Original Research Article

Effect of Weather Parameters on the incidence of Thrips, *Thrips tabaci* on *Bt* Cotton

ABSTRACT

The field experiments were conducted during *kharif* (July–December), 2014 and *kharif* (July–December), 2015 at Agricultural Research Station, Rajendranagar, Hyderabad, Telangana state, India to study the influence of weather parameters on the incidence of thrips population in *Bt* cotton.. Data on the incidence of thrips population were collected at weekly interval under no pesticide spray conditions which were correlated with weather parameters collected from automatic weather station, Agro Climatic Research Centre, Rajendranagar. The results revealed that the peak incidence of thrips population was recorded on 35th Standard Week i.e., last week of August (32.87 thrips leaf^{-1}) during *kharif* (July to December),2014 and two peaks *i.e.*, 35th Standard Week *i.e.*, last week of August (33.93 thrips leaf^{-1}) and 40 Standard Week i.e., the first week of October (40.40 thrips leaf^{-1}) were recorded during *kharif* (July to December) 2015. Thereafter, its population declined gradually during both seasons. Correlations worked out between thrips population and weather parameters revealed that, one week (0.51*) and two weeks lag (0.65**) minimum temperature, one week lag (0.56**) morning relative humidity showed significant and positive influence, while one week lag (–0.44*) evaporation showed significant negative influence on thrips incidence. The prediction model developed for the thrips population revealed that the model explained the variation to an extent of 54% in thrips incidence under the influence of minimum temperature and morning relative humidity.

Keywords: *Bt* Cotton, correlations, regressions**,** thrips, weather parameters

1. INTRODUCTION

Cotton is a significant cash crop accounting for 30% of India's agricultural gross domestic product (Fayet, and Vermeulen, 2014). The majority of Indian farmers are smallholders with less than two hectares of land to cultivate [Riar et al. 2017; Coventry et al 2015). There are several factors that influence the low production levels and increase poverty of Indian small holder farmers. The most important ones include the constantly rising production costs (seeds and pesticides), the pressure of cosmopolitan pests (Gutierrez, 2015).

India was a leading country in terms of area (123 lakh hectares) and production (28,500 million bales) of cotton during 2017–18, but the productivity was decreased from 541 kg ha^{-1} during 2016–17 to 524 kg ha^{-1} during 2017–18 (Anonymous, 2018). The cotton bollworm is a major pest limiting cotton productivity worldwide. Three bollworm species cause main damage on cotton in India: The pinkbollworm (*Pectinophora gossypiella*), the spotted bollworm (*Earias vitella*), and the American bollworm (*Helicoverpa armigera*). The Bt cotton hybrid (GM cotton) was introduced to India in 2002 followed by a radical transformation of cotton cultivation (Fand et al. 2019). Since the release of Bt cotton technology, it has emerged as an effective alternative to traditional cotton varieties by inhibiting bollworm attack, there by improving yield and income. This has resulted in fast adoption of Bt cotton over conventional cotton. Cotton production in India has accelerated more than 4 times and reached a peak of 359.02 lakh bales during 2013-14 as compared to 86.24 lakh bales in 2002-03 (Anonymous, 2017). With introduction of Bt cotton technology farmers of India are getting good production as the pest status of bollworms was declined dramatically but, the sucking pests such as cotton aphids (*Aphis gossypii*), cotton jassids (*Amrasca biguttula biguttula*), thrips (*Thrips* spp.), and whiteflies (*Bemisia tabaci*) have become the major constraints in Bt cotton production. Thrips had recently attained the status of a regular pest on *Bt* cotton in the Telangana. This species overwinters in ploughed soil, plant debris, and perennial weeds and becomes active in the spring. With its rapid life cycle and high reproductive capacity, it has become a perennial and serious pest of seedling to mid-season cotton in many cotton regions in India (Khan et al. 2008). *T. tabaci* has a unique feeding method in which it rasps leaf surface cells and consumes their liquid contents, thus reducing the photosynthetic capacity of the plant and vigor of the plants is impaired to a great extent.

Climatic conditions have a great influence on the population, survival, development, out-breaks, reproductive capacity and activity of pest as well as predators and parasites either directly or indirectly (Arif et al.,2007). For developing a weather based pest fore-casting system, information regarding population dynamics in relation to prevalent meteorological parameters (temperature, relative humidity, rainfall etc.) is needed. Moreover, the same meteorological parameters also influence the growth and development of crop. Thus, the knowledge about incidence of pest during cropping season and the influence of meteorological parameters on thrips of cotton will help to develop a forecasting system which in turn is helpful in decision making system and timely application of suitable insecticides for effective management of thrips (*T. tabaci* Lindeman) in cotton agro–ecosystem. Therefore, the present investigation was undertaken to find out the relationship between the populations dynamics of thrips (*T. tabaci* Lindeman) on *Bt* cotton with meteorological parameters in Rajendranagar, Hyderabad.

2. MATERIALS AND METHODS

2.1. Experimental Procedure

The field experiments were conducted during *Kharif* (July–December) 2014 and *Kharif* (July–December) 2015 at Agricultural Research Station, Rajendranagar (17 .19 N' Latitude and 78 .23E' Longitude 542 m above mean sea level), Hyderabad, Telangana to investigate seasonal incidence of thrips on *Bt* cotton and to know the impact of weather parameters on population dynamics of thrips population. The crop was raised in three plots each with a plot size of 10.8×4.8 m with a spacing of 90X60 cm. All the agronomic practices like weeding, fertilizer application etc. were accomplished according to the standard recommendations. No plant protection measures were followed to the crop to allow the pest population build up under natural conditions.

2.2. Observations

Observations on the population of thrips were recorded at weekly intervals from 10 randomly selected plants from each plot starting from the initiation of insect pests and continued till the end of crop growth. Population of thrips was recorded by observing three leaves, each from upper, middle and lower portion of each plant. The thrips counts were made during early morning hours(8:00-10:00), based on standard meteorological week (SMW).

2.3. Meteorological data

Weather parameters like maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, average wind speed, sunshine hours and rainfall were obtained from the meteorological observatory, Agro Climate Research Centre (ACRC), Agricultural Research Station, Rajendranagar.

2.4. Data analysis

With a view to study the impact of different weather parameters on pest incidence, a simple correlation between pest population and weather parameters and regression analysis was worked out by using SPSS statistical software.

3. RESULTS AND DISCUSSION

Population of thrips in *Bt* cotton recorded with a range of 0.00 to 32.87 thrips leaf^{-1} during *kharif* (July to December), 2014 and 0.00 to 40.40 during *kharif* (July to December), 2015. Results on the seasonal incidence of thrips population revealed that the population of thrips commenced its activity from 32nd Standard Week i.e., the second week of August (1.75 thrips leaf^{-1}) onwards during kharif, 2014 and 33rd Standard Week i.e., the third week of August (2.93 thrips leaf^{-1}) during kharif 2015, respectively. Its population increased rapidly from 34th Standard Week onwards during both the years. Peak incidence was observed on 35th Standard Week i.e., last week of August (32.87 thrips leaf^{-1}) during kharif, 2014 and two peaks *i.e.*, 35th Standard Week i.e., last week of August (33.93 thrips leaf^{-1}) and 40th Standard Week i.e., the first week of October (40.40 thrips leaf^{-1}) were recorded during kharif, 2015. Thereafter, its population declined gradually during both seasons (Fig.1). The present investigation is in partial agreement with Gupta et al. (1997) who observed that the peak population of thrips was recorded during the second fortnight of August to the first fortnight of October with 30^{0}C temperature and 74–85% relative humidity on the cotton in Madhya Pradesh. According to Gosalwad et al. (2009) studied the population dynamics of major insect pests of cotton and reported that thrips attained their peak in August. According to Makwana et al. (2018**)** revealed that the activity of thrips was highest (22.4 thrips 3 leaves^{-1} plant^{-1}) in 4th week of September. Muchhadiya et al. (2014) reported that the average data of four years indicated that the pest appeared from 4th week of July and reached its peak 2.94/3 leaves on 3rd week of Sept and then decreased in subsequent weeks. The thrips occurrence started with peak 9.35 thrips leaf^{-1} and 8.33 thrips leaf^{-1} in 31th MSW i.e. after three week of sowing and its infestation remained throughout the crop growth in both Bt and non Bt cotton crops (Panwar et al., 2015).

The data on association between thrips incidence and weather parameters during during *kharif* (July to December), 2014 are presented in Table 1. The results revealed that one week lag (r=0.55**) minimum temperature, current week (r=0.69*) and one week lag (r=0.70**) morning relative humidity showed significant and positive influence, while current week (r= –0.58*) and one week lag (r= –0.65*) evaporation showed significant negative influence on thrips incidence.

Correlation worked out between thrips population and weather parameters during kharif, 2015 are presented in Table 2. The results revealed that, one week (r=0.64*) and two weeks lag (r=0.65**) minimum temperature, current week (r=0.59*) and one week lag (r=0.61**) morning relative humidity and one week lag rainy days (r=0.56*) showed significant and positive influence, while current week evaporation (r= –0.60*) showed significant negative influence on thrips incidence.

Correlations worked out between thrips population and weather parameters (pooled data of two years i.e., *kharif*, 2014 and *kharif*, 2015) are presented in Table 3. one week (r=0.51*) and two weeks lag (r=0.65**) minimum temperature, one week lag (r=0.56**) morning relative humidity showed significant and positive influence, while one week lag (r = –0.44*) evaporation showed significant negative influence on thrips incidence. Similarly, Muchhadiya et al. (2014) reported that thrips population showed significantly positive correlation with minimum temperature. The results are in conformity with the results of Sitaramaraju et al. (2010) who reported that minimum temperatures showed positive and significant effect on thrips incidence. According to Ahmed et al. (2017), thrips population was significantly and positively correlated with the minimum temperature followed by the average daily temperature and humidity. Madankar et al. (2015) revealed that thrips population showed a positive correlation with morning relative humidity. The positive significant correlation was found between thrips population and minimum temperature (Bt r = 0.518*) (non Bt r = 0.480*), morning humidity (Bt r = 0.455*) (non Bt r = 0.424*) and rainy days (Bt r = 0.409*)(non Bt r = 0.440*) in Bt and non Bt cotton (Panwar et al. 2015). In contrast to the present results Kadam et al. (2015) reported that thrips showed negatively significance relationship with relative humidity.

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The regression coefficient of pest population on weather parameters is presented in Table 4. In simple regression analysis impact of weather parameters on the thrips population revealed that one week lag morning relative humidity exerted an 11% role in thrips population variation while one week lag minimum temperature contributed 20%. When both i.e., one week lag morning relative humidity and one week lag minimum temperature was added than the impact was 54% on thrips population. The prediction model developed for the thrips population revealed that the model explained the variation to an extent of 54% in thrips incidence under the influence of minimum temperature and morning relative humidity. The present findings corroborated with the results of Ahmed et al. (2017) who revealed that regression analysis showed a linear increase in the thrips population with minimum temperature. The highest thrips populations were noted when minimum temperature was 25°Ċ but at high temperature there was no effect. Thrips counts were highest at temperature (34-35°Ċ) but declined at high temperature. Further, they reported that, although there was positive relationship between the thrips population and percent humidity yet relationship was weak but maximum thrips population was noted in the range of 75 to 85 percent. Similarly, Gupta et al. (1997) who reported that a positive correlation of relative humidity with the thrips population. The present investigations are also supported by findings of Khan et al. (2008) who noticed that incidence of thrips was highly affected by weather factors like mean air temperature; relative humidity and rainfall. They revealed that temperature played a significant and positive role in thrips (r=0.65) population development. Relative humidity and rainfall were also positively associated with the thrips population.

4. CONCLUSION

The studies on seasonal incidence of thrips population in *Bt* cotton clearly indicated that thrips were the predominant pests than other sucking pests viz., aphids, jassids and whiteflies as their incidence recorded throughout the season during both the years i.e., *kharif*, 2014 and *kharif*, 2015. The correlation studies indicated that the correlation exist between thrips population with different weather parameters. Also there was a combined effect of weather parameters on thrips population and their incidence on cotton. Mostly, the correlation between thrips population with weather parameters obtained was positive and definite as the incidence of thrips on *Bt* cotton was due to the variation in weather parameters like minimum temperature and morning relative humidity, these weather parameters were found favourable for the multiplication of the thrips population.

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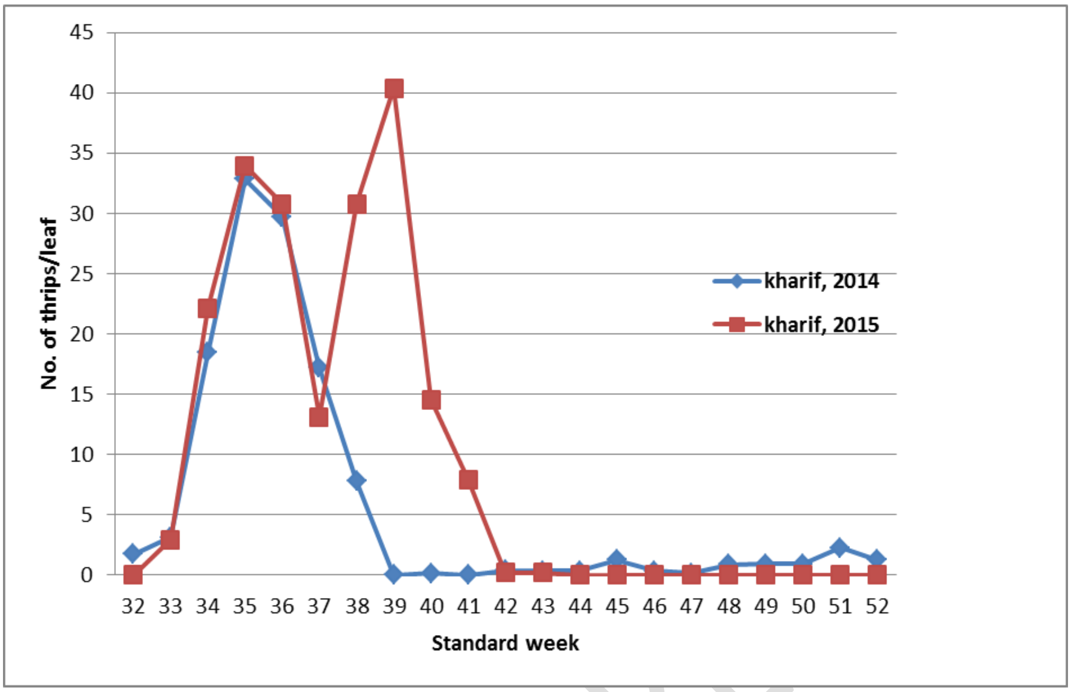

Fig. 1: Seasonal incidence of thrips in *Bt* cotton at ARI, Rajendranagar during *kharif*, 2014 and *kharif*, 2015

Table 1: Correlation coefficients between thrips and weather parameter in *Bt* cotton during *kharif*, 2014

Weather parameters	Current week	Preceding 1 week	Preceding 2 weeks
T max. (°C)	–0.49	–0.56	–0.16
T min. (°C)	–0.03	0.54*	0.36
RH I (%)	0.68*	0.70*	0.46
RH II (%)	0.34	0.40	0.31
Rainfall (mm)	0.12	0.27	–0.23
RD (days)	0.03	0.12	–0.23
SSH	–0.31	–0.54	–0.43
WS (km h^{-1})	–0.33	0.02	0.06
Evap (mm)	–0.57*	–0.65*	–0.27

T mean (^{O}C)	–0.35	–0.08	0.18

Note: Tmax (Maximum temperature °C), Tmin (Minimum temperature °C), RHI 1 (Morning relative humidity, %), RHII (Evening relative humidity %), RF (Rainfall, mm), RD (rainydays), SSH (sunshine hours), Tmean (Mean temperature)

Table 2: Correlation coefficients between thrips and weather parameter in *Bt* cotton during *kharif*, 2015

Weather parameter	Current week	Preceding 1 week	Preceding 2 weeks
T max. (^{O}C)	–0.20	0.04	0.01
T min. (^{O}C)	0.49	0.64*	0.67**
RH I (%)	0.59*	0.61*	0.33
RH II (%)	0.48	0.43	0.19
Rainfall (mm)	0.41	0.36	–0.02
RD (days)	0.38	0.56*	0.28
SSH	–0.47	–0.23	0.21
WS (km h^{-1}) (WS)	–0.01	–0.13	0.09
Evap (mm)	–0.60*	–0.41	–0.32
T mean (^{O}C)	0.20	0.40	0.37

Note: Tmax (Maximum temperature °C), Tmin (Minimum temperature °C), RHI 1 (Morning relative humidity, %), RHII (Evening relative humidity %), RF (Rainfall, mm), RD (rainydays), SSH (sunshine hours), Tmean (Mean temperature)

Table 3: Correlation coefficients between thrips and weather parameter in *Bt* cotton during *kharif*, 2014 and 2015			
Weather parameters	Current week	Preceding 1 week	Preceding 2 weeks
T max.	–0.11	–0.09	–0.11
T min. (^{O}C)	0.30	0.51^{*}	0.65^{**}
RH I (%)	0.40	0.56^{**}	0.35
RH II (%)	0.20	0.40	0.18
Rainfall	0.18	0.15	0.00
RD (days)	0.03	0.16	0.17
SSH	–0.28	–0.29	–0.12
WS (km h^{-1})	–0.21	–0.21	–0.15
Evap (mm)	–0.43	$–0.44^{*}$	–0.01
T mean (^{O}C)	0.08	0.21	0.22

Note: Tmax. (Maximum temperature °C), Tmin. (Minimum temperature °C), RHI 1 (Morning relative humidity, %), RHII (Evening relative humidity %), RF (Rainfall, mm), RD (rainy days), SSH (sunshine hours), T_{mean} (Mean temperature)

Table 4: Regression model for prediction of thrip population in *Bt* cotton (Two years pooled data of *kharif*, 2014 & *kharif*, 15)		
Insect pest	Model Equation	R^2
Thrips	Y = –79.688+1.02*RH I–1	0.11
	Y = –19.336+ 1.435*Tmin–1	0.20
	Y = –266.63+1.92*RH I–1+5.27*Tmin–1	0.54

Note: RH I–1 (Preceding one week morning relative humidity)
Tmin–1 (Preceding one week minimum temperature)