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Effect of trichome density on the resistance to the jassids in inter-specific *G. hirsutum* x *G. barbadense* cotton recombinant inbred lines (RIL) population

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Abstract: Cotton is the most important fibre crop in the world. After the introduction of Bt. Cotton which is resistant to bollworms, the sucking pests incidence has increased. Among the sucking pests, jassids cause more loss. In the present study, the RILs derived from the cross between *Gossypium hirsutum* and *Gossypium barbadense*, both diverse with respect to trichome density, were used to study the trichome density on leaf lamina, mid-rib and leaf vein. There was wide variation for the trichome traits, jassid injury and yield traits among the RILs. The correlation was studied to find the effect of trichomes on the incidence of jassids in the RIL population. The results showed that there was significant negative correlation of jassids per leaf with abaxial leaf pubescence count (-0.16), leaf mid-rib pubescence count (-0.21) and leaf vein pubescence count (-0.17). The jassid injury was also significantly and negatively correlated with trichome density on leaf lamina (- 0.34), mid-rib (-0.33) and leaf vein (-0.37).

Key words: Cotton, Jassid, Pubescence, Trichome

Introduction

Cotton (*Gossypium* spp.) is the principal commercial crop of India since time immemorial. It plays a pivotal role in the agriculture based economy of India and fibre has global importance. Despite the increasing production of artificial fibers which some time back was thought to threaten the very existence of cotton fiber, the latter has maintained its prime place to this day as the king of fiber crop.

Growing of transgenic cotton is a relatively new technology in Indian Agriculture. In India commercial cultivation of Bt cotton started in 2002. Bt. cotton has provided a specific, safe and effective tool for the control of Lepidopterous pests (Shelton *et al.,* 2002; Mendelsohn *et al.,* 2003; Wu and Guo, 2005). But it is highly susceptible to sucking pests of which jassid (*Amrasca bigutulla bigutulla* (Ishida) (Homoptera: Cicadellidae) is the most important and very serious pest reported to cause retardation in plant growth and loss of cotton yield. The jassid nymphs + adults both are involved in the crop damage by sucking the cell sap, turning the leaf pale yellow and curling it downward leading to leaf fall later. *Amrasca biguttula biguttula* lays its eggs on the midrib of the leaves. The use of resistant genotypes is a familiar tool for bio-intensive pest management and the characters contributing to resistance to pests once identified, can be transferred to genotypes to make them resistant. Trichomes are unicellular outgrowths from the epidermis of leaves, shoots and roots. The trichome cover of a plant surface is collectively called pubescence. Hairiness acts as an important insect non-preference trait against the sucking insect pests of cotton. The degree of hair or trichome density on the leaves of Gossypium species and cultivars is related to varying degrees of resistance/susceptibility to jassids (Meagher *et al.,* 1997).

The recombinant inbred lines (RIL) in the present study derived from the interspecific cross between *G. hirsutum* var. DS-28 and *G.barbadense* var. SBYF-425 are diverse with respect to morphology and yield traits. These RILs were used in screening for jassid resistance.

Material and methods

200 recombinant inbred lines of F_{12} generation derived from the interspecific cross between *G. hirsutum* var. DS-28 and *G.barbadense* var. SBYF-425 were evaluated in augmented design-II during *kharif* 2015 at Agricultural Research Station, Dharwad Farm, University of Agricultural Sciences Dharwad. Seeds from these recombinant inbred lines were sown in the field under protected (pesticide sprayed) and unprotected (unsprayed) condition. Phenotyping was done for trichome density under protected situation and jassid reaction under unprotected situation.

Observations for different pubescence traits, involved in jassid resistance, on the plants were recorded based on qualitative grading (Pubescence rating) and quantitative measurement (Trichome density and trichome length) as detailed by Bourland *et al.* (2003) and Hornbeck and Bourland (2007). The hirsutum parent was more hairy than the barbadense parent giving rise to genetically variable segregants showing varying densities and lengths of trichomes.

The observations for jassid injury symptoms were recorded at 120 days after sowing. Observations for jassid damage were recorded based on the symptoms and 1-4 grades were used to score the symptoms caused by jassids. Grade-1 refers to entire foliage free from crinkling or curling with no yellowing. Grade-2 is crinkling and curling of few leaves in the lower portion of plant and marginal yellowing of leaves. Grade-3 is when crinkling and curling of leaves almost all over the plant is seen and plant growth is hampered and Grade-4 refers to extreme curling, crinkling, yellowing, bronzing and drying of leaves.

Results and discussion

The analysis of variance showed significant differences among the genotypes for all the characters studied (Table 1). The presence of significant differences among the varieties for leaf pubescence traits and yield traits indicates the presence of desirable genes for the traits in these RILs. The leaf pubescence traits observed were abaxial leaf pubescence count (ALFPc), leaf mid-rib pubescence count (LFMPc), leaf vein pubescence count (LFVPc) and trichome length.

The general performance of each genotype for leaf pubescence and yield characters studied are presented in Table 2 along with range, general mean, phenotypic and genotypic variances. A wide range of variability was recorded for several characters *viz.,* ALFPc (1.25-61.5), LFMPc (4.00-63.50), LFVPc (2.75-51.75), trichome length (10.68-66.55), leaf pubescence score (1.00-5.00), jassids/leaf (0.33-26.67), jassid injury (1.00-4.00), seed cotton yield (155.00-3,618.60 kg/ha), bolls per plant (2.00-14.60) and boll weight (1.18-7.89g). Among 200 recombinant inbred lines, wide range of genetic diversity existed for the leaf pubescence and yield traits. In the present investigation, the jassid population, injury grade, $ALFP_C$, $LFMP_C$, $LFVP_C$, hair length and leaf pubescence had high GCV and PCV. Similar results were obtained by Indrayani *et al.* (2007). Phenotypic and genotypic variances were high for all the traits studied. The heritability was also high for all the traits except bolls per plant. The variation for different pubescence traits based on pubescence rating or trichome density indicates that selection could be used either to increase or decrease the trichome density on different parts of the cotton plant depending on the need. In the RILs, high heritability was observed for all the leaf pubescence traits except ALFPc which was moderate.

The phenotypic correlation coefficients were computed among the traits, trichome length, jassids per leaf and yield traits to understand the nature of association among traits and the results are presented in Table 3. The jassids per leaf recorded significant negative correlation with ALFPc (-0.16), LFMPc (-0.21) and LFVPc (-0.17). ALFPc recorded a significant positive phenotypic correlation with both LFMPc (0.85) and LFVPc (0.81). The correlation of $ALFP_C$ with $LFMP_C$ and $LFVP_C$ was significantly positive. This result confirms the findings of Bourland *et al.* (2003) and Hornbeck and Bourland, (2007). The jassid injury grade was significantly and negatively correlated with all the three leaf pubescence traits $ALFP_C$ (- 0.34), $LFMP_C$

Table 1. Analysis of variance for leaf pubescence, jassid injury and yield traits in recombinant inbred lines of cotton 2015-16

		Mean sum of squares									
Source of variation	Df	$ALFP_C$	$LFMP_C$	$LFVP_C$	Leaf pubescence score	Trichome length (µm) (kg/ha)	Jassids/ leaf	Jassid injury	Seed cotton yield	Number of bolls perplant	Boll weight (g)
Block (eliminating Checks+ genotypes)	9	248.75	153.04	42.29	0.33	11.74	0.46	0.11	25781.29	1.82	0.12
Entries (ignoring blocks)	201	311.05	462.32	193.84*	1.28**	72.47**	24.03**	0.95	542506.60**	4.56*	5.03**
Checks	1	31577.40**	50810.26**	21236.94**	76.05**	384.47**	41.041**	20.00*	602575.50**	0.02	9.52**
Genotypes	199	119.25*	141.48*	60.07	0.78**	67.61**	23.21**	0.83	447695.00**	6.14	5.02**
Checks vs. Genotypes	1	7211.94**	13962.31**	5771.01**	25.31**	727.20**	186.03**	5.60**	349940.00 **	296.73**	5.02 **
Error	9	233.86	174.14	53.67	0.16	6.76	1.33	0.44	32602.68	2.31	0.12

*Significance at 5 % probability level ** Significance at 1 % probability level

Note: ALFPc- Abaxial leaf pubescence count, LFMPc- Leaf mid-rib pubescence count, LFVPc- Leaf vein pubescence count

Table 2. Mean, range and genetic parameter values for leaf pubescence, jassid injury and yield traits in recombinant inbred lines of cotton 2015-16.

Parameters	$ALFP_C$	$LFMP_C$	$LFVP_C$	Trichome length (µm)	Leaf pubescence score	Jassids/ leaf	Jassid injury	Seed cotton yield(kg/ha)	Number of bolls perplant	Boll weight (g)
Mean	24.36	31.80	19.87	35.94	2.17	6.63	3.005	1637.7	6.96	4.28
Maximum	61.50	63.50	51.75	66.55	5.00	26.67	4.00	3618.6	14.60	7.89
Minimum	1.25	4.00	2.75	10.68	1.00	0.33	1.00	155.8	2.00	1.18
GCV (%)	73.31	67.60	69.52	23.51	49.081	72.46	32.25	46.3	40.47	26.39
PCV (%)	97.82	68.65	73.28	25.58	59.33	83.76	46.09	56.8	40.26	29.13
h^2(bs)	0.56	0.97	0.90	0.84	0.68	0.74	0.49	0.91	0.01	0.82
GA	35.50	43.68	27.005	16.008	1.925	8.572	1.365	1482.132	0.562	2.084
GAM (%)	145.73	140.90	135.93	44.51	88.47	129.26	44.59	90.49	8.07	48.59

Table 3. Phenotypic correlation coefficients among leaf pubescence and yield traits in recombinant inbred lines of cotton 2015-16

Parameters	$ALFP_C$	$LFMP_C$	$LFVP_C$	Trichome length (µm)	Jassids/ leaf	Jassid injury	Seed cotton yield (kg/ha)	Number of bolls per plant	Boll weight (g)
$ALFP_C$	1								
$LFMP_C$	0.85 **	1							
$LFVP_C$	0.81**	0.85**	1						
Trichome length (µm)	0.11	0.11	0.06	1					
Jassids/leaf	-0.16*	-0.21**	-0.17*	0.06	1				
Jassid injury	-0.34**	-0.33 **	-0.37 **	0.02	0.14 *	1			
Seed cotton yield (kg/ha)	-0.12	-0.09	-0.11	0.19	0.13	0.09	1		
Number of bolls/plant	-0.11	-0.14*	-0.15*	0.16*	0.20**	0.06	0.78**	1	
Boll weight(g)	0.12	0.19*	-0.15*	0.07	-0.09	0.40**	0.47**	-0.11	1

*Significance at 5% probability level ** Significance at 1% probability level

(-0.33) and $LFVP_C$ (-0.37). This proved that the higher density of hairs on the leaf surface at various spots deterred the jassids from settling on the leaf, thus leading to lesser leaf injury symptoms being seen. Similar results were obtained by Murugesan and Kavitha (2010) and Bhatti (2015). The jassid injury grade was also significantly positively correlated with the jassid number per leaf (0.14) proving that fewer jassids caused lesser damage. Among yield traits, seed cotton yield recorded significant positive phenotypic correlation with both number of bolls per plant (0.78) and boll weight (0.47). Similar results were obtained by Vinodhana Kumari *et al.* (2013), Farooq (2014), Bayyapu Reddy *et al.* (2015), Latif Asif *et al.* (2015) and Baloch *et al.* (2016) where they also observed increased yields due to more number of bolls per plant and higher boll weight.

Overall, increased density of trichomes leads to lesser damage by the jassids. However, the absence of clear associations among the trichome traits and seed cotton yield are to be investigated further to find the optimum hairiness that confers tolerance without having any yield penalty. This can be done by using experimental material generated from proven diverse sources where extreme hirsuteness has already been implicated in decreased yields.

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