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Seasonal Activities of Diamond Back Moth (*Plutella xylostella* L.) in Cabbage (*Brassica oleracea* var. *capitata*) and their Relation with the Various Environmental Factors under the Gangetic Plains of West Bengal

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ABSTRACT

The experiment was to study the population dynamics of DBM conducted during the *rabi* season of 2017-18 and 2018-19 in the new alluvial zone of West Bengal. The farm is located at 23° N latitude and 89" E longitudes at an elevation of 9.75 meters from the mean sea level at the Central Research Farm of BCKV, Nadia. The land is topographically referred to as medium land with typically Gangetic alluvial soil (Entisol) having sandy clay loam texture and good drainage facility. The whole experiment was laid out in a Randomized Block Design. The main pests encountered were DBM and the natural enemies found were *Cotesia plutellae* and spiders. The peak population of DBM was noticed in the fourth week of February in both years 13.00 larvae/plant in season I and in season II 17.00 larva/plant. It showed that significant positive correlation with maximum temperature and minimum temperature and non-significant positive correlation with the sunshine hour and significant negative correlation with the morning and evening relative humidity in the season I and in season II it showed a significant positive correlation with maximum temperature and non-significant positive correlation with minimum temperature, sunshine hour and non-significant negative correlation with the morning and evening relative humidity. *Cotesia plutellae* population started to appear in the field the second week of January and reached the maximum in the fourth week of February in both years. The spider population initiated in the third week of January and reached its peak in the third week of February in both years. It showed a significant positive correlation in the population of *Cotesia plutellae* and spiders with the diamondback moth.

Keywords Cabbage, Diamond back moth, *Cotesia plutellae*, Population fluctuation, Weather parameters, Alluvial zone.

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INTRODUCTION

Cabbage (*Brassica oleracea* subsp. *capitata* L.) is one of the most significant vegetable in the world

(Matharu and Mehta 2017). Cabbage grown in all five continents and in more than 90 different nations. In India, cabbage is one of the most popular winter vegetables. India is the second largest producer of cabbage in the world after China (Hotric. Div., MOA and FW, GOI 2018). The major cabbage-producing states are West Bengal, Uttar Pradesh, Orissa, Bihar, Assam, Maharashtra and Karnataka. The area under the production of cabbage is 395 ha with a production of 8807 MT (Anonymous 2017). These crops are distributed all over the agro-climatic situations like temperate, sub-tropical, and tropical regions of the world (Nimasow *et al.* 2014). Global temperature has risen during the previous century, while humidity, precipitation and atmospheric carbon dioxide concentration have all substantially increased and will double in 2100. This change is attributed largely to natural and anthropogenic causes, which have led to abnormal weather events like modified rainfall patterns, frequent droughts and floods, increased heat and cold wave intensity and frequency, outbreaks of insect pests and diseases, which have a profound influence on a variety of biological systems and ultimately on agricultural insect pests and people (Samanta *et al.* 2022). So it is important to know when and what conditions are preferred for insect pests and which weather parameters or abiotic factors are favorable for insect pests and which we have found that the particular time that, insects cause economic losses so we can apply management procedures and prevent them from loss. In India, DBM was first recorded in 1914 on cruciferous vegetables (Gopika *et al.* 2022). It is now found to be the most serious pest in major Cole crops growing areas of West Bengal, Punjab, Haryana, Delhi, Uttar Pradesh, Maharashtra, Tamil Nadu and Karnataka (Meghana *et al.* 2017) Cruciferous vegetables are the most suitable host plant for DBM for both Early and late maturing varieties for intensive cultivation of both involving more crops in sequence throughout the year (Lal *et al.* 2020). It was estimated that at least 53–80% loss in marketable yield is due to the DBM attack alone and loss could be more if the attack is severe (Rajput and Naqvi 2022). To protect the crop from this infestation, insecticides are being used widely to control the insect pests of vegetables because of their easy adoption, effectiveness and immediate control. Indiscriminate and irrational use of chemical insecticides at higher dosages results in resurgence, resistance and residual problems we studied the seasonal abundance of diamondback moth in cabbage and their relation with various environmental factors.

MATERIALS AND METHODS

Study site

The metrological data on different abiotic factors viz. ,temperature (maximum and minimum in °C), relative humidity (maximum and minimum in %), total rainfall (mm) and bright sunshine hours (hr) during the crop growth period were collected from the AICRP on Agro Metrology Unit, BCKV.

Observation

The observation was recorded at weekly intervals. The diamondback moth population was recorded by counting the larva in each plant. Five plants were randomly selected from each plot. Meteorological data were recorded throughout the crop growth period to work out the correlation between the abiotic factors and population density.

Statistical analysis

Seasonal incidence of DBM was recorded as no. of larva/plant at an interval of seven days. The influence of different weather parameters like maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and sunshine hours (hr) on population dynamics of DBM has been investigated through correlation studies, calculating respective- "r" (correlation coefficient) through Pearson's correlation method.

RESULTS AND DISCUSSION

Seasonal incidence pattern of diamondback moth (*Plutella xylostella* L.) infesting cabbage

Studies on seasonal incidence of the diamondback moth of cabbage revealed that the occurrence of diamondback moth was observed from 10-12 days after sowing for both years. Observations were recorded from the fourth week of December to the second week

Table 1. Correlation between diamondback moth and weather parameters in the year 2017-18. **Significant at 1% level of signification.

Environmental factors		Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Temperature (°C)	Maximum	887**	0.7865	y= 0.954x–19.891
	Minimum	835**	0.6966	y= 0.9401x–4.9649
Relative humidity %	Morning	–549	0.3013	y= –0.9538x+93.421
	Evening	–755**	0.5698	y= –0.4973x+29.145
Sunshine (hr)	Duration	035	0.0012	y= 0.1374x+6.1098

of March. The pest population of diamondback moth was recorded on the cabbage as per the procedure mentioned under "Materials and Methods". The observation was recorded on the seasonal occurrence of the diamondback moth. Population dynamics of diamondback moth and predators found in the cabbage agro ecosystem during the experimental season i.e., *rabi* 2017-18 and *rabi* 2018-19 have been presented in Tables 1–2.

Diamondback moth (*Plutella xylostella* L.)

The population of diamondback moth was ranged from 0.20 to 13.00 and 0.60 to 17.00 larva per plant in season I and season II respectively. It was first appeared on the crop during the last week of December in both the season. Thereafter, the density of diamondback moth increased steadily and reached to a peak of 13.00 larva per plant in the fourth week of February in 2017-18 and to a peak of 17.00 per plant in fourth week of February in 2018-19. The population of the Diamondback moth started declining after reaching to its maximum with the maturity of the crop. These finding are in agreement with Patra *et al.* (2013) reported that the peak population of Diamondback moth (DBM) was recorded on 1st March and 23rd February with 13.60 and 14.33 larvae/plant during 2011-12 and 2012-13 respectively.

Natural enemy incidence pattern

Cotesia plutellae

The population of *Cotesia plutellae* ranged from 0.06 to 1.60 per plant in season I and in season II the population of the *Cotesia plutellae* range from 0.40 to 1.80 per plant. In the year 2017-18 they first appeared on the crop in the 2nd week of January with 0.06 and in the year 2018-19 they first appeared on the 2nd week of January 0.40 per plants and their peak activity was observed in 4th week of February with 1.60 and 1.80 per plants in season I and season II respectively.

Spiders

The spider first appeared on the crop in the 3rd week of January in both the season. They were active throughout the growth period of the crop with peak of 1.20 per plant in the 3rd week of February in 2017-18 and to a peak of 1.40 per plant in the 3rd week of February in 2018-19.

Table 2. Correlation between diamondback moth and weather parameters in the year 2018-19. *Significant at 5% level of signification.

Environmental factors		Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Temperature (°C)	Maximum	654*	0.4282	y= 1.5135x–34.511
	Minimum	272	0.074	y= 0.3791x+ 1.1842
Relative humidity %	Morning	–537	0.2882	y= -1.0014x+97.273
	Evening	-454	0.2059	y= -0.3277x+20.394
Sunshine (hr)	Duration	388	0.1505	y =1.7677x–6.5351

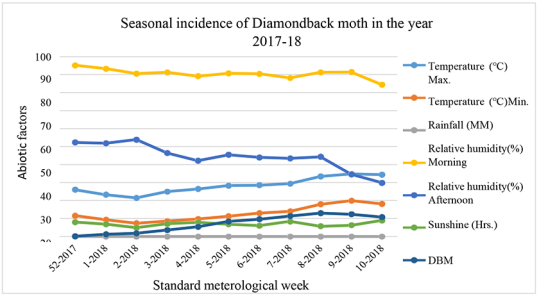

Fig. 1. The influence of various abiotic factors on the population dynamics of diamondback moth in the year 2017-2018.

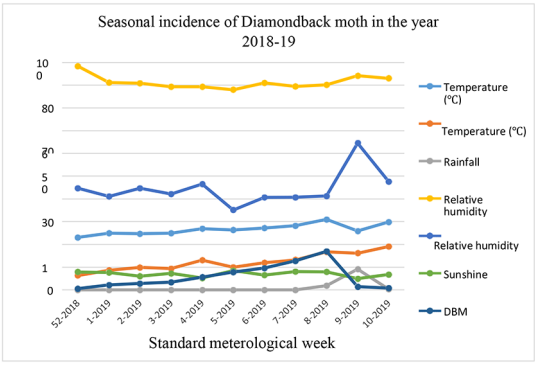

Fig. 2. The influence of various abiotic factors on the population dynamics of diamondback moth in the year 2018-2019.

The role of various abiotic factors influencing the population dynamics of diamondback moth

The influences of maximum temperature, minimum and average temperature, morning relative humidity, evening and average relative humidity and sunshine hours on the population of diamondback moth was worked out for both the season and have been presented in the Figs. 1–2. The Diamondback moth was first appeared in the fourth week of December in 2017- 18 when maximum and minimum temperature, morning and evening relative humidity, rainfall and sunshine hour were 26.04°C, 11.57°C, 95.14%, 52.29%, 00 mm and 8.40 hrs respectively. It reached to maximum in the fourth week of February when the maximum and minimum temperature, morning and evening relative humidity, rainfall, and sunshine hour were 33.39°C, 17.96°C, 91.29%, 44.33%, 00 mm, and 5.70 hrs respectively. The correlation coefficient between the number of diamondback moth per plant and temperature, relative humidity and sunshine hours were worked out (Figs. 1–2).

Population revealed that the correlation study between various factors and DBM there was a significant positive correlation between DBM population and with maximum temperature and minimum temperature, a non-significant positive correlation with h sunshine hour and a significant negative correlation with the morning and evening relative humidity.

In the next year 2018-19 also diamondback moth first appeared in the fourth week of December in 2018-19 when maximum and minimum temperature, morning, and evening relative humidity, rainfall, and sunshine (hr) were 23.11°C, 6.36°C, 98.29%, 44.71%, 0.00 mm and 7.90 h respectively (Table 2).

The correlation coefficient study revealed that there was a significant positive correlative with maximum temperature and non-significant positive correlation with minimum temperature and sunshine hour, and a non-significant negative correlation with the morning and evening relative humidity.

These findings agree with (Maity *et al*. 2018)

Table 3. Correlation between biotic factors and diamondback moth in the year 2017-18. **Significant at 1% level of signification *Significant at 5% level of signification.

Biotic factors	Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Cotesia plutellae	0.947**	0.8971	y=7.7307x+2.111
Spiders	0.604*	0.3649	y= 6.5429x+3.7418

Table 4. Correlation between biotic factors and diamondback moth in the year 2018-19. **Significant at 1% level of signification.

Biotic factors	Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Cotesia plutellae	0.932**	0.8683	y= 7.9403x+0.0434
Spiders	0.917**	0.8405	y= 9.7507x+0.6769

reported that the DBM population had a positive correlation with temperature and sunshine hours and a negative correlation with relative humidity.

The role of various biotic factors influencing the population dynamics of the diamondback moth

To observe the effect of predatory on the activity of the DBM like the population of predators was co-related on with the DBM (Tables 3–4). There was a positive trend in the population of *Cotesia plutellae* and spiders with that of DBM having a significant positive correlation at 1% and 5% level signification.

CONCLUSION

The result revealed that the Diamond Back Moth first appeared on the crop in the fourth week of December in the year. Thereafter, the density of diamondback moth increased steadily and reached to peak during the fourth week of February in 2017-18 and 2018-19. Then the population of the diamondback moth started declining with the maturity of the crop. There was a positive correlation in the population of *Cotesia plutellae* and spider the of diamondback moth having a significant positive correlation at 1% and 5% level signification in season I and 1% level signification in season II. The inference drawn from the correlation studies revealed that in case of diamondback moth there was a significant positive correlation with maximum temperature and minimum temperature, non-significant positive correlation with sunshine hour and significant negative correlation with the morning and evening relative humidity in both the year.

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