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Research Article

INTER-RELATIONSHIP BETWEEN ABIOTIC FACTORS AND POPULATION DYNAMICS OF SUCKING INSECT PESTS IN GENETICALLY MODIFIED COTTON

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Abstract- A field study was done to determine the effect of ecological factors on the incidence of sucking insect pests on seven varieties of genetically /non genetically modified cotton. Sucking insect pests (whitefly, leafhopper, thrips) remained active throughout the crop season with little differences among them. Whitefly was active from 24th to 41st standard meteorological weeks (SMW *i.e.* June to October, 2014) while leafhopper from 25th to 41st and thrips from 25th to 40th (SMW). Whitefly and leafhoppers population were negatively correlated with maximum temperature, minimum temperature, average wind speed and rainfall and positively correlated with RHm, RHe and sunshine hours. While thrips population showed positive correlation with temperature and negative with sunshine hours. There was no significant difference among sucking insect pests among the *Bt* and non *Bt* cotton genotypes.

Keywords- Abiotic factors, *Bt* Cotton, Sucking insect pests, Population dynamics

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Introduction

Cotton, *Gossypium hirsutum* L., is one of the commercially important fiber crops in the world grown as an annual crop in both tropical and warm temperate regions [1]. Being cash crop, it provides a livelihood to millions of people linked with its cultivation, textile and apparel industries [2]. The crop is grown principally for the fiber and the seed is used as a source of animal feed. Pest damage is varying with respect to climatic factors and different stages of crop growth are one of the factors limiting its agricultural production [3]. In case of cotton, pest damage varies significantly in different agro-climatic regions across the country, mainly due to various abiotic factors such as humidity, temperature and rainfall [4,5]. This has major inference for the intensification of yield losses due to potential changes in crop diversity and increased incidence of insect-pests in the perspective of imminent climate change. Among the insect pests, a complex of sucking pests *viz.,* aphid, *Aphis gossypii* (Glover), whitefly, *Bemisia tabaci* (Gennadius), , green leafhopper, *Amrasca biguttula biguttula* (Ishida) and thrips, *Thrips tabaci* (Lindeman) occupy major pest status and cause considerable damage in cotton.

B. tabaci is a major pest of many field and horticultural crops, throughout the various regions of the world [6, 7]. It damages the plants directly and indirectly, the sucking of plant cell sap in the form of direct damage. The result indicates that 50% reduction in the boll formation as well as the transmission of the viral diseases by this insect. It is found to play a significant role in the spread of the CLCu virus [8]. Leaf hopper and thrips are very destructive pest and cause economic losses to the crop by not only sucking the cell sap but also by inducing poisonous materials, into the leaves of cotton, which cause a 4.45% reduction in the yield [9].

For averting losses due to insect pests, entire dependence has been on pesticides as a tool of pest control & foreign exchange worth millions of rupees is being spent every year. As such, a different management strategy must develop. One best option is the use of insect resistant, genetically modified cultivars, that convey lepidopteron-active *Cry* proteins, such as *Cry1Ac* and *Cry2Ab* derived from the soil bacterium, *Bacillus thuringiensis* (*Bt*). Keeping in view, the existing condition of outbreaks of piercing sucking insects on *Bt* cotton, this envises an urgent need to amend crop protection procedures with changed climate in order to attain prerequisite effective pest management, which encompasses the knowledge of ecological requirements, particularly for environmental factors like relative humidity, temperature and precipitation, which play a key role in multiplication and distribution of insect pests and also perilously affect agricultural production and the livelihood of farmers in India [10,11].

Work done in this regard is still at its infancy and needs more extensive research. Hence, present field trail was paying attention on location precise seasonal occurrence of sucking pests of cottons at different crop growth stages on *bt*/non *bt* cotton and their relation with weather factors which is of great consequence in formulating efficient pest management tactics.

Materials and Methods

Population dynamics of different sucking insect pests

The present study was conducted at C.C.S., Haryana Agricultural University, Hisar, during the crop season 2014-15 in order to study the seasonal incidence of sucking insect pests of cotton. For this purpose experiment was carried out under unsprayed conditions on seven cotton genotypes. Seven cotton cultivars/hybrid namely BIOSEED-6588, NECH-6, JK-1947, SP-7007 and RCH-134, HHH-223 and H-1236 procured from Private Sector and Department of Genetics & Plant Breeding, Cotton Section were grown in the field using standard package of practices [12]. Out of seven genotypes, five were *Bt* with different gene construct (BIOSEED-6588, NECH-6, JK-1947, SP-7007 and RCH-134), and two were non *Bt* (HHH-223 and H-1236). Sowing was done on May, 2014 with randomized block design (RBD).

Population dynamics of different sucking insect pests on various *Bt* and non-*Bt* genotypes were recorded at weekly intervals under natural field conditions. Observations were initiated 20 days after sowing (DAS). For this, 5 plants per replication per treatment were selected randomly. Among sucking insect pests, observations were recorded on the population of cotton leafhopper (*Amrasca biguttula biguttula*) nymphs, Whitefly (*Bemisia tabaci*) adults and thrips (*Thrips tabaci*) adults and nymphs both. Population of these pests was counted with the help of magnifying glass where ever required on the lower surface of leaves. For this three leaves were selected randomly from each plant representing the top, middle and bottom portion of plant.

Statistical analysis

The data recorded during the field experiment was got computed for analysis of variance using the methods of [13].

Correlation with weather parameters

Meteorological data was collected from the Department of Agricultural Meteorology Chaudhary Charan Singh Haryana Agricultural University, Hisar to correlate the population of sucking insects with the weather parameters.

Results and Discussion

Whitefly; *Bemisia tabaci* (Gennadius)

Population of whitefly on different cotton genotype

Overall mean values for the population of whitefly on different genotypes of cotton being tested is shown in the [Table-1]. The maximum average population of whitefly was found to be 19.75 adults/leaf, on transgenic genotype RCH-134 and the minimum was recorded to be 12.00 adults/leaf, on non-transgenic hybrid HHH-223. The population, on other transgenic genotypes was 13.53, 13.89, 13.50, 15.89 and 12.33 adults /leaf, on BIOSEED-6588, NECH-6, JK-1947, SP-7007 and H-1236 respectively, which were virtually similar. This difference in the population dynamics of whitefly on *Bt* and non-*Bt* cotton can be corroborated with the increased amount of different anti-oxidant enzymes *viz*., peroxidases and PAL *etc*, which act as a defense agent against the pest attack to the crop.

Population trend of whitefly throughout the year

The results on the periodic fluctuation of whitefly on cotton are presented in [Table-1]. Data indicated that pest remained active on the crop throughout the period of study *i.e.* from 24th to 41st standard meteorological weeks (SMW) (*i.e.* June to October, 2014). Population build up was recorded in 26th SMW, but the adult population was below the economic threshold level (6 adults /leaf). Economic threshold level by whitefly was crossed in 28th SMW on all genotypes whereas; it crossed ETL on RCH-134 genotype (6.60 adults/leaf) on 27th SMW. The population increased gradually and reached to its peak in the month of August and again in the month of September. The population started declining and persisted till harvesting of crop in the present investigation. The present finding are in line with the findings of [14, 15] who reported that the incidence of whitefly started in June and the peak period attained during September (39th SMW) and it remained throughout the crop season. According to the present study, the whitefly population showed two peaks (*i.e.* 34th and 39th SMW). Different workers, [16-18] also reported two peaks of whitefly population.

Table-1 *Population dynamics of cotton whitefly (Bemisia tabaci) on Bt and non Bt cotton genotypes during kharif 2014*

Genotypes	Mean population of whitefly during different periods of observation (Adults/leaf) Standard Meteorological Weeks																		
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	Mean
BIOSEED-6588	0.43 (1.19)	0.57 (1.25)	0.80 (1.33)	3.80 (2.19)	8.80 (3.13)	11.10 (3.47)	20.80 (4.67)	21.80 (4.77)	21.07 (4.69)	23.07 (4.90)	25.73 (5.17)	17.50 (4.30)	14.94 (4.04)	8.83 (3.13)	11.33 (3.51)	29.37 (5.50)	11.53 (3.53)	12.00 (3.60)	13.53
NECH-6	0.41 (1.18)	0.43 (1.19)	2.33 (1.83)	4.40 (2.32)	15.47 (4.04)	12.27 (3.61)	13.53 (3.75)	14.87 (3.92)	14.93 (3.99)	21.47 (4.72)	22.13 (4.79)	20.33 (4.61)	13.44 (4.28)	15.47 (4.04)	14.73 (3.96)	28.87 (5.45)	21.13 (4.70)	13.73 (3.83)	13.89
JK-1947	0.33 (1.15)	0.67 (1.28)	1.40 (1.94)	5.13 (2.47)	13.23 (3.77)	16.00 (4.12)	16.27 (4.15)	17.37 (4.28)	19.27 (4.50)	17.60 (4.30)	22.67 (4.86)	18.37 (4.40)	14.00 (4.09)	13.23 (3.77)	13.83 (3.85)	27.47 (5.32)	15.47 (4.05)	10.67 (3.41)	13.50
SP-7007	0.37 (1.17)	0.53 (1.23)	1.20 (1.90)	5.03 (2.45)	15.60 (4.07)	14.87 (3.94)	14.73 (3.97)	16.07 (4.13)	16.73 (4.19)	29.83 (5.54)	29.83 (5.54)	25.83 (5.17)	18.01 (4.69)	15.60 (4.06)	16.53 (4.17)	31.33 (5.68)	18.00 (4.34)	15.92 (4.11)	15.89
RCH-134	0.60 (1.26)	0.83 (1.35)	3.17 (2.04)	6.60 (2.75)	19.27 (4.49)	23.03 (4.90)	24.50 (5.04)	26.67 (5.26)	28.27 (5.41)	26.63 (5.24)	32.33 (5.76)	26.73 (5.25)	21.39 (5.11)	19.27 (4.49)	18.03 (4.35)	36.47 (6.12)	24.93 (5.08)	16.72 (4.20)	19.75
HHH-223	0.30 (1.14)	1.27 (1.50)	1.13 (1.38)	4.47 (2.33)	10.07 (3.32)	12.00 (3.52)	13.47 (3.74)	14.80 (3.94)	15.33 (4.03)	18.53 (4.41)	23.47 (4.94)	17.67 (4.31)	12.66 (3.73)	10.07 (3.32)	8.74 (3.09)	24.93 (5.08)	18.20 (4.38)	8.85 (3.14)	12.00
H-1236	0.47 (1.20)	0.53 (1.23)	1.07 (1.66)	4.27 (2.28)	14.40 (3.90)	9.61 (3.25)	10.17 (3.34)	11.83 (3.58)	16.87 (4.18)	18.70 (4.41)	20.70 (4.64)	18.53 (4.41)	15.05 (4.08)	14.40 (3.90)	15.22 (3.99)	19.80 (4.53)	19.07 (4.48)	11.22 (3.49)	12.33
Mean	0.42	0.69	1.59	4.81	13.83	14.13	16.21	17.63	18.92	22.26	25.27	20.71	15.64	13.84	14.06	28.32	18.33	12.73	14.41
SE(m)±	(0.08)	(0.07)	(0.14)	(0.10)	(0.18)	(0.32)	(0.29)	(0.27)	(0.21)	(0.26)	(0.23)	(0.21)	(0.19)	(0.18)	(0.22)	(0.24)	(0.22)	(0.15)	
CD(P=0.05)	(N.S.)	(N.S.)	(0.45)	(0.32)	(0.55)	(0.98)	(0.92)	(0.84)	(0.65)	(0.82)	(0.72)	(0.65)	(0.58)	(0.55)	(0.67)	(0.74)	(0.67)	(0.45)	

*Figures in parentheses are √n+1 transformed values

Leafhopper; *Amrasca biguttula biguttula* (Ishida)

Population of leafhopper on different cotton genotypes

An overall comparison of mean-values for the population of leafhoppers is presented in [Table-2]. A perusal of this table, showed a maximum population of leafhopper was 2.21 nymphs/leaf, recorded on transgenic genotype SP-7007 and the minimum population was found to be 1.29 nymphs/leaf, on non-transgenic genotype H-1236. There was, however, an intermediate position of the population, that is, 1.52, 1.31, 1.40, 1.48 and 1.37 nymphs per leaf recorded on BIOSEED-6588, NECH-6, JK-1947, RCH-134 and HHH-223 respectively.

Population trend of leafhoppers throughout the year

The present study revealed that the incidence of leafhopper appeared in the month of June and remained throughout the crop season. The population increased gradually and reached to its peak in 28th and again in 33rd SMW. The population of leafhopper crossed economic threshold level (2 nymphs/leaf) on all the genotypes. Leafhopper population declined from 34th SMW onwards. The present finding are in agreement with [14] they reported the appearance of leafhopper in 3rd week of June and peak population in the last week of August. And also with [15] they reported that the incidence of leafhopper started in June and the population increased gradually and reached to its peak in 32nd and 33rd SMW, while present results are not in agreement with [19] who reported that the incidence started in the second fortnight of July. This may be due to different environmental condition as well as different sowing time and different geological location under study.

Thrips; *Thrips tabaci* (Lindeman)

Population of Thrips on different cotton genotypes

Deciphering an overall comparison of mean-values for the population of thrips it was found that the maximum population of thrips was 6.71 thrips/leaf, recorded on transgenic genotype RCH-134 and the minimum population was found to be 3.50 thrips/leaf, on transgenic genotype NECH-6 [Table-3]. However, no particular trend in variation of populations of thrips amongst *Bt* and non-*Bt* cotton genotypes. It was found to be 5.51, 4.35 and 4.46 thrips per leaf on BIOSEED-6588, JK-1947 and SP-7007 respectively.

Population trend of Thrips throughout the year

Corroborating the effect of monthly conditions with the thrips population in the present study it was found that the pest commenced during the month of June and remained active throughout the crop season. Thrips population reached to peak level during 33rd SMW (Third week of August). Its population fluctuated at a lower rate initially and thereafter increased rapidly and reached the peak level at 33rd SMW (11.29 thrips/leaf). Later on, it gradually declined and reached at least level on 40th SMW *i.e.* first week of October (0.73 thrips/leaf). These results are in accordance with [20, 21], they reported that incidence started in the month of June. The present findings are in conformity with several workers [19, 22, 20] they reported that the thrips attained its peak during the third week of August.

[23] has also evaluated physio-morphic characteristics of *Bt* transgenic cotton and non *Bt* varieties with whitefly and jassids and found that the maximum population of the whitefly and jassid was observed on transgenic genotypes VH-255 and I-2086, respectively; while, the lowest population was recorded on the control.

Table-2 *Population dynamics of cotton leafhopper (Amrasca bigutulla bigutulla) on Bt and non Bt cotton genotypes during kharif 2014*

Genotypes	Mean population of leafhopper during different periods of observation (Nymphs/leaf) Standard Meteorological Weeks																	
	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	Mean
BIOSEED-6588	0.43 (1.19)	0.73 (1.31)	1.33 (1.53)	2.90 (1.97)	1.60 (1.61)	1.50 (1.58)	1.40 (1.54)	2.95 (1.99)	4.40 (2.32)	1.25 (1.50)	1.23 (1.49)	0.67 (1.29)	0.73 (1.31)	1.27 (1.50)	1.43 (1.56)	1.32 (1.51)	0.77 (1.32)	1.52
NECH-6	0.18 (1.08)	1.13 (1.45)	1.10 (1.44)	3.07 (2.02)	1.43 (1.56)	1.67 (1.63)	1.92 (1.71)	3.05 (2.01)	1.80 (1.67)	1.18 (1.47)	0.84 (1.35)	1.13 (1.45)	1.07 (1.43)	0.66 (1.28)	0.77 (1.33)	0.50 (1.22)	0.41 (1.18)	1.31
JK-1947	0.10 (1.04)	0.47 (1.21)	0.40 (1.18)	2.77 (1.94)	0.73 (1.31)	1.37 (1.54)	1.24 (1.49)	2.70 (1.92)	2.60 (1.88)	1.40 (1.54)	1.04 (1.42)	0.60 (1.26)	1.26 (1.50)	1.76 (1.66)	2.04 (1.74)	1.70 (1.64)	1.57 (1.59)	1.40
SP-7007	0.57 (1.25)	1.40 (1.54)	1.37 (1.54)	3.80 (2.17)	2.33 (1.82)	2.27 (1.77)	2.36 (1.83)	3.87 (2.20)	5.50 (2.55)	2.12 (1.76)	1.97 (1.72)	1.33 (1.52)	1.95 (1.71)	2.08 (1.75)	1.90 (1.70)	1.91 (1.70)	0.91 (1.38)	**2.21**
RCH-134	0.30 (1.14)	0.50 (1.22)	1.80 (1.66)	1.83 (1.67)	1.87 (1.68)	0.53 (1.23)	1.62 (1.60)	1.86 (1.69)	3.68 (2.16)	0.93 (1.38)	1.61 (1.61)	1.33 (1.52)	1.60 (1.60)	1.35 (1.53)	1.57 (1.60)	1.38 (1.54)	1.35 (1.53)	1.48
HHH-223	0.37 (1.16)	0.37 (1.17)	1.20 (1.48)	2.80 (1.94)	1.13 (1.45)	1.40 (1.55)	1.33 (1.53)	2.50 (1.85)	2.87 (1.94)	2.36 (1.83)	2.19 (1.78)	0.53 (1.23)	0.80 (1.33)	0.93 (1.38)	1.05 (1.42)	0.77 (1.32)	0.73 (1.31)	1.37
H-1236	0.07 (1.03)	0.50 (1.22)	1.60 (1.61)	2.33 (1.82)	1.27 (1.50)	0.93 (1.39)	0.82 (1.34)	1.05 (1.43)	2.20 (1.78)	1.68 (1.63)	1.52 (1.58)	1.93 (1.70)	1.53 (1.58)	1.07 (1.41)	1.30 (1.50)	1.17 (1.45)	1.24 (1.49)	**1.29**
Mean	0.29	0.73	1.26	**2.79**	1.48	1.38	1.53	2.57	**3.29**	1.56	1.49	1.08	1.28	1.30	1.44	1.25	1.00	1.51
SE(m)±	(0.05)	(0.06)	(0.08)	(0.08)	(0.08)	(0.09)	(0.08)	(0.10)	(0.13)	(0.09)	(0.08)	(0.07)	(0.08)	(0.09)	(0.07)	(0.09)	(0.07)	
CD(P=0.05)	(N.S.)	(0.21)	(0.24)	(0.27)	(0.26)	(0.31)	(0.28)	(0.33)	(0.42)	(0.28)	(0.26)	(0.24)	(0.26)	(0.28)	(0.23)	(0.30)	(0.22)	

*Figures in parentheses are √n+1 transformed values

Table-3 *Population of cotton thrips (Thrips tabaci) on Bt and non Bt cotton genotypes during kharif 2014*

Genotypes	Mean population of thrips during different periods of observation (Thrips/leaf) Standard Meteorological Weeks																
	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Mean
BIOSEED-6588	1.03 (1.42)	1.37 (1.53)	3.55 (2.13)	8.16 (3.01)	10.29 (3.34)	10.27 (3.35)	11.28 (3.50)	11.87 (3.58)	14.33 (3.89)	7.89 (2.98)	3.80 (2.19)	1.37 (1.53)	0.61 (1.26)	0.33 (1.15)	0.67 (1.29)	1.40 (1.54)	5.51
NECH-6	1.40 (1.55)	1.88 (1.68)	2.36 (1.83)	5.64 (2.55)	5.91 (2.59)	7.63 (2.92)	5.42 (2.53)	8.10 (3.01)	6.36 (2.69)	3.81 (2.19)	4.40 (2.32)	0.44 (1.20)	0.40 (1.18)	0.52 (1.23)	0.55 (1.24)	1.13 (1.45)	3.50
JK-1947	1.77 (1.66)	1.87 (1.69)	3.69 (2.11)	5.27 (2.49)	7.58 (2.89)	8.76 (3.12)	8.16 (2.99)	9.40 (3.17)	8.87 (3.08)	6.22 (2.67)	5.13 (2.47)	0.66 (1.28)	0.56 (1.24)	0.83 (1.34)	0.40 (1.17)	0.47 (1.21)	4.35
SP-7007	0.77 (1.33)	1.19 (1.48)	3.36 (2.06)	5.84 (2.61)	6.49 (2.73)	7.57 (2.92)	7.76 (2.95)	10.39 (3.37)	11.19 (3.43)	5.27 (2.51)	5.03 (2.45)	2.06 (1.74)	1.47 (1.57)	0.95 (1.39)	1.23 (1.49)	0.73 (1.31)	4.46
RCH-134	2.66 (1.91)	3.10 (2.02)	4.03 (2.24)	9.00 (3.15)	11.49 (3.53)	11.70 (3.56)	10.39 (3.37)	14.50 (3.93)	17.89 (4.34)	7.23 (2.85)	6.60 (2.75)	2.88 (1.96)	2.29 (1.82)	1.30 (1.51)	1.77 (1.65)	0.50 (1.22)	6.71
HHH-223	1.47 (1.57)	2.03 (1.74)	3.78 (2.19)	6.84 (2.79)	6.69 (2.77)	8.51 (3.08)	7.80 (2.96)	9.16 (3.16)	10.95 (3.41)	5.92 (2.61)	4.47 (2.33)	0.86 (1.35)	0.84 (1.34)	0.50 (1.22)	0.73 (1.31)	0.37 (1.16)	4.43
H-1236	2.26 (1.78)	2.77 (1.94)	6.61 (2.76)	9.42 (3.22)	11.62 (3.52)	6.53 (2.74)	8.13 (3.02)	6.88 (2.80)	9.48 (3.23)	5.88 (2.62)	4.27 (2.28)	1.74 (1.65)	1.53 (1.58)	1.03 (1.42)	1.36 (1.53)	0.50 (1.22)	5.00
Mean	1.62	2.03	3.91	7.17	8.58	8.71	8.42	10.04	**11.29**	6.03	4.81	1.43	1.10	0.78	0.96	0.73	4.85
SE(m)±	(0.11)	(0.09)	(0.15)	(0.13)	(0.2)	(0.15)	(0.17)	(0.22)	(0.29)	(0.14)	(0.10)	(0.08)	(0.07)	(0.06)	(0.07)	(0.06)	
CD (P=0.05)	(0.34)	(0.29)	(0.46)	(0.42)	(0.61)	(0.47)	(0.52)	(0.68)	(0.89)	(0.43)	(0.32)	(0.27)	(0.22)	(0.21)	(0.23)	(0.21)	

*Figures in parentheses are √n+1 transformed values

Role of abiotic factors in population fluctuation of sucking insect pests

Simple correlation

The results regarding the correlation between abiotic factors and population of whitefly, leafhopper and thrips are given in [Table-4]. The results revealed that the minimum temperature, average wind speed and rainfall were non- significant and negatively correlated with the whitefly and leafhopper population. Many authors were reported that meteorological parameters play an important role in the population fluctuation of sucking insect pests [24-26]. The relative humidity and maximum temperature were significantly correlated with whitefly and leafhoppers, while thrips population showed positive correlation with temperature and negative correlation with sunshine hours and rainfall and was not significant. [17, 27] support the present findings, who reported whitefly and the leafhopper population was negatively correlated with temperature and positively with relative humidity. The present findings are in contradictory with the findings of [28, 29] who reported that the leafhopper population increased with maximum temperature. [30] reported that high temperature and scanty rainfall aggravate the severity of sucking insect pests and also reported *Thrips tabaci* has population peaks during a dry spell with high temperature and low humidity which are optimum for population build up. The contradictory result of the work of some authors can be attributed to the different abiotic factors prevailing in different geological area under study.

The multiple regression analysis [Table-5] revealed that 54% variability in whitefly adult population was due to various abiotic factors. Maximum temperature, morning relative humidity (RHm) and wind speed (WS) accounted for 33% variability (regression equation - Y2) and these were the most important factors affecting whitefly abundance. Out of 33% variability in whitefly adult population maximum temperature, morning relative humidity (RHm) accounted for a 31% contribution (regression equation – Y3). Whitefly population in present studies showed non-significant positive correlation with sunshine hours. Results are in accordance with several workers [31, 32].

Table-4 *Correlation of whitefly, Leaf hopper and thrips population with weather parameters*

Weather parameters	Correlation coefficient (r value)		
	Whitefly	Leafhopper	Thrips
Temperature max. (ºC)	-0.557*	-0.412	0.068
Temperature min. (ºC)	-0.293	-0.071	0.657*
Morning RH (%)	0.480*	0.455*	0.011
Evening RH (%)	0.192	0.252	0.377
Sunshine (hrs)	0.231	0.245	-0.457
Rainfall (mm)	-0.198	-0.126	-0.070
Wind speed (Km/hr)	-0.387	-0.074	0.069

*Significant at 5%

While, in the case of leafhopper, 62% variability in leafhopper nymphal population was due to various abiotic factors, maximum temperature and morning relative humidity (RHm) accounted for 21% variability (regression equation - Y2) and these were the most important factors affecting leafhopper abundance. Out of 21% variability in leafhopper's population morning relative humidity (RHm) accounted for 17% contribution (regression equation – Y3).

Deciphering the population dynamics of thrips, 61% variability in the population was accounted to abiotic factors, minimum temperature and sunshine hours accounted for 45% variability (regression equation - Y2) and these were the most important factors affecting thrips abundance. Out of 45% variability in thrips population minimum temperature accounted for 43% contribution (regression equation – Y3).

Table-5 *Multiple regression analysis between whitefly, Leaf hopper and thrips with abiotic factors on cotton genotypes*

	Regression equations	R^2
Whitefly	Y1= 152.40 -4.43 X1 + 1.41 X2 - 0.52 X3 + 0.28 X4 – 0.46 X5 + 2.81 X6 – 0.12X7	0.54
	Y2=107.75-2.19-2.19X1-0.09X3-0.82X5	0.33
	Y3=113.06-2.48X1-0.09X3	0.31
Leafhopper	Y1= 2.35 -0.32 X1 + 0.22 X2 + 0.07 X3 - 0.04 X4 + 0.24 X5 + 0.09 X6 – 0.02X7	0.62
	Y2=0.14-0.03X1+0.03X3	0.21
	Y3= -7.59-0.17X3	0.17
Thrips	Y1= -32.16 -0.42 X1 + 1.84 X2 + 0.04 X3 + 0.05 X4 - 0.49 X5 + 0.45 X6 – 0.05X7	0.61
	Y2= -29.29+1.28X2+0.15X6	0.45
	Y3= -25.29+1.17X2	0.43

X1 = Temperature (maximum), X2 = Temperature (minimum), X3 = Relative humidity (morning), X4 = Relative humidity (evening), X5 = Wind speed, X6 = Sun shine hours, X7 = Rainfall (mm)

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Conclusion

Study of the climatic changes is a difficult task owing to its complexity, uncertainity and disparity impacts over time and place. Understanding abiotic stress responses in crop plants, insect-pests population dynamics emphasizes on devising adjustment and improvement strategies for pest management programmes. Hence, to overcome tedious climatic checks, more studies are required to produce genetically transformed cotton with specific genes, which could check sucking insect pests also as it has been successful to check bollworms attack on cotton.

Conflict of Interest: None declared

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