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Population Dynamics of *Thrips tabaci* (Lindeman) in Relation to Abiotic Climate Factors on *Bt* and Non-*Bt* Cotton Cultivars

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Authors' Contribution
MHA planned and conducted study. MIU reviewed and interpreted results. ABMR helped in data collection and analysis. MA critically reviewed and interpreted results. YAand AK helped in data analysis. HMA reviewed and helped in planning and conducting the study.

Key words
Bt cotton, Thrips tabaci, Population dynamics, Abiotic factors, Environment.

ABSTRACT

Cotton is an important fibrous crop and called as white gold of Pakistan. Like many other crops, various chewing and sucking insect pests attack on different *Bt* and non-Bt cotton genotypes. Furthermore, metrological factors (especially temperature, relative humidity and rainfall) also play vital role in the population dynamics of sucking insect pest complex like jassid, aphid, thrips and mites. The present study was conducted on six cotton cultivars (3 *Bt* and 3 non-*Bt*) to monitor the population dynamics of thrips in relation to abiotic climatic factors. Interaction effect was found significant in *Bt* varieties but not for non-*Bt* cultivars. Average thrips population per leaf on various *Bt* and non-*Bt* varieties showed that the CIM-557 along with BT-703 had the highest number of thrips density while *Bt* variety FH-113 had the lowest thrips population per leaf. Similarly, in relation to thermal effect, high thrips population was recorded at 29-35°C but population declined at 40°C. Findings are helpful for appropriate management of sucking complex in case of cotton crop.

INTRODUCTION

The *Gossypium* is the genus of the cotton having hard seed coat. Cotton growing history is as old as human beings. Tropical and subtropical regions of the world including United States of America (USA), China, India and Pakistan are the most leading cotton producing countries of the world (Allen, 2000; McKinion *et al*., 1989; Saeed *et al*., 2007). It is the main fibrous crop which provides different products for domestic usage (Ali *et al*., 1993). Cotton, rice, wheat and sugarcane are the major agronomic crops of Pakistan which accounts about 33.4 percent (Shafiq and Rehman, 2000).

The average cotton yield of cotton in Pakistan is 571 kg/ha which is very less as compared with the other cotton growing countries as it is attacked by several insect pests. Losses in cotton crop have reported by attack of about 162 species of different insect pests and plenty of diseases (Manjunath, 2004). In cotton growing areas, cotton provides 40% cash income for rural household products. Moreover, exporting cotton, our earning comprises as much as 60 percent. Unrefined material provided to 1200 ginning factories, 458 textile mills and 5000 oil expellers (Nazli and Meilke, 2008; Agha, 1994).

Besides the agronomic practices used in cotton production that increase the chances of pest outbreaks, environmental conditions are also important in the population dynamics of different insect pests (Khaliq *et al*., 2014; Hasan *et al*., 2013). Other than chewing insect pests, sucking insect pests are playing an important role in the damaging to the crop. They suck cell sap from their piercing sucking mouthparts from the twigs, shoot, stem and leaves. Discoloration of leaves occurs due to the sucking of these pests (Khaliq *et al*., 2014).

Thrips and mites favor low rainfall and high relative humidity for their proper development (Khaliq *et al*., 2014). During favorable conditions, these pests cause heavy losses to development and growth of the crops (Zhang *et al*., 2013). Thrips (Thysoptera: Thripidae) are very small insects having orange yellowish to brown color (Mass, 2013) with definite type of strippy wings (Lewis, 1997). Thrips are cylindrical, and adult have yellow to brown color. Pupation of the thrips occurs in the soil among fallen fruits or in crakes and crevices. Thrips mostly become active throughout the year and heavy populations pose sever losses (Mound, 2005). Moreover,

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all the major pests of thrips are related to family Thripidae, having different major pest species belong to different genera's including *Taeniothrips*, *Scirtothrips*, and *Thrips* (Triplehornn and Johnson, 2005). In case of cotton, a special gene was derived from a soil borne bacteria named as *Bacillus thuringiensis* so that was it called as Bt. Gene have the capacity to produces different types of crystal proteins in the plant cells that infect the insect gut (Barwale *et al*., 2004). Pest population was also increased due to different agronomic practices were carried out to increase the fertility of the soil, which provide optimum conditions for the development of different insect pests (Bakhsh *et al*., 2005; Saeed *et al*., 2016).

MATERIALS AND METHODS

Sites and location

Experiments were conducted in the research area of Department of Entomology at University College of Agriculture, University of Sargodha Pakistan during the cropping season 2011-12. Field selection was carried out while considering the suitable insect pressure, soil fertility status, meteorological conditions and availability of optimum farm inputs to the research field.

Plant material

Six transgenic and non-transgenic cotton genotypes were chosen to monitor the population dynamics of thrips in relation to abiotic climatic factors. Out of six cotton genotypes, three were transgenic cotton and three were conventional cotton cultivars. Transgenic cotton genotypes included (*Bt*-703, *Bt*-3701, FH-113) and traditional cotton varieties included (CIM-557, CIM-608, CIM-573). The seeds of two *Bt* cotton genotypes (Bt-3701, FH-113) were obtained from the germplasm source center of University College of Agriculture, University of Sargodha. The seed of *Bt* cotton was obtained from the office of local seeds suppliers, Sargodha. Non-*Bt* cotton genotypes were obtained from the department of plant breeding, Central Cotton Research Institute, Multan. Fuzz of cotton seed was removed by concentrated sulfuric acid (95%). Varieties were considered as treatments and there were six treatments and three blocks. Treatments were assigned randomly to each block. Each block was 158ft in length with 2.50ft wide.

Field conditions

Cotton raised beds were prepared for planting seeds of six cotton varieties. Two seed were dibbled at a plant to plant distance of 20 cm and 150 cm. Rigorous sampling of the soil of experimental field was carried out to check the fertility and salinity status of the field. The soil was clay type with average of EC of 3.4 d m^{-2} while the organic matter was below 1%. The experimental field was divided into three blocks based on fertility gradient.

Experimental layout

The experiments were laid out in Randomized Complete Block Design (RCBD) with three replications for each treatment. Six treatments were randomized in three blocks. The plot size was about 1 kanal (20 Marlas) in which six *Bt* and non-*Bt* genotypes were randomly assigned in three blocks. Cotton seeds were sown on 9 inch raised beds with 5 ft distance between the two beds. The length of each bed in each block was 49.4 ft and width was 2.50 ft. The total length of each bed was 158 ft. All the agronomic practices were accomplished according to the recommendations of Department of Agriculture Extension, Punjab, Pakistan. No pesticides were applied to the crop. Data for population estimation of thrips was recorded once in a week. Three plants were randomly selected from each block of six varieties. Thrips population was counted on upper, middle and lower portion of each plant.

Procedure for counting pest population

Data for population estimation of cotton thrips (*Thrips tabaci* Lind.) was recorded once in a week per leaf basis. Three plants were randomly selected from each replication of each treatment. Three plants were selected at randomly and the population of thrips was counted from upper, middle and lower portion of each plant. A total of 20 observations regarding the population of sucking insect pest were taken during the study.

Meteorological data

Meteorological data were obtained by the meteorological department, Sargodha and to correlate with thrips population and for Path coefficient analysis studies.

Data analysis and statistical procedure

Data were analyzed in randomized block design with three factors *i.e.* canopy positions, sampling interval and varieties. Significance of interactions estimated was as follows:

$$CP \times V,\ SI \times V,\ SI \times CP,\ V \times SI \times CP$$

Where, CP is canopy position, Vis varieties and SI is sampling interval.

Correlations were estimated with computer based software Mini Tab 15 and Path analysis technique was done according to Dewey and Lu (1959).

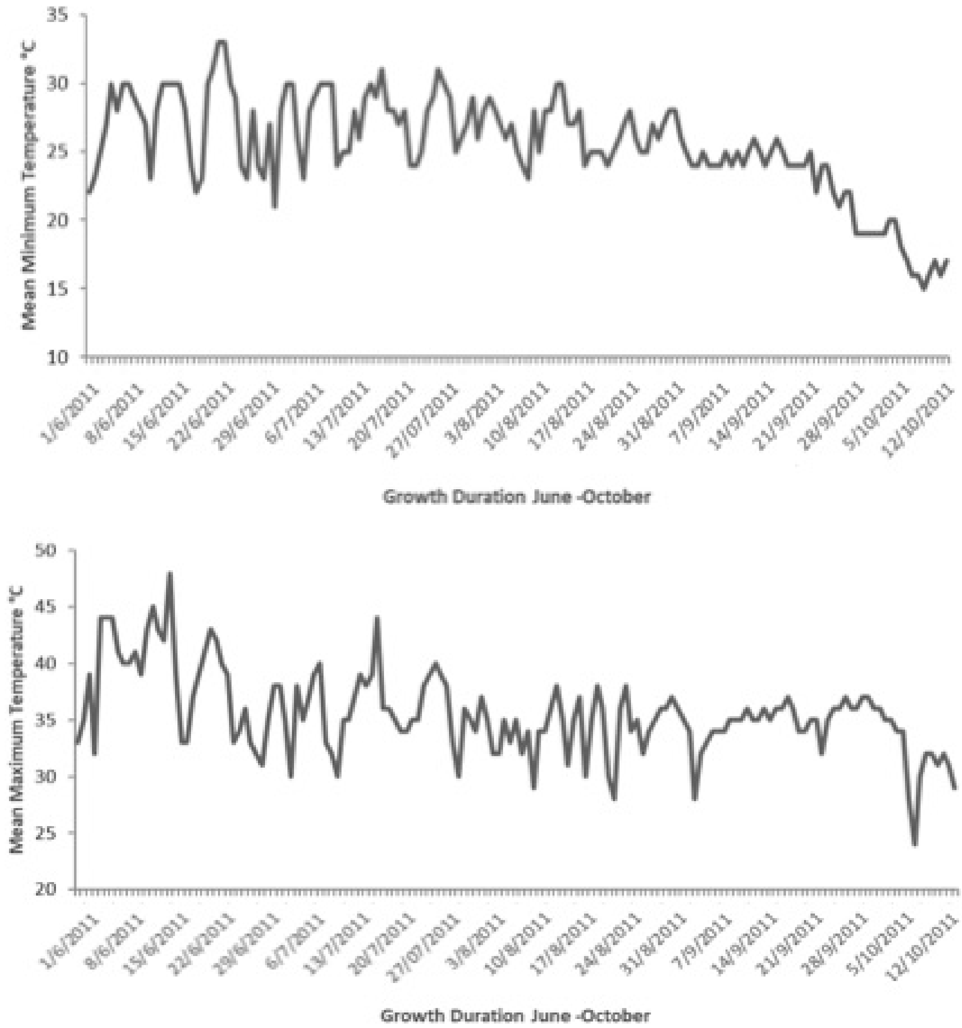

Fig. 1. Mean maximum and minimum temperature °C during the sampling for thrips population from June-October.

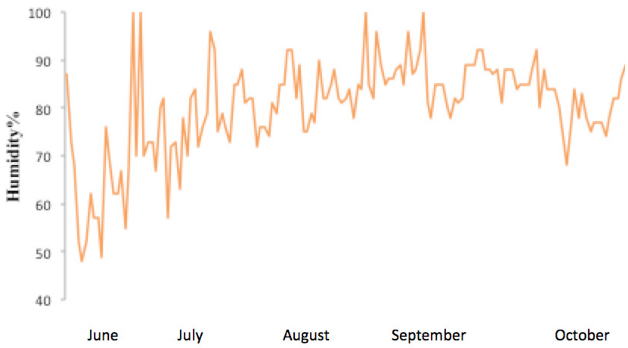

Fig. 2. Percent humidity during the sampling thrips populations from June-October.

RESULTS

Population dynamics of thrips on various cotton varieties were estimated periodically over twenty sampling intervals. Variations among the *Bt* cotton varieties for thrips population was significant ($P \leq 0.01$) but there was no such difference among the non-*Bt* group (Fig. 2). Plant canopy showed a considerable difference among the thrips density. Interaction between the varieties and sampling intervals was significant but there was on such effect in other interactions such as intervals × canopy or varieties × intervals × canopy. Average thrips population per leaf on various *Bt* and non-*Bt* varieties showed that the CIM-557 along with *Bt*-703 had the highest number of thrips density while *Bt* variety FH-113 had the lowest thrips population per leaf (Fig. 3B). Highest intensity on the upper part was found and followed by the middle part while the lower canopy had the lowest number of thrips (Fig. 3A).

Thrips populations per leaf continue to increase at eighth or ninth sampling interval and afterward declined.

Highest population of thrips (13/leaf) was noted in *Bt*-3701 followed by FH-113, *Bt*-703, and CIM-557(Fig. 4). All the varieties showed no thrips population at the last sampling interval.

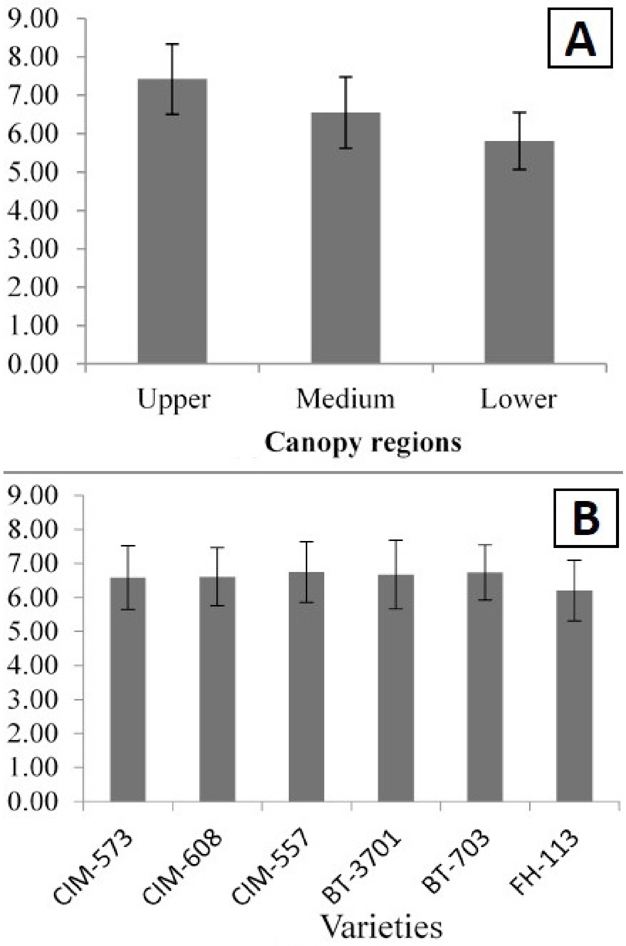

Fig. 3. Variation in canopy (A) and varieties (B) for thrips population.

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 (Fig. 5A, B).

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 (Fig. 5C). The highest thrips counts were noted when mean temperature fluctuated between 29.5- 31°C while lowest count was observed at 23°C (Fig. 6).

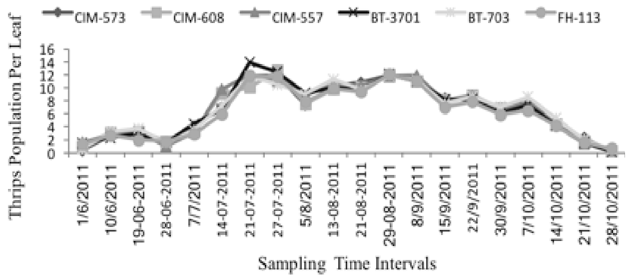

Fig. 4. Population dynamics of thrips sampled over twenty intervals in six cotton varieties.

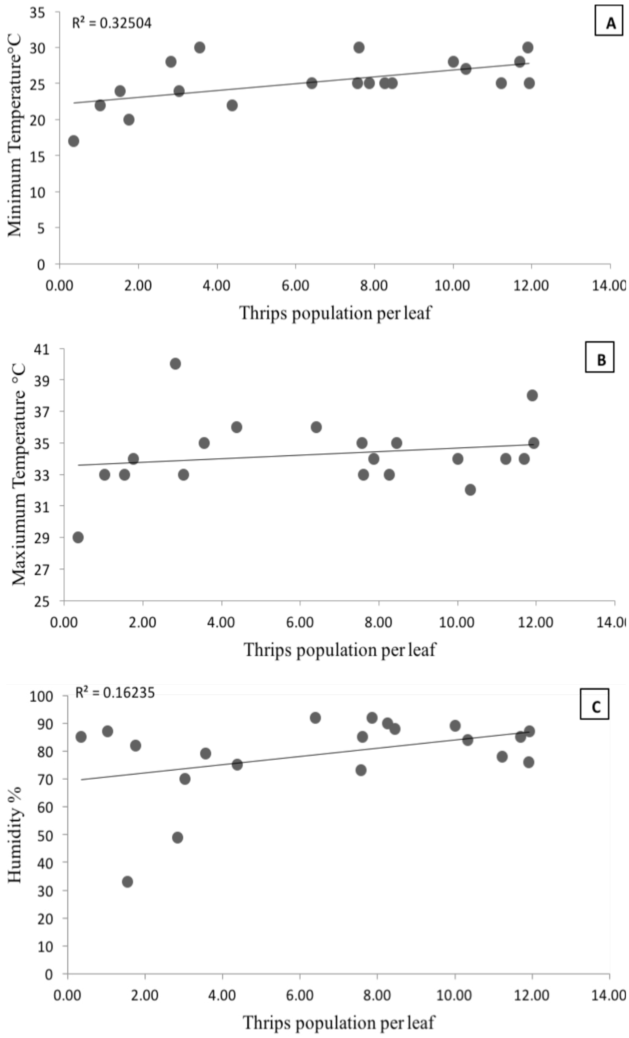

Fig. 5. Relationships of thrips population with minimum temperature (A), maximum temperature (B) and humidity (C).

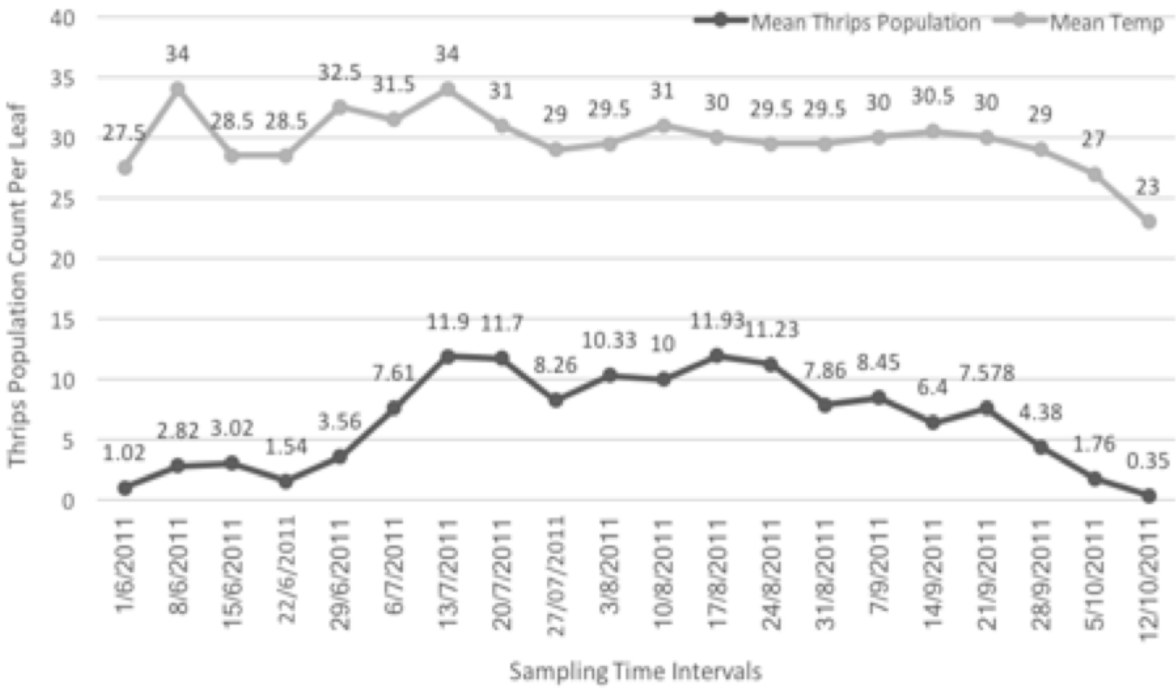

Fig. 6. Fluctuations in the mean temperature and thrips count per leaf in twenty sampling intervals.

Table I.- Correlation matrix among the meteorological and thrips population data.

Parameters	Min	Max	Hum	Avg	Thrips
Min	1				
Max	0.50	1			
Hum	-0.04	-0.28	1		
Avg	0.92	0.80	-0.15	1	
Thrips	0.57**	0.20^{NS}	0.40**	0.48**	1

Min, minimum; Max, maximum; Hum, humidity; Avg, average, NS, non-significant.

Table II.- Path analysis direct (Bold) and indirect effects of various meteorological traits over thrips populations.

Character	Min	Max	Hum	Avg	Sum
Min	**-9.23**	-3.20	-0.01	13.02	0.57
Max	-4.62	**-6.40**	-0.10	11.32	0.20
Hum	0.37	1.79	**0.36**	-2.12	0.40
Avg	-8.50	-5.12	-0.05	**14.15**	0.48

Min, minimum; Max, maximum; Hum, humidity; Avg, average.

Correlation between the thrips population and the climatic factors was also noted which showed that thrips population was significantly and positively correlated with the minimum temperature followed by the average daily temperature and humidity (Tables I and II). The correlation between the minimum temperature and thrips population was positive and significant yet it showed negative direct effect on the thrips population. The direct effect of the humidity on thrips population was positive its indirect effect via minimum and maximum temperature was also positive as average temperature of 29.5 to 31°Ċ showed the highest thrips population.

DISCUSSION

Studies on the population dynamics of various insect species have shown differences among the cultivars for the insect infestation (Abro *et al*., 2004). Transgenic cultivar FH-113 showed least attack of insect infestation and contributed toward the significant variation among the cultivar for insect infestation while other cultivar whether Bt or non-*Bt* were statistically similar for insect infestation (Basson and Terblanche, 2010; Saleem *et al*., 2013). However, it has been showed that non-target insects of cotton could also play a vital role in increasing the damage to the cotton crop (Men *et al*., 2005). Previously, studies have also been carried out to determine the variations in the insect infestation among cotton cultivars and climatic factors affecting these insects. Raza (1999) and Abro *et al*. (2004) showed that susceptibility toward sucking insect was due to secretion of honey dew. Khan *et al*. (2008) also found significant correlation as gossypol glands and thickness of lamina were positively correlated with whitefly that *Bt*-496 variety showed the highest whitefly population while Bt-703 was resistance. Amjad *et al*. (2009) studied cotton genotypes against cotton sucking insect pests like thrips, jassid *etc*. and concluded that FH-634, FH-628 and FH-682 genotype was resistant to whitefly, jassid and thrips, respectively. In addition, studies showed that Bt and non Bt varieties had the same population of sucking insect pests which were attacked on the cotton crop (James, 2002). Use of unwanted insecticides on different Bt crops, enhance the chances of secondary insect pests attacks on the crop due to build up insect immunity (Qayum, 2003). Shad *et al*., (2001) studied varietal resistance of different cotton genotypes against sucking insect pests of cotton proving that NIAB Karishma variety was the most susceptible variety against the jassid population. Meteorological or Environmental factors such as temperature and relative humidity regulates the thrips population as climatic factors, affects the physiological and bio-chemical processes of the insect which ultimately regulates its populations normally thrive in narrow range of climatic conditions suitable for their development and oviposition. Temperature had the highest direct effect on the mite and thrips population while minimum temperature showed the highest correlation with mites per leaf or thrips per leaf. Mahmood *et al*. (1990) also showed that low temperature was positively correlated to pest population furthermore humidity, temperature and rainfall effects the thrips and leafhopper population. Thrips are less active and negatively correlated with increase in the temperature above the survival range of the thrips. Thrips reduces its activities in hot condition because temperature fluctuation effects the thrips population.

Statement of conflict of interest

Authors have declared no conflict of interest.

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