of October, 2017-2018 and 2018-2019 respectively in the main field. Transplanting was done manually keeping two seedlings per hills. Spacing between row to row and plant to plant was kept 60 x 45 cm respectively. Gap filling was done one week after transplanting from the same raised nursery to maintain the optimum plant population. All agronomic practices were followed upto harvesting.

Fertilization: Farm Yard Manure (FYM) 20-25 t/ha was incorporated into the soil three weeks before transplanting of Cauliflower saplings i.e., 100 kg/ha, 125 kg/ha and 150 kg/ha N, P and K fertilizers respectively in field. After 5-6 weeks of transplanting, three to four split doses of liquid nitrogen (100 kg N/ha) were also applied.

Weeding: The experimental plots were kept free of weeds throughout the crop period by giving two manual weeding at 30 and 45 days after transplanting with the help of spade/khurpi.

Water Management: Cauliflower requires heavy moisture in soil during early stages but heavy irrigation should be avoided at the head formation stage because irrigation after long dry spells causes Cauliflower curds to burst. The estimated daily irrigation water requirement of Cauliflower crop is 4.66 l/4plants during early stage and 6.62 l/4 plants during peak growth stage. Water management was done on a regular basis.

Layout Of Experiment: The experiment was laid out in randomization block design (RBD) with

three replications each containing seven treatments including a control. Pusa Snow ball-1 variety of Cauliflower was taken in this study. The plot size for each treatment was kept 3.5 x 4.0 m² with spacing between row to row and plant to plant 60 cm and 45cm respectively.

Random sampling was carried out from experimental field to record the population fluctuation of Diamondback Moth larvae. Five plants were taken randomly from each experimental treated plot including the control. The field observations were taken at weekly intervals. Weekly meteorological data on temperature (minimum and maximum) relative humidity and rainfall was also recorded throughout the crop season. The simple correlation was done using the following formula:

$$X_1Y_1 = \frac{\sum XY - \frac{(\sum X_1)(\sum Y_1)}{N}}{\sqrt{\left[\sum X_1^2 - \frac{(\sum X_1)^2}{N}\right] \left[\sum Y_1^2 - \frac{(\sum Y_1)^2}{N}\right]}}$$

Where,

X₁Y₁ = Simple correlation coefficient

X₁ = Infestation percent

Y₁ = Meteorological parameter

N = Number of observation

Statistical Analysis: The data recorded during the investigation was subjected to statistical analysis using the analysis of variance technique (ANOVA) for Randomized Block Design as suggested by Panse and Sukhatme [3]. The data was transformed necessarily. Standard error of mean in each case and critical difference was computed at 5% probability level.

$$SE(m) \pm \sqrt{\frac{EMSS}{r}}$$

Where

SE(m) = Standard error of mean

EMSS = Error mean sum of square

r = Number of replication

- The critical difference @ 5 percent level of probability was worked out to compare treatment mean wherever 'F' was significant.

Critical difference = SE (m) ± x √2x t (at degree of freedom).

The recorded data was also analyzed with the help of computer software "OPSTAT1" developed by O.P. Sheoren, CCS HAU Hisar.

3. RESULT AND DISCUSSION

Diamondback Moth larvae was found to be the dominating pest species in Gurugram district. Population buildup of Diamondback Moth larvae in Cauliflower was studied during two consecutive seasons November – February of 2017 – 2018 and 2018- 2019 at Cauliflower research field of Khanpur, block Pataudi of Gurugram district. Area of observation for each crop comprised 50 cents. Mean population of caterpillars per plant per week was observed from thirty randomly selected plants. The data collected was analyzed and compared with specific growth stages to draw conclusions on the susceptibility of each stage of the insect pests [4].

RABI, 2017-2018: The observations recorded for incidence of Diamondback Moth larval population in relation to abiotic factors during Rabi, 2017-2018 was presented in Table 1 and depicted in Fig. 1. Data revealed that Diamondback Moth population (0.33) appeared in first week of October (41st standard week) and gradually reached up to maximum level of 8.33 Diamondback Moth larvae / 05 plants during third week of December (50th standard week) when temperature ranged from 22.20 to 11.10°C (mean temperature 16.65°C) and relative humidity 86.10 and 55.10 percent humidity (mean humidity 70.60 percent) respectively. The population of Diamondback Moth decreased very fast during 51 standard week.

The information on the seasonal incidence of diamondback moth and its correlation with different abiotic factors was however generated by many workers [5,6] from different regions of India. However, the present investigation study was carried out in Gurugram, Haryana area at Cauliflower field. The coefficient of correlation showed that the average temperature and average humidity indicated negative (r=-0.746) and positive (r=0.257) relationships during the 2017-2018 crop season respectively (Table 3). Shyam et al., (2020) studied seasonal incidence of Diamondback Moth, *Plutella xylostella* (Linn.) infesting Cauliflower crop and found that the first appearance of pest was started during second week of December and reached peak (5.8 larvae/plant) in the last week of January (5th SMW) with significant negative correlation with maximum (r= -0.496), minimum (r= -0.484) and average (r= -0.534) temperature and other weather parameters had non-significant impact on the larval population.

Table 1. Larval population of Diamondback Moth, *Plutella xylostella* Linn. on Cauliflower during Rabi October, 2017 to January, 2018

S.W	Crop stage (week after planting)	Average population (DBM/05 plants)	Temperature (°C)			Relative humidity (%)			Rain fall (mm)
			Max. (°C)	Min. (°C)	Average (°C)	Morning (%)	Evening (%)	Average (%)	
41	1	0.33	35.20	22.20	28.70	70.20	33.70	51.95	0.00
42	2	1.67	34.70	19.70	27.20	66.0	31.50	48.75	0.00
43	3	2.67	33.40	18.70	26.05	69.00	27.00	48.00	0.00
44	4	4.67	30.90	18.50	24.70	80.50	42.70	61.60	0.00
45	5	5.00	29.20	15.50	22.35	83.40	40.80	62.10	0.00
46	6	5.67	27.30	15.00	21.15	80.10	43.40	61.75	0.00
47	7	6.33	25.10	10.50	17.80	59.40	28.80	44.10	0.00
48	8	7.33	27.00	11.80	19.40	64.50	28.00	46.25	0.00
49	9	7.67	24.60	11.80	18.20	58.20	31.40	44.80	0.00
50	10	8.33	22.20	11.10	16.65	86.10	55.10	70.60	0.00
51	11	6.00	22.70	9.80	16.25	78.80	42.00	60.40	0.00
52	12	5.66	23.90	9.40	16.65	83.70	40.60	62.15	0.00
1	13	3.12	19.10	7.50	13.30	95.80	58.70	77.25	0.00
2	14	2.68	22.00	7.70	14.85	82.50	38.70	60.60	0.00
3	15	2.11	24.00	8.00	16.00	88.00	38.70	63.35	0.00

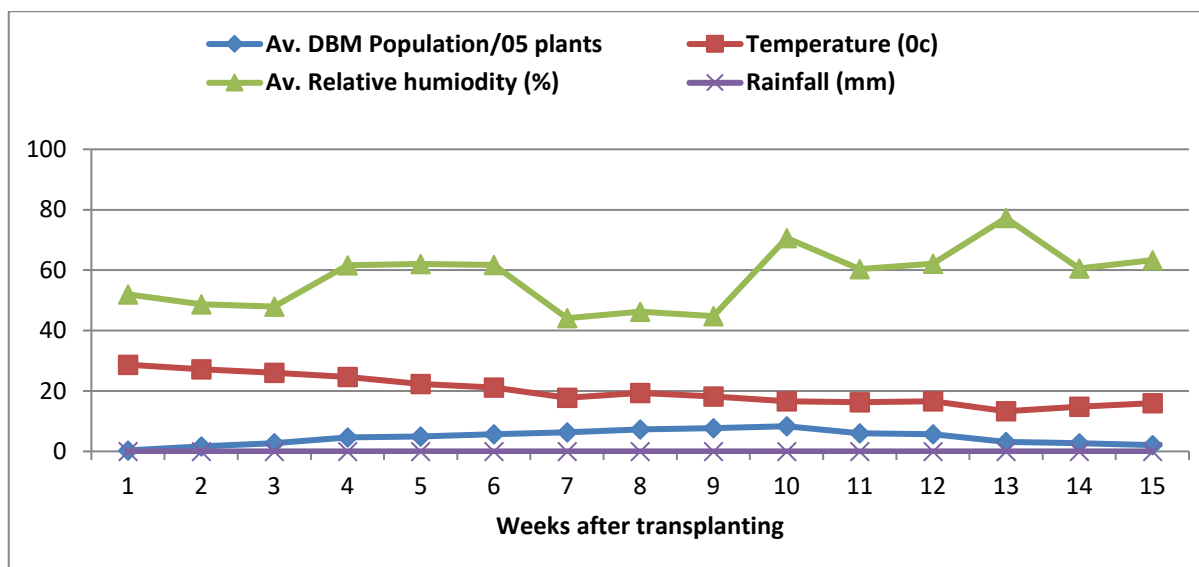


Fig. 1. Impact of weather on larval population of Diamondback Moth, *Plutella xylostella* Linn. on Cauliflower during Rabi October, 2017 to January, 2018

The present findings are in agreement with Malik et al., [7] who also reported that Cauliflower aphid, *B. brassicae* population fluctuated from the 51th standard week to fourth metrological week. The present findings are dissimilar with those of Ahmad and Ansari [8] who conducted a survey in three locations in the Aligarh district and showed that initial infestation of *P. xylostella* occurred when the farmers started transplanting Cauliflower seedlings. The density of *P. xylostella* ranged between 0.90 to 2.38 and 0.27 to 5.84 larvae and pupae /plant in first week of July, 2004 and 2005 respectively. During that period the temperature and relative humidity of Aligarh varied from 24.15^oc to 32.91^oc and 68.90 % to 91.30% respectively.

RABI, 2018-2019: For the second year the observation recorded for incidence of Diamondback Moth larval population about abiotic factors during 2018-2019 was presented in Table 2 and depicted in Fig. 2. Data revealed that Diamondback Moth population (1.33) appeared in the second week of October (42nd standard week) and gradually reached to the maximum level of 8.67 Diamondback Moth larvae/05 plants during the second week of December (49 standard weeks) when temperature ranged from 25.10^oc to 11.20^oc (mean temperature 18.15^oc) and relative humidity 70.80 and 40.80 percent (mean humidity 55.80 percent) respectively. The population of Diamondback Moth decreased very fast during 50 standard weeks. The coefficient of correlation showed that the average temperature and average humidity indicated negative ($r=-0.715$) and positive ($r=0.733$) relationship during 2018-2019 crop season respectively (Table 3).

The present results are in conformity with Meena and Singh's [9] findings in which the incidence of Diamondback Moth was recorded after 35 days of transplanting seedlings along with its peak population in January. The DBM population fluctuated between 2.0 to 11.0 larvae / plant. However, the maximum temperature, low and high relative humidity (RH), rainfall and wind speed had non-significant correlations while positive significant correlation with a larval population at minimum temperature was recorded. Similar observation was also recorded by Patra et al., [10] who reported that peak population of Diamondback Moth was observed on 1st March and 23rd February with 13.60 and 14.33 larvae / plant during the year 2011-12 and 2012-2013 respectively.

Vanlaldiki et al., [11] reported that Diamondback Moth larvae first appeared at the end of January increased gradually and reached its peak by the end of March for two consecutive years. The larval population declined by the end of April. The correlation studies indicated a significant positive correlation between the *P. xylostella* larval population and temperature except in second year which showed non-significant correlation with maximum temperature. The present results conformity with Bashir et al., [12] who reported that minimum temperature ($r=0.02$ and 0.06) showed positive non-significant correlation whereas negative non-significant correlation ($r=-0.31$ and -0.18) with maximum temperature. The relative humidity had positive relationship with larval population while it had a negative co-relationship with total rainfall.

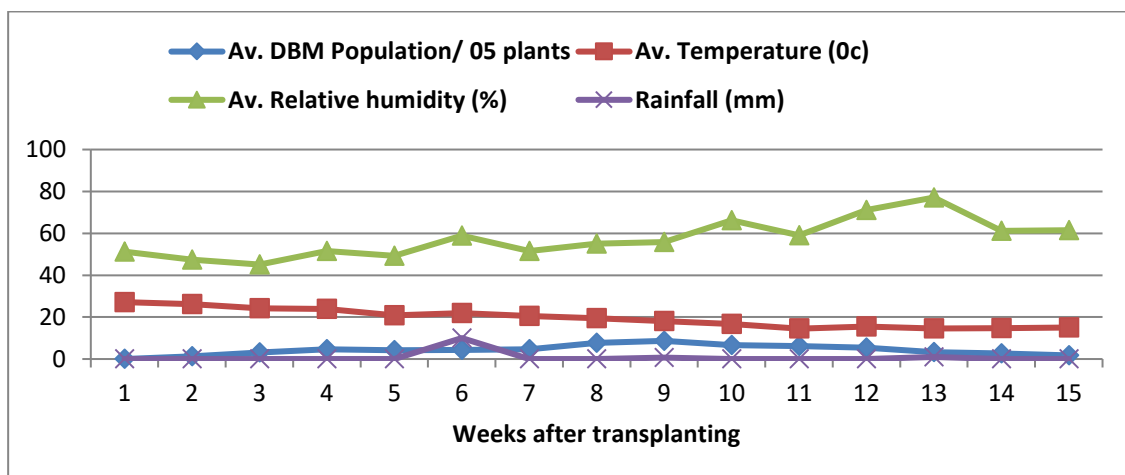


Fig. 2. Impact of weather on larval population of Diamondback Moth, *Plutella xylostella* Linn. on Cauliflower during Rabi, October, 2018 to January, 2019

Table 2. Larval population of Diamondback Moth, *Plutella xylostella* Linn. on Cauliflower during Rabi October, 2018 to January, 2019

S.W	Crop stage (week after planting)	Average population (DBM/05 plants)	Temperature (°C)			Relative humidity (%)			Rainfall (mm)
			Max. (°C)	Min. (°C)	Average (°C)	Morning (%)	Evening (%)	Average (%)	
41	1	0.00	33.70	20.60	27.15	62.20	40.40	51.30	0.00
42	2	1.33	33.50	18.90	26.20	62.70	32.10	47.40	0.00
43	3	3.12	31.40	16.90	24.15	57.50	32.70	45.10	0.00
44	4	4.68	30.30	17.40	23.85	63.00	40.10	51.55	0.00
45	5	4.11	28.80	12.80	20.80	62.00	36.40	49.20	0.00
46	6	4.33	28.50	15.20	21.85	73.70	44.20	58.95	10.00
47	7	4.67	27.60	13.60	20.60	65.40	37.80	51.60	0.00
48	8	7.67	26.70	12.30	19.50	68.70	41.50	55.10	0.00
49	9	8.67	25.10	11.20	18.15	70.80	40.80	55.80	0.60
50	10	6.68	22.40	10.90	16.65	80.20	52.10	66.15	0.00
51	11	6.11	21.50	7.50	14.50	77.00	41.20	59.10	0.00
52	12	5.34	23.00	7.90	15.45	93.10	49.20	71.15	0.00
1	13	3.33	20.70	8.50	14.60	92.20	62.00	77.10	1.00
2	14	2.67	21.10	8.40	14.75	81.00	41.40	61.20	0.00
3	15	1.68	22.10	8.10	15.10	78.50	44.50	61.50	0.00

Table 3. Correlation of Diamondback Moth on Cauliflower in relation to climatic factors during Rabi, 2017-2018 and 2018-19

Insect pests	Temperature (°C)			Relative humidity (%)			Rainfall (mm)
	Maximum	Minimum	Average	Morning	Evening	Average	
Diamondback Moth	-0.739*	-0.592*	-0.746*	0.212 ^{NS}	0.233 ^{NS}	0.257 ^{NS}	-0.165 ^{NS}
Diamondback Moth	-0.675*	-0.708*	-0.715*	0.385 ^{NS}	0.711 ^{NS}	0.733 ^{NS}	-0.187 ^{NS}

* Significant at 5% level ($p=0.05$)

Similarly, Sharma et al., [5] reported a significantly negative correlation between maximum and minimum temperature and the larval population of the Diamondback Moth. However, relative humidity and sunshine hours were non-significantly correlated with the Diamondback Moth population which appeared from the third week of November and attained a maximum population of upto 45.2 larvae /10 plants by the first week of January. However, Venugopal et al., [13] found *P. xylostella* damage throughout the year from a minimum 0.32 percent (second fortnight of February) to a maximum 5.98 percent (third fortnight of March) with a significant positive correlation in case of temperature and negative correlation w.r.t relative humidity (R.H), total rainfall and sunshine hours (SSH).

4. CONCLUSION

The effect of abiotic factors on the larval population of Diamondback Moth was conducted at research field of Khanpur, block Pataudi of district Gurugram, Haryana during two rabi seasons i.e., 2017-2018 and 2018-2019. It was found that the Diamondback moth, *P. xylostella* population (0.33) appeared in the first week of October (41st standard week) and gradually reached up to maximum level of 8.33 Diamondback Moth larvae/05 plants during third week of December (50th standard week) during 2017-2018 however it appeared in second week of October (42nd standard week) (1.33) and gradually reached up to maximum level of 8.67 Diamondback Moth larvae/05 plants during second week of December (49th standard week) during the year 2018-2019.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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