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Influence of Prevailing Weather Parameters on Population of Fruit Borer, *Helicoverpa armigera* (Hubner) on Tomato in Western Uttar Pradesh

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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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Original Research Article

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ABSTRACT

A field experiment was conducted for two years (2021-22 and 2022-23) at Crop Research Center, College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, to ascertain the influence of various meteorological parameters on population fluctuations of *Helicoverpa armigera* on tomato. The peak period of occurrence of this insect was observed in 20th standard week (fourth week of May, 2022). The maximum population of this insect was recorded as 4.73 larvae/plant. Larval population of fruit borer had significant positive correlation with maximum temperature (r=0.593*) and minimum temperature (r=0.551*). Larval population of fruit borer had significant negative correlation with morning relative humidity (r=-0.598*) and evening relative

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humidity (r=-0.531*). Non-signification positive correlation was observed with the rainfall and larval population (r=0.052NS). The peak period of occurrence of this insect was observed in 23rd standard week (second week of June, 2023). The maximum population of this insect was recorded as 3.80 larvae/plant. Larval population of fruit borer had highly significant positive correlation with maximum temperature (r=0.693**) and minimum temperature (r=0.635**).

Keywords: Tomato; Helicoverpa armigera; population; correlation.

1. INTRODUCTION

"Tomato *(Solanum lycopersicum*, Mill.), being the second most important vegetable crop, is cultivated throughout the world either outdoor or indoor for its edible fruits and fresh market consumption. It is one of the most important and remunerative vegetable, grown both as commercially and in kitchen gardens. Tomato is a good source of vitamins A, B and C, also helps in healing of wounds due to antibiotic properties" [1]. "With regard to phytonutrients, it includes flavanones, flavonols and carotenoids like lycopene, zeaxanthin and beta-carotene. Reduced risk of heart disease is an area of health benefits in which tomatoes truly excel. There are two basic lines of research that have repeatedly linked tomatoes to heart health. The first line of research involves antioxidant support and the second line involves regulation of fats in the blood stream" [2].

"It is affected by several biotic, physiochemical and mesobiotic factors. Among the biotic factors insect pests are predominant and occur regularly at different stages of crop growth. A number of insect pests *i.e.* about 100 insect pests and 25 non insect pests species are reported to ravage the tomato fields" [3]. "In India, tomato occupies an area of 0.84 million hectare with production of 20.69 million metric tonnes" [4]. "Major tomato growing states in India are Madhya Pradesh, Odisha, Karnataka and Gujarat. In Uttar Pradesh, it occupies an area of 22.79 thousand hectare with production of 9.09 lakh metric tonnes" [4].

"Among many factors responsible for low yields of tomato, insect pests are major ones that have been reported to attack tomato at all stages of crop growth. The important insect pests of tomato are fruit borer, whitefly, leaf hopper, leaf miner, potato aphid and hadda beetle" [5]. "Out of these insect pests, the damage caused by fruit borer, *Helicoverpa armigera* surpass the loss caused by all other insect pests together and it has been reported that the losses due to this pest range from 20-50 percent" [6].

Studies on seasonal incidence in relation to abiotic factors are important for better understanding of pest scenario in different agroclimatic conditions. Before developing any management programme against insect-pests for particular agro ecosystem, it is necessary to have basic information on seasonal abundance of pest as well as their natural enemies in relation to meteorological parameters, as it helps to determine weak link in insect life cycle. Keeping this in view, we studied population dynamics of *H. armigera* and its relation with prevailing weather parameters.

2. MATERIALS AND METHODS

The experiment was conducted for two years (2021- 22 and 2022-23) at Crop Research Centre (CRC) in the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, (U.P.), India. The tomato was sown in plot size 21.6 m2 with spacing of 60 x 45 cm. the experiment was replicated for three times. Population of *H. armigera* larvae was recorded at weekly interval starting from plant establishment till end of the crop. Five plants were tagged randomly from each plot. These plants were observed regularly at weekly interval. Weekly meteorological data on temperature (minimum and maximum), relative humidity and rainfall were recorded throughout the crop season. Simple correlation was done using following formula.

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

Where,

X_1Y_1 Simple correlation coefficient
X_1 = Infestation percent
Y_1- Meteorological parameter
n = Number of observations

3. RESULTS

The weekly observation of *H. armigera* on tomato starting from germination to harvest. The population recorded fruit borer during experimental period were analysed statistically.

Zaid, 2021-22: The infestation was started from third week of April 2022 (15th SMW) to till harvest of the crop with varying population ranging from 0.67-4.73 larvae/plant. The peak period of occurrence of this insect was observed in 20th standard week (fourth week of May 2022) (Fig. 1). The maximum population of this insect was recorded as 4.73 larvae/plant (Table 1). The occurrence of fruit borer larvae was correlated with abiotic factors by determining correlation coefficients. The fluctuating incidence of *H. armigera* population mainly due to change in weather conditions. Larval population of fruit borer had significant positive correlation with maximum temperature (r=0.593*) and minimum temperature (r=0.551*). Larval population of fruit borer had significant negative correlation with morning relative humidity (r=-0.598*) and evening relative humidity (r=-0.531*). Non-signification positive correlation was observed with the rainfall and larval population (r=0.052NS) (Table 2).

Zaid, 2022-23: The infestation was started from third week of April 2023 (15th SMW) to till harvest of the crop with varying population ranging from 0.73-3.80 larvae/plant. The peak period of occurrence of this insect was observed in 23rd standard week (second week of June 2023) (Fig. 2). The maximum population of this insect was recorded as 3.80 larvae/plant (Table 3). The occurrence of fruit borer larvae was correlated with abiotic factors by determining correlation coefficients. The fluctuating incidence of *H. armigera* population mainly due to change in weather conditions. Larval population of fruit borer had highly significant positive correlation with maximum temperature (r=0.693**) and minimum temperature (r=0.635**). Larval population of fruit borer had non-significant positive correlation with morning relative humidity (r=0.415NS) and evening relative humidity (r=0.297NS). Non-signification negative correlation was observed with the rainfall and larval population (r=-0.194NS) (Table 4).

4. DISCUSSION

The infestation was started from third week of April 2022 (15th SMW) to till harvest of the crop with varying population ranging from 0.67-4.73 larvae/plant. The peak period of occurrence of this insect was observed in 20th standard week (fourth week of May 2022). The maximum population of this insect was recorded as 4.73

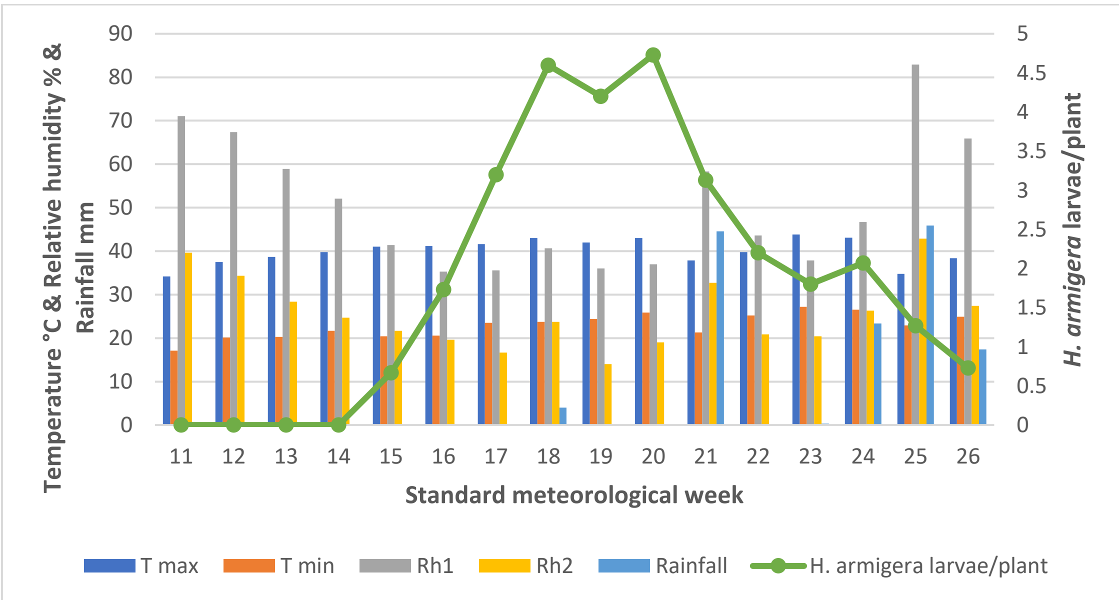

Fig. 1. Population dynamics of *H. armigera* to different weather parameters in tomato during *Zaid,* 2021-22

Table 1. Population dynamics of *H. armigera* to different weather parameters in tomato during *Zaid,* 2021-22

SMW	Temperature (C°)		Relative humidity (%)		Rainfall (mm)	*H. armigera* larvae/plant
	Maximum	Minimum	Maximum	Minimum		
15	41.00	20.40	41.40	21.70	0.00	0.67
16	41.20	20.60	35.30	19.60	0.10	1.73
17	41.60	23.50	35.60	16.70	0.00	3.20
18	43.00	23.70	40.70	23.70	4.00	4.60
19	42.00	24.40	36.00	14.00	0.00	4.20
20	43.00	25.90	37.00	19.00	0.00	4.73
21	37.90	21.30	58.30	32.70	44.60	3.13
22	39.80	25.20	43.60	20.90	0.00	2.20
23	43.80	27.20	37.90	20.40	0.30	1.80
24	43.10	26.50	46.70	26.30	23.40	2.07
25	34.80	22.90	82.90	42.90	45.90	1.27
26	38.40	24.90	65.90	27.40	17.40	0.73

Table 2. Correlation co-efficient between *H. armigera* population to different weather parameters in tomato during *Zaid,* 2021-22

Weather parameter	Larvae/plant
Maximum temperature (Tmax)	0.593*
Minimum temperature ((Tmin)	0.551*
Morning relative humidity (Rh1)	-0.598*
Evening relative humidity (Rh2)	-0.531*
Rainfall (mm)	0.052^{NS}

Table 3. Population dynamics of *H. armigera* to different weather parameters in tomato during *Zaid,* 2022-23

SMW	Temperature (C°)		Relative humidity (%)		Rainfall (mm)	*H. armigera* larvae/plant
	Maximum	Minimum	Maximum	Minimum		
15	34.93	17.80	45.14	26.86	0.00	0.73
16	37.23	22.03	44.86	25.00	0.00	1.20
17	33.23	20.23	51.71	33.29	0.00	3.07
18	28.79	18.49	79.00	57.43	13.00	1.13
19	36.63	20.46	47.14	31.57	0.00	3.67
20	38.06	24.30	51.29	32.71	13.00	2.93
21	37.97	22.69	56.43	36.00	15.70	1.67
22	33.71	21.94	70.57	53.71	3.40	1.60
23	36.94	23.80	57.14	37.00	0.00	3.80
24	39.66	27.40	50.43	38.57	0.00	2.07
25	36.43	26.61	76.29	59.57	13.60	0.93
26	31.54	24.96	92.43	80.57	120.90	0.40

Table 4. Correlation co-efficient between *H. armigera* population to different weather parameters in tomato during *Zaid,* 2022-23

Weather parameter	Larvae/plant
Maximum temperature (Tmax)	0.693**
Minimum temperature ((Tmin)	0.635**
Morning relative humidity (Rh1)	0.415^{NS}
Evening relative humidity (Rh2)	0.297^{NS}
Rainfall (mm)	-0.194^{NS}

** Significant at 5% level ** Significant at 1% level NS = Non significant*

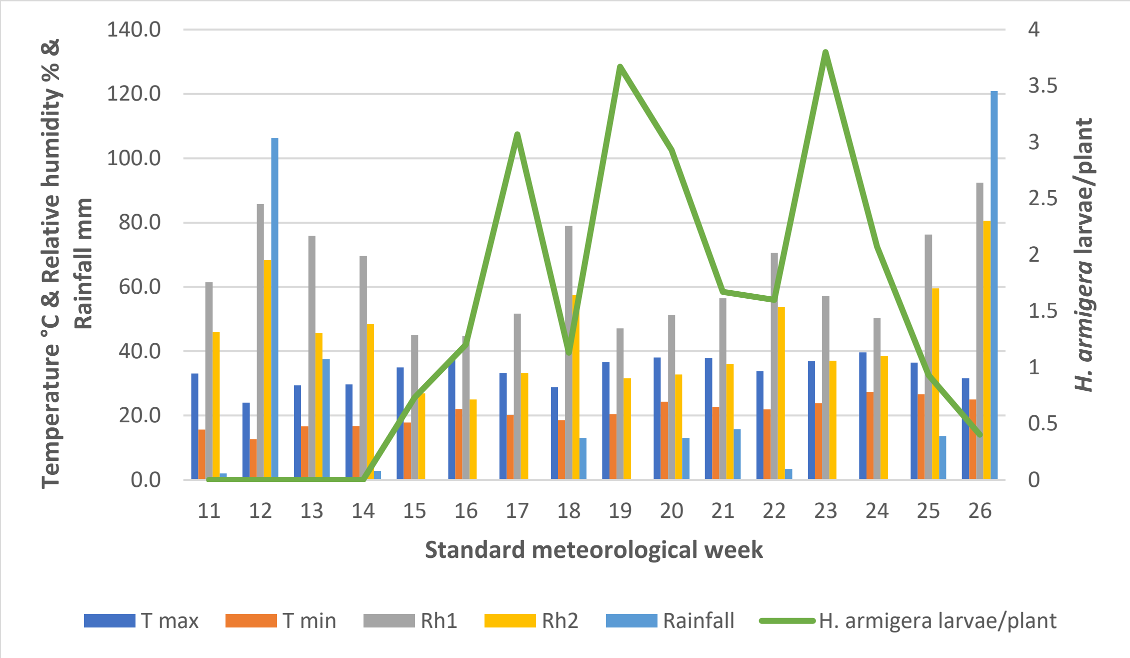

Fig. 2. Population dynamics of *H. armigera* to different weather parameters in tomato during *Zaid,* 2022-23

larvae/plant. In *Zaid,* 2021-22, larval population of fruit borer had significant positive correlation with maximum temperature (r=0.593*) and minimum temperature (r=0.551*). Larval population of fruit borer had significant negative correlation with morning relative humidity (r=-0.598*) and evening relative humidity (r=-0.531*). Non-signification positive correlation was observed with the rainfall and larval population ($r=0.052^{NS}$). In *Zaid,* 2022-23, the peak period of occurrence of this insect was observed in 23rd standard week (second week of June 2023). Larval population of fruit borer had highly significant positive correlation with maximum temperature (r=0.693**) and minimum temperature (r=0.635**). Larval population of fruit borer had non-significant positive correlation with morning relative humidity ($r=0.415^{NS}$) and evening relative humidity ($r=0.297^{NS}$). Non-signification negative correlation was observed with the rainfall and larval population ($r=-0.194^{NS}$). Findings are supporting the findings of Kakati et al. [7] who reported that "pest population of *H. armigera* starting from the first week of November and reached its peak during the first week of December. The population buildup of the pest revealed non-significant positive impacts of relative humidity, total rainfall and bright sunshine hours were also recorded on tomato fruit borer incidence. High and low temperature, evening relative humidity and bright sunshine hours had non-significant negative impacts, while morning relative humidity and total rainfall had non-significant positive impacts on percent fruit infestation". Similar work was also noticed with Singh et al. [8] where they reported "the first appearance of *H. armigera* was recorded in 50th and 52nd SMW (0.12 larvae per meter row irrespectively). The initial population gradually increased and remained confined to vegetative growth but it rapidly increased during fruiting stage and attained its peak in 15th SMW. Thereafter, the pest population declined. Rainfall and relative humidity were negatively correlated with the pest activity. Likewise, maximum and minimum temperatures were positively associated in enhancing the pest populations. The maximum temperature demonstrated negative impact with relative humidity in the buildup of larval population of *H. armigera*. larval population was at peak (4.91 larvae/ plant) during 16th SMW". The result is also supporting the findings of Shivani et al. [9] they stated that "the larval population showed significant positive correlation with maximum temperature (r=0.617 *) and highly significant negative correlation with morning (r=-0.784**) as well as evening relative humidity (r=-0.814**)". This is also in accordance with Bala and Sarkar [10] they found that "the larval population of tomato fruit borer, *H. armigera* first appeared in the field during 3rd standard metrological week (SMW) which gradually increased and reached its peak (7.37 larvae per plant) during 12th SMW *i.e.,* on 21.3.16. Correlation between various abiotic factors *viz.,* maximum relative humidity (r =-0.38), minimum relative humidity (r =-0.21) and rainfall (r =-0.33) with fruit borer larval population was found to be negative whereas maximum temperature (r =0.88), minimum temperature (r =0.86) and sunshine hour (r =0.34) were positively correlated with *H. armigera* larval population".

5. CONCLUSION

It is evident from the two year study that larval population occurred during 20th and 23rd SMW coinciding with vegetative and fruit development stage of the crop, respectively. The larval population had significant positive correlation with maximum & minimum temperature in both years, and while in relative humidity it was found negative correlation in first year and positive correlation in next year.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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