The Pharma Innovation Journal 2022; SP-11(5): 616-620

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(5): 616-620

www.thepharmajournal.com
Received: 22-03-2022
Accepted: 24-04-2022

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Effect of abiotic factors on the seasonal incidence of fruit borer, *Helicoverpa armigera* (Hub.) on tomato with and without marigold as a trap crop

Vijay Kumar, MK Mahla, Jhumar Lal and Beerendra Singh

Abstract
Field experiment was conducted to study the seasonal incidence of tomato fruit borer, *H. armigera* (Hub.) on tomato with and without marigold as a trap crop. The incidence of *H. armigera* on tomato without marigold as a trap crop was first noticed in the first week of February. The pest touched the peak with a mean of 4.40 larvae / plants during third week of March. Similarly, the incidence of *H. armigera* on tomato with marigold as a trap crop was first noticed in the fourth week of January. The pest touched the peak with a mean of 1.20 larvae/plant during third week of March. The correlation between fruit borer population and mean atmospheric temperature was positive and significant in with and without marigold (r= 0.633 and 0.677, respectively). The significantly positive correlation were found between *H. armigera* larvae and damaged fruits in tomato with and without marigold (r = 0.878 and 0.929, respectively).

Keywords: *H. armigera*, tomato, correlation, marigold, abiotic factors, trap crop

1. Introduction
Tomato is an important vegetable grown worldwide and it is also an important ingredient in our daily cuisine, but to produce healthy and good tomatoes and make it available to the consumers is a difficult task, as it undergoes a lot of pest attack from different angles. The tomato fruit borer, *Helicoverpa armigera* (Hub.) is a key pest as it infests fruits and makes them unfit for human consumption causing considerable (55%) crop loss [1]. It has been estimated that crops worth Rs.1000 crore are lost annually by this pest [2]. Over the years, the more common method for the control of this pest has been to have a film of a persistent effective insecticide over the foliage and fruiting bodies. However, the indiscriminate use of insecticides has eroded sustainability and resulted in buildup of pesticide residues, resistance to pesticides, resurgence and secondary outbreak of this pest [3, 4]. Therefore, switching from the use of insecticides alone to more bio-intensive methods of pest management such as the use of trap crops and farmscaping has become the trend. Trap cropping and planting of diversionary hosts have been widely applied and recommended in the past. Tomato fruit worm adults prefers marigold at flowering stage for oviposition as compared to tomato, which reduced *H. armigera* infestation of tomato [5]. So, to have clear proven idea on the incidence of fruit borer and to find the population build-up of these pest attacking tomatoes and their relation with abiotic factors like temperature, rainfall and relative humidity, the present experiment was conducted for further understanding of the role played by the abiotic factors in the incidence of fruit borer which is harmful to tomato growers which ultimately will help tomato growers for better return in terms of yield as well as income generation.

2. Material and Methods
The investigation was carried out at the Horticulture Farm of Rajasthan College of Agriculture, MPUAT, Udaipur during *Rabi* (October 2015 to April 2016). Geographically, Udaipur is located at 23.4°N longitude and 75°E latitude at an elevation of 579.5 MSL in the state of Rajasthan, India. The experiment was laid out on seasonal incidence of tomato fruit borer with and without marigold. A block of 8.2×10 m^2 was laid out in uniformly sized plots measuring 3.6 m x 3 m (10.8 m^2) with six plots for both experiments (with and without marigold). Tomato variety Samradhi was used for the experiment. Marigold was transplanted as the trap crop as per recommendation. The meteorological data on weather parameters *viz*, temperature, relative humidity and rainfall were collected from the atmospheric observatory, Department of

Agronomy, RCA, MPUAT, Udaipur.
Five plants were randomly selected and tagged from each plot. The population of *H. armigera* larv*ae* was estimated visually five randomly selected & tagged plants for each plot. At fruiting stage, the population of fruit borer was counted on five randomly selected plants in each plot. The damage caused by fruit borers were estimated by the method [6]. The percentage infestation will be work out on the basis of number of damaged fruits out of the total number of fruits at weekly interval. The weekly data thus obtained will be correlated to the abiotic factors of the environment.

2.1 Statistical analysis: Population data of *H. armigera* thus obtained were subjected to statistical analysis to find out the coefficient of correlation with average temperature and relative humidity. A simple correlation was worked out between the population of *H. armigera* and abiotic environmental factor using the following formula.

$$r_{xy} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where,
r_{xy} = Simple correlation coefficient
X = Variable i.e. abiotic component. (Average temperature and relative humidity)
Y = Variable i.e. mean number of insect pests
n = Number of paired observations
Significance of correlation is tested by using following formula.

$$t = \frac{r}{\sqrt{1 - r^2}} \times \sqrt{n-2} \sim t_{n-2} \text{ d.}$$

3. Result and Discussion

3.1 Seasonal incidence of *H. armigera* on tomato without marigold as a trap crop: The larval population of *H. armigera* was recorded at weekly intervals during entire crop season of tomato. The data is presented in Table 1 and depicted in Fig.1 reveal that the incidence *H. armigera* on tomato initiated in the first week of February (5th SMW). Initial mean population of larvae was 0.40/plant. The population increased gradually and touched its peak with a mean of 4.40 larvae per plant during third week of March (12th SMW). Thereafter, pest population declined gradually and reached to the minimum of 1.60 larvae per plant in the second week of April. (15thSMW). The mean atmospheric temperature and relative humidity during the peak period of incidence were 24.90 ºC and 34.80 per cent respectively. The pest showed positive and significant correlation with maximum, minimum and mean atmospheric temperature (r = 0.670, 0.655 and 0.677, respectively). The damaged fruits recorded during first week of February (5th SMW) were 0.20 damaged per plant. The maximum number of damaged fruits per (3.60/plant) was recorded during the third week of March (12thSMW) when the larval population was at its peak with a mean of 4.40 larvae/plant. The damaged fruits/plant showed a significant positive correlation with number of larvae/plant. Earlier some entomologists [7, 8, 9, 10] studied the seasonal incidence of *H. armigera* on tomato reported incidence of *H. armigera* to initiate by first week of February with the peak in March. Tomato fruit borer population initiated in the 14th standard meteorological week (2.50 borers/plant) with a population peak of 13.70 borer/ plant during the 21st standard meteorological week [9]. The borer population exhibited significant positive correlation with the temperature (maximum, minimum) (r=0.921, 0.626), whereas, it was positive and non-significant with sunshine hours (r =0.246). A significant negative correlation between borer population and maximum and minimum relative humidity (r =-0.700, -0.641) and non-significant negative with rainfall (r =-0.420) was observed during the study. The peak larval population of *H. armigera* from November 2012 to March 2013 with two distinct peaks on 11th and 12th SW (6.02 and 6.11 larvae/plant) [10]. The fruit borer had a significant positive correlation with number of rainy days (0.428*).

3.2 Seasonal incidence of *H. armigera* on tomato with marigold as a trap crop: The larval population of *H. armigera* was recorded at weekly interval during entire crop season of tomato. The data is presented in Table (2) and depicted in Fig.2 reveal that the incidence *H. armigera* on tomato initiated in the fourth week of January (4th SMW). Initial mean population of larvae was 0.20 per plant. The population increased gradually and touched its peak with a mean of 1.20 larvae per plant during third week of March (12th SMW). Thereafter, pest population declined gradually and reached to the minimum of 0.80 larvae per plant in the second week of April (15th SMW). The mean atmospheric temperature and relative humidity during the peak period of incidence were 24.90 ºC and 34.80 per cent respectively. The pest showed positive and significant correlation with maximum, minimum and mean atmospheric temperature (r = 0.628, 0.610 and 0.633, respectively). The infestation of fruits was recorded during fourth week of January (4thSMW) with 0.20 damaged fruits per plant. The maximum number of damaged fruits per plant (0.80/plant) was recorded during the third week of March (12thSMW) when the larval population was at its peak with a mean of 1.20 larvae/plant. The number of fruit borer larvae per plant was positively and significantly correlated with the damaged fruits. Earlier studied the seasonal incidence of *H. armigera* on tomato and revealed that in relation to abiotic factors of climate and marigold as a trap crop on tomato crop which reduced the larval population compare then without marigold the population of *H. armigera* to initiate by fourth week of January with the peak in March [11, 12, 13, 14, 15]. The IPM module consisting of trap crop (15 rows of tomato: 1 row marigold) + *Trichogramma pretiosum* (45000/ha) was significantly superior over the rest of the modules tested in restricting the larval population (100% after the fourth spray) [12]. The stacked tomato cultivated with marigold was more effective against the tomato fruit borer infestation [14].

Table 1: Effect of abiotic factors on the seasonal incidence of fruit borer larvae on tomato without marigold during *rabi* 2015-16

SMW	Dates of Observation	Abiotic factors						Damaged fruits/ plant	Fruit borer larvae/ plant
		Temperature (°C)			Relative Humidity (%)				
		Maximum	Minimum	Mean	Maximum	Minimum	Mean		
4	26-01-2016	25.9	6.0	15.95	80.1	22.1	51.10	0	0
5	02-02-2016	27.7	10.0	18.85	78.0	19.6	48.80	0.20	0.40
6	09-02-2016	26.6	7.3	16.95	78.0	19.6	48.80	0.80	1.60
7	16-02-2016	26.0	12.2	19.10	68.1	27.3	47.70	0.60	1.80
8	23-02-2016	30.5	11.9	21.20	67.0	18.0	42.50	1.20	2.60
9	01-03-2016	31.6	11.6	21.60	67.5	21.0	44.25	1.40	2.80
10	08-03-2016	31.7	14.1	22.90	67.6	28.7	48.15	1.20	2.40
11	15-03-2016	30.9	15.7	23.30	70.0	32.1	51.05	2.40	3.20
12	22-03-2016	34.1	15.7	24.90	51.7	17.9	34.80	3.60	4.40
13	29-03-2016	35.9	17.9	26.90	52.9	19.7	36.30	3.20	3.60
14	05-04-2016	36.6	19.5	28.05	39.7	16.9	28.30	1.80	3.20
15	12-04-2016	36.33	19.46	27.89	39.71	16.86	28.29	0.60	1.60
Seasonal Mean		30.27	12.49	21.38	67.33	23.07	45.20	1.42	2.30
Coefficient of correlation (r) for population and Maximum Temperature								0.621*	0.670*
Coefficient of correlation (r) for population and Minimum Temperature								0.579*	0.655*
Coefficient of correlation (r) for population and Mean Temperature								0.613*	0.677*
Coefficient of correlation (r) for population and Maximum Relative Humidity								-0.471	-0.562
Coefficient of correlation (r) for population and Minimum Relative Humidity								-0.024	-0.016
Coefficient of correlation (r) for population and Mean Relative Humidity								-0.399	-0.472
Coefficient of correlation (r) for population of fruit borer and fruit damage								0.929*	

SMW- Standard meteorological week, * Value of 't'- significant at 5% level of significance.

Table 2: Effect of abiotic factors on the seasonal incidence of fruit borer larvae on tomato with marigold during *rabi* 2015-16

SMW	Dates of Observation	Abiotic factors						Damaged fruits/plant	Fruit borer larvae/plant
		Temperature (°C)			Relative Humidity (%)				
		Maximum	Minimum	Mean	Maximum	Minimum	Mean		
4	26-01-2016	25.9	6.0	15.95	80.1	22.1	51.10	0.20	0.20
5	02-02-2016	27.7	10.0	18.85	78.0	19.6	48.80	0.20	0.40
6	09-02-2016	26.6	7.3	16.95	78.0	19.6	48.80	0.60	0.60
7	16-02-2016	26.0	12.2	19.10	68.1	27.3	47.70	0.20	0.40
8	23-02-2016	30.5	11.9	21.20	67.0	18.0	42.50	0.20	0.20
9	01-03-2016	31.6	11.6	21.60	67.5	21.0	44.25	0.40	0.40
10	08-03-2016	31.7	14.1	22.90	67.6	28.7	48.15	0.60	0.60
11	15-03-2016	30.9	15.7	23.30	70.0	32.1	51.05	0.40	0.60
12	22-03-2016	34.1	15.7	24.90	51.7	17.9	34.80	0.80	1.20
13	29-03-2016	35.9	17.9	26.90	52.9	19.7	36.30	0.60	0.80
14	05-04-2016	36.6	19.5	28.05	39.7	16.9	28.30	0.60	0.60
15	12-04-2016	36.33	19.46	27.89	39.71	16.86	28.29	0.80	0.80
Seasonal Mean		30.27	12.49	21.38	67.33	23.07	45.20	0.47	0.57
Coefficient of correlation (r) for population and Maximum Temperature								0.728*	0.628*
Coefficient of correlation (r) for population and Minimum Temperature								0.626*	0.610*
Coefficient of correlation (r) for population and Mean Temperature								0.690*	0.633*
Coefficient of correlation (r) for population and Maximum Relative Humidity								-0.701*	-0.612*
Coefficient of correlation (r) for population and Minimum Relative Humidity								-0.301	-0.187
Coefficient of correlation (r) for population and Mean Relative Humidity								-0.672*	-0.565
Coefficient of correlation (r) for population of fruit borer and fruit damage								0.878*	

SMW- Standard meteorological week, * Value of 't'- significant at 5% level of significance.

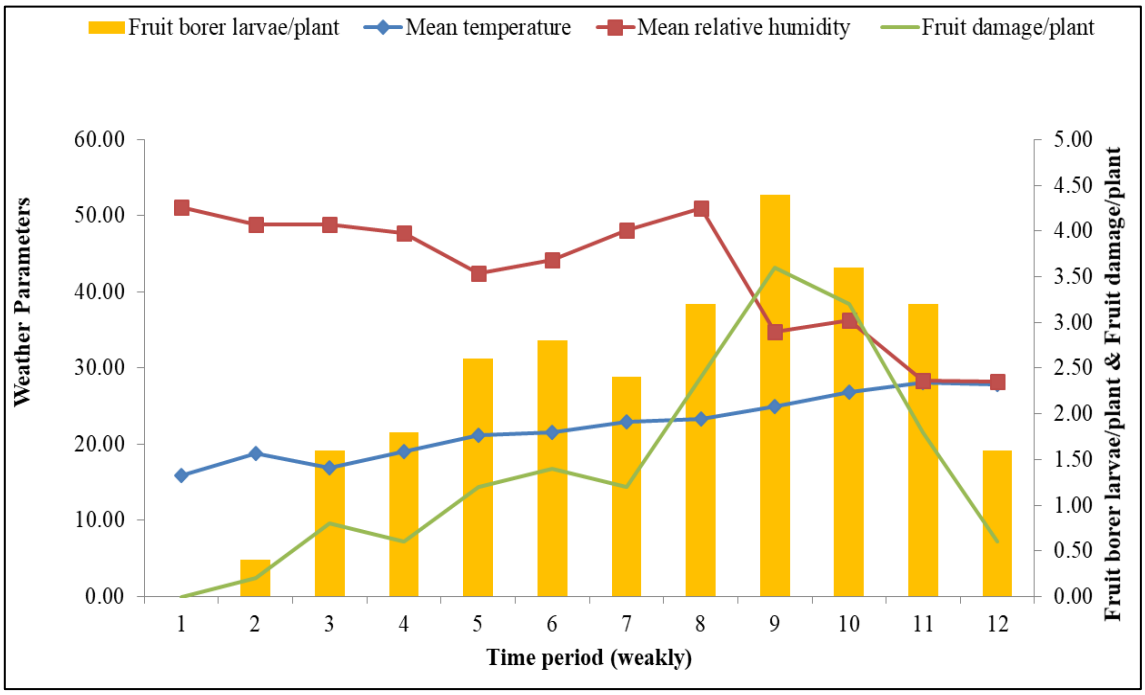

Fig 1: Seasonal incidence of fruit borer, *H. armigera* on tomato without marigold

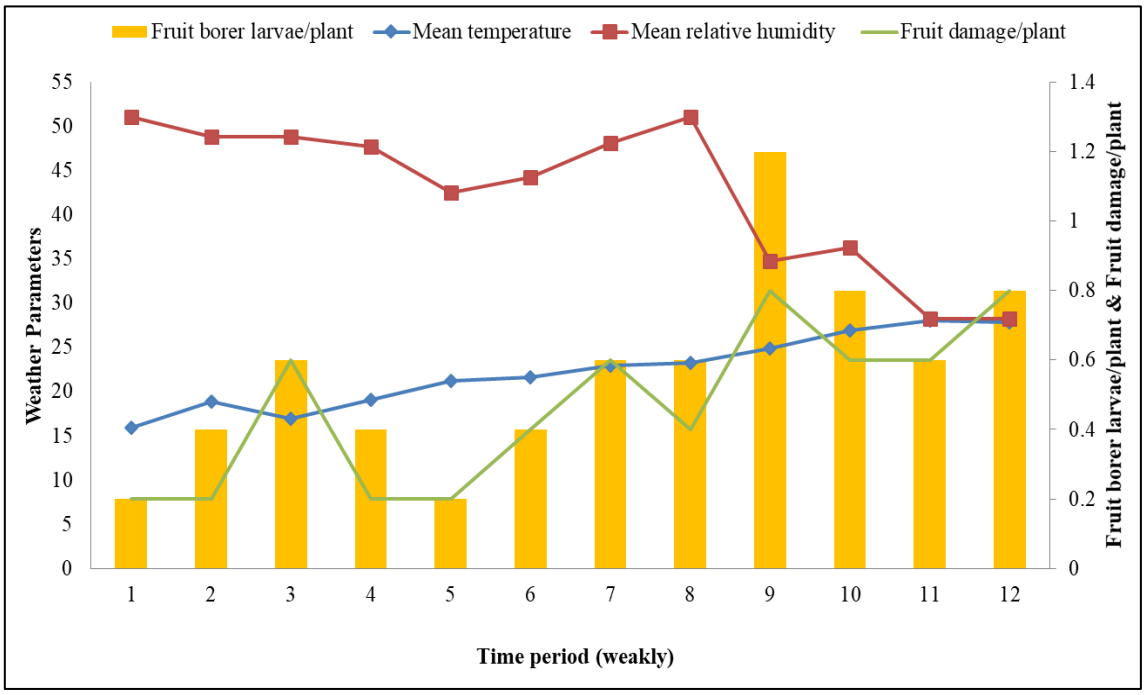

Fig 2: Seasonal incidence of fruit borer, *H. armigera* on tomato with marigold as a trap crop

4. Conclusion

The seasonal incidence of *H. armigera* on tomato was studied for the year, 2015-16 which will be helpful in preparing proper schedule for effective management of this pest. It is concluded from the present studies that the *H. armigera* (Hub.) larvae were found to infest tomato crop throughout the growing season but tomato grown with marigold as a trap crop was the most effective for the reducing *H. armigera* larval population as compared to sole tomato. It recorded minimum number of larval population and fruit damage.

5. Acknowledgement

We are thankful to all the colleagues for their help during this study. This study is a part of M.Sc. thesis of the first author.

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