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Morphological and biochemical basis of resistance to jassid (*Amrasca devastans*) in cotton *Gossypium hirsutum* L.

R. RUSHPAM* AND R. RAVIKESAVAN

Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore - 641 003

****E-mail : pushpamtnau@gmail.com***

ABSTRACT: To elucidate the morphological and biochemical parameters associated with resistance to jassid (*Amrasca devastans*) the morphological parameters *viz.*, trichome density, gossypol gland density, biochemical parameters *viz.*, total phenol, gossypol and tannin were studied in thirteen *Gossypium hirsutum* genotypes and thirty hybrids differing in susceptible reactions to this insect pest. From this study, the resistant parents KC 2, Stoneville and DHY 286 had more number of trichomes on the adaxial surfaces of leaves pointing to the fact that density of the hair exclusively determines the resistance to jassid in cotton. The leaves of resistant genotypes KC 2, Stoneville and DHY 286 also recorded higher gossypol gland density establishing a close relationship between jassid resistance and high gossypol gland density. Significant negative correlation between trichome density (r = - 0.65) and gossypol gland density (r =-0.37) with jassid susceptibility grade was also observed. Total phenol and gossypol was high in resistant varieties KC 2 and Stoneville proving its resistance. Significant negative correlation was observed between total phenol (r=-0. 32) and gossypol (r = - 0.40) with jassid sussceptiblity. From this study it was concluded that selection and utilization of genotypes with higher trichome density and gossypol gland density in breeding programme may aid in developing genotypes resistance to jassids in cotton. Further it may be suggested that jassid resistance in cotton appears to be controlled by the inherent capacity of the plant to produce higher quantities of total phenol and gossypol. These two chemicals can be used as an index for screening large populations for jassid resistance and short list the progenies for evaluation at the field level.

Key words: Cotton, gossypol, hairiness, jassid, resistance

Cotton is a warm weather plant and its production is limited to tropics and temperate zones. Of the many pests that infest cotton, the leafhopper, *Amrasca devastans* is an important one. The nymphs and adults suck the sap from leaves and cause phytotoxic symptoms known as hopper burn which results in complete desiccation of plants. Severe infestation leads to poor crop stand and stunted growth. Many cotton growers depend on chemical insecticides for controlling the leafhopper. However, the use of pesticides has led to problems such as development of resistance and resurgence of secondary pests. Therefore there is a need for exploring alternative methods of managing this pest. One of the alternative methods is the use of resistant varieties (Halder and Srinivasan, 2011; Nawab *et al.,* 2014). For that we have to know about the mechanism of resistance.

Both morphological and biochemical mechanisms against the leafhopper (jassid) operate in *Gossypium* spp. The role of pubescence in imparting resistance to leafhopper in cotton and the breeding of very hairy cottons, in Africa and Asia, to combat jassids is well established and documented. Hairiness on the undersurface of leaves is the most important morphological character positively related with leafhopper resistance (Amstrong *et al.,* 2009; Murugan and Kavitha, 2010).

There is very little information available on the biochemical basis of resistance to jassid on different cotton varieties. The presence of higher amount of total phenols of the plant responsible for resistance to jassids same of the scientific here reported the positive and significant correlation between total nymphal population and tannin indicating high amount of tannin in varieties susceptible to jassids, tannins, free gossypol were the key factors that influenced antixenosis mechanism of the leafhopper, an increase in tannin and total phenols in resistant genotypes. The antinutritional factors like total phenols and epiculticular waxes showed significant adverse effects on leafhopper survival and oviposition and these compounds were in high concentration in resistant plants a significant negative linear relationship existed between tannin concentration and the population density of piercing and sucking insects. In this present study an attempt has been made to find out the role of trichome density, gossypol glands, tannin, gossypol and total phenol in imparting resistance to jassid in cotton.

MATERIALS AND METHODS

The experiment was conducted at Department of Cotton, TNAU, Coimbatore. Hybridization was effected between ten male and three female parents of *G. hirsutum* and thirty hybrids were synthesized. The above thirteen *G.hirsutum* genotypes and 30 hybrids (F_1) were chosen for morphological and biochemical studies and also artificial screening for jassids.

Artificial screening: Screening was done by caging, five pairs of leaf hopper for each plant. The third instar nymphs of leaf hoppers from a stock culture maintained were released. The leaf hoppers were released on 25 day old plants and counts made on the increase in population and hopper burn injury upto 60 days of age. Hopper burn injury was assessed as per the Indian Central Cotton Committee (ICCC, 1960) methods and based on resultant symptoms of infestation and jassid resistance index was calculated. Screening was conducted for two years.

Estimation of morphological parameters: Trichome density was estimated for the 13 parents and 30 F_1's. The third fully developed leaf from the top was selected at random from the plants sampled for recording trichome density. The number of trichomes per microscopic field was counted under fluorescence microscope at 100 x magnification. The density of gossypol glands on leaves per microscopic field was counted at 100 x magnification. The density of glands was expressed in number/microscopic field.

Estimation of biochemical parameters: For the estimation of total phenol, tannin was done according to the standard procedures.

Correlation studies: The association of morphological and biochemical constituents with jassid susceptibility grade was studied by analyzing the correlation coefficients.

RESULTS AND DISCUSSION

Morphological studies: It has widely been believed, not only with regard to cotton but also in several crops, such as potato, lucerne, clover, *etc.,* that jassid attack is determined largely by the hairiness of the leaf surface. The length and density of hair on the leaves, thickness of the cuticle, lamina and leaf veins, and the osmotic pressure of cell sap govern the resistance in cotton against cotton jassid *Amrasca devastans*. The results of Halter *et al.,* (2016) supported the findings that the hairiness on the under surface of the leaves was found to be the most important morphological character which related positively with jassid resistance. Nawab *et al.,* (2011) expressed that density and length of the hair of the lamina or midrib would be sufficient to confer resistance.

The morphological and the biochemical parameters revealed significant differences in both parents and hybrids. In the parents the trichome density on the abaxial side of leaves per microscopic field ranged from 10.50 to 38.80 recorded by MCU 7 and DHY 286. The trichome density ranged between 21.00 in SVPR 3 x MCU 5 and 37.00 in KC 2 x MCU 5 and DHY 286 x MCU 5 among the hybrids. The density was significantly higher in the hybrids KC 2 x MCU 5, DHY 286 x MCU 5, Stoneville x MCU 5, Khandwa 2 x MCU 12, DHY 286 x MCU 5 and DHY 286 x MCU 12 (Table 1 and 2).

The density of glands per microscopic field ranged between 5.23 in SRT 1 to 6.93 in KC 2. Among the parents gossypol gland density was significantly high in KC 2, followed by Stoneville and DHY 286. Gossypol gland density in hybrids

Table 1. Morphological and biochemical constituents and mean jassid injury index of parents

Parents	Trichome density/ microscopic field	Gossypol gland density/ microscopic field	Tannin (mg/g)	Total phenols (mg/g)	Gossypol (%)	Jassid injury index
KC 2	34.00	6.93	5.00	6.83	3.47	1.00
SVPR 2	25.87	5.77	3.43	4.00	2.57	2.30
SVPR 3	20.27	6.10	3.33	6.27	2.13	2.15
SRT 1	28.53	5.23	4.00	4.83	2.20	2.30
Laxmi	24.17	6.07	3.20	2.83	2.10	2.30
Stoneville	33.57	6.90	4.23	6.67	3.67	1.60
DHY 286	38.80	6.80	3.53	6.60	3.17	2.00
Khandwa 2	29.50	6.17	3.20	3.33	2.10	2.00
Badnawar 1	22.47	6.17	5.40	6.17	3.10	2.80
B 1007	30.90	6.17	4.87	6.60	1.90	2.40
MCU 5	18.67	6.33	4.63	5.17	2.60	2.15
MCU 7	10.50	5.77	3.13	5.50	2.63	3.30
MCU 12	23.03	5.63	3.40	6.83	2.67	2.30
Mean	**26.18**	**6.15**	**3.95**	**5.46**	**2.63**	**1.98**
CD (p=0.05)	4.26	0.44	0.41	0.82	0.31	0.80

varied from 5.83 in SRT 1 x MCU 5 to 9.33 in KC 2 x MCU 5. The hybrids KC 2 x MCU 5, SVPR 2 x MCU 5, DHY 286 x MCU 5, DHY 286 x MCU 12, B 1007 x MCU 5, B 1007 x MCU 7 and B 1007 x MCU 12 exhibited significantly higher number of gossypol glands.The association between morphological parameters with jassid susceptibility grade is given in Table 3. The correlation coefficients between trichome density and gossypol glands on the one hand and jassid susceptibility grade on the other were showed significant negative correlation.

Table 2. Morphological and biochemical constituents and mean jassid injury index of hybrids

Parents	Trichome density/ microscopic field	Gossypol gland density/ microscopic field	Tannin (mg/g)	Total phenols (mg/g)	Gossypol (%)	Jassid injury index
KC 2 x MCU 5	37.00	9.33	4.47	13.17	2.93	1.30
KC 2 x MCU 7	30.67	6.10	4.43	11.00	2.80	1.5
KC 2 x MCU 12	31.33	7.27	4.10	12.17	2.10	1.6
SVPR 2 x MCU 5	27.00	8.27	4.93	13.00	1.80	2.15
SVPR 2 x MCU 7	23.73	6.03	4.53	12.00	1.13	2.15
SVPR 2 x MCU 12	22.00	5.90	4.20	8.50	1.33	2.12
SVPR 3 x MCU 5	21.00	6.33	3.27	9.33	1.57	2.18
SVPR 3 x MCU 7	22.83	6.40	3.47	6.70	1.40	2.28
SVPR 3 x MCU 12	26.77	7.23	4.30	11.67	1.97	1.78
SRT 1 x MCU 5	26.83	5.83	4.87	6.70	1.57	2.0
SRT 1 x MCU 7	26.00	6.10	4.03	11.50	1.27	1.8
SRT 1 x MCU 12	22.30	5.90	5.00	8.17	2.10	2.0
Laxmi x MCU 5	21.67	6.33	4.67	6.50	1.87	2.0
Laxmi x MCU 7	22.33	6.57	4.33	7.67	1.87	2.25
Laxmi x MCU 12	21.90	6.33	3.27	7.33	2.10	2.0
Stoneville x MCU 5	33.50	6.83	5.37	8.17	3.53	1.50
Stoneville x MCU 7	30.00	6.50	4.23	8.67	3.27	1.64
Stoneville x MCU 12	29.00	6.00	4.63	8.50	3.53	1.33
DHY 286 x MCU 5	37.00	8.17	3.77	7.50	3.27	1.48
DHY 286 x MCU 7	31.67	6.67	3.47	7.33	3.37	1.72
DHY 286 x MCU 12	31.67	8.27	4.20	8.50	3.37	1.65
Khandwa 2 x MCU 5	28.83	6.67	4.33	9.17	1.30	1.72
Khandwa 2 x MCU 7	26.93	6.43	4.60	10.67	1.90	3.1
Khandwa 2 x MCU 12	32.00	6.33	3.57	9.20	1.50	2.0
Badnawar 1 x MCU 5	28.33	6.50	4.13	10.10	2.50	1.6
Badnawar 1 x MCU 7	26.20	6.17	3.67	9.80	2.13	2.0
Badnawar 1 x MCU 12	26.67	6.50	4.73	11.83	2.57	1.8
B 1007 x MCU 5	30.67	8.57	3.63	9.50	2.03	2.12
B 1007 x MCU 7	29.00	8.37	5.00	8.50	1.77	2.25
B 1007 x MCU 12	30.33	8.67	3.27	10.50	2.63	1.70
Mean	**27.84**	**6.88**	**4.22**	**9.44**	**2.21**	**1.89**
CD (p=0.05)	3.54	1.07	0.35	0.92	0.28	0.29

In the present study, resistant parents *viz.,* KC 2, Stoneville and DHY 286 had more number of trichomes on the adaxial surfaces of leaves pointing to the fact that density of the hair exclusively determines the resistance to jassid in cotton. Significant negative correlation between trichome density and jassid susceptibility grade (r = -0.65) was also observed. Density of trichomes conferring resistance was also reported and Murugesan and Kavitha (2010). There are quite a number of evidences to show that resistant cotton varieties contain high density of long trichomes on the under surface of leaves contributing resistance to hopper (Murugesan and Kavitha, 2010). The resistant genotype Khandwa 2 had less trichome density. Glabrous *hirsutum* types can withstand jassid attack under certain conditions. In this study however, the resistant hybrids KC 2 x MCU 5, KC 2 x MCU 12, Stoneville x MCU 5, DHY 286 x MCU 5, DHY 286 x MCU 7, DHY 286 x MCU 12, Khandwa 2 x MCU 12 displayed maximum trichome density.

In the present investigation, the leaves of resistant genotypes KC 2, Stoneville and DHY 286 also recorded higher gossypol gland density establishing a close relationship between jassid resistance and high gossypol gland density. Similarly, the resistant hybrids also had significant gossypol gland density and supported the earlier inference that resistance is highly correlated with the density of gossypol glands. Statistically the correlation coefficient was significant and negative between jassid susceptibility grade and the density of glands. Negative correlation of gossypol gland density with bollworm damage was reported.

Table 3. Correlation co efficients among morphological and biochemical constituents with jassid susceptibility grade

Constituents	Jassid susceptibility grade
Trichome density	- 0.65**
Gossypol glands	- 0.37 *
Tannin	- 0.17
Total phenols	- 0.32 *
Gossypol	- 0.40 **

* Significant at 5 per cent level

** Significant at 1 per cent level

Biochemical studies: Biochemical factors are important components in conferring non-preference and antibiosis in insect resistance. There is very little information available on the biochemical basis of resistance to jassids on different cotton varieties. Several secondary plant metabolites are alleyed to confer resistance to many insects and mites in cotton. Allelochemicals mediated interactions have gained increasing importance in host plant resistance studies recently. Allelochemicals produced by plants also considerably influence prey / host selection behaviour of insects so that the plant, herbivores and natural enemies are interconnected through the well knit array of chemicals. In the present study, efforts were made to understand the significance of chemically mediated interactions and also to study the possible role of phenols, tannins, and gossypol to elucidate the biochemical bases of non-preference. Apart from pubescence, some other factors such as the presence of certain chemical substances in plants confers resistance to jassid either through non-preference or antibiosis or both.

The tannin content in leaves ranged from 3.13 mg in MCU 7 to 5.40 mg in Badnawar 1.

The tannin content was significantly higher in Badnawar 1 (5.40 mg). While MCU 7 recorded a very low value of 3.13 mg. The highest tannin content was recorded by the hybrids Stoneville x MCU 5 (5.37 mg) followed by B 1007 x MCU 7 (5.00 mg) while the lowest tannin content was recorded by the hybrids SVPR 3 x MCU 5, Laxmi x MCU 12 and B 1007 x MCU 12 (3.27 mg).

The content of total phenols ranged from 2.83 mg to 6.83 mg recorded by Laxmi, KC 2 and MCU 12. Among the parents the total phenol content was higher in KC 2, MCU 12, Stoneville, B 1007 and DHY 286.Among the hybrids Laxmi x MCU 5 and KC 2 x MCU 5 recorded the lowest and highest values of 6.50 mg and 13.17 mg (Table 1 and 2).

The gossypol content in leaves varied from 1.90 to 3.67 per cent recorded by B 1007 and Stoneville, respectively. The gossypol content was higher in the parental genotypes Stoneville, KC 2 and Badnawar 1, the values being 3.67, 3.47 and 3.10 per cent, respectively. Among hybrids gossypol content was the highest in the hybrids Stoneville x MCU 5, Stoneville x MCU 12 (3.53%) and lowest in the hybrid SVPR 2 x MCU 7.

The association between biochemical constituents with jassid susceptibility grade is given in Table 3. The correlation coefficients between total phenol and gossypol content on the one hand and jassid susceptibility grade on the other were showed significant negative correlation except for tannin content. The tannin content did not show a significant association with jassid injury index.

In the present study, significant amount of tannin was observed in only one resistant variety KC 2, but susceptible varieties such as Badnawar 1, B 1007 and MCU 5 also contained significant tannin content. So also, the resistant hybrids SVPR 2 x MCU 5, SRT 1 x MCU 5, Laxmi x MCU 5, Stoneville x MCU 5, Badnawar x MCU 12 recorded significant tannin content. There was a negative correlation between tannin content and jassid susceptibility in the present study.

Total phenol content was high in resistant varieties KC 2 and Stoneville. The correlation between total phenol content and jassid susceptibility was also negative and significant. These results are in conformity with those of Rohini *et al.,* 2011; Shinde *et al.,* (2014); Venkatesha (2014); Harijan *et al.,* 2017. In the present study, among the hybrids most of the resistant combinations had high amount of total phenol as reported by Harijan *et al.,* 2017.

Gossypol, a naturally occurring polyphenolic compound as a source of resistance was under investigation for several years. It was observed in the present study that the gossypol content was high in resistant varieties proving its role in resistance. It showed significant negative correlation with jassid susceptibility grade. High concentration of gossypol was responsible for resistance. From the observations made above, it may be suggested that jassid resistance in cotton appears to be controlled by the inherent capacity of the plant to produce higher quantities of total phenol and gossypol. These two chemicals can be used as an index for screening large populations for jassid resistance and short list the progenies for evaluation at the field level. The cultivars with such chemical constututents can be incorporated for further breeding work to evolve jassid resistant varieties. Apart from this, trichome density on the adaxial surface of leaf play are important role in conferring resistance. It was also concluded that selection and utilization of genotypes with more number of trichome density and gossypol glands in breeding programme may aid in developing genotypes resistance to jassid in cotton.

REFERENCES

Armstrong, S., Coleman, R.J. and Setamou. 2009. Oviposition patterns of Creontiades signatus on Okra – leaf and normal leaf cotton. *Ann. Ent. Society of America* **102 :** 196 – 200.

Halder, J., Sanwal, S. K., Dibyendu, Deb, Rai, A. B. and Singh, B. 2016. Mechanisms of physical and biochemical basis of resistance against leaf hopper (*Amrasca biguttula biguttula*) in different Okra genotypes. *Indian J. Agric. Sci.* **86 :** 57- 60.

Halder, J. and Srinivasan, S. 2011. Varietal screening and role of morphological factors on distribution and abundance on spotted pod borer, *Moruca Virata* in mung bean. *Jour. Entomol. Res.* **30 :** 313- 16.

Harijan, Y., Nishanth, G.K., Katageri, I.S., Khadi, B.M. and Patil, B.R. 2017. Biochemical and Anatomical Factors Imparting Resistance against Sucking Pests in Cotton. *Int.J.Curr.Microbiol.App.Sci.* **6 :** 2542-53

Murugesan, N. and Kavitha, A. 2010. Host plant resistance in cotton accessions to the leafhopper, *Amrasca devastans* (Distant). *Jour. Biopest.* **3 :** 526-33.

Nawab, N.N., Khan, I. A., Khan, A.A. and Amjad, M. 2011. Characterization and inheritance of cotton leaf pubescence. *Pak. J. Bot.* **43 :** 649 – 58.

Nawab, N. N., Mehmood, A., Jeelani, G., Farooq, M. and Khan, T. N. 2014. Inheritance of okra leaf type, gossypol glands and trichomes in cotton. *The J. Anim. Plant Sci.* **24:** 526-33.

Rohini, A., Prasad, N.V., Chalam, M. S.V. and Veeraiah, K. 2011. Identification of suitable resistant cotton genotypes against sucking pests. *J. Ent. Res.* **35 :** 197-202.

Shinde, B. A., Gurve, S.S., Gonde, A.D. and Hole, U. B. 2014. Studies on resistance of cotton genotypes against jassids (*Amrasca biguttula biguttula* Ishida). *Bioinflolet.* **11:** 758 -62.

Venkatesha, K. T. 2014. Studies on resistance to jassids *Amrasca devastans* (Dist.) in cotton (*Gossypium hirsutum* L.). *Karnataka Jour. Agric. Sci.* **27 :** 378 – 426.

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