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Population Dynamics of Sucking Pests on Transgenic Bt Cotton In Relation With Abiotic Factors And Physio-Morphological Plant Characters

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Abstract
Six transgenic cotton varieties (Sitara-009, FH-114, Neelum-121, Ali Akbar-703, FH-142, MNH-886) were sown without application of any insecticide till maturity of the crop. Data of sucking insect pests was started after seedling emergence and taken fortnightly and continued up till harvesting the crops. The sucking insect population further correlated with abiotic factors and plant physio-morphological plan characters. Maximum whitefly population fluctuation was observed on MNH-886 (9.30/leaf) while Sitara-009 (7.97/leaf) showed minimum whitefly population build up. Maximum jassid population fluctuation was observed on FH-142 (2.08/leaf) while Sitara-009 (1.82/leaf) showed minimum jassid population build up. Maximum thrips population fluctuation was observed on MNH-886 (6.46/leaf) while FH-142 (5.80) showed minimum thrips population build up. Average temperature had positive response on sucking insect population while percentage relative humidity and rainfall had negative response. In case of physio-morphological plant character, average cotton plant height and average number of leaves had negative response on sucking insect pest population while gossypol glands and hair leaf density had positive response on sucking insect pest population.

Keywords: Whitefly, Jassid, Thrips, Bt cotton, Abiotic factors, Physio-morphological traits

1. Introduction
Pakistan is the fourth largest producer of cotton in the world, the third largest exporter of raw cotton and the fifth largest consumer of cotton. Cotton has unique place as commodity and major source of foreign income for economy of Pakistan. By introduction of transgenic Bt cotton, farmer mis concept that it may control all type of pest and not use any control measure to control sucking insect pest and these pest become primary insect pest of cotton. Several factors contribute for low production of cotton but insect pest damage is most important. Among insect pest, chewing and sucking types cause major damage to cotton crop [1, 2]. By the introduction of transgenic cotton, chewing type of insect pests are under check but sucking type of insect remain a problematic for cotton crop. Whitefly (*Bemisia tabaci*), Jassid (*Amrasca devastans*), Thrips, (*Thrips tabaci*) are major sucking insect, caused considerable damage to transgenic cotton crop by cell sap sucking due to this curling and shedding of plant leaves results in weaken plant [3-5].

Cotton plant has certain physio-morphological characters (leaves trichome density, midrib trichome density, vein trichome density, gossypol glands, and hairs on leaf and plant height) resist to up to certain level against sucking insect pest attack [6]. In case of transgenic cotton, work is scanty on Physio-morphological characters and there is need to study these impacts of these characters on the population fluctuation of sucking insect pest. Abiotic factors (temperature, relative humidity and rainfall) play important role in the fluctuation and buildup of insect pest population and need to study its impact on transgenic Bt cotton. Keeping above all, present study was design to evaluate the performance transgenic Bt cotton, physio-morphological characters of transgenic cotton and role of abiotic factors on the fluctuation of sucking insect pest.

2. Materials and Methods

Six transgenic cotton varieties (Sitara-009, FH-114, Neelum-121, Ali Akbar-703, FH-142, MNH-886) were sown in Randomized Complete Block Design on one-acre field plot at Entomological Research field area, University of Agriculture Faisalabad and replicated thrice during June to September, 2017. No spray was applied on crop but recommended agronomic practices were done for crop maturity and growth. Data of sucking insect (Whitefly (*Bemisia tabaci*), Jassid (*Amrasca devastans*), Thrips, (*Thrips tabaci*)) was started after seedling emergence and taken fortnightly by randomly selected 20 plants in each replicate and continued up till harvesting the crops.

Physio-morphological plant characters (gossypol glands and hair density on leaf midrib, leaf lamina and leaf vein) data were taken by randomly by selected 10 plant in each replicate. The plant leaves of each replicate were put in to bags and brought in the Insect Biodiversity and Biosystematics lab for microscopic observation of gossypol gland, hair density on leaf. For gossypol gland and hair density an area of 1.5 cm² was cut from leaf and count number gossypol gland and hair density on leaf midrib, leaf lamina and leaf vein by using an index card under microsphere. At crop maturity, number of plant leaves and plant height (measured in cm by using meter rod) were observed by randomly selected 10 plants in each replicate. The data of abiotic factor (average daily temperature percentage relative humidity and percent rain fall) were taken from department of crop physiology, University of Agriculture Faisalabad further correlated with population fluctuation of sucking insect pest.

Statistical analysis

The data was put in excel sheet and analyzed with the help of Mini tab 18 software to know the significant level among varieties. The means were separated by using Tukey's HSD test to at 5% significance level. The data of population fluctuation further corelated with physio-morphological plant characters and abiotic factor (temperature, relative humidity and rainfall).

3. Results and Discussion

Whitefly population fluctuation and trend on Bt cotton

Maximum whitefly population fluctuation was observed on MNH-886 (9.30) followed by FH-114 (9.06), Ali Akbar-703 (8.56), FH-942 (8.48) and Neelum-121 (8.30) on per leaf basis. Sitara-009 (7.97/leaf) showed minimum whitefly population build up and statistically at per from MNH-886, IUB-222, IUB-09 varieties (Table 1). The whitefly population (per leaf) was started to gradually build up from last week of June and reached its peaks in second week of August and then started declined (Table 2). These results are in line with the results of Inee-Gogoi *et al*. (2000) and Arshad and Suhail (2010) [7, 8] showed the whitefly population build up reached its peak in month of August.

Correlation of whitefly population with abiotic factors and physio-morphological plant characters

The value of correlation coefficients for weather factors (average temperature, relative humidity and rainfall) (R= 0.72, -0.35, -0.30 respectively) showed mean whitefly population (per leaf) on transgenic Bt cotton showed positive correlation with temperature and negative correlation with rainfall and humidity (Table 3). The results depicted that as temperature increased results in whitefly population buildup and as relative humidity and rainfall increased the mean whitefly population started declined. Similar results were obtained by Otoidobiga *et al*. (2004); Ashfaq *et al*. (2010); Amjad *et al*. (2009) and Shivanna *et al*. (2011) [9, 6, 10, 11] and differed from results of Umar *et al*. (2003) [12].

The value of correlation coefficients for physio-morphological plant characters as gossypol gland (leaf midrib, leaf vein and leaf lamina) (R= 0.86, 0.70, 0.73 respectively) showed positive correlation with whitefly population (per leaf) while correlation coefficient for hair density (leaf midrib, leaf vein and leaf lamina), (-0.96, -0.70, -0.88 respectively) number of leaves (-0.17) and plant height (-0.01) showed negative correlation. Similar results were obtained Khalifa and Gameel (1983); Lee (1985) and Meagher *et al*. (1997) [13, 14, 25] and contradictory with Butter and Vir (1989); Hassan *et al* (1999) and Raza *et al* (2000) [16-18].

Jassid population fluctuation and trend on Bt cotton

Maximum jassid population fluctuation was observed on FH-142 (2.08/leaf) followed by FH-114 (2.04), MNH-886 (1.86), Ali Akbar-703 (1.94) and Neelum-121 (1.92) on per leaf basis while Sitara-009 (1.82) showed minimum jassid population build up (Table 1). The trend of Jassid population start build gradually from first week of observation reached its peaks upto first week of august and started declined (Table 2). Similar results were obtained by Ashfaq *et al*. (2010); Arshad and Suhail (2010) [6, 8] who reported only one peak of jassid population in the month of July. jassid population attain its peak during first week of august.

Correlation of whitefly population with abiotic factors and physio-morphological plant characters

The value of correlation coefficients for weather factors (average temperature, relative humidity and rainfall) (R= 0.36, -0.42, -0.56 respectively) and mean jassid population (per leaf) on transgenic Bt cotton showed weak positive correlation with temperature and weak negative correlation with rainfall and humidity (Table 3). Similar finding were reported by the findings of Arif *et al*. (2006); Shivanna *et al*. (2009); Ashfaq *et al*. (2010) [19, 11, 10] and contradictory with findings of Ammar *et al*. (1986); Ramamurthy *et al*. (2000); Aheer *et al*. (2006); Parsad *et al* (2008); Shitole and Patel (2009); Kaur *et al*. (2009) and Selvaraj *et al*. (2010) [20- 26].

The R-value of correlation coefficients for physio-morphological plant characters as gossypol gland (leaf midrib, leaf vein and leaf lamina) (R= -0.35, -0.26, -0.34 respectively) and hair density (leaf midrib, leaf vein and leaf lamina), (-0.44, -0.32, -0.36 respectively) showed negative correlation, while number of leaves (0.12) and plant height (0.04) showed positive correlation (Table 3). Similar results were obtained by Singh and Agarwal (1988); Hassan *et al*. (1999); Aheer *et al*. (2006); Raza *et al*. (2000) and Ashafq *et al*. (2010) [27, 17, 22, 6] who reported hair density and gossypal gland on cotton leaves had negative impact on jassid population.

Thrips population fluctuation and trend on Bt cotton

Maximum thrips population fluctuation was observed on MNH-886 (6.46) followed by FH-114 (6.24), Ali Akbar-703 (6.16), Sitara-009 (6.03) and Neelum-121 (6.00) on per leaf basis while FH-142 (5.80) showed minimum jassid population build up (Table 1). Jassid population was started to gradually build up from last week of June and reached its peak in first week of August and then started declined (Table 2). These results are in line with the findings of [7, 8] showed the whitefly

population build up reached its peak in month of August. Similar results were reported by Abro *et al.* 2004; Solangi *et al.* 2008 and Godhani *et al.* 2009 [1, 28, 29].

Correlation of thrips population with abiotic factors and physio-morphological plant characters

The value of correlation coefficients for weather factors (average temperature, relative humidity and rainfall) (R= 0.39, -0.55, -0.43 respectively) and mean thrips population (per leaf) on transgenic Bt cotton showed weak positive correlation with temperature and weak negative correlation with rainfall and humidity (Table 3). Similar finding were observed Arif *et al*. (2006) and Shivanna *et al*. (2011) [19, 11] who reposted that temperature had positive impact of thrips population build up and contradictory with the findings of Selvaraj *et al.* (2011) [26].

The R-value of correlation coefficients for physio-morphological plant characters as gossypol gland (leaf midrib, leaf vein and leaf lamina) (R= -0.45, -0.47, -0.49 respectively), hair density (leaf midrib, leaf vein and leaf lamina), (-0.54, -0.51, -0.48 respectively) and plant height (R= -0.22) showed negative correlation, while number of leaves (0.02) had no impact of thrips population buildup. (Table 4). Similar results were reported by Baloch *et al*. (1982) and Raza *et al*. (2000) [30, 18].

4. Conclusion

The purpose of present study was to evaluate the performance of transgenic Bt cotton, physio-morphological characters of transgenic cotton and role of abiotic factors on the fluctuation of sucking insect pest. Results indicated that cotton variety Sitara-009 in case of whitfly and jassid while FH-142 in case of thrips performed well with low population as compared to other cotton varieties. Positive response of average temperature was observed on all sucking insect population as compared to percentage relative humidity and rainfall. Gossypol glands and hair leaf density of cotton had positive response on sucking insect pest population.

Table 1: Population (per leaf) sucking type of insect pest

Transgenic cotton cultivars	Mean populations		
	Whitefly	Jassid	Thrips
Sitara-009	7.97^{C}	1.82^{C}	6.03^{BC}
FH-114	9.06^{A}	2.04^{AB}	6.24^{AB}
Neelum-121	8.40^{BC}	1.92^{C}	6.00^{BC}
Ali Akbar-703	8.56^{B}	1.94^{BC}	6.16^{B}
FH-142	8.48^{B}	2.08^{A}	5.80^{C}
MNH-886	9.21^{A}	1.86^{C}	6.45^{A}

Table 2: Population (per leaf) sucking type of insect pest on fortnight basis

Sampling dates	Mean populations		
	Whitefly	Jassid	Thrips
20-June-2017	2.07	0.34	2.57
27-June-2017	2.98	1.85	2.43
4-July-2017	4.17	2.44	6.43
11-July-2017	8.18	2.45	5.53
18-July-2017	8.64	2.52	4.6
25-July-2017	9.56	2.69	8.36
01- August -2017	15.9	2.92	11.52
8-August-2017	20.43	2.78	10.5
15-August-2017	8.32	1.65	7.45
22-August-2017	9.85	1.55	6.73
29-August-2017	10.86	2.32	5.4
5-September-2017	7.74	1.36	4.57
12-September-2017	3.19	0.3	3.3

Table 3: Abiotic factor correlation with sucking type insect pest

Abiotic factors	Whitefly	Jassid	Thrips
Temperature (°C)	0.72	0.36	0.39
Relative humidity (%)	-0.35	-0.42	-0.55
Rainfall (mm)	-0.30	-0.56	-0.43

Table 4: Physio-morphological plant characters correlation with sucking type insect pest

Character	Whitefly	Jassid	Thrips
Gossypol gland			
▪ On Leaf midrib	-0.86	-0.35	-0.45
▪ On Leaf vein	-0.70	-0.26	-0.47
▪ On Leaf lamina	-0.73	-0.34	-0.49
Hair density			
▪ On Leaf midrib	-0.96	-0.44	-0.54
▪ On Leaf vein	-0.70	-0.32	-0.51
▪ On Leaf lamina	-0.88	-0.36	-0.48
Number of leaves/plant	-0.17	0.12	0.02
Plant height	-0.01	0.04	-0.22

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