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Population Dynamics of Sucking Pest Complex on Some Advanced Genotypes of Cotton under Unsprayed Conditions

Muhammad Zeeshan Majeed,* Mudassar Javed, Muhammad Asam Riaz and Muhammad Afzal
Department of Entomology, University College of Agriculture, University of Sargodha, 40100 Sargodha, Pakistan

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MZM and MA conceived and designed the experimental protocols. MZM and MJ performed experiments with technical assistance of MAR and MA. MZM and MJ performed statistical analyses. MZM and MAR wrote the article.

Key words
***Gossypium hirsutum, Bemisia tabaci, Amrasca devastans, Thrips tabaci, Tetranychus urticae*, weather factors, population dynamics.**

A B S T R A C T

Sucking pests (insects and mites) deteriorate significantly cotton crop both in terms of quantity and quality. Screening plant material under prevailing agro-climatic conditions is an essential element of integrated pest management. The present study aimed at evaluating eight genotypes of cotton (*Gossypium hirsutum* L.) under agro-climatic conditions of Faisalabad region against sucking pest complex (whitefly, jassid, thrip and red-spider mite). Secondary objective was to assess the influence of weather factors (temperature, relative humidity, and rainfall) on population dynamics of major sucking insect/mite pests on some advanced cotton genotypes (viz. NIBGE-I, IR-443, IR-448, NK, FH-901, FH-925, NIAB-999 and NIAB-98). Data of these insect/mite pests were taken on per leaf basis under unsprayed conditions and were subjected to statistical analysis which showed that mean population incidence on all genotypes was significant for all the four sucking insect/mite pests. Among genotypes, NIAB-98 was least attractive to whitefly infestation while both IR-genotypes were relatively less attractive to mite infestation. Similarly, both NIAB-genotypes were found most attractive to cotton jassid and NK genotype was less attractive to thrips infestation as compared to other genotypes. Moreover, the influence of all three weather factors was not significant on overall trend of sucking insect/mite pests.

INTRODUCTION

Pakistan is an agricultural country with an annual gross domestic production (GDP) of about 22 percent from agricultural sector. Cotton (*Gossypium hirsutum* L.: Genus: Hirsutum; Family: Malvaecae) has a pivotal position in the country's agro-based economy. It is top listed cash crop of the country, which besides earning a substantial foreign exchange provides bread and butter to the millions of people from field to factories (Salman *et al*., 2011). It contributes respectively about 7 and 10 percent to agricultural value-added and GDP of the country (Pakistan Economic Survey, 2012-13). However, throughout its growing period, cotton crop is vulnerable to be attacked in the field by a number of sucking and chewing insect/mite pest species, causing considerable reduction in both the yield quantity and quality of cotton crop (Arshad *et al*., 2001).

Under climatic conditions of Indo-Pak region, American cotton, *G. hirsutum* (L.), is more susceptible to the attack of sucking insect/mite pests as well as bollworm complex than desi cotton, *Gossypium arborium* (Nath *et al*., 2000). Among sucking insect/mite pest complex of cotton, whitefly (*Bemisia tabaci* (Genn), Homoptera: Aleyrodidae), jassid (*Amrasca devastans* (Dist.), Homoptera: Cicadellidae), thrip (*Thrips tabaci* (Lind.), Thysanoptera: Thripidae) and red-spider mite (*Tetranychus urticae* (Koch.), Acari: Tetranychidae) are the most destructive ones (Arif *et al*., 2006; Ali and Aheer, 2007; Salman *et al*., 2011). These sucking insect/mite pests are reported to cause gradual retardation in plant vigor and deterioration of cotton lint quality as well as quantity (Amin *et al*., 2008; Shah, 2014). Whitefly has been ranked as the most serious pest of cotton for the last few years (Ali *et al*., 1993; Aheer *et al*., 1999). This insect pest not only desaps the host plant but also facilitates transmission of cotton leaf curl virus (CLCV) disease among cotton plants (Harrison *et al*., 1997). Similarly, jassid is also a notorious sucking insect pest of cotton plant (Gupta *et al*., 1997; Inee-Gogoi *et al*., 2000). Apart from whitefly and jassid, thrips and red-spider mites severely infest cotton plant and cause reduction in cotton yield and fiber quality throughout cotton growing tract of the country (Arif *et al*., 2006; Khan *et al*., 2008).

Incidence and development of insect/mite pests have led to indiscriminate use of synthetic insecticides by cotton growers to save their crops, which are not only environmentally hazardous but also posed the problem of

* Corresponding author: zeeshan.majeed@uos.edu.pk
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insect/mite resistance to these chemicals and crop failure (Salman *et al*., 2011). Effective and eco-friendly pest management tactics are, hence, the need of time to lower down the insect/mite pest pressure on cotton crop (Fiaz *et al.*, 2012). In-situ screening of cotton genotypes or cultivars against sucking insect/mite pests under the prevailing climatic conditions of a particular region is one of these pest management tactics (Ali and Aheer, 2007; Amin *et al*., 2008; Yousafi *et al*., 2013).

Moreover, weather factors such as temperature, relative humidity, rainfall, play a significant role in the incidence, development and population fluctuations of sucking insect/mite pests on cotton crop as reported previously (Aheer *et al*., 1994; Mohapatra, 2008; Akram *et al*., 2013). For instance, population dynamics of cotton jassid is severely influenced by temperature and humidity (Inee-Gogoi *et al*., 2000; Sharma and Sharma, 1997). Ali *et al.* (1993) revealed that temperature played a significant and positive role for jassid population density (r = 0.297) and rainfall showed a negative and significant effect (r = 0.483), while the effect of relative humidity was non-significant. Similarly, temperature, humidity and rainfall explained more than 50 percent influence on population dynamics of jassid, whitefly and thrips (Arif *et al*., 2006; Mohapatra, 2008; Akram *et al*., 2013).

The present study was undertaken on eight advanced genotypes of cotton with the objective to assess the relative attraction of these genotypes for major sucking insect/mite pests under agro-climatic conditions of Faisalabad (Punjab, Pakistan) under unsprayed conditions and to determine the influence of some weather parameters like temperature, relative humidity and rainfall in population dynamics of major sucking insect/mite pests of cotton.

MATERIALS AND METHODS

Study was carried out at the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, Pakistan from May to December 2013. The climatic conditions of the area comprise of very hot summer (mean maximum temperature up to 37°C and mean minimum temperature up to 21°C) and cold winter (mean temp. 13°C) with average annual rainfall less than 350 mm.

The cotton genotypes investigated were NIBGE-I, IR-443, IR-448, NK, FH-901, FH-925, NIAB-999 and NIAB-98, selected on the basis of their higher cotton seed production and lint quality. Experiment was laid out in a randomized complete block design with three replications for each variety. Plot size was kept as 8 x 3 m and row-to-row and plant-to-plant distance was maintained as 75 and 45 cm, respectively. Plants were sown in mid May by dibbling method using 5 seeds per hole with sowing depth of 2.5 cm. All agronomic practices, such as seed-bed preparation, irrigation, hoeing, fertilization, were carried out as recommended by Provincial Agricultural Department except pest control measures *i.e.*, pesticide sprays.

Data regarding sucking insect/mite pest complex including whitefly, jassid, thrips and red-spider mites (both adult and nymphs) were recorded on per leaf basis. Observations were made early in the morning between 7:00 to 10:00 am at weekly intervals. Data was taken on 5 randomly selected plants, taking two leaves from top of the first plant, two leaves from the middle portion of the second and two from bottom portion of the next plant in each replication of each treatment. Meteorological data regarding mean daily temperature, relative humidity and rainfall were acquired from the meteorological observatory of plant physiology section of Ayub Agricultural Research Institute (AARI), Faisalabad.

The data collected were subjected to statistical analysis using Statistica® software. Duncan's Multiple Range (DMR) test at 5% confidence interval was applied to test the level of significance after one-way analysis of variance (ANOVA) (Steel and Torrie, 1980). Associations between insect/mite pest populations and cotton genotypes, as well as, weather factors were estimated using Pearson's correlation coefficient. The results are graphically depicted to determine the comparative response of genotypes to sucking insect/mite pests and to see the effect of different weather parameters on the incidence and development of sucking insect/mite pests under unsprayed conditions.

RESULTS AND DISCUSSION

Population dynamics of sucking insect/mite pests on cotton genotypes

Sucking insect/mite pest incidence significantly differed among genotypes tested, particularly in case of thrips population (Table I). Data regarding mean population of sucking insect/mite pests (Fig. 1) demonstrate that mean whitefly population remained maximum on NIBGE-I (4.1/leaf) and minimum on NIAB-98 (3.6/leaf) without any significant difference. NIAB-999 and NIAB-98 were found to be the most attractive genotypes to jassid infestation (1.6/leaf), while others showed an average infestation of 1.4 whitefly adult or nymphs per leaf, but again all genotypes tested were not statistically different from each other. Data regarding mean population of thrips revealed that NK genotype was the least attractive (2.5/leaf) and was statistically at par from all other genotypes and NIAB-98 was the most attractive (5.8/leaf) to thrips infestation. Likewise, maximum mean red-spider mite population (2.0/leaf) was

Table I.- Analysis of variance for overall mean population of sucking insect/mite pests on different genotypes of cotton under unsprayed conditions at NIAB, Faisalabad.

Insect/Mite Pest	Source of variance	Degree of freedom	Sum of squares	Mean squares	F-Value
Whitefly	Replication	2	0.40	0.20	3.98
	Genotype	7	1.92	0.27	5.48*
	Error	14	0.71	0.05	-
	Total	23	3.03	-	-
Jassid	Replication	2	0.19	0.10	21.34
	Genotype	7	0.31	0.05	9.96*
	Error	14	0.06	0.00	-
	Total	23	0.57	-	-
Thrips	Replication	2	0.09	0.04	2.53
	Genotype	7	28.45	0.06	226.85**
	Error	14	0.25	0.02	-
	Total	23	28.79	-	-
Red-spider mites	Replication	2	0.07	0.03	0.72
	Genotype	7	0.76	0.11	2.32*
	Error	14	0.66	0.05	-
	Total	23	1.49	-	-

* = Significant at $P \leq 0.05$; ** = Significant at $P \leq 0.01$

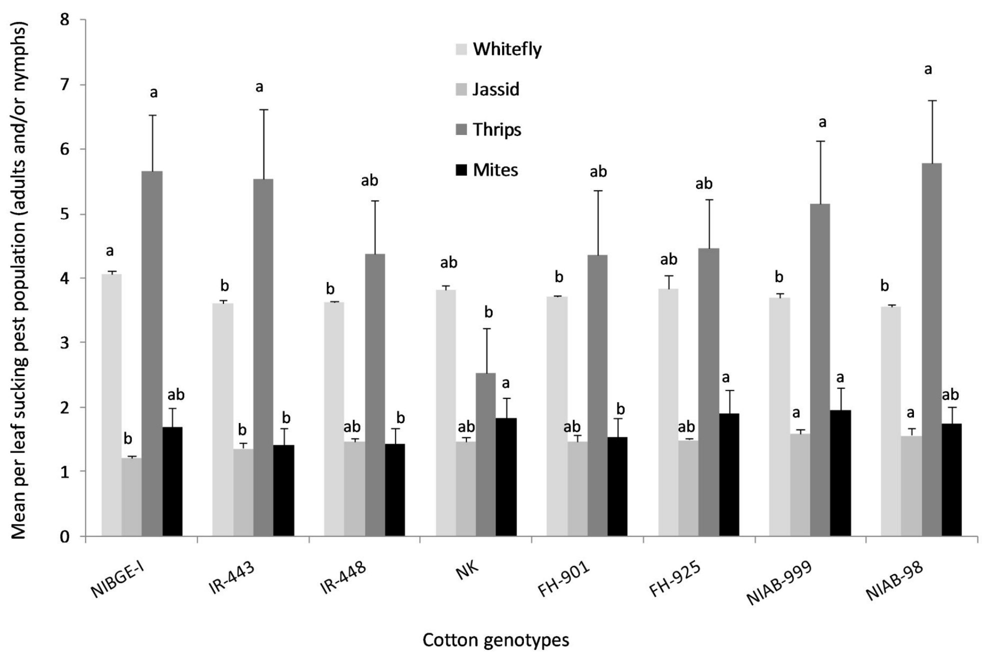

Fig. 1. Mean population of sucking insect/mite pests observed on different genotypes of cotton under unsprayed conditions at NIAB, Faisalabad.

recorded on NIAB-999 and FH-925 with significant difference from other six genotypes, while minimum mite infestation (1.4/leaf) was found on IR-443 and IR-448. On overall basis, all cotton genotypes studied exhibited almost same response to all the sucking insect/mite pests complex, except NK genotype which was statistically at par from other genotypes in case of thrips infestation. This could be probably due to physio-morphic plant traits or due to greater adaptability of genotype to prevailing climatic and weather conditions (Shah, 2003; Arif *et al*.,

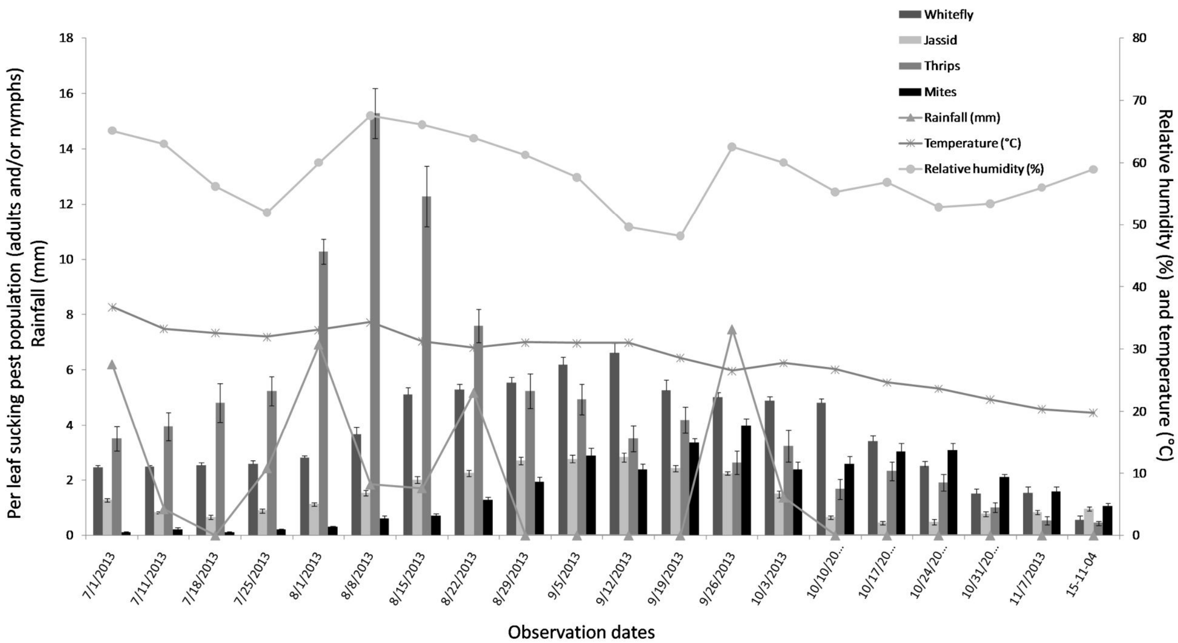

Fig. 2. Population trend of different sucking insect/mite pests on some cotton genotypes along with weather factors.

2006). Genotype Niab Karishma (NK) usually exhibits highest leaf lamina hair density among the genotypes tested and this plant trait has been found deterring sucking insect/mite pests (Arif *et al.*, 2004).

Population trend and influence of weather factors on sucking insect/mite pest complex

Based on overall population trend (Fig. 2), incidence of all sucking insect/mite pests was observed during whole study period except for red-spider mites which commenced developing predominantly in the second fortnight of August to mid November 2013 with peak population count in second fortnight of September. This is consistent with the fact that warm and dry conditions favors red spider-mites in cotton ecosystem (Wilson and Sadras, 2001; Russell, 2012). Whitefly population was peaked in the month of September 2013 when weather conditions were warm and dry. This is in line with other works showing that whitefly infestation was at peak in mid August to Mid September on cotton (Abro *et al.*, 2004; Ashfaq *et al.*, 2011). Khan and Ullah (1994) described that the population of whiteflies started to buildup in early July and reached to its peak in the months of August and September, which supported the current effort. Overall per leaf thrips and jassid population peaked in the months of August and September, respectively, as shown by Abdullah (2010) and Mohapatra (2008), most probably due to warm and humid weather conditions in these months. Peak populations of jassid were found in the first fortnight of August and declined in early October, as reported by Shad *et al.* (2001), Khan and Ullah (1994) and Gupta *et al.* (1997).

Correlation analysis depicted that on individual genotype basis (Table II), weather factors explained all sucking insect/mite pest populations except for jassids on NIAB-98. Temperature played a significant and positive role in thrips population, particularly on genotypes NIAB-98, NIAB-999, FH-925 and NIBGE-I, but affected significantly and negatively to mites populations, particularly on NIAB-98 and IR-443 genotypes. Similarly, whitefly infestation also showed positive and significant interaction with temperature on IR-448, NK and NIAB-98. Umar *et al.* (2003) and Wahla *et al.* (1996) also reported whitefly population positively correlated with the air temperature, and negatively correlated with the relative humidity, which seems in line with our findings (Table II). Data analysis revealed that the response of temperature for whitefly and jassid was positive and of relative humidity and rainfall was negative. However, relative humidity is positively associated with thrips infestation and negatively with mite population, particularly in NIAB-98. Rainfall did not any correlation with insect/mite pests' incidence on any genotype except for weak positive correlation on NIAB-98. However, on overall basis (Table III), weather

Table II.- Correlation coefficient of weather factors and population of sucking insect/mite pests on different genotypes of cotton under unsprayed conditions at NIAB, Faisalabad.

Genotypes	Whitefly			Jassid			Thrips			Mites		
	Temp. (°C)	Relative humidity (%)	Rainfall (mm)	Temp. (°C)	Relative humidity (%)	Rainfall (mm)	Temp. (°C)	Relative humidity (%)	Rainfall (mm)	Temp. (°C)	Relative humidity (%)	Rainfall (mm)
NIBGE-I	0.27	-0.17*	-0.07	0.29	0.19*	0.24*	0.65*	0.54	0.30	-0.48	-0.38	-0.07
IR-443	0.25	-0.03	-0.02	0.38*	-0.07	-0.14	0.54	0.54	-0.20	-0.54*	-0.45*	-0.18
IR-448	0.43*	-0.13*	-0.14	0.36*	0.16	-0.17	0.63	0.57*	0.29	-0.50	-0.31	-0.12
NK	0.44*	-0.07	-0.09	0.31	-0.03	-0.12	0.56	0.55	0.39*	-0.42	-0.39	-0.19
FH-901	0.31	0.03	-0.09	0.27	-0.09	-0.173	0.57	0.54	0.29	-0.56	-0.42*	-0.18
FH-925	0.33	-0.05	-0.01	0.33	0.19*	-0.09	0.66*	0.49	0.29	-0.45	-0.43*	-0.26
NIAB-999	0.33	-0.04	0.04	0.26	-0.02	-0.01	0.68**	0.49	0.36	0.36	-0.32	-0.16
NIAB-98	0.44**	-0.05	0.01	0.32	-0.03	0.21*	0.73**	0.58*	0.37*	-0.63**	-0.45*	-0.37

* = Significant at P ≤ 0.05; ** = Significant at P ≤ 0.01

Table III.- Correlation coefficient of weather factors and overall mean population of sucking insect/mite pests on different genotypes of cotton under unsprayed conditions at NIAB, Faisalabad.

Weather factors/ Insect/mite pests	Temperature (°C)	Relative humidity (%)	Rainfall (mm)
Whitefly	0.36	0.00	-0.03
Jassid	0.33	-0.09	-0.14
Thrips	0.65*	0.55	0.32
Mites	-0.51	-0.42	-0.20

factors did not influence the sucking insect/mite pest populations during the study period except for a significantly positive correlation of temperature with thrips populations. Similar observations have been found by Aheer *et al.* (1999) and Akram *et al.* (2013). The Table II present findings are not in conformity with those of Umar *et al.* (2003) and Otoidobiga *et al.* (2004) who reported that rainfall and relative humidity were significantly correlated with the whitefly population. Conclusively, cotton genotype Niab-Karishma (NK), and FH-901 to some extent, appeared to be least attractive than other genotypes for sucking insect/mite pests studied, while abiotic (weather) factors did not play significant role in mediating population dynamics of these pests. Therefore, cultivation of these genotypes is recommended for cotton growers under agro-climatic conditions of Faisalabad (Punjab), Pakistan.

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