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Effect of Abiotic Factors on Larval Population Build Up of Tomato Fruit Borer, *Helicoverpa armigera* Infesting Different Tomato Germplasm

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ABSTRACT

Studies were carried out at Experimental Farm, Faculty of Agriculture, Wadura, Sopore, SKUAST-K, during the year, 2016-2017. The larval infestation of *H. armigera* started a month and half (22SW) after transplanting of the crop in all the tomato genotypes. A negative and non-significant correlation was computed between *H. armigera* larval population and maximum temperature (r = -0.032), whereas sunshine hours had negative and significant association (r = -0.566) with fruit borer larvae. The other abiotic factors such as minimum temperature, rainfall, maximum and minimum humidity had significant and positive correlation with r values of 0.874, 0.734, 0.543 and 0.593, respectively.

Introduction

Helicoverpa armigera in India attacks more than 182 plant species (Gowda, 2005) and is found all the year around, being more abundant during August to January, particularly in the southern parts of the country on crops like cotton, groundnut, beans, pigeon pea, chickpea, etc. On tomato, the pest is reported to cause considerable fruit damage and yield losses depending upon agro climatic conditions. *H. armigera* feeds on both tomato foliage as well as fruit by feeding inside it, thus affecting fruit quality. The damage by *H. armigera* starts soon after fruiting period of the crop; and the newly hatched larvae bore into the fruit and feed inside. In India, three species, namely *H. armigera*, *H. peltigera* (Schiff.) and *H. assulta* (Guenee) occur on tomato, but *H. armigera* is by far the most important and devastating (Jayaraj, 1982). *H. armigera* larvae are extremely damaging because they prefer to feed and develop on the reproductive structures of crops which are rich in nitrogen (Fitt, 1989) and these structures are often part of the crop that is harvested (King, 1994). Insect abundance and distribution are regulated by several biotic and abiotic factors and their interactions. Among abiotic factors, temperature and humidity stand out as the most important ones, constraining abundance and distribution of insect. Furthermore, it is well documented that abiotic factors, especially temperature, regulate the ecology of insect communities. The ecological factors, temperature (14-45 ^{0}C), photoperiod (10-14 hrs), relative humidity (15-95%) coupled with optimum and intermittent rainfall were found to affect the population build-up, adult emergence and fecundity of the female moths of *H. armigera* (Tripathi and Singh, 1993) Monitoring of the larval population of *H. armigera* and the effect of various abiotic factors in the field is a prerequisite for successful pod borer management.

Materials and Methods

To study the effect of various abiotic factors on population build up of tomato fruit borer, *H. armigera* in different tomato germplasm for their relative resistance/ susceptibility against the pest, one month old seedlings of different tomato genotypes were transplanted in the month of May, 2016 in Randomized Block Design, with all recommended agronomical package of practices of the University in Experimental Farm, Faculty of Agriculture, Wadura.

Number of *H. armigera* larvae has been recorded on five tagged plants randomly selected per genotype in each replication. Data on larval count was recorded at weekly interval starting from the first appearance of larvae till the final harvest of the crop; and mean larval population per genotype was calculated. The data of various abiotic factors during the period of investigations was procured from Meteorological Observatory of the University. Simple correlation analysis between important weather parameters and larval population of *H. armigera* was computed at five per cent level of significance to work out the effect of such abiotic factors on the population build up of the pest.

Results and Discussion

The data revealed that in almost all the tomato genotypes, *H. armigera* larval infestation started from the first fortnight of June. In genotype SK-TVAR-1093, the larval population at 22SW was 0.07 larvae/plant which gradually increased in succeeding weeks till it maximized to 0.80 larvae/ plant at 31SW (Table 1). Thereafter it decreased and reached to 0.20 larvae/ plant at second fortnight of August (33 SW). However, the cumulative mean for all period of observation was lowest as 0.39 larvae /plant in SK-TVAR-1093. Next minimum larval population of tomato fruit borer was in genotype SK-TVAR-1048 as 0.42 larvae/ plant; followed by genotype SK-TVAR-1142 which had a cumulative mean larval population of 0.53/plant. The rest of genotypes *viz.*, SK-TVAR-1181, H-86, SK-TVAR-1083, SK-TVAR-1101, Punjab Chuhara, SK-TVAR-1089, BRDT-2, BRDT-3, Roma, Local, SK-TVAR-209, Punjab Ratta, Kashi Aman, SK-TVAR-1134, Arka Vikas, SK-TVAR-1121 and SK-TVAR-1018 recorded cumulative mean larval population of 0.59, 0.66, 0.71, 0.71, 0.79, 0.86, 0.93, 0.99, 1.03,1.13, 1.19, 1.26, 1.33, 1.39, 1.46, 1.53 and 1.66 larvae/plant, respectively (Fig. 01). However, the highest larval population of fruit borer was recorded in SK-TVAR-1107 at 1.79 larvae /plant. The present findings are more or less in accordance with observations recorded by Jamadar (2006) who opined that among different tomato genotypes, population of *H. armigera* varied from 0.68 to 2.05 larvae per plant. Similarly, Selvanarayanan and Narayanasamy (2006) in varietal screening of tomato germplasm against fruit borer recorded minimum population of 0.20 larvae per plant in genotype Varushanadu Loca which increased to 0.82 larval per plant in check I - 979.

Table.1 Larval population of tomato fruit borer, *Helicoverpa armigera* in different tomato germplasm during 2016

Genotypes/ varieties	Larval population per plant at weekly intervals												Cumulative Mean
	Standard weeks (SW)												
	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	31st	32nd	33rd	
SK-TVAR-1107	1.47 (2.88)^{d}	1.53 (2.94)^{f}	1.60 (2.99)^{f}	1.73 (3.10)^{f}	1.80 (3.16)^{f}	1.87 (3.21)^{f}	1.93 (3.26)^{f}	2.00 (3.31)^{e}	2.07 (3.36)^{f}	2.20 (3.46)^{e}	1.73 (3.10)^{f}	1.60 (2.99)^{f}	1.79
SK-TVAR-1101	0.40 (1.71)^{b}	0.47 (1.82)^{b}	0.53 (1.91)^{b}	0.60 (2.07)^{b}	0.73 (2.15)^{b}	0.80 (2.22)^{b}	0.87 (2.30)^{b}	0.93 (2.37)^{b}	1.00 (2.44)^{b}	1.07 (2.58)^{b}	0.60 (2.07)^{b}	0.53 (1.91)^{b}	0.71
SK-TVAR-1181	0.27 (1.52)^{a}	0.33 (1.63)^{b}	0.40 (1.73)^{b}	0.53 (1.91)^{b}	0.60 (1.98)^{b}	0.67 (2.07)^{b}	0.73 (2.15)^{b}	0.80 (2.22)^{a}	0.87 (2.30)^{b}	1.00 (2.44)^{b}	0.53 (1.91)^{b}	0.40 (1.73)^{b}	0.59
SK-TVAR-1089	0.53 (1.88)^{b}	0.60 (1.99)^{c}	0.67 (2.07)^{c}	0.80 (2.22)^{c}	0.87 (2.30)^{c}	0.93 (2.37)^{c}	1.00 (2.44)^{c}	1.07 (2.51)^{b}	1.13 (2.58)^{c}	1.27 (2.70)^{b}	0.80 (2.22)^{c}	0.67 (2.07)^{c}	0.86
SK-TVAR-1018	1.33 (2.75)^{d}	1.40 (2.82)^{e}	1.47 (2.88)^{f}	1.60 (2.99)^{e}	1.67 (3.05)^{e}	1.73 (3.10)^{e}	1.80 (3.16)^{e}	1.87 (3.21)^{e}	1.93 (3.26)^{e}	2.07 (3.36)^{e}	1.60 (2.99)^{e}	1.47 (2.88)^{f}	1.66
SK-TVAR-1093	0.07 (1.13)^{a}	0.13 (1.27)^{a}	0.20 (1.41)^{a}	0.33 (1.62)^{a}	0.40 (1.71)^{a}	0.47 (1.82)^{a}	0.53 (1.91)^{a}	0.60 (1.98)^{a}	0.67 (2.07)^{a}	0.80 (2.22)^{a}	0.33 (1.62)^{a}	0.20 (1.41)^{a}	0.39
SK-TVAR-1134	1.07 (2.51)^{d}	1.13 (2.58)^{d}	1.20 (2.64)^{e}	1.33 (2.76)^{d}	1.40 (2.82)^{d}	1.47 (2.88)^{e}	1.53 (2.94)^{e}	1.60 (2.99)^{d}	1.67 (3.05)^{e}	1.80 (3.16)^{d}	1.33 (2.76)^{d}	1.20 (2.64)^{e}	1.39
SK-TVAR-1142	0.20 (1.41)^{a}	0.27 (1.52)^{a}	0.33 (1.91)^{b}	0.47 (1.82)^{a}	0.53 (1.91)^{a}	0.60 (2.00)^{a}	0.67 (2.07)^{a}	0.73 (2.15)^{a}	0.80 (2.22)^{a}	0.93 (2.37)^{a}	0.47 (1.82)^{a}	0.33 (1.91)^{b}	0.53
SK-TVAR-1048	0.13 (1.27)^{a}	0.20 (1.41)^{a}	0.27 (1.52)^{a}	0.33 (1.62)^{a}	0.40 (1.73)^{a}	0.47 (1.82)^{a}	0.53 (1.91)^{a}	0.60 (1.98)^{a}	0.67 (2.07)^{a}	0.80 (2.22)^{a}	0.33 (1.62)^{a}	0.27 (1.52)^{a}	0.42
SK-TVAR-1121	1.20 (2.64)^{d}	1.27 (2.70)^{e}	1.33 (2.76)^{e}	1.47 (2.88)^{e}	1.53 (2.94)^{e}	1.60 (2.99)^{e}	1.67 (3.05)^{e}	1.73 (3.10)^{d}	1.80 (3.16)^{e}	1.93 (3.26)^{e}	1.47 (2.88)^{e}	1.33 (2.76)^{e}	1.53
SK-TVAR-1083	0.40 (1.71)^{b}	0.47 (1.82)^{b}	0.53 (1.91)^{b}	0.60 (2.07)^{b}	0.73 (2.15)^{b}	0.80 (2.22)^{b}	0.87 (2.30)^{b}	0.93 (2.37)^{b}	1.00 (2.44)^{b}	1.07 (2.58)^{b}	0.60 (2.07)^{b}	0.53 (1.91)^{b}	0.71
SK-TVAR-209	0.87 (2.30)^{c}	0.93 (2.38)^{d}	1.00 (2.44)^{d}	1.13 (2.58)^{d}	1.20 (2.64)^{d}	1.27 (2.70)^{d}	1.33 (2.76)^{d}	1.40 (2.82)^{c}	1.47 (2.88)^{d}	1.60 (2.99)^{d}	1.13 (2.58)^{d}	1.00 (2.44)^{d}	1.19
BRDT-2	0.60 (1.98)^{b}	0.67 (2.08)^{c}	0.73 (2.15)^{c}	0.87 (2.30)^{c}	0.93 (2.37)^{c}	1.00 (2.44)^{c}	1.07 (2.51)^{c}	1.13 (2.58)^{c}	1.20 (2.64)^{c}	1.33 (2.76)^{c}	0.87 (2.30)^{c}	0.73 (2.15)^{c}	0.93
BRDT-3	0.67 (2.06)^{c}	0.73 (2.52)^{d}	0.80 (2.22)^{c}	0.93 (2.37)^{c}	1.00 (2.44)^{c}	1.07 (2.51)^{c}	1.13 (2.58)^{c}	1.20 (2.64)^{c}	1.27 (2.70)^{c}	1.40 (2.82)^{c}	0.93 (2.37)^{c}	0.80 (2.22)^{c}	0.99

H-86	0.33 (1.57)[b]	0.40 (1.71)[b]	0.47 (1.82)[b]	0.60 (2.00)[b]	0.67 (2.07)[b]	0.73 (2.15)[b]	0.80 (2.22)[b]	0.87 (2.30)[b]	0.93 (2.37)[b]	1.07 (2.51)[b]	0.60 (2.00)[b]	0.47 (1.82)[b]	0.66
Arka Vikas	1.13 (2.58)[d]	1.20 (2.64)[e]	1.27 (2.70)[e]	1.40 (2.82)[e]	1.47 (2.88)[e]	1.53 (2.94)[e]	1.60 (2.99)[e]	1.67 (3.05)[d]	1.73 (3.10)[e]	1.87 (3.21)[d]	1.40 (2.82)[e]	1.27 (2.70)[e]	1.46
Kashi Aman	1.00 (2.44)[c]	1.07 (2.51)[d]	1.13 (2.58)[e]	1.27 (2.70)[d]	1.33 (2.76)[d]	1.40 (2.82)[d]	1.47 (2.88)[d]	1.53 (2.94)[d]	1.60 (2.99)[d]	1.73 (3.10)[d]	1.27 (2.70)[d]	1.13 (2.58)[e]	1.33
Local	0.80 (2.22)[c]	0.87 (2.30)[d]	0.93 (2.37)[d]	1.07 (2.51)[d]	1.13 (2.58)[d]	1.20 (2.64)[d]	1.27 (2.70)[d]	1.33 (2.76)[c]	1.40 (2.82)[d]	1.53 (2.94)[c]	1.07 (2.51)[d]	0.93 (2.37)[d]	1.13
Punjab Chuhura	0.47 (1.82)[b]	0.53 (1.91)[b]	0.60 (2.00)[c]	0.73 (2.15)[b]	0.80 (2.22)[b]	0.87 (2.30)[c]	0.93 (2.37)[b]	1.00 (2.44)[b]	1.07 (2.51)[b]	1.20 (2.64)[b]	0.73 (2.15)[b]	0.60 (2.00)[c]	0.79
Punjab Ratta	0.93 (2.37)[c]	1.00 (2.44)[d]	1.07 (2.51)[d]	1.20 (2.64)[d]	1.27 (2.70)[d]	1.33 (2.76)[d]	1.40 (2.82)[d]	1.47 (2.88)[d]	1.53 (2.94)[d]	1.67 (3.05)[d]	1.20 (2.64)[d]	1.07 (2.51)[d]	1.26
Roma	0.73 (2.13)[c]	0.80 (2.22)[c]	0.87 (2.30)[d]	1.00 (2.44)[c]	1.07 (2.51)[c]	1.07 (2.51)[c]	1.13 (2.58)[c]	1.20 (2.64)c	1.27 (2.70)[c]	1.40 (2.82)[c]	1.00 (2.44)[c]	0.87 (2.30)[d]	1.03
Mean	**0.70**	**0.76**	**0.83**	**0.95**	**1.03**	**1.09**	**1.16**	**1.22**	**1.29**	**1.42**	**0.95**	**0.83**	
C.D.(p<0.05)	**(0.41)**	**(0.28)**	**(0.22)**	**(0.26)**	**(0.25)**	**(0.22)**	**(0.23)**	**(0.26)**	**(0.21)**	**(0.22)**	**(0.26)**	**(0.22)**	**-**
S.E.(d)	**(0.20)**	**(0.14)**	**(0.10)**	**(0.13)**	**(0.12)**	**(0.11)**	**(0.11)**	**(0.13)**	**(0.10)**	**(0.11)**	**(0.13)**	**(0.10)**	**-**
S.E(m)	**(0.14)**	**(0.10)**	**(0.07)**	**(0.09)**	**(0.08)**	**(0.08)**	**(0.08)**	**(0.09)**	**(0.07)**	**(0.08)**	**(0.09)**	**(0.07)**	**-**
C.V.	**(12.26)**	**(8.07)**	**(5.98)**	**(6.87)**	**(6.27)**	**(5.83)**	**(5.48)**	**(5.99)**	**(4.77)**	**(4.80)**	**(6.87)**	**(5.98)**	**-**

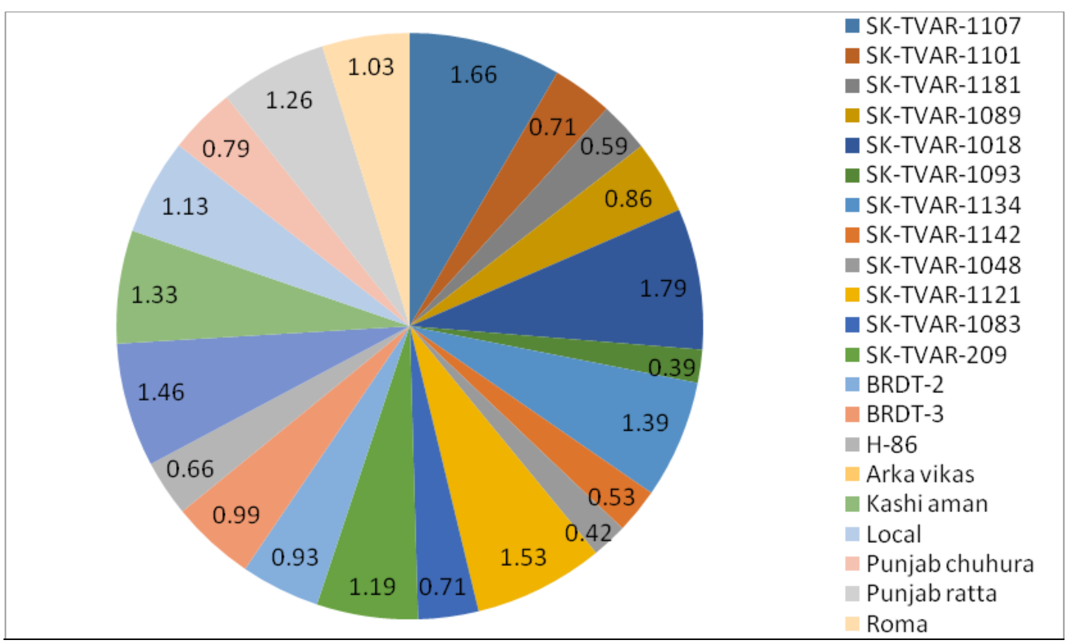
Each value is mean of three replications.
Figures in parentheses are square root transformed values.
The values in individual column superscripted by similar letter(s) do not differ significantly at $p \leq 0.05$.

Table.2 Correlation matrix of weekly weather parameters and mean larval population of *Helicoverpa armigera* 2016

	Weekly Mean larval population	Temperature (°C)		Rainfall (mm)	Relative humidity	
		Max.	Min.		Max.	Min.
		X_2	X_3	X_4	X_5	X_6
X_2	-0.032 (0.922)					
X_3	0.874 (0.000)*	0.041 (0.898)**				
X_4	0.743 (0.006)*	-0.345 (0.273)**	0.583 (0.047)*			
X_5	0.543 (0.068)*	-0.589 (0.044)*	0.407 (0.190)	0.673 (0.017)*		
X_6	0.593 (0.042)*	-0.551 (0.063)*	0.703 (0.011)*	0.739 (0.006)*	0.624 (0.030)*	
X_7	-0.566 (0.055)*	0.417 (0.177)*	-0.721 (0.008)*	-0.594 (0.042)*	-0.575 (0.050)*	-0.813 (0.000)*

* Significant at P = 0.05.

Fig.1 Cumulative mean larval infestation of *Helicoverpa armigera* in various tomato germplasm



Sajjad *et al.,* (2011) too reported that larval population per plant varied significantly on different tomato genotypes. The present findings are also in conformity with the work of Ashfaq *et al.,* (2012) and Usman *et al.,* (2013) who while screening tomato varieties to check their susceptibility against *H. armigera*, recorded lowest population of 0.35 larvae per plant in Tommy, Pant Bahr and Rio Grande; and highest larval population per plant as 1.90 and 1.91 in genotype Bambino and GS-5575, respectively.

Correlation matrix between various abiotic factors and larval population of *H. armigera*

A simple correlation analysis between important weather parameters and larval population of *H. armigera* (Table 2) infesting different tomato genotypes revealed a negative and non-significant association (r =-0.032) with maximum temperature whereas sunshine hours had negative but significant correlation (r =-0.566) with larval population. The other abiotic factors such as minimum temperature, rainfall, maximum and minimum humidity had significant and positive correlation (r = 0.874, 0.734, 0.543 and 0.593) in population build-up of the pest. The results are in confirmation with the work of Prasannakumar *et al.,* (2011) who reported maximum temperature to be negatively correlated; rainfall and minimum temperature as positively correlated with larval population build up. However, the experimental findings are in contradiction with Singh *et al.,* (2011) who reported rainfall and relative humidity to be negatively correlated whereas maximum temperature was positively associated with larval population of *H. armigera,* though minimum temperature was in accordance with the present results i.e. positively correlated.

The difference in significance of weather parameters could be due to difference in agro climatic conditions as the authors carried population succession studies of fruit borer in hot tropical climatic conditions.

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