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Trichomes of Cotton Leaf as an Aspect of Resistance to Sucking Insect Pests

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Abstract: Field experiments were conducted to study the effect of cotton leaf phenology and morphology on incidence and population buildup of sucking insect pests of cotton. Fifteen cotton cultivars were screened for trichome density and population buildup of jassids, thrips and white fly. The effect of leaf type on incidence of sucking insect pests was also determined. The results revealed that Trichome density varied with the cotton cultivars and it decreased with the age of the leaves of respective cotton cultivars. Jassid population had negative significant correlation with Trichome density. Thrips also had negative but non-significant correlation with Trichome density. However, white fly population buildup had positive significant correlation with trichome density on cotton leaves of respective cultivars. Cotton varieties with okra leaves harboured less jassids and thrips infestation as compared with normal leaf variety. However, jassids and thrips population was significantly the least on red and super okra leaves respectively. The white fly population was also significantly the least on red leaf variety Red Russian.

Keywords: Phenology, cotton, pubescent, thrips, jassid, whitefly

1. INTRODUCTION

Sucking pests of cotton suck the sap of cotton and together with bollworms cause about 20-40% yield losses in Pakistan (Ahmad 1999). Cotton (*Gossypium hirsutum* L.) is the most important cash crop in Pakistan and produced 9.30, million 480-pound bales. (Anonymous 2014). It also contributes about 69.5 % share in national oil production [Awan 1994]. Cotton seed cake is important animal feed and organic manure (Chidda 1997).

The control of insect pests is one of the major problems affecting cotton production. The only tool available with farmers to combat pest ravages is insecticide. However, indiscriminate use of insecticide s on cotton has created problems of environmental population, pest resistance to pesticides and misbalance of natural fauna of predators and parasites. It has not become necessary to complement our traditional reliance on poisonous chemicals with less hazardous and more environmentally acceptable pest control methods. The host plant resistance either heritable or induced is one of the fool proofs, economical, effective and ecologically preferred forms of crop protection. The present studies were therefore, carried out to determine the effect of cotton leaf phenology and morphology on population buildup of sucking insect pests.

2. MATERIALS AND METHODS

Field experiments were conducted to study the effect of cotton leaf phenology and morphology on incidence and population buildup of sucking insect pests on different cotton cultivars. The seeds of fifteen cotton cultivars viz. Rehmani, Cris-9, TS-31/89, M-195, Empire, TH-35/83, TH-38/83, Qalandri, Rex, TH-16/82, BW-76-31, Reshmi, 74-IC-3, NIAB-78 and Red Russian were sown, according to randomized complete block design with four replications. Each replicate comprised of 15 sub plots; had 5 meter long rows spaced at 0.75 meters. The recommended cultural practices were performed uniformly in all the subplots and no insecticides were sprayed in and around the experimental plot.

Effect of leaf phenology on cotton sucking insects.

The cotton leaves freshly emerged were tagged with the emergence date to measure the age of the leaf in all the test cotton cultivars. The leaves of 7, 14, 21 and 28 days ages were brought to the laboratory and 1 mm section of each section was scanned under microscope to count Trichome density per unit area. Simultaneously, population counts of jassids, thrips and whiteflies were made on leaves of different ages in the field on respective cotton cultivars.

Effect of leaf type (morphology) on cotton sucking insects

Cotton cultivars with okra leaf, semi-okra leaf, super okra, normal and red leaves were screened for their effect on the population of sucking insect pests. The population count of jassids, thrips and whiteflies were made on all the said leaf types regularly.

Data Analysis

The data on Trichome density, population levels of jassids, thrips and whiteflies on leaves of different ages were analyzed according to randomized complete block design. The main value was compared by New Duncan's Range Test for significance of the differences.

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3. RESULTS AND DISCUSSION

The results of (**Table-1)** depicted that the Trichome density on leaves of different cotton cultivars as influenced by age of the leaves, the Trichome density varied significantly with the cotton cultivars and age of the leaves. The hair density on 7-days old leaves was significantly higher on all the cotton cultivars. The hair density had negative significant correlation with the age of the leaves. The hair density reduced as the age of the leaves progressed. The hair density on 7 days old leaf of TH-16/82 was significantly higher (33.55) when compared with rest of the cotton cultivars. This was followed by Rehmani (32.55), TH-35/83 (31.85), TH-38/83 (29.30), CRIS-9 (26.65), Qalandri (24.37), TS-31/89 (24.32), M-195 (21.58), Rex (18.80) and Empire (18.55) respectively. The analysis of variance indicated significant differences among the cotton cultivars; however, new DMR test revealed non-significant variations between Empire and Rex smooth leaf varieties. It is evident from the data that TH-16/82, Rehmani and TH-75/83 are densely pubescent varieties. However, TH-38/83, CRIS-9, and Qalandri cultivars were moderately pubescent whereas, M-195, Empire and Rex are smooth leaf cultivars. The results on Trichome density on different cotton cultivars revealed that hair density pattern on all the cultivars remained identical on 7-, 14, 21- and 28-days old leaves of respective cultivars.

Table 1: Trichome density on leaves of different cotton cultivars as influenced by the age of leaves.

Cultivars	Mean number of hairs/mm2 on leaves of			
	7-day	14-day	21-d ay	23-day
Rehmani	32.55b	31.68a	27.82b	26.38b
CRIS-9	26.65e	24.2e	21.18e	18.78e
TS-31/89	24.32f	21.88f	18-30f	16.32g
M-195	21.58g	18.78h	16.47h	15.52h
Empire	18.55h	14.92i	12.55i	12.42i
TH-5/83	31.85c	28.3c	24 .95c	22.82c
TH-38/83	29.3d	26.8d	22.-57d	20.85d
Qalandri	24.37f	21.15g	17 .38g	16.85j
Rex	18.8h	14.65i	12.62i	11.85j
TH-16/82	33.55a	31.17b	28.62a	27.65a

Varieties	CD =0.27
	CD2=0.39
Time interval	CD1= 0.17
	CD2= 0.25

Mean values with similar alphabets in each column are statistically non-significant (P=0.05)

Thrips population vs Leaf phenology

The results of **(Table-2)** presented that on per leaf population of *Thrips tabaci* Lind. on different day old leaves of various cotton cultivars. The Intensity of thrips population varied significantly with the age of the leaves in different cotton cultivar. However, the variation between thrips population of 21 and 28 day old leaves of Rehmani, Empire and Qalandri were statistically non-significantly. Thrips population also varied significantly with the cotton cultivar under trial, however, the differences among Rex (6.08), Qalandri (6.27), TH-35/83 (6.27) and M-195 (6.23) were statistically non-significant. Similarly, the variation amongst Rehmani (5.65 thrips/leaf), Empire (5.65 thrips/leaf), Empire (5.75 thrips/leaf) were also statistically non-significant. Thrips population was significantly the highest (7.92/leaf) on 7 day old leaves of TS-31/89; however, 7 day old leaves of Th-16/82 harboured the least population of thrips (4.90/leaf). It is evident from the data that thrips population reduced with the increased age of the leaves of cotton cultivars. However, the infestation pattern of thrips remained almost similar on yhe leaves of 7, 14, and 21 and 28 days old respectively in all the cultivars. The results on the correlation coefficients and regression equations for leaf phenology and population of cotton sucking insect pests of cotton indicated that thrips population was negatively correlated with the age of the leaves. Thrips population had negative non significant correlation with trichome density of leaves of age group. The correlation coefficient for 7 day old , 14 day old, 21 day old and 28 day old also indicated negative non significant correlation with the trichome density. Regression equations for respective age groups also supported this contention.

Table 2: Mean per leaf population of *Thrips tabaci* Lind. on different day old leaves of various cotton cultivars

Cultivar	Mean number of thrips on leaves of			
	7-day	14-day	21-day	28-day
Rehmani	5.65de	7.05d	7.60f	7.65d
CRIS-9	7.20b	8.75a	8.97b	8.55b
TS-31/89	7.92a	8.82a	9.27a	9.00a
M-195	6.23c	7.50c	8.00d	7.78d
Empire	5.75d	6.92d	7.32g	7.40e
TH-35/83	8.27c	7.55c	7.95e	8.12c
TH-38/83	5.52e	6.30e	6.15h	5.98f
Qalandri	6.27c	7.62c	7.50f	7.45e
Rex	6.08c	7.88b	8.27c	8.15c
TH-16/82	4.90f	5.52f	5.90i	5.75g

Varieties	CD =0.17
	CD2=0.24
Time interval	CD1= 0.11
	CD2= 0.15

Mean values with similar alphabets in each column are statistically non-significant (P=0.05)

Whitefly population vs Leaf phenology

The results on the population density of *Bemisia tabaci* Genn. on leaves of different cotton cultivars **(Table-3)** indicated that the populatin levels were variable with the cotton cultivars and age of the leaves. Mean number of whitefly/leaf of TH-16/82 was significantly the highest (5.25) on 7-day old leaves and this was followed , in descending order of population levels, by TH-35/83 (5.05), Reshmi (4.20), TH-38/83 (4.00), Qalandri (3.75), CRIS-9 (3.12), TH-31/89 (2.65), M-195 (2.35), Rex (1.87), and Empire (1.82). The analysis of variance (F=594.33, df=9) indicated significant variations amongst the cotton cultivars regarding whitefly infestation. However, new DMR test revealed non-significant (p=0.05) differences between Rex and Empire cotton cultivars. The whitefly population reduced significantly as the age of the leaves progressed. Furthermore the population trend on different day old leaves was almost identical to that recorded on 7-day old leaves. The population intensity of whitefly on different cotton cultivars showed that TH-35/83, TH-16/82, TH-38/83 and Reshmi were comparatively more prone to the infestation of whitefly; however, Rex and Empire were significantly least susceptible to the attack of whitefly.

The results on the correlation coefficient and regression equations for leaf phenology and population of whitefly (Table-3) revealed that Trichome density decreased with the age of the leaves. Furthermore, whitefly population had positive significant correlation (P=0.05) with the Trichome density of the cotton leaves of different varieties. The correlation coefficients for respective age groups of different cotton cultivars showed positive significant correlation between hair density and whitefly population. The correlation coefficients for 7-day old (0.948), 14-day old (0.832), 21-day old (0.832) and 28-day old (0.934) also indicated positive significant correlation between hair density and whitefly population. The regression equations for respective age groups also supported the contention that whitefly population decreased with the decrease in Trichome density.

Table 3: Population density of *Bemisia tabaci* Genn. on leaves of different cotton cultivars.

Cultivars	Mean number of whitef1y on leaves of			
	7-day	14-day	21-day	28-day
Rehmani	4.20c	3.12d	3.07d	2.55c
CRIS-9	3.12f	2.82e	2.75f	2.05e
TS-31/89	2.65g	2.05g	1.72h	1.50g
M-195	2.35h	2.17f	1 .68h	1.75f
Empire	1.82i	1.82h	1.87g	0.90h
TH-35/83	5.05b	4.68b	4 .60a	2.97a
TH-38/83	4.00d	3.62c	3.25c	2.78b
Qalandri	3.75e	3.15d	2.95e	2.22d
Rex	1.87i	1.68i	1 .15i	0.82h
TH-16/82	5.25a	4.92a	4.15b	2.98a

Varieties	CD =0.10
	CD2=0.14
Time interval	CD1= 0.06
	CD2= 0.09

Mean values with similar alphabets in each column are statistically non-significant (P=0.05)

Jassid population vs Leaf phenology

The per leaf intensity of *Amrasca biguttula* Dist. on different day old leaves of various cotton cultivars are presented in **(Table-4)**. A persusal of the data and analysis of variance indicated that jassid population varied significantly with the cotton cultivars and age of the leaves of respective cotton cultivars the data on means number of jassids per leaf of 7-day age was significantly the highest (1.05) on Rex smooth leaf variety. This was followed, in descending order of jassid population, by Empire-H2 (0.95 per leaf), M-195 (0.70), Qalandri (0.68), RRIS-9 (0.65), RS-31/89 (0.60), TH-35/83 (0.58), TH-38/83 (0.45) Rehmani (0.45), and TH-16/82 (0.20). The application of CD1 (0.07) and CD2 (0.09) values to the mean jassid population revealed that variations amongst Qalandri, TH-35/83, CRIS-9, and TS-31/89 were statistically non-significant (P=0.05). Similarly the differences between Rehmani and TH-38/83 were also statistically non-significant both at 1% and 5% level of significance.

It was evident from the data on mean number of jassids per leaf of 14- and 21- and 28-day age that jassid population increased with the age of the leaves and maximum jassid number was recorded on 28-day old leaves of respective cotton cultivar. However the population trend of jassid on different day old leaves of respective cotton cultivar was almost identical at all age groups.

Table 4: Per leaf intensity of *Amrasca bigutulla* Dist. on different day old leaves of various cotton cultivars

Cultivars	Mean number of jassids on leaves of			
	7-day	14-day	21-day	28-day
Rehmani	0.45f	0.40g	0.57g	0.65g
CRIS-9	0.65de	0.70e	0.82f	0.82f
TS-31/89	0.60e	0.82d	0.95e	1.32d
M-195	0.70c	1.05c	1.10c	1.65b
Empire	0.95b	1.25b	1.40b	1.55c
TH-35/83	0. 58e	0.70e	0.80f	0.88f
TH-38/83	0.45f	0.55f	0.85f	0.88f
Qalandri	0.68d	0.80d	1.00d	1.17e
Rex	1.05a	1.68a	1.65a	1.78a
TH-16/82	0.20g	0.45g	0.48h	0.50h

Varieties	CD =0.07	
	CD2=0.09	
Time interval	CD1= 0.04	
	CD2= 0.06	

Mean values with similar alphabets in each column are statistically non-significant (P=0.05)

Leaf taxonomy vs Cotton sucking insects

The results on population intensity of jassids, thrips and whitefly as influenced by leaf type of different cotton varieties **(Table-5)** revealed that infestation varied significantly with the leaf morphology. The data on mean number of jassids/leaf showed that significantly higher number of jassids (0.95) was observed feeding on normal cotton leaf of NIAB-78 as compared with red leaves of Red Russian Cotton Variety (0.28). The jassid population was comparatively the least (0.30/leaf) on super okra leaves of 79-IC-3 variety when compared with semi-okra leaves of Reshmi (4.0/leaf) and okra leaves of BW-76-31 (0.58 per leaf). The separation of mean values through new DMR test indicated that variations amongst okra leaf varieties were statistically non-significant (p=0.05) regarding jassid infestation. Similarly thrips population was also significantly higher on normal leaf variety NIAB-78 (8.85/leaf) and the least population was recorded super okra leaves of 79-IC-3 (2.87/leaf). Thrips infestation was comparatively higher (7.33/leaf) on semi okra leaf variety Reshmi followed by Red Russian (6.40/leaf) with red leaves and BW-78-31 (4.90 /leaf) with okra leaves. The whitefly population was significantly higher (2.10/leaf) on semi okra leaves of Reshmi variety. This was followed in descending order of whitefly population of 79-IC-3 having super okra leaves (1.65/leaf), BW-78-31 having okra leaves (1.53/leaf). NIAB-78 (1.40/leaf) with normal cotton leaves and Red Russian (0.97/leaf) having red colored leaves. The analysis of variance revealed significant variations amongst different cotton varieties, however new DMR test for separation of mean values revealed non-significant differences amongst okra (BW-76-31), super okra (79-IC-3) and normal (NIAB-78) cotton leaves regarding whitefly population.

Table-5 Population intensity (no/leaf) of jassids, thrips and whitefly as influenced by leaf type of different cotton varieties.

Parameters	Age (days)	R	Regression equation	
1) Trichome density vs Jassid population	7	-0.903	1.627	-0.0398
	14	-0.923	2.213	-0.0588
	21	-0.945	4.137	-0.0580
	28	-0.934	4.557	-0.0758
2) Trichome density vs Thrips population	7	-0.314	7.449	-0.048
	14	-0.414	8.826	-0.063
	21	-0.945	9.187	-0.074
	28	-0.934	9.261	-0.089
3) Trichome density vs whitefly population	7	-0.948	-2.149	+0.2125
	14	0.832	-0.586	+0.1536
	21	0.832	-0.556	+0.1618
	28	-0.934	-0.441	+0.1317

The correlation coefficients and regression equations for leaf phenology and population of sucking insect pests of cotton **(Table-6)** revealed that the jassid population was negatively correlated with the trichome density. The correlation coefficients (r) for 7-day old leaves (-0.903), 14-day old leaves (-0.923), 21-day old leaves (-0.945) and 28 day old leaves (-0.934) indicated that correlation of jassid population with Trichome density was negative and significant (P=0.05) at all age groups. The regression equations (negative values) for leaves of different ages also supported that Trichome density decreased with age of the leaves indicating negative and significant correlation between trichome density and jassid population.

Table 6: Correlation coefficient and regression equation for leaf phenology and population of sucking insect pests of cotton

Varieties	Leaf type	Mean number/leaf of		
		Jassids	Thrips	Whitefly
BW-76-31	Okra	0.58 b	4.90 d	1.53 b
Reshmi	Semi-okra	0.40 cd	7.35 b	2.10 a
74-IC-3	Super-okra	0-30 d	2.87 e	1.65 b
NIAB-78	Norma1	0.95 a	8.85 a	1.40 b
Red Russian	Red	0.28 d	6.40 c	0.97 c

Varieties CD =0.13, 0.44, 0.25

CD2=0.19, 0.66, 0.33

Mean values with similar alphabets in each column are statistically non-significant (P=0.05)

The results on the correlation coefficients and regression equations for leaf phenology and population of sucking insect pests of cotton revealed that Trichome density had negative and significant correlation with jassid infestation. Similarly the population levels of thrips were also higher on cotton varieties with densely pubescent leaves. However, whitefly population has positive and significant correlation with trichome density. It could therefore be inferred that densely pubescent cottons imported resistance to jassids and thrips but at the same time these varieties were susceptible to whitefly.

Cotton strains range from densely pubescent to smooth on virtually all above ground plant parts to other that are entirely glabrous. Manipulation of this vestiture through breeding has provided some of the earliest and most effective examples of contrived host resistance in cotton.

Butler *et al*. (1991) reported that the increased whitefly population and trichome density relationship does not appear valid under extremely high trichome density and adult whitefly density decreased as trichome density increased. Chu *et al.* (2000) did not find adult whiteflies on some exceptionally hairy cotton plants. Norman and Sparks, 1977; Sippell *et al*., 1983; Chu *et al*., 1999, documented that hairy cotton cultivars have higher *Bemisia*, compared the densities with smooth leaf cultivars. Van Lenteren and Noldus (1990) opposed that heavy trichome density habitats were preferred for whitefly colonization.

Bhat *et al*. (1984) concluded that cotton yield loss by jassid could be reduced from 25% to 12% by growing a hairy variety. A yield advantage of 12% was obtained by incorporation of hairiness and open plant canopy to control jassids and whitefly, as well as improved fiber quality, full resistance against jassids and hence delayed early sprayings, and better overall tolerance against the insect pest complex (Mursal, 1994).

Ballard, (1951) Quisenberry and Rummel, 1979; Rummel and Quisenberry, 1979; Walker *et al*., 1979. reported that pubescent and pilose varieties afforded greater thrips resistance than glabrous cultivars. Hawkins *et al.* (1966) concluded that thrips damage to the very pubescent terminals of Empire cotton was lower than to cultivars with less pubescent terminals of Empire cotton was lower than to cultivars with less pubescence.

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