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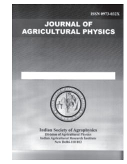

Research Article

Impact of Weather Parameters and Plant Spacing on Population Dynamics of Sucking Pests of Cotton in South Western Punjab

HARPREET SINGH*, PRABHJYOT KAUR AND JOYDEEP MUKHERJEE

School of Climate Change & Agricultural Meteorology, Punjab Agricultural University, Ludhiana-141004,. Punjab

ABSTRACT

The present study on cotton was conducted during two crop seasons of 2006 and 2007 at regional research station (Bathinda) of Punjab Agricultural University. The field experiment included three Bt cotton cultivars (viz. RCH-134, MRC-6301 and Akur-651) sown at three different row × plant spacings namely; 67.5cm × 75cm (S_1), 67.5cm × 90cm (S_2) and 67.5cm × 105cm (S_3). Data were collected on weather parameters and population of sucking pests (*viz*. jassid, whitefly and thrips) in cotton under no-pesticide spray conditions. Relationships between weather parameters, plant population and pest abundance were developed. Results revealed that the population of pests significantly decreased with the increase in plant spacings. An analysis of both season's pooled data revealed that population of jassid had a positive correlation with the maximum and minimum temperatures, but negative correlation with morning and evening relative humidity, and the rainfall. However, the whitefly population had a negative correlation with the maximum temperature and rainfall but a positive correlation with minimum temperature, morning and evening relative humidity. Likewise, thrips population showed a positive correlation with the maximum temperature and morning relative humidity but a negative correlation with minimum temperature, evening relative humidity and rainfall. The multiple correlation coefficients using pooled data for different treatments were 0.70, 0.90 and 0.89 for jassid, whitefly and thrips population, respectively.

Key words: Bt cotton, Whitefly, Thrips, Jassid, Weather parameters

Introduction

Weather based pest forewarning systems can act as an effective tool in developing suitable control measures against pest incidence in crops. Information on abundance and distribution of pest in relation to meteorological parameters is the basic requirement for developing pest management program for a specific agro-ecosystem,. Both maximum and minimum temperatures, total rainfall, and relative humidity are the major weather parameters that largely control the dynamics of a given insect species.

*Corresponding author,
Email: harpreetsingh@pau.edu

Prevalent weather conditions either directly or indirectly affects the occurrence and distribution of pest population by way of its influence on the rate of development and availability of food source. Insect pests are known to cause considerable loss to agricultural production throughout the world. In a region, the severity of pest population and resultant crop damage is governed by the environmental factors and natural enemies (Becker, 1974). As a consequence of climatic changes over time, there could be shift in rainfall patterns. Such changes will affect cotton production and sucking pest incidence under field conditions. Thus, weather and climate play a leading role in determining the precise epidemiology of outbreak of any pest or disease. Recent studies on Integrated Pest Management (IMP) and epidemiology suggest that the weather conditions play a crucial role in pest outbreaks. Effect of weather factors on some crop pests has earlier been studied by Rote and Puri (1991) and Saminathan *et al* (2001). Relevant information on population dynamics of sucking pests in cotton under different plant populations and the nature and degree of relationship between pest population and weather factors under south western region of Punjab is lacking. The present study was undertaken to gather this information, which will be helpful for real time weather agroadvosiory services for farmers to have suitable control measures.

Materials and Methods

The present study seeks to know the impact of weather parameters and plant spacing on population dynamics of sucking pests of cotton in south western Punjab. The experiment comprising three Bt cotton cultivars (namely, RCH-134, MRC-6301 and Akur-651) at three different row×plant spacings viz., 67.5cm × 75cm (S1), 67.5cm × 90cm (S2) and 67.5cm × 105cm (S3) during *kharif* seasons of 2006 and 2007 at PAU, Regional Station, Bathinda (30°17′ N latitude, 74°58′ E longitude and 211 m altitude) which were replicated three times in a randomized block design. The crop was grown under no-pesticide spray conditions to monitor dynamics of abundance of sucking pests in relation to prevalent weather parameters.

Daily data on meteorological parameters of maximum and minimum temperature, morning and evening relative humidity, and rainfall were recorded. Data on sucking pests namely jassid, whitefly and thrips were recorded from the upper three leaves of ten randomly selected plants at weekly intervals starting from July to September. The count of both adults and nymphs were taken for jassid and thrips while only adults were counted for whitefly population. A stepwise multiple regression analysis was applied between sucking pest population and meteorological parameters. The quantitative relationship between the weekly mean population and the weather parameters were worked out by correlation and regression analysis.

Results and Discussion

Dynamics of jassid population

Seasonal weekly data on jassid population are shown in Table 1 and the data under the three crop cultivars are shown in Table 2. Results revealed that maximum population of jassid (2.36 and 2.44 leaf^{-1}) was recorded during 31st Standard Meteorological Week (SMW) in both the crop seasons. The population trend shows that the activity of jassid started from 26th SMW under all treatments (pooled data) during the two crop seasons and a first sharp increase in jassid population was observed during 28th SMW reaching the peak in 31st SMW (Fig. 1). The population decreased thereafter and reached down to 0.05% per leaf during the 38th SMW. The present findings are in conformity with those of Butter *et al* (1992). Population of jassid was above economic threshold level during 27-34 SMW for both the crop seasons and for all the treatments. It is evident that a decrease in temperature and increase in RH favour the population build up of jassid under all the treatments. Our findings agree with Simwat and Gill (1992) and Aheer *et al* (2006) who reported positive correlation between population of jassid and RH.

Effect of plant spacing and cultivars on jassid population

Plant spacing showed a significant effect on jassid population at 30th SMW (Table 1). Maximum population of jassid was recorded as 1.05 and 1.11% per leaf from those plots where minimum plant spacing (75 cm) was maintained for crop season 2006 and 2007, respectively. The population of jassid decreased as the plant to plant distance increased. The population of jassid decreased significantly (0.83 and 0.87% per leaf) in those plots where maximum plant spacing (105 cm) was maintained. Mohite and Uthamasamy (1997) also reported higher population of jassid

Table 1. Sucking pest population per leaf recorded on various spacing during *kharif* crop season 2006 and 2007

Treat-ments	Standard Meteorological weeks													Mean
	26	27	28	29	30	31	32	33	34	35	36	37	38	
Jassid							**2006**							
S_1	0.29	0.48	1.39	1.57	2.13	2.65	1.88	1.4	0.63	0.43	0.46	0.29	0.07	1.05
S_2	0.27	0.31	1.32	1.50	1.96	2.42	1.72	1.31	0.55	0.36	0.42	0.25	0.05	0.96
S_3	0.23	0.23	1.29	1.34	1.72	2.01	1.61	1.10	0.51	0.17	0.32	0.24	0.02	0.83
Mean	0.26	0.34	1.33	1.47	1.94	2.36	1.74	1.27	0.56	0.32	0.4	0.26	0.05	
LSD	NS	0.19	0.19	NS	0.34	NS	NS	NS	NS	0.17	NS	NS	NS	
Jassid							**2007**							
S_1	0.31	0.49	1.45	1.68	2.41	2.69	1.99	1.43	0.69	0.44	0.51	0.29	0.09	1.11
S_2	0.28	0.38	1.36	1.56	2.04	2.53	1.78	1.29	0.54	0.39	0.50	0.25	0.07	1.00
S_3	0.24	0.22	1.31	1.38	1.83	2.11	1.69	1.13	0.52	0.21	0.38	0.24	0.05	0.87
Mean	0.28	0.36	1.37	1.54	2.09	2.44	1.82	1.28	0.58	0.35	0.46	0.26	0.07	
	NS	0.20	0.19	NS	0.36	NS	NS	NS	NS	0.15	NS	NS	NS	
Whitefly							**2006**							
S_1	0.43	0.49	1.51	1.16	0.87	1.93	1.53	1.39	1.30	1.70	1.31	0.99	0.89	1.16
S_2	0.31	0.43	1.11	1.10	0.63	1.82	1.47	1.35	1.20	1.20	1.20	0.90	0.65	1.02
S_3	0.24	0.30	1.03	0.91	0.53	1.43	1.35	1.21	1.10	1.00	0.56	0.80	0.55	0.85
Mean	0.33	0.41	1.22	1.06	0.68	1.73	1.45	1.32	1.20	1.30	1.02	0.90	0.70	
LSD	NS	NS	NS	NS	0.22	0.32	NS	NS	NS	0.38	0.44	NS	NS	
Whitefly							**2007**							
S_1	0.45	0.53	1.56	1.18	0.95	2.01	1.54	1.41	1.31	1.72	1.38	1.01	0.99	1.23
S_2	0.33	0.48	1.21	1.13	0.76	1.92	1.48	1.36	1.21	1.23	1.26	0.99	0.69	1.08
S_3	0.26	0.31	1.13	1.00	0.65	1.54	1.36	1.22	1.12	1.11	0.76	0.89	0.58	0.92
Mean	0.35	0.44	1.30	1.10	0.79	1.82	1.46	1.33	1.21	1.35	1.13	0.96	0.75	
LSD	NS	NS	NS	NS	0.18	0.31	NS	NS	NS	0.35	0.41	NS	NS	
Thrips							**2006**							
S_1	11.4	23.3	14.8	10.5	3.10	2.8	1.93	1.87	0.47	0.38	0.31	0.23	0.19	5.48
S_2	9.81	22.31	13.49	9.88	2.83	2.22	1.72	0.85	0.32	0.27	0.19	0.13	0.80	4.99
S_3	7.72	20.88	12.9	8.90	2.51	2.29	1.88	0.81	0.24	0.41	0.06	0.05	0.04	4.51
Mean	9.64	22.16	13.73	9.76	2.81	2.44	1.84	1.18	0.34	0.35	0.19	0.14	0.34	
LSD	2.04	NS	NS	1.00	NS	NS	NS	0.43	NS	NS	NS	NS	NS	
Thrips							**2007**							
S_1	11.8	22.1	14.9	11.52	3.22	2.91	2.01	1.75	0.54	0.48	0.51	0.35	0.23	5.56
S_2	9.99	21.31	13.82	10.35	2.75	2.25	1.86	0.93	0.39	0.29	0.26	0.20	0.09	4.96
S_3	8.01	19.86	12.96	8.89	2.59	2.12	1.75	0.85	0.28	0.21	0.09	0.06	0.06	4.44
Mean	9.93	21.09	13.89	10.25	2.85	2.43	1.87	1.18	0.40	0.33	0.29	0.20	0.13	
LSD	1.97	NS	NS	1.09	NS	NS	NS	0.39	NS	NS	NS	NS	NS	

Where, S_{1-} 67.5 X 75 cm, S_2-67.5 X 90 cm and S_3 – 67.5 X 105 cm

Table 2. Sucking pest population per leaf recorded on various genotypes during *kharif* crop seasons 2006 and 2007

Treat-ments	Standard Meteorological weeks													Mean
	26	27	28	29	30	31	32	33	34	35	36	37	38	
Jassid							**2006**							
V_1	0.35	0.89	1.39	1.63	1.87	2.10	1.96	1.30	0.98	0.50	0.49	0.39	0.07	1.10
V_2	0.31	0.34	1.23	1.27	1.73	1.89	1.90	1.30	0.50	0.22	0.18	0.14	0.05	0.89
V_3	0.24	0.30	1.11	1.21	1.69	1.70	1.47	1.03	0.50	0.21	0.17	0.11	0.03	0.77
Mean	0.30	0.51	1.24	1.37	1.76	2.07	1.78	1.21	0.66	0.31	0.28	0.21	0.05	
LSD	0.11	0.39	0.28	NS	0.23	NS	NS	NS	0.13	0.21	0.18	NS	NS	
Jassid							**2007**							
V_1	0.36	0.91	1.43	1.73	1.94	2.23	2.01	1.51	1.01	0.52	0.53	0.43	0.01	1.12
V_2	0.32	0.35	1.28	1.34	1.78	1.93	1.99	1.42	0.60	0.23	0.21	0.35	0.09	0.91
V_3	0.25	0.34	1.13	1.31	1.79	1.86	1.59	1.13	0.55	0.22	0.20	0.21	0.05	0.82
Mean	0.31	0.53	1.28	1.46	1.84	2.01	1.86	1.35	0.72	0.32	0.31	0.33	0.05	
LSD	0.11	0.30	0.28	NS	0.21	NS	NS	NS	0.13	0.212	0.19	NS	NS	
Whitefly							**2006**							
V_1	0.27	0.35	1.22	1.11	0.67	1.93	1.97	1.43	1.28	2.06	2.06	2.30	1.67	1.33
V_2	0.19	0.19	0.83	1.09	0.43	1.10	1.13	1.03	0.90	0.90	1.75	1.62	1.51	0.99
V_3	0.18	0.14	0.70	0.70	0.23	1.07	1.00	0.98	0.81	1.00	1.23	0.85	0.75	0.75
Mean	0.21	0.23	0.92	1.02	0.44	1.34	1.36	1.08	1.00	1.01	1.68	1.59	1.31	
LSD	NS	NS	0.24	NS	0.17	0.35	NS	NS	NS	0.47	0.32	NS	NS	
Whitefly							**2007**							
V_1	0.26	0.32	1.23	1.15	0.66	1.99	2.01	1.41	1.27	2.01	2.00	2.31	1.71	1.41
V_2	0.18	0.18	0.84	1.07	0.43	1.21	1.14	1.01	0.90	0.80	1.81	1.63	1.56	0.98
V_3	0.15	0.13	0.71	0.60	0.21	1.10	0.90	0.96	0.76	0.79	1.31	0.89	0.76	0.71
Mean	0.20	0.21	0.93	0.96	0.43	1.43	1.35	1.13	0.98	1.20	1.71	1.61	1.34	
LSD	NS	NS	0.24	NS	0.17	0.32	NS	NS	NS	0.47	0.28	NS	NS	
Thrips							**2006**							
V_1	12.50	21.90	13.73	9.12	3.92	2.58	1.83	1.20	1.02	0.62	0.60	0.53	0.29	5.37
V_2	6.60	20.80	12.70	8.77	3.37	2.27	1.77	0.93	0.27	0.48	0.50	0.45	0.26	4.55
V_3	5.61	18.97	9.40	8.67	1.83	2.17	1.47	0.67	0.25	0.41	0.40	0.41	0.22	3.88
Mean	8.24	20.56	11.94	8.85	3.04	2.34	1.69	0.93	0.51	0.50	0.50	0.46	0.26	
LSD	2.95	NS	0.21	0.89	NS	NS	NS	0.33	0.18	NS	NS	NS	NS	
Thrips							**2007**							
V_1	12.4	20.89	13.61	9.15	4.01	2.78	1.93	1.41	1.13	0.69	0.63	0.57	0.34	5.35
V_2	6.50	19.76	11.80	8.90	3.91	2.35	1.79	0.96	0.38	0.51	0.53	0.46	0.32	4.47
V_3	5.40	19.38	8.60	8.60	2.83	2.19	1.46	0.69	0.29	0.43	0.42	0.43	0.26	3.92
Mean	8.10	20.01	11.34	8.88	3.58	2.44	1.73	1.02	0.60	0.54	0.53	0.49	0.31	
LSD	2.96	NS	0.28	0.87	NS	NS	NS	0.38	0.20	NS	NS	NS	NS	

V_{1-} RCH-134, V_2 -MRC-6301, V_3- Ankur 651 (Non BT)

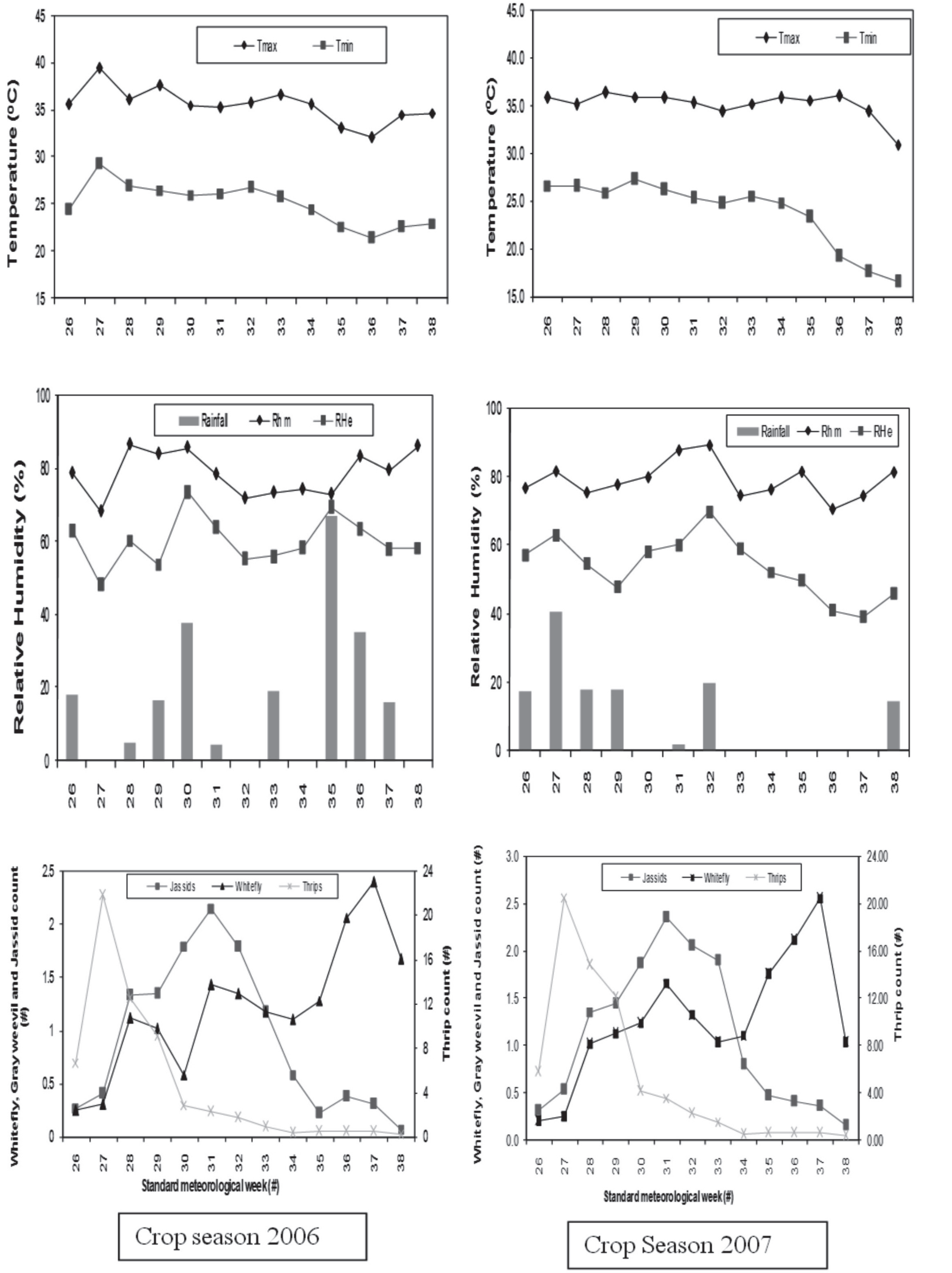

Fig 1. Meteorological parameters and population dynamics in cotton during *kharif* 2006 & 2007crop seasons

at narrow plant spacing. Cultivar RCH-134 and Ankur-651 showed maximum peak during 31st SMW whereas, MRC-6301 showed maximum peak during 32nd SMW. Data also indicated that jassid population started to build up in 26th SMW and increased gradually reaching to its maximum (2.07 and 2.01 per leaf) in 31st SMW (Table 2). These results are in partial agreement with Aheer *et al.* (2006). Cultivar RCH-134 was found as the most susceptible (1.10 and 1.12 per leaf) whereas Ankur 651 was comparatively resistant (0.77 and 0.82 per leaf) against jassid population for crop season 2006 and 2007, respectively.

Dynamics of whitefly population

Activity of whitefly started from 26th SMW under all treatments (pooled data) during the 1 and 2 crop seasons (Table 1 & 2). Maximum population was recorded during 36-37th SMW for both the crop seasons. The first sharp increase was happened in 28th SMW, with another in 31st SMW while the peak population occurred in 36-37th SMW (Fig. 1). Population of whitefly was above the economic threshold level from 27th to 38th SMW for both the crop seasons under all treatments. It is evident that the decrease in temperature and increase in RH favor the population build up of whitefly in all the treatments. Similarly, Butter (1985) demonstrated positive correlation between the population of whitefly and temperature, and a negative correlation with RH.

Effect of plant spacing and cultivars on whitefly population

Plant spacing showed a significant effect on whitefly population (Table 1). Seasonal average population of whitefly was the maximum at 1.16 and 1.23 per leaf under minimum plant spacing (75 cm) for crop season 2006 and 2007, respectively. Population of whitefly decreased as the plant to plant distance increased. Seasonal average population decreased significantly to 0.85 and 0.92 per leaf under 105 cm plant to plant spacing for crop seasons 2006 and 2007, respectively. These results are similar to those reported by Anonymous (1999-2000) who observed low population in July, and higher in August. Our findings also agree with those of Seif (1980), Isler and Ozgur (1992) and Majeed *et al.* (1995). Cultivar RCH-134, MRC-6301 and Ankur-651 revealed seasonal average population of 1.33, 0.99 and 0.75 per leaf, respectively during 2006 (Table 2) where as the corresponding populations for 2007 were 1.41, 0.98 and 0.71 per leaf, respectively. Thus cultivar RCH-134 was found the most susceptible whereas Ankur-651 was comparatively more resistant against the whitefly incidence during both the crop seasons. These results partially coincide with Aheer *et al.* (2006).

Assessemnt of thrips population:

Peak population of thrips was recorded during 27th SMW. Peak population averaged over plant spacings was 22.16 per leaf for 2006 and 21.09 per leaf for the 2007 season. Similarly, peak population averaged over cultivars was 20.56 and 20.01 per leaf for 2006 and 2007, respectively. The thrip population decreased after 27th SMW and recorded as 0.26-0.31 per leaf during the 38th SMW. In general, the population of thrips was above economic threshold level between 26 and 30 SMW under all the treatments during both the crop seasons. It appears that increases in temperature and decreases in RH favor the population build up of thrips in all the treatments (Fig. 1). However, the present findings are not in agreement with those of Al-Faisal and Kardo (1986) who reported two population peaks, one in early May and one in June or early July.

Effect of plant spacing and cultivars on thrips population

Plant spacing showed a significant effect on thrips population (Table 1). The highest seasonal average population of thrips was recorded to be 5.48 and 5.56 per leaf from narrow plant spacing (75 cm) during crop season of 2006 and 2007, respectively. Wider plant-to-plant spacing (105 cm) caused significant reduction in thrips population, with 4.51 and 4.44 per leaf for crop seasons 2006 and 2007, respectively. Thus the population of thrips decreased as the plant-to-

Table 3. Correlation between jassid, whitefly and thrips population and various meteorological parameters (Pooled data over 2006 and 2007)

Weather parameter	Jassid	Whitefly	Thrips
Maximum temperature (^{o}C)	0.39	-0.49	0.59
Minimum temperature (^{o}C)	0.22	-0.27	-0.17
Morning relative humidity (%)	-0.40	0.22	0.21
Evening relative humidity (%)	-0.33	0.24	-0.28
Rainfall (mm)	-0.24	-0.15	-0.21

plant distance increased. At any time during both the crop seasons the thrip population was observed to be highest in Cultivar RCH-134, followed in decreasing order by cultivar MRC-6301 and Ankur-651 (Table 2). Average seasonal thrip population for cultivar RCH-134, MRC-6301 and Ankur-651 were recorded at 5.37, 4.55 and 3.88 per leaf, respectively for 2006 season while for the 2007 season the corresponding population were 5.35, 4.47 and 3.92 per leaf, respectively. Thus cultivar RCH-134 was found to be most susceptible whereas Ankur- 651 was comparatively more resistant against thrips incidence during both crop seasons.

Correlation matrix

The correlation matrix revealed that the jassid population showed a positive correlation with the maximum and minimum temperature and negative correlation with morning and evening RH and rainfall (Fig. 3). In case of whitefly, a negative correlation of population with maximum and minimum temperatures and rainfall, and positive correlation with morning and evening RH was observed. A positive correlation of thrip population with maximum temperature and morning RH but a negative correlation with minimum temperature, evening RH and rainfall was found. The present findings are in partial agreement with those of Bishnoi *et al.* (1996) and Wahla e*t. al.* (1975).

Cumulative effect of abiotic factors on pest population

From the correlation study, it was apparent that none of the meteorological parameters were alone responsible for multiplication and growth of the sucking pest in cotton crop. This could be expected because under natural conditions, no environmental factor acts/reacts in isolation, rather it acts in combination with other

Table 4. Regression equations for sucking pest population and meteorological parameters (pooled data)

Regression equation	Multiple correlation coefficient
Jassid	
$Y = -42.4+0.0001X_1+0.68\ X_2+0.57\ X_3-0.11X_4\ +0.16X_5$	0.70
$Y = -217+0.022X_1-2.26X_2+6.04X_3+.0996X_4$	0.67
$Y = -80.86+0.049X_1-1.04X_2+3.25X_3$	0.65
$Y = 40.057-0.0369X_1-1.079X_2$	0.62
Whitefly	
$Y = -196+0.02X_1-2.53\ X_2+5.70\ X_3+1.10X_4\ -0.13X_5$	0.90
$Y = -217+0.02X1-2.26X2+6.04X3+.0996X_4$	0.89
$Y = -81.9+0.05X_1-1.05X_2+3.26X_3$	0.68
$Y = 40.057-0.04X_1-1.08X_2$	0.67
Thrips	
$Y = -157.89+0.017X_1-2.56\ X_2+6.1\ X_3+1.21X_4\ -0.17X_5$	0.89
$Y = -219+0.032X_1-2.56X_2+6.14X_3+.1009X_4$	0.89
$Y = -81.06+0.07X_1-1.24X_2+3.265X_3$	0.62
$Y = 41.04-0.0381X_1-1.057X_2$	0.27

Y= Sucking pest population per leaf; X_1 = Rainfall, X_2 = Minimum temperature, X_3 = Maximum temperature, X_4 = Morning RH, X_5 = Evening RH environmental factors. So, stepwise regression analysis between sucking pest populations and meteorological parameters was performed to evaluate the cumulative effect of different meteorological parameters on sucking pest multiplication and development (Table 4). It was evident that rainfall and minimum temperature exerted 62, 67 and 27% effect on the population fluctuation of jassid, whitefly and thrips, respectively. The effect increased to 70, 90 and 89 % when the effect of RH and maximum temperature was included. Our findings are in partial agreement with those of Bishnoi *et al* (1996) who reported that mean air temperature and relative humidity showed significant relationship with jassid population.

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