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Population dynamics of diamondback moth, *Plutella xyllostella* (L.) on cabbage

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Abstract
The experiment was conducted during *Rabi*, 2018 -19 and 2019-20 at the experimental area of Instructional Farm, College of Agriculture, S.K.R.A.U., and Bikaner. The cabbage crop was found to be infested by diamondback moth, *P. xylostella* first appeared on the crop in the first week of December. Maximum number of larvae was observed during first week of February and thereafter, the population started declining. There was a significant negative association of *P. xylostella* population with maximum and minimum temperature. The influence of morning relative humidity and evening relative humidity was significant positive on the larval population build up. Though, the rainfall had non-significant effect on larval population build up. More or less same order of correlation was observed during 2019-2020.

Keywords: Cabbage, larval, maximum, minimum, *P. xylostella*, population, significant

Introduction
Various vegetables produced in India, the cool season crucifer vegetables, particularly the cabbage and cauliflower crops are most important in terms of nutritional and economic significance. Major cabbage producing country in the world are China, India, Russia, Japan, Republic of Korea, Ukraine, Indonesia, Poland, and Romania and united State of America. China rank first in cabbage production followed by India. In India the existing estimated area under cabbage cultivation was 0.403 lakh hectare with estimated production touching around 93.69 million tonnes (Anonymous, 2019) [1]. In Rajasthan, the area and production under cabbage was 12000 hectares and 11690 metric tonnes, respectively (Anonymous, 2017-18) [2]. One of the major constraints for not attaining higher yield in crucifers is the damage caused by insect pests that attack at various growth stages of the crops. Insect pests causes nearly 60-80 percent on an average yield loss in crucifer's crops. Different insect pests pose threat to the production of cabbage throughout the world. Maison (1965) [6] listed 51 insect pests which damage cruciferous crops throughout the world out of which diamondback moth (DBM), *P. xylostella* (Linnaeus) is one of the major constraints in the profitable cultivation of cole crops, wherever they are grown (Talekar and Shelton 1993) [10]. In order to prevent the loss caused by insects and produce a quality crop, it is essential to manage the pest population at appropriate time with suitable measures. A thorough knowledge of seasonal activity of different insect pests determines the predisposing climatic factors affecting their population dynamics.

Materials and Methods
The experiment was conducted at Instructional Farm, College of Agriculture, S.K.R.A.U., and Bikaner during *rabi*, 2018 and 2019. The use of cabbage variety was golden acre and spacing was maintained 45cm X 45 cm.

Methods of Observations
Twenty plants were selected and tagged to record the larval population of diamondback moth of cabbage. The cabbage crop was kept under natural condition throughout the crop season. Observations were recorded on these tagged plants after 15 days of transplanting at weekly interval during 7.00 AM to 8.00 AM.

Statistical analysis
Population data of diamondback moth thus obtained were subjected to statiscal analysis to find out the coefficient of correlation with maximum and minimum temperature, relative humidity and rainfall. A simple correlation was worked out between the larval population of diamondback moth and abiotic environmental factors using the following formula.

$$rX_1Y_1 = \frac{\sum X1Y1 - \frac{\sum X1 \sum Y1}{n}}{\sqrt{\left[\sum X_1^2 - \frac{(\sum X_1)^2}{n}\right]\left[\sum Y_1^2 - \frac{(\sum X_1)^2}{n}\right]}}$$

Where,
rX_1Y_1= Simple correlation coefficient
X_1=Independent variable i.e. abiotic component
Y_1= Dependent variable i.e. per cent infestation
n= Number of observations

Results and Discussion

The data depicted in Table 1 inferred that during 2018-19, the population of *P. xylostella* was first appeared on the crop in first week of December (49th Standard Meteorological Week). Initially, the population of *P. xylostella* was recorded as 0.80 larva/ plant. Gradually an increasing trend was observed in the population buildup of *P. xylostella* larvae and the maximum number of larvae (6.30 larvae/ plant) was observed during first week of February (5th Standard Meteorological Week). Thereafter, the population started declining and reached at the level of 0.60 larva/ plant during the first week of March when the harvesting of cabbage crop was completed.

During the next consecutive year (2019-20), the dynamics of larval population of *P. xylostella* differed (Table 2) The pest (0.60 larva/ plant) commenced its activity during first week of December (49th Standard Meteorological Week), which slightly increased to 1.80 larva/ plant in the next week. The peak population of *P. xylostella* larvae was observed being 5.80 larvae/ plant during first week of February (5th Standard Meteorological Week). Later, the population decreased and 1.00 larva/ plant was recorded soon before harvest of the crop *i.e.* first week of March (09th Standard Meteorological Week). The results obtained in the present investigation are thus in close agreement with the earlier reported by Meena and Sharma (2003) [7] who recorded that the *P. xylostella* started attacking on cabbage crop initially in the last week of November (1.00 larva/ plant) and attained its peak (8.06 larva/ plant) in the fourth week of January. The present findings also more or less confirmed with the results obtained by Rao and Lal (2005) [8] who reported the peak population of *P. xylostella* in the first and second weeks of February during both the years and Goud *et al.* (2006) [5] observed the initiation of larval population in the third week of November and continued peak incidence till the first week of February, thereafter a declined trend of population was observed.

Table 1: Population dynamics of diamondback moth, *P. xyllostella L.* on cabbage in Relation to abiotic factor during *Rabi* season 2018-2019

Month and Week	SMW	Temperature ºC		Relative humidity (%)		Total rainfall (mm)	DBM Larva/ plant
		Maxi.	Mini.	Morning	evening		
November							
III	47	30.4	10.9	75.1	27.4	0.8	0.00
IV	48	29.7	10.0	72.6	28.6	0.8	0.00
December							
I	49	28.3	8.7	64.7	29.3	0.0	0.80
II	50	21.7	5.8	88.4	41.9	0.0	2.30
III	51	24.3	1.8	74.0	27.6	0.0	3.00
IV	52	26.6	3.0	78.0	29.9	0.0	2.50
January							
I	01	22.8	5.9	88.0	35.7	0.0	3.80
II	02	22.5	5.6	85.6	34.1	0.0	4.50
III	03	24.6	6.3	80.3	32.0	0.0	5.00
IV	04	18.8	5.7	94.1	46.0	2.5	5.40
February							
I	05	20.9	4.5	82.7	40.9	0.2	6.30
II	06	22.7	6.6	87.1	37.1	0.0	5.70
III	07	25.1	9.6	75.7	36.3	0.0	4.00
IV	08	24.2	9.9	81.9	41.7	0.0	2.30
March							
V	09	24.2	9.5	79.4	37.4	0.0	0.60

SMW- Standard Meteorological Week

Table 2: Population dynamics of diamondback moth, *P. xyllostella L.* on cabbage in Relation to biotic factor during *Rabi* season 2019-2020

Month and Week	SMW	Temperature ºC		Relative humidity (%)		Total rainfall (mm)	DBM Larva/ plant
		Maxi.	Mini.	Morning	Evening		
November							
III	47	28.0	11.9	79.1	42.3	0.0	0.00
IV	48	23.0	9.1	90.7	53.6	7.8	0.00
December							
I	49	24.6	6.1	81.1	32.4	0.0	0.60
II	50	19.0	7.5	92.1	62.0	6.8	1.80
III	51	20.6	4.5	86.3	41.9	0.0	2.50
IV	52	21.7	2.3	86.3	43.3	0.0	3.00
January							
I	01	20.8	5.9	85.3	47.9	0.0	4.50
II	02	18.3	4.7	81.9	53.7	9.8	3.70
III	03	18.3	3.7	92.9	49.6	0.0	4.30
IV	04	22.2	6.3	82.3	41.7	12.0	5.00

February							
I	05	22.4	5.2	84.7	50.4	0.0	5.80
II	06	23.0	5.4	74.7	31.1	0.0	4.50
III	07	29.1	7.1	72.1	23.4	0.0	3.40
IV	08	27.4	10.1	82.3	36.4	0.0	1.70
March							
V	09	31.4	12.4	78.3	25.9	0.0	1.00

SMW- Standard Meteorological Week

Correlation coefficient between *P. xylostella* and weather parameters

The data on correlation coefficient between *P. xylostella* larval population and weather parameters for 2018-2019 presented in Table 3 indicated that a significant negative association of *P. xylostella* population was computed with maximum and minimum temperature (r= -0.781 and r= -0.545). The influence of morning relative humidity (r= 0.625) and evening relative humidity (r= 0.509) was significant positive on the larval population build up. Though, the rainfall (r= 0.076) had non-significant effect on larval population build up. The present findings confirmed the results obtained by Bana *et al.* (2012) [3] who recorded a significant negative correlation of diamondback moth larval population with the maximum and minimum temperatures whereas, relative humidity computed non-significant correlation, while, Bashir *et al.* (2015) [4] reported a negatively non-significant correlation with maximum temperatures, whereas, minimum temperature was positively non-significant also partially corroborate the present results. Similarly, Sharma *et al.* (2017) [9] reported a significant negative correlation between larval population and maximum and minimum temperature is in the line of present studies. Venugopal *et al.* (2017) [11] reported a significant positive correlation between larval population of *P. xylostella* and rainfall, contradict the present studies. Slight variation in seasonal abundance in larval population of *P. xylostella* may be due to local climate factors, variety and date of transplanting of the crop.

The correlation study between weather parameters and larval population of *P. xylostella* during 2019-2020 inferred maximum temperature (r= -0.450) showed non-significant negative, while minimum temperature (r= -0.644) had significant negative association with the *P. xylostella* larval population. There was non-significant negative association of morning (r= -0.039) and non-significant positive correlation of evening relative humidity (r= 0.102) with larval population of *P. xylostella.* Larval population of *P. xylostella* also had non-significant positive (r= 0.086) correlation with rainfall.

Table 3: Correlation coefficient (r) of abiotic factors with diamond back moth on cabbage crop during 2018 and 2019

S. No.	Abiotic components	Diamondback moth	
		2018-19	2019-20
1.	Maximum temperature (ºC)	-0.781*	-0.450
2.	Minimum temperature (ºC)	-0.545*	-0.644*
3.	Morning Relative humidity (%)	0.625*	-0.039
4.	Evening Relative humidity (%)	0.509*	0.102
5.	Rainfall	0.076	0.086

*Significant at 5% level of significance

Conclusion

The cabbage crops was found to be infested by Diamondback moth, *P. xylostella* was observedmost serious pest attacking the crop throughout of the growth stage. It was first appeared on the crop in the first week of December and reached its peak during first week of February.

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