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Seasonal incidence and effect of abiotic factors on population dynamics of diamondback moth (*Plutella xylostella* L.) on cabbage (*Brassica oleracea* var. Capitata L.) crop

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Abstract
Field experiment was conducted at research farm of Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (C.G.) during the *rabi* seasons of 2015-2016 and 2016-2017 to evaluate the seasonal incidence of diamondback moth in cabbage crop and impact of weather parameters on it's population dynamics. Infestation of diamondback moth started from the end of December in 2015-2016 (0.075/ 20 plants) and first week of January in 2016-2017 (0.125/ 20 plants) and reached peak in the month of March in both years (6.85/ 20 plants and 5.25/ 20 plants). Correlation study revealed that the maximum temperature had non significant negative correlation (r = -0.005) with larval population but had positive correlation (r = 0.19) in year 2016-17. Minimum temperature had a positive correlation in both years (r = 0.24 and r = 0.21, respectively). Though, the relative humidity had negative and positive relation with the larval population of diamondback moth in both years (r = -0.26 and r = 0.11 respectively). Sunshine hours had negative but non-significant (r=-0.31) effect in 2015-16 while positive relation (r=0.38) was observed in 2016-2017. However rainfall had positive non significant relation (r=-0.05 and r= -0.08 respectively), in both years.

Keywords: cabbage, diamondback moth, population dynamics, weather parameters

1. Introduction
Cruciferous vegetables have an important place among rabi crops grown in India. Cabbage, *Brassica oleracea* var. capitata (Linn.), is a popular vegetable that is grown in all the states of India and has appreciable nutritional and economic value. Insect pests are a serious menace in the profitable cultivation of cabbage. More than 40 per cent yield loss is caused due to direct pests attack in different vegetables and also make most of the left over crop produces as unfit for human consumption. Among all, the insect pests that attack crucifer vegetable crops, *viz*., tobacco caterpillar, *Spodoptera litura* Fabricius; diamondback moth, *Plutella xylostella* Linnaeus; cabbage leaf webber, *Crocidolomia binotalis* Zeller; aphids, *Brevicornye brassicae* Linnaeus and *Lipaphis erysimi* Kalt; painted bug, *Bagrada cruciferum* Kirk.; and flea beetle, *Phyllotreta cruciferae* Goeze [12]. Out of these, diamondback moth, *Plutella xylostella* (L.) is the most destructive cosmopolitan pest [10, 8]. In India, diamondback moth has national importance on cabbage as it causes 50-80% annual loss in the marketable yield [4, 1]. Krishnamoorthy [7] also reported that there is 52% loss in yield due to the attack of diamondback moth. The severity of the incidence of diamondback moth is greatly influenced by the prevailing climatic conditions which vary from region to region. The basic information of the insect species of an agro-ecosystem and their population densities during the crop cycle is indispensable for planning well-timed measures for controlling phytophagous insects and minimizing economic losses for the producer [5]. Such studies can explore the synchronization of pest and predator emergence and suggest ways to better implementing biological control strategies. With this objective seasonal fluctuations in population density of the diamondback moth in cabbage ecosystem (from planting to harvest) were studied.

2. Material and Methods
2.1 Design and layout
The experiment was carried out during rabi, 2015-16 in cabbage variety Golden Acre. The field study was conducted at the experimental area of Indira Gandhi Agricultural University,

Raipur (C.G.). Weekly data of temperature (maximum and minimum), relative humidity and sunshine hours were collected from Meteorological observatory, Department of Meteorology, I.G.K.V. Raipur, (C.G.). In a plot size of 10 x10 sq m area,variety "Golden Acre" was sown with two replications.

2.2 Observation
The crop was kept under vigil for the appearance of diamondback moth larva. To estimate the larval population of diamondback moth, direct visual counting method was used [9]. The observations were recorded at weekly interval throughout the crop growth on twenty randomly selected plants from each plot. The weather data *viz*., maximum and minimum temperature, relative humidity, rainfall and bright sunshine hours recorded in the meteorological observatory were collected for correlating with the population fluctuation phenomena of diamondback moth.

2.3 Statistical analysis
The data on the pest incidence were statistically analysed for the seasonal incidence and then computed with correlation co-efficient studies to see the effect of different abiotic factors on the population of diamondback moth.

3. Result and Discussion
Trend of incidence of diamondback moth (DBM) on cabbage during 2015-16 and 2016-17 crop seasons are depicted in table no. 1 and 2 respectively. Cabbage was attacked by this pest about one month after transplanting during both the years. The data on seasonal abundance of diamondback moth recorded on cabbage (Table 1) revealed that during 2015-2016, the infestation of diamondback moth (larva) was first recorded at the end of December month with an initial population of 0.075/ 20 plants. The population increased gradually in successive weekly counts and reached a peak of 6.85/ 20 plants on the first week of march and thereafter, the population dwindled to 4.65/ 20 plants. During 2016-2017 also, the population fluctuation trend was similar to that of 2015-2016.It reached its peak in second week of March with a population of 5.25/20 plants and declined thereafter to 0.43/ 20plants on first week of April. These findings of population trend are in conformity with the findings of Goudegnon *et al*. [6] who observed that diamondback moth population attained its peak during February and March. A simple correlation co-efficient was worked out between the number of larvae and the weather factors *viz*., temperature (max. and min.), relative humidity, rainfall and bright sunshine hours. The results revealed that the maximum temperature had negative correlation (r = -0.005) with larval population but had positive correlation (r = 0.19) in year 2016-2017. Minimum temperature had a positive correlation in both years (r = 0.24 and r = 0.21, respectively). Though, the relative humidity had negative and positive relation with the larval population of diamondback moth in both years (r = -0.26 and r = 0.11, respectively) but they had no significant effect with the pest population. The correlation studies also revealed that sunshine hours had negative but non-significant (r=-0.31) effect in 2015-16 while positive relation (r=0.38) was observed in 2016-2017. However rainfall had positive non significant relation (r=-0.05 and r= -0.08 respectively), in both years.

The present findings of the positive correlation of diamondback moth population with the maximum and minimum temperature was also reported by Venkateswarlu *et al*. [13] but the findings of the same author that negative relation with the relative humidity and positive with sunshine hours is in contrast with the present findings as it has been observed that the relative humidity has no significant effect and sunshine hours has negative and non-significant relation with the population fluctuation of diamondback moth. The finding of Aysheshim *et al.* [2] also showed that the population of diamondback moth had positive non-significant relation with the maximum temperature and justified partial agreement with the present finding. Meena and Singh [11] also reported that the minimum temperature showed positive relation with the larval population of diamondback moth which corroborates the present findings. The present finding of the non-significant relation of diamondback with the relative humidity and sunshine hours is in conformity with the observations made by Bana *et al*. [3].

Table 1: Seasonal incidence and population dynamics of diamondback moth and abiotic factors in cabbage ecosystem during *rabi* 2015-16

SMW	Date of observation	Temperature (˚C)			Relative humidity (%)			Sun shine (Hours)	Rainfall (mm)	*P. xylostella* Larvae / 20 Plants
		Maximum	Minimum	Average	Morning	Evening	Average			
52th	29/12/2015	25.79	12.00	18.895	87.86	39.83	63.845	4.61	0.14	0.075
1st	05/01/2016	30.77	11.99	21.38	81.57	27.29	54.43	8.09	0.00	0.425
2nd	12/01/2016	29.63	11.37	20.5	87.29	25.00	56.145	6.80	0.00	1.575
3rd	19/01/2016	28.40	14.20	21.3	86.29	43.86	65.075	5.41	0.00	1.85
4th	26/01//2016	26.07	8.64	17.355	91.14	34.00	62.57	7.47	0.29	2.5
5th	02/02/2016	30.89	14.03	22.46	87.14	35.14	61.14	8.37	0.00	3.05
6th	09/02/2016	31.30	14.28	22.79	77.00	26.61	51.805	8.79	0.00	3.65
7th	16/02/2016	31.81	19.30	25.555	80.43	41.43	60.93	5.15	0.07	4.05
8th	23/02/2016	34.77	18.99	26.88	72.71	28.86	50.785	7.80	0.00	6.1
9th	02 /03 /2016	33.13	20.90	27.015	79.29	41.14	60.215	2.63	0.00	6.85
10th	09/03/2016	30.73	20.57	25.65	76.00	27.00	51.5	7.25	0.09	4.65
11th	16/03/2016	33.84	20.57	27.205	62.63	29.86	46.245	6.76	0.41	3.5
12th	23/03/2016	40.12	23.22	31.67	59.35	26.77	43.06	7.44	0.00	2.55
13th	30 /03/2016	40.44	23.47	31.955	60.00	22.57	41.285	9.22	0.00	1.3
14th	06/04/2016	41.10	24.34	32.72	60.05	17.90	38.975	8.47	0.00	0.35
Seasonal Mean		32.59	17.19	24.89	76.58	31.15	53.86	6.95	0.07	2.84
Coefficient of correlation (r) for population and Maximum Temperature										-0.005
Coefficient of correlation (r) for population and Minimum Temperature										0.24
Coefficient of correlation (r) for population and mean Temperature										0.13
Coefficient of correlation (r) for population and Relative Humidity										0.105
Coefficient of correlation (r) for population and Sunshine										-0.31
Coefficient of correlation (r) for population and Rainfall										0.05

Table 2: Seasonal incidence and population dynamics of diamondback moth and abiotic factors in cabbage ecosystem during *rabi* 2016-17

SMW	Date of observation	Temperature (°C)			Relative humidity (%)			Sun shine (Hours)	Rainfall (mm)	*P. xylostella* Larvae / 20 plants
		Maximum	Minimum	Average	Morning	Evening	Average			
52th	25/12/2016	27.8	9.5	18.65	85.4	26.3	55.85	7.6	0	0
1st	01/01/2017	29	12.07	20.535	89.71	33.86	61.785	6.39	0	0.125
2nd	08/01/2017	28.24	12.66	20.45	86.14	33.71	59.925	6.69	0.8	0.3
3rd	15/01/2017	27.73	10.46	19.095	83.14	26	54.57	8.23	0	0.325
4th	22/01/2017	29.84	13.21	21.525	84.29	28.29	56.29	8.66	0	1.075
5th	29/01/2017	29.89	13.33	21.61	79	27.71	53.355	8	0	1.45
6th	05/02/2017	31.63	12.94	22.285	83.86	24.29	54.075	9.6	0	2.25
7th	12/02/2017	31.19	16.19	23.69	79.57	34.29	56.93	6.37	0.8	2.1
8th	19/02/2017	33.89	15.29	24.59	75	18.14	46.57	10.24	0	3.1
9th	26/02 /2017	33.54	14.53	24.035	68.29	15.29	41.79	10.06	0	3.7
10th	05/03/2017	33.81	19	26.405	67.29	30.29	48.79	7.3	0.79	3.75
11th	12/03/2017	32.2	17.19	24.695	60.86	21.43	41.145	8.26	0	5.25
12th	19/03/2017	35.17	18.96	27.065	65.14	18.14	41.64	9.07	0	2.05
13th	26/03/2017	40.4	22.61	31.505	60.86	13.57	37.215	8.93	0	1.05
14th	02/04/2017	41.43	25.87	33.65	52.71	16.14	34.425	8.37	0	0.43
Seasonal Mean		32.38	15.59	23.99	74.75	24.50	49.62	8.25	0.16	1.80
Coefficient of correlation (r) for population and Maximum Temperature										0.19
Coefficient of correlation (r) for population and Minimum Temperature										0.21
Coefficient of correlation (r) for population and mean Temperature										0.20
Coefficient of correlation (r) for population and Relative Humidity										-0.41
Coefficient of correlation (r) for population and Sunshine										0.38
Coefficient of correlation (r) for population and Rainfall										0.08

4. Conclusion

It may be concluded from the present study that infestation of *P. xylostella* started from the end of December in 2015-2016 and first week of January in 2016-2017 and reached peak in the month of March in both years in Raipur district. The correlation between population of *P. xylostella* and weather parameters (temperature (maximum and minimum), percent relative humidity,sunshine hours and rainfall) was found statistically non significant. These findings can be used by the farmers for developing a sound programme to counter the attack of *P. xylostella* in cabbage crop to minimize losses.

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