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Population dynamics of fruit borer, *Helicoverpa armigera* and whitefly, *Bemisia tabaci* on tomato

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Abstract

The investigation was carried out during rabi season of 2014-15 in a farmer's field of an extensive tomato growing village Surajgarh, block Matanhail, District Jhajjar, Haryana. For fruit borer and whitefly population of tomato, a block of 20×20 m^2 area was transplanted on 25.12.2014 by following the recommended agronomical practices. A distance of 60 cm from row to row and 45 cm plant to plant was maintained at the time of transplanting. The population of fruit borer, *Helicoverpa armigera* and whitefly, *Bemisia tabaci* were recorded starting from the 4th standard week at crop establishment stage and till 18th standard week at the crop maturity stage. The first appearance of the fruit borer was noticed during 11th standard week (12th -18th March) and it reached maximum in 16th standard week (16th -22nd April), while the population decreased up to crop maturity. A negligible population of whitefly was first observed during 16th standard week which remained below ETL ranging from 0.1 to 0.2 adults per plant till crop maturity (18th standard week).

The fruit borer population had a significant positive correlation with maximum temperature, minimum temperature and bright sunshine while significant negative correlation with morning and evening relative humidity. Similarly, whitefly population had a significant positive correlation with temperature, while significant negative correlation with relative humidity although the population was far below ETL.

Keywords: Tomato, fruit borer, whitefly, population dynamics, correlation

1. Introduction

Tomato (*Lycopersicon esculentum* Mill.) belonging to the family Solanaceae is the native of Peru Ecuador region [1] and is one of the most popular and widely grown crops of commercial and dietary significance in the world as it is a very versatile vegetable. Due to its high consumption rate in developed and developing countries, it is often referred to as a luxury crop. In England, it is popularly known as *Love Apple* and is grown in all home gardens and by a large number of market and truck growers. Whatever has been the early history of its cultivation, the popularity of tomato has increased rapidly from the middle of the nineteenth century to the present time. It is also being grown in greenhouse in off-season. Hence, now, it has become a good source of income to small and marginal farmers.

In many countries, it is considered as *poor man's orange*. Tomato is also an important source of lycopene, ascorbic acid and β-carotene, which are potent antioxidants. Hence, its fruits are valued for their colour and flavours. In India, it ranks second among vegetables in area and production and occupies an area of 1.20 million hectares with a production of 19.4 million tonnes and average yield of 16.1 tonnes per hectare. Haryana is one of the major tomato growing states covering an area of 29.4 thousand hectares with a production of 0.62 million tonnes and average yield of 21.32 tonnes per hectare [2].

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 *Helicoverpa armigera*, whitefly *Bemisia tabaci*, leaf hopper *Amrasca devastans*, leaf miner *Liriomyza trifolii*, potato aphid *Myzus persicae* and hadda beetle *Epilachana dedecastigma* [3]. Out of these insect pests, the damage caused by fruit borer, *Helicoverpa armigera* Hubner 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. [4]. *H. armigera* is the most devastating pest causing losses upto the tune of 18.2 to 80.0 percent to the crop depending on different agroclimatic conditions [5] and [6] across the country. However, sometimes there has been complete destruction of tomato crop by this pest [7].

Inspite of regular spraying of insecticides, its incidence in farmers' fields varies from 10 to 20 percent and at times, this pest causes yield loss up to 40 percent [8].

The whitefly, *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) is a widely distributed polyphagous pest in tropical and subtropical regions of India. Both adult and nymph suck the cell sap from phloem and also secreting honey dew, causes weakening and dryness of the plant. Indirect damage caused by *Bemisia tabaci* to tomato is by transmitting leaf curl virus. This is one of the most important limiting factors for tomato cultivation in warm climates [9].

2. Materials and methods

Tomato crop was raised on an area of 20m×20m size following all recommended agronomical practices except insecticidal sprays. The transplanting of tomato was done in the month of December. After establishment of plants, 20 plants were randomly tagged for recording observations for fruit borer and whitefly.

Following observations were recorded:

a) Population of *H. armigera* larvae and *B. tabaci* were recorded at weekly interval starting from plant establishment till end of the crop. For whitefly, nymphs and adults were counted early in the morning on the tagged plants and three leaves one each from top, middle lower canopy were taken for recording the population. For fruit borer, the larvae were recorded on selected plants at weekly interval using drop sheet (1x1m) method.

b) Pest population data were correlated with abiotic factors *viz*., temperature, humidity, rainfall and bright sunshine.

3. Results and discussion

The data presented in Table 1 indicated that observations on the population of fruit borer, *Helicoverpa armigera* and whitefly, *Bemisia tabaci* were recorded starting from the 4th standard week (crop establishment stage) till 18th standard week (crop maturity stage). The first appearance of the fruit borer (0.98 larva/plant) was noticed during the 11th standard week (12th -18th March) reaching it's highest (3.79 larvae/plant) in 16th standard week (16th -22nd April). After that the population decreased up to crop maturity. A negligible population of whitefly was first observed during 16th standard week which remained below ETL ranging from 0.1 to 0.2 adults per plant till crop maturity (18th standard week).

Table 1: Population dynamics of fruit borer and whitefly on tomato during Rabi seasonof 2014-15

Sr. No.	Date	SMW	Population (Average of 20 plants)	
			Fruit borer (No. of larvae/plant)	Whitefly (No. of adults/3leaves)
1	25/01/2015	4	0	0
2	01/02/2015	5	0	0
3	08/02/2015	6	0	0
4	15/02/2015	7	0	0
5	22/02/2015	8	0	0
6	01/03/2015	9	0	0
7	08/03/2015	10	0	0
8	15/03/2015	11	0.98	0
9	22/03/2015	12	1.67	0
10	29/03/2015	13	2.14	0
11	05/04/2015	14	3.02	0
12	12/04/2015	15	3.56	0
13	19/04/2015	16	3.79	0.1
14	26/042015	17	3.42	0.1
15	03/05/2015	18	3.30	0.2

3.1 Correlation between abiotic factors and population of fruit borer, *Helicoverpa armigera* and whitefly, *Bemisia tabaci* on tomato

The pest population was correlated with the abiotic factors. The meteorological data pertaining to temperature, relative humidity and bright sunshine were obtained from the website www.msn weather.com and data on rainfall were collected from Department of Agriculture, Jhajjar. The fruit borer population had a significant positive correlation with maximum temperature, minimum temperature and bright sunshine while significant negative correlation with morning and evening relative humidity. There was no significant correlation between rainfall and larval population. Similarly, whitefly population had a significant positive correlation with temperature and while significant negative correlation with relative humidity although the population was for below ETL.

The abiotic factors during 16th standard week, i.e. average temperature 29.1 ˚C (max. ˚C and min. ˚C) accompanied with 48.5 percent RH (morning and evening) and average sunshine of 9.5 hours per day proved congenial for a peak population buildup of *H. armigera* on tomato (Fig.1).

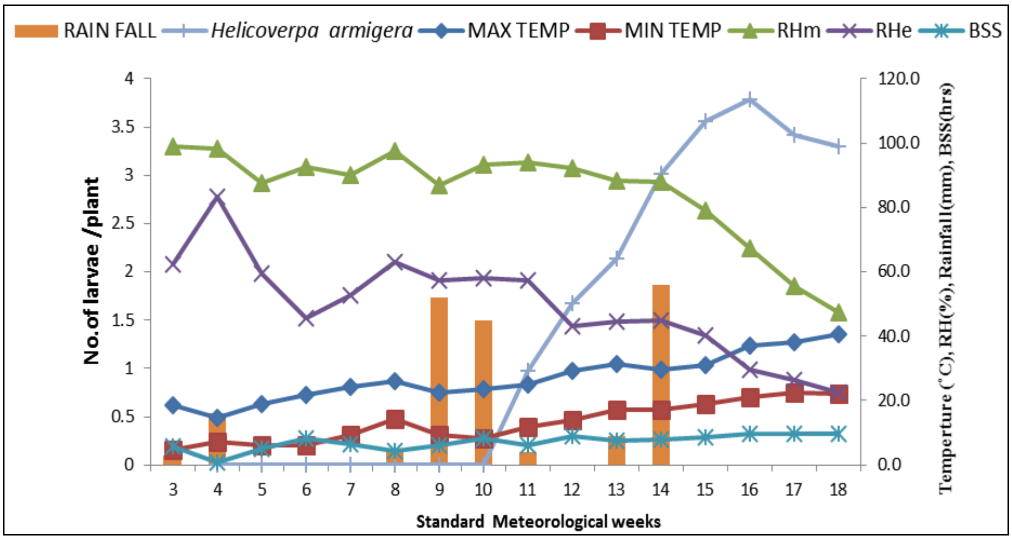

Fig 1: Population of fruit borer in relation to temperature, relative humidity rainfall and bright sunshine during different standard weeks on tomato

The multiple regression analysis, which explained the average relationship between fruit borer and whitefly with abiotic factors *i.e*. the amount of changes in population of these pests per unit change in weather parameters, indicated that there was 95 percent (regression equation Y1) contribution of these factors (R^2 = 0.95) for variability in larval population of fruit borer and 94 percent (regression equation Y2) contribution of these factors (R^2 = 0.94) for variability in population of whitefly (Table 3).

Table 2: Simple correlation between abiotic factors and population of fruit borer, *Helicoverpa armigera* and whitefly, *Bemisia tabaci* on tomato

Abiotic factors	Fruit borer	Whitefly
Temperature (maximum)	0.877**	0.760**
Temperature (minimum)	0.927**	0.671**
Relative humidity (%) Morning	- 0.743**	-0.929**
Relative humidity (%) Evening	- 0.810**	-0.713**
BSS	0.679**	0.500
Rainfall (mm)	-0.177	-0.292

* *Significant at 1% level of significance

These findings are in agreement with the observations recorded by [10]. Dattar and [11]. And [12]. The efforts were made to correlate the abiotic factors and their impact through multiple regression analysis on the population buildup of fruit borer (Table 3) collectively, abiotic factors contributed for 95 percent variability in larval population.

Table 3: Multiple regression analysis between fruit borer population and abiotic factors on tomato

	Regression equations	R^2
Fruit borer	Y1= 8.453831 -0.4335X1 + 0.534128X2+0.01359X3 -0.06211X4 +0.253046X5 -0.00026X6	0.95
Whitefly	Y2= 0.072446919+0.015198394X1 -0.011682247X2-0.003436508 X3+0.001418944X4-0.01205882X5+3.1634X6	0.94

X1 = Temperature (maximum),
X2 = Temperature (minimum),
X3 = Relative humidity (morning),
X4 = Relative humidity (evening),
X5 = bright sunshine
X6 = Rainfall (mm)

The whitefly appeared on the crop during second fortnight of April (16th standard week) and its population remained negligible and below ETL till crop maturity (18th standard week) but showed significant positive correlation with temperature during this short span. The results are in conformity to the observations of [13]. While in contrast to the findings of [14]. Who found temperature to be negatively correlated with whitefly population?

4. Conclusion
Among abiotic factors, only temperature and sunshine had significant positive correlation with population build of *H. armigera* while relative humidity was negatively correlated.

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