Host plant resistance in cotton accessions to the leafhopper, *Amrasca devastans* (Distant)

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ABSTRACT

In the recent years, incidence of the leafhopper, *Amrasca devastans* (Distant) in cotton has been prevalent from vegetative to reproductive phase of crop growth. The loss in seed cotton yield due to leaf hopper is accounted to 390 kg ha^{-1} and 330 kg ha^{-1}. In India 45 per cent of the pesticides are applied to cotton. Hence, development of a resistant / tolerant cultivar is the need of the hour to to reduce three ' R ' *viz.*, Resistance, Resurgence and Residues in biota. Screening of twenty six cotton accessions against the leafhopper, *A. devastans* (Distant) was carried out by following ICCC grades. The susceptiblity of cotton entries varied significantly. Based on the resistance index the entries were grouped under five categories as, Highly resistant- KC 2, SVPR 2; Resistant-TKH 1128: Intermediate- MCU 5, MCU 10, NISD 2, TKH 1143,TKH 1175: Susceptible- TKH 1789, TKH 1173, TKH 1174, TKH 1178, TKH 1179, TKH 1185, TKH 1186, TKH 1209, TKH 1225, TKH 1233 and Highly susceptible- ICMF 20, LRA 5166, TKH 1133, TKH 1172, TKH 1176, TKH 1182, TKH 1197, TKH 1198. Studies on the mechanism of resistance revealed that leafhoppers discriminated cotton entries for orientation and settling and feeding. Highly susceptible entiries were preferred for settling and feeding. Varieties less preferred for settling were less preferred for oviposition too. Since antixenosis and antibiosis were considered for mechanism of resistance various plant parameters *viz.*, Plant height, internodal length, petiole length, leaf area, thickness of leaf, trichome density on the ventral surface of the leaves, hair length, hair density on mid-vein, distance between bases of hairs in mid vein, chlorophyll content, moisture content and protein content were estimated and correlated with leafhopper ovipostion and damage caused. Plant height, internodal length, trichome density on the ventral surface of the leaves, hair length, hair density on mid-vein had negative association with leafhopper damage and oviposition by leafhopper; leaf area, leaf thickness and protein content had no significant association. Susceptible entries had less chlorophyll and more moisture.

Key words : Host plant resistance, mechanism of resistance, cotton, leafhopper, *Amrasca devastans.*

INTRODUCTION

For over thousand years (1500 BC to 1700 AD) India was recognized as the cradle of cotton industry. India thus enjoys the distinction of being the earliest country in the world to domesticate cotton and to utilize its fibre to manufacture fabric (Mayee *et al.*, 2004). India ranks first in global scenario with about 20 per cent of the world cotton area but with regard to production it ranks second to China with 93.73 lakh under cotton. Textile exports and cotton account for nearly one third of total foreign exchange earnings of India crossing Rs. 60,000 crores (Pundhir *et al.*, 2009). In India cotton ecosystem harbours about 162 insect pest species and the monetary value of yield losses due to insect pests has been estimated to be Rs 2,87,000 million annually (Dhawan *et al.*, 2008). The extent of losses caused by sucking pests, bollworms and both sucking pests and bollworms have been worked out 12, 44, and 52 per cent (Dhawan *et al.*, 1988). In the absence of effective genetic resistance against these sucking pests and bollworms, farmers solely relied on insecticides for their effective production management (Dhawan *et al.*, 2008). Cotton accounts for 50 per cent of pesticide consumption in the country despite being grown on area of 5 - 10 per cent (Dhawan *et al.*, 2008; David, 2008). Leafhopper, *Amrasca devastans* is a regular and key pest in Southern Tamil Nadu. The loss in seed cotton yield due to leafhopper alone is accounted to 390 kg ha^{-1} (Pandi, 1997). Even though the recently introduced Bt cotton hybrids are resistant to bollworms, most of them succumb to the leafhopper scourge (Kalkal *et al.*, 2009; Raja *et al.*, 2007; Murugesan *et al.*, 2009). Hence, the development of the high yielding leafhopper tolerant genotypes becomes the need of the hour. In Integrated Pest Management Programme, resistant cultivar is to be

used as a basement over which other tactics are to be pyramided over to have an effective management of the pest. Identification and use of tolerant / resistant cultivar may be of great relevance during these day as they are ecofriendly and cost - effective. The present investigation was carried out with the objective of identifying resistant sources to *A. devastans* and to study the mechanism of resistance in the promising entries.

MATERIALS AND METHODS

Screening entries to identify varietal resistance

A total of 24 entries (Set I) were screened against *A. devastans*. The promising resistant entries for resistance were further screened (Set II) with susceptible checks to confirm the resistance. The entries were raised in three rows of six metres each and bhendi was raised in between each variety. The bhendi plants were cut after the sufficient growth of leafhopper population for 30 days after sowing (DAS) and left *situ.* Population of nymphs of *A. devastans* was recorded on 45 and 60 DAS on ten randomly selected plants in each plot. In each plant three leaves - one each from top, middle and bottom strata- were observed and mean population per three leaves was worked out. Hopper burn assessment was rated adopting 1-4 Grade Scale of Indian Central Cotton Committee (ICCC) as given below:

Leaves free from crinkling and curling, yellowing , bronzing and drying (Grade 1), Crinkling, curling, slight yellowing in few leaves on lower portion of the plant (Grade 2), Crinkling, curling, yellowing, browning and bronzing in the middle and lower (Grade 3), portion and plant growth hampered. (Grade 4) and Extreme crinkling, curling, yellowing, browning, bronzing and drying of leaves, defoliation and stunted growth (Grade 5).

Leafhopper Resistance Index (LHRI)

The entries were classified into different categories based on leafhopper resistance index (LHRI) (Nageswararao, 1973 a).

$$LHRI = \frac{(G_1 \times P_1) + (G_2 \times P_2) + (G_3 \times P_3) + (G_4 \times P_4)}{P_1 + P_2 + P_3 + P_4}$$

Where, G - Leafhopper Injury Grade, P - The plant population under the grade for each category

After indexing, the entries were categorized as highly resistant (1.0 - 1.5), resistant (1.51 - 2.0), intermediate (2.01 - 2.5), susceptible (2.51 - 3.0) and highly susceptible (3.01 - 4.0) detailed below following Pandi (1997).

Mechanism of Resistance

The level and mechanism of resistance was studied in ten selected cotton entries *viz.*, ICMF 20, KC 2, LRA 5166, MCU 5, MCU 10, NISD 2, SVPR 2, TKH 1175, TKH 1178 and TKHH 1. Potted plants were placed at random but equidistantly apart in a circle inside the hopper net. Each pot represented a replication. Three replications were maintained. Three hundred field collected adults were released in the middle and the top of the set up. The number of insects that settled on different entries was recorded at 1, 6, 24 and 48 hours after release. Percentage of leafhoppers settled at each time interval on test entries was worked out.

The entries in the potted plants were placed at random but equidistantly apart in a circle inside the hopper net. The leaves other than the third ones from the top were removed. Each pot represented a replication. Three replications were maintained. Three hundred field collected adults were released in the middle and the top of the set up. One leaf from each pot was plucked 10 days after release and was boiled in lactophenol solution. Lactophenol was prepared in the ratio of 1:1:2:1 containing lactic acid + phenol + glycerine + distilled water. After boiling the leaves were allowed to remain in lactophenol mixture for seven days. The blackish yellow coloured eggs observed in the tissue of mid and lateral veins were counted under a binocular microscope (Khan and Agarwal, 1984).

The plant characters, both morphological and bio-chemical, in relation to leafhopper resistance were studied in randomized block design and three replications were maintained. The moisture content of the leaves was determined by drying the leaves at 70^{o} C for 48 hrs in an oven and the difference in the weight before and after drying was used to express the moisture in percentage. The leaf chlorophyll was extracted at 80 per cent acetone and the absorbance at 645 nm (chlorophyll. a), 665 nm (chlorophyll. b) and 652 nm (total chlorophyll) were read in spectrophotometer (Sadsivam and Manickam, 1992). The contents were expressed in mg^{-1} of tissue. The leaf protein was extracted at 80 per cent ethanol and Folin ciocalteau reagent reacts with protein and a blue colour is formed which is measured colorimetrically at 660 nm (Sadasivam and Manickam, 1992). The protein concentration was expressed in mg 100 g $^{-1}$ of plant tissue.

RESULTS AND DISCUSSION

Screening for resistance

The results of the screening of entries in two sets are presented in Tables 1 and 2. The susceptiblity varied significanty. In set I, mean leafhopper incidence ranged from 0.85 (KC 2) to 5.37/3 leaves (TKH 1209). Based on the resistance index the cotton entries were grouped into five categories as mentioned in the materials and methods.

Table 1. Screening of cotton entriesagainst *A. devastans* - Set I.

Entry	Leafhopper incidence (no/ 3 leaves)	Leafhopper resistance index	Resistant category
ICMF 20	4.01[ef]	3.30	HS
KC 2	0.85 [a]	1.15	HR
LRA 5166	5.29 [l]	3.70	HS
MCU 10	2.72 [c]	2.25	I
NISD 2	4.53 [fghij]	2.28	I
TKH 789	4.59 [ghijk]	2.85	S
TKH 1128	1.79 [b]	1.57	R
TKH 1133	4.53 [fghijk]	3.10	HS
TKH 1143	4.71 [ijk]	2.40	I
TKH 1172	3.34 [d]	3.01	HS
TKH 1173	4.26 [efg]	2.93	S
TKH 1174	4.72 [hijk]	2.72	S
TKH 1175	5.06 [kl]	2.08	I
TKH 1176	4.61[fghijk]	3.07	HS
TKH 1178	3.62 [d]	2.71	S
TKH 1179	5.37 [m]	2.60	S
TKH 1182	3.26 [d]	3.13	HS
TKH 1185	3.47 [d]	2.80	S
TKH 1186	2.76 [c]	3.00	S
TKH 1197	3.15 [cd]	3.01	HS
TKH 1198	4.07 [c]	3.42	HS
TKH 1209	4.91 [jkl]	2.75	S
TKH 1225	4.26 [efghi]	2.95	S
TKH 1233	4.34 [efgh]	2.80	S
Mean	3.93	2.73	-
Significance	0.01	-	
CD (P = 0.05)	0.11		

In a column, means followed by a common letter are not significantly different at 5% level (LSD); **HR** - Highly Resistant; **R -** Resistant; **I -** Intermediate; **S** - Susceptible; **HS -** Highly Susceptible.

Insect resistant crop varieties have the unique advantage of providing inherent insect control which is genetically compatible with other methods of insect control (Khan and Saxena, 1998). It provides more practical approach in leafhopper management utilizing resistant varieties. While screening 24 entries the leafhopper population was found to be low on KC 2 and TKH1128 compared to other entries. By indexing the resistance, KC 2 was rated as highly resistant, while TKH 1128 was resistant. Several earlier workers have reported on the varietal susceptibblity in cotton to *A.devastans* (Balasubramanian *et al.*, 1978; Khan and Agarwal, 1981; Chandramani *et al*., 2004). There have been accessions resistant to leafhopper (Ambekar and Kalbhor, 1981; Khan and Agarwal, 1981; Pandi, 1997; Manish 1998; Chandramani *et al*., 2004).

Table 2. Screening of cotton entries against *A. devastans* - Set II

Entry	Leafhopper incidence (no/ 3 leaves)	Leafhopper resistance index	Resistant category
ICMF 20	4.11 cde	3.43	HS
KC 2	0.93 a	1.19	HR
LRA 5166	4.55 de	3.50	HS
MCU 5	3.59 c	2.30	I
MCU 10	2.71 b	2.47	I
NISD 2	3.57 c	2.32	I
SVPR 2	1.18 a	1.45	HR
TKH 1175	2.81 b	2.12	I
TKH 1178	3.99 cd	2.72	S
TKHH 1	4.59 e	3.30	HS
Mean	3.20	2.48	-
Significance	0.01		
CD (P = 0.05)	0.13		

In a column, means followed by a common letter are not significantly different at 5% level (LSD); **HR** - Highly Resistant; **R** - Resistant; **I** - Intermediate; S - Susceptible; **HS** - Highly Susceptible.

Mechanism of resistance

The data on the mechanism of resistance was determined in ten selected cotton entries *viz.*, ICMF 20, KC 2, LRA 5166, MCU 5, MCU 10, NISD 2, SVPR 2, TKH 1175, TKH 1178 and TKHH 1. There was significant influence of varieties on the orientation and settling response.The adults aggregated on different varieties on susceptible varieties. Resistant varieties *viz.*, KC 2 and SVPR 2 harboured the population of leafhoppers (Table 3). The preferential response of adult leafhoppers for alighting on highly susceptible entries (ICMF 20, LRA 5166 and TKHH 1) indicated the presence of some factors which significantly influenced the preference of insect. Adult leafhoppers settled in more numbers on highly susceptible and susceptible plants indicating more sustained feddiong on susceptible plants. Mohankumar (1996) and Manish (1998) had similar results. Barroga and Bernardo (1993) observed more preferential settling of *A. devastans* on susceptible *okra*. The variability in number of eggs laid due to the varieties and periods was evident (Table 4). Interaction effect was also significant. Highly resistant lines, KC 2 and SVPR 2 received least no of eggs than the intermediate ones. The trend was similar at each level of crop age. Thirty days old plants recorded lesser number of eggs than the 60 days old ones.

Varieties less preferred for settling were also less preferred for oviposition. Highly resistant entries (KC 2 and

Table 3. Orientation and settling response in selected entries

Entry	Leafhopper incidence (no/ 3 leaves)	Leafhopper resistance index	Resistant category
ICMF 20	4.11^{cde}	3.43	HS
ICMF 20	15.75^{c}	3.30	HS
KC 2	8.25 ^{a}	1.15	HR
LRA 5166	15.75^{c}	3.70	HS
MCU 5	12.83^{b}	2.10	I
MCU 10	15.25^{c}	2.25	I
NISD 2	12.58^{b}	2.28	I
SVPR 2	9.50 ^{a}	1.25	HR
TKH 1175	12.00^{b}	2.08	I
TKH 1178	17.00^{c}	2.71	S
TKHH 1	16.88^{c}	3.45	HS
Mean	13.58	2.43	-
Significance	0.01		
CD (P = 0.05)	1.63		

In a column, means followed by a common letter are not significantly different at 5% level (LSD) ; HR - Highly Resistant; R- Resistant; I - Intermediate; S - Susceptible; HS- Highly Susceptible.

SVPR 2) received less number of eggs compared to resistant, intermediate (MCU 5, MCU 10, NISD 2, TKH 1175), susceptible (TKH 1178) and highly susceptible lines (ICMF 20, LRA 5166 and TKHH 1). The ovipositional preference to susceptible varieties documented here gains supported by Krishnananda (1973), Balsubramaian *et al*, (1978), Mohankumar (1996) and Manish (1998).

Table 4. Oviposition by *A. devastans* in selected entries

Entry	No of eggs laid per leaf			Leafhopper resistance index	Resistant category
	Days after sowing				
	30	60	Mean		
ICMF 20	17.67^{Aa}	19.67^{Ad}	18.67^{d}	3.30	HS
KC 2	4.97^{Aa}	5.33^{Aa}	5.15^{a}	1.15	HR
LRA 5166	21.33^{Af}	26.77^{Be}	24.05^{e}	3.70	HS
MCU 5	16.25^{Ade}	16.57^{Ac}	16.41^{c}	2.10	I
MCU 10	14.53^{Acd}	17.00^{Bc}	15.77^{c}	2.25	I
NISD 2	11.92^{Ab}	13.53^{Ab}	12.73^{b}	2.28	I
SVPR 2	5.53^{Aa}	6.03^{Aa}	5.78^{a}	1.25	HR
TKH 1175	13.88^{Ac}	13.40^{Ab}	13.64^{b}	2.08	I
TKH 1178	15.40^{Acd}	17.43^{Bc}	16.42^{c}	2.71	S
TKHH 1	23.10^{Af}	28.00^{Be}	25.55^{e}	3.45	HS
Mean	14.46^{A}	16.37^{B}	15.42	2.43	-

In a column /row, means followed by a common letter (Capital letter in rows / small letter in column) are not significantly different at 5% level (LSD). **HR** - Highly Resistant; **R-** Resistant; **I-** Intermediate; **S** - Susceptible; **HS** - Highly Susceptible

Leafhoppers oviposited more in plants of 60 days old ones than that of 30 days old ones irrespective of varietal response. The development of midvein was complete after 30 days (Balasubramanian, 1965) which may be the plausible reason for more oviposition in 60 days old plants.

Insect plant interaction

Since antixenosis and antibiosis were considered as mechanism of resistance, various plant parameters were estimated and correlated with leafhopper oviposition and damage caused. The data on the plant characters *viz.*, plant height, internodal length, length of leaf petiole, area and thickness of leaves, leaf hair density, hair density in mid vein, distance between hair bases in mid vein, moisture content, chlorophyll content recorded on different entries are presented in tables 5-7 and simple correlation coeffcients estimated between the plant characters and leafhopper damage and oviposition are tabulated in table 8.

Leafhopper damage

The leafhopper injury grade had negative association with plant height, inter nodal length, leaf hair density, hair length, hair density on mid vein, total chlorophyll, chlorophyll a and chlorophyll b and positive association with the distance between bases of hairs on mid vein and moisture content.

The plant height had negative association on leafhopper damage. On a contrary, Jayaraj (1968), Uthamasamy *et al.* (1972) and Balasubramanian *et al.* (1977a) recorded

Table 5. Plant morphological characters in selected entries

Entry	Plant morphological characters					Leafhopper resistance index	Resistant category
	Plant height(cm)	Internodal length (cm)	Petiole length (cms)	Leaf area(cm^2)	Thickness of leaf (µ)		
ICMF 20	46.00^{cde}	4.00^{cd}	6.30^{b}	78.63^{a}	226.67^{ab}	3.30	HS
KC 2	75.67^{a}	5.20^{a}	4.67^{c}	41.53^{f}	220.00^{ab}	1.15	HR
LRA 5166	51.00^{c}	4.47^{abcd}	6.23^{b}	61.21^{e}	250.00^{a}	3.70	HS
MCU 5	49.17^{cd}	4.30^{bcd}	8.07^{a}	64.03^{de}	184.00^{bc}	2.10	I
MCU 10	38.80^{f}	3.80^{d}	7.98^{a}	61.87^{e}	226.67^{ab}	2.25	I
NISD 2	50.00^{cd}	4.67^{abc}	8.07^{a}	59.10^{e}	263.33^{a}	2.28	I
SVPR 2	68.33^{b}	4.97^{ab}	5.50^{bc}	43.63^{f}	230.00^{ab}	1.25	HR
TKH 1175	50.00^{cd}	3.98^{cd}	6.10^{b}	66.73^{cd}	250.00^{a}	2.08	I
TKH 1178	43.00^{def}	3.73^{d}	8.57^{a}	70.19^{bc}	156.67^{c}	2.71	S
TKHH 1	40.67^{ef}	2.93^{e}	7.80^{a}	72.16^{b}	266.67^{a}	3.45	HS
Mean	51.26	4.20	6.93	61.91	227.40	2.43	-
Significance	0.01	0.01	0.01	0.01	0.01		
CD (P = 0.05)	6.57	0.77	1.36	4.48	48.58		

In a column, means followed by a common letter are not significantly different at 5% level (LSD) ; **HR** - Highly Resistant; **R -** Resistant; **I -** Intermediate; **S** - Susceptible; **HS -** Highly Susceptible

positive influence of plant height over leafhopper on castor, okra and cotton respectively. Singh and Shekhon (1992) and Mohankumar (1996) documented that internodal length had no significant relationship with leaf hopper damage. But in the present study internodal length had negative association with leafhopper damage. Petiole length had no significant relationship with leafhopper infestation; similar was the observation, reported by Balasubramanian *et al.* (1977a). Non - significant relationship between leaf thickness and leafhopper damage was observed in the present study in line with Ambekar and Kalbhor (1981) and Mohan kumar (1996). On the contrary, Tidke and Sane (1962) and Batra and Gupta (1970) reported resistance with thicker leaves. Hairiness, as indicated by the length and density of trichomes on leaf lamina as well as on veins, was considered responsible for conferring resistance (Ambekar and Kalbhor, 1981; Mohankumar, 1996). The trichome density on the ventral surface of the leaves, hair length, hair density on mid vein, on ventral surface of the leaves

Table 6. Leaf hair parameters in selected entries

Entry	Leaf hair parameters				Leafhopper resistance index	Resistant category
	Leaf hair density (No/ cm^2)	Hair length (mm)	Hair density on mid vein (no/cm^2)	Distance between bases on mid vein (mm)		
ICMF 20	15.00^{f}	0.50^{de}	15.13^{e}	0.52^{a}	3.30	HS
KC 2	32.92^{a}	0.79^{a}	22.13^{a}	0.30^{d}	1.15	HR
LRA 5166	20.42^{cde}	0.56^{bcde}	17.07^{cd}	0.47^{a}	3.70	HS
MCU 5	23.75^{bc}	0.59^{bc}	15.57^{de}	0.38^{bc}	2.10	I
MCU 10	21.67^{cd}	0.60^{b}	16.03^{cde}	0.40^{b}	2.25	I
NISD 2	20.58^{cde}	0.59^{bc}	16.27^{cde}	0.38^{bc}	2.28	I
SVPR 2	28.33^{ab}	0.72^{a}	19.23^{b}	0.33^{cd}	1.25	HR
TKH 1175	21.67^{cd}	0.58^{bcd}	17.43^{c}	0.41^{b}	2.08	I
TKH 1178	17.08^{def}	0.51^{cde}	15.47^{de}	0.41^{b}	2.71	S
TKHH 1	15.42^{ef}	0.49^{e}	14.77^{e}	0.52^{a}	3.45	HS
Mean	21.68	0.60	16.91	0.41	2.43	-
Significance	0.01	0.01	0.01	0.01		
CD (P = 0.05)	5.21	0.08	1.66	0.05		

In a column, means followed by a common letter are not significantly different at 5% level (LSD). **HR** - Highly Resistant; **R -** Resistant; **I -** Intermediate; **S** - Susceptible; **HS -** Highly Susceptible

Table 7. Plant biochemical parameters in selected entries

Entry	Chlorophyll (mg/100g)			Moisture content (%)	Protein content(%)	Leafhopper resistance index	Resistant category
	Total	a	b				
ICMF 20	0.340^{g}	0.160^{f}	0.180^{f}	72.60^{abcd}	8.30^{f}	3.30	HS
KC 2	1.050^{a}	0.437^{a}	0.600^{a}	71.17^{abc}	7.20^{de}	1.15	HR
LRA 5166	0.660^{d}	0.270^{cd}	0.390^{d}	72.73^{abcd}	3.90^{a}	3.70	HS
MCU 5	0.470^{e}	0.250^{de}	0.220^{e}	71.75^{abc}	18.00^{g}	2.10	I
MCU 10	0.670^{d}	0.293^{bc}	0.380^{d}	70.69^{a}	6.30^{bc}	2.25	I
NISD 2	0.750^{c}	0.320^{c}	0.430^{c}	73.33^{bcd}	7.50^{e}	2.28	I
SVPR 2	0.830^{b}	0.320^{c}	0.510^{b}	70.86^{a}	6.70^{cd}	1.25	HR
TKH 1175	0.750^{c}	0.320^{c}	0.430^{c}	73.60^{cd}	7.10^{de}	2.08	I
TKH 1178	0.410^{f}	0.230^{e}	0.180^{f}	73.10^{bcd}	5.60^{b}	2.71	S
TKHH 1	0.310^{g}	0.100^{g}	0.210^{e}	74.50^{d}	7.10^{de}	3.45	HS
Mean	0.62	0.28	0.35	72.33	7.77	2.43	-
Significance	0.01	0.01	0.01	0.01	0.01		
CD (P = 0.05)	0.05	0.03	0.03	2.20	0.72		

In a column, means followed by a common letter are not significantly different at 5% level (LSD).

had significant negative association with leafhopper damage and oviposition by leafhopper. Many researchers related plant pubescence as a positive factor for leafhopper resistance (Sivasubramanian *et al.*, 1991; Mohankumar, 1996). Hairiness on ventral surface was the most important morphological character related positively to leafhopper resistance (Uthamasamy, 1985; Mohankumar, 1996). The distance between bases of hairs on mid vein had positive association with leafhopper damage. Mohankumar (1996) reported that susceptiblity to leafhopper decreased as the hair bases were closer to each other. The significant impact of cholorophyll on leafhopper incidence noticed in the present studies is in agreement with the reports of Nagerwararao (1973b), Sivasubramanian *et al.* (1991) and Manish (1998). The moisture content had positive correlation in the present investigation. Ramsingh and Taneja (1989) have also implicated higher leaf moisture for the susceptiblity to cotton leafhopper.

Ovipositional preference

The number of eggs laid, a measure of ovipositional preference, had positive association with petiole length, distance between bases of hairs on mid vein and moisture content and negative association with plant height , inter

Table 8. Correlation of Plant morphological and biochemical parameters characters with leafhopper damage and oviposition

Character	**Leafhopper damage**	**Oviposition**
Plant height	- 0.6878 * *	- 0.7520*
Internodal length	- 0.5529 * *	- 0.6430* *
Petiole length	0.3503 ^{NS}	0.4438 *
Leaf area	0.2605 ^{NS}	0.2598 ^{NS}
Thickness of leaf	0.2401 ^{NS}	0.2304 ^{NS}
Leaf hair density	- 0.7851 * *	- 0.7461* *
leaf Hair length	- 0.7973 * *	- 0.7953 * *
leaf Hair density on mid vein	- 0.6862* *	- 0.7288* *
Distance between bases of hairs on mid vein	0.8698 * *	0.8357* *
Total Chlorophyll	- 0.7419* *	- 0.7718* *
Chlorophyll a	- 0.6382* *	- 0.6770* *
Chlorophyll b	- 0.7521* *	- 0.7748* *
Moisture content (%)	0.5268* *	0.5219* *
Protein content (%)	- 0.2210 ^{NS}	- 0.0565 ^{NS}

nodal length, density of leaf hairs, leaf hair length, hair density on mid vein, total chlorophyll, chlorophyll a and chlorophyll b. The thickness of leaf and protein content had no correlation with number of eggs laid. The hairiness interfering with oviposition established in the present study gains support from the earlier reports (Tidke and Sane, 1962; Balasubramanian *et al*. 1977a; Uthamasamy, 1985; Mohankumar, 1996; Pandi, 1997; Manish, 1998). The present investigation has brought out the promising nature of KC 2 and SVPR 2 for using in resistance breeding to develop the high yielding genotypes with resistance to cotton leafhopper.

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