International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 166-169

Received: 25-05-2019
Accepted: 27-06-2019

RS Bhoge
All India Co Ordinated Cotton Improvement Project, MPKV, Rahuri, Maharashtra, India

UB Hole
All India Co Ordinated Cotton Improvement Project, MPKV, Rahuri, Maharashtra, India

SM Gangurde
All India Co Ordinated Cotton Improvement Project, MPKV, Rahuri, Maharashtra, India

RS Wagh
All India Co Ordinated Cotton Improvement Project, MPKV, Rahuri, Maharashtra, India

Correspondence
RS Bhoge
All India Coordinated Cotton Improvement Project, MPKV, Rahuri, Maharashtra, India

Biochemical and morphological factors responsible for jassid resistance in cotton

RS Bhoge, UB Hole, SM Gangurde and RS Wagh

Abstract
The field experiments were conducted at All India Coordinated Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri for three consecutive years from 2015-16 to 2017-18 for studying biochemical and morphological factors responsible for resistance against jassids on cotton. Results indicated that based on infestation of jassids, biochemical and morphological traits of cotton, the genotype GISV 272 is recommended as resistant source against jassid. Correlation studies revealed that trichome density of cotton genotype had negative direct effect (- 0.996) on jassid infestation. Thickness of leaf midrib has positive and direct effect (0.947) on jassid infestation. Thickness of leaf lamina, gossypol content and total phenols showed significant and negative (-0.973, -0.974 and -0.928) correlation with jassid incidence. The peroxidase activity and polyphenol oxidase activity was higher in GISV-272 and showed significant positive correlation with jassid incidence (0.977 and 0.938). Nitrogen and phosphorus content showed significant positive (0.854 and 0.986) correlation with jassid incidence.

Keywords: Cotton genotypes, resistance jassid, biochemical traits, morphological traits

Introduction
Cotton (*Gossypium hirsutum* L) is a fibre, feed and food crop widely cultivated in India. It is popularly called as friendly fiber because of its versatility, appearance, performance and all its natural comfort. Cotton is attacked by a large number of insect pests right from sowing till harvest. In India, the cotton ecosystem harbors about 162 species of insects which are known to devour cotton at various stages of growth, of which 15 are considered to be key pests. In early stages, sucking pests like aphids, thrips, jassids and whiteflies and in later stage, different kinds of bollworms cause reduction in yield and quality of cotton. Among many production constraints of this crop, in the recent years, incidence of sucking pest, *Amrasca biguttula biguttula*, also called *Amrasca devastans* (Dist.), has become serious not only in India, but also in Pakistan, Bangladesh, Thailand and other South East Asian countries. This is prevalent from vegetative to reproductive phase of the crop growth. Nymphs and adults of this insect cause damage by sucking cell sap from leaves which results in yellowing, reddening and drying of leaves characteristics of phtotoxaemia, called " hopper burn" leading to significant yield loss. In severe cases of infestation jassid causes yield reduction upto 24.45 % (Ahmed *et al*, 2005).The differential survival of pest on resistant and susceptible varieties has been attributed mainly to morphological, nutritional and antinutritional factors (Singh and Agarwal, 1988). In any Integrated Pest Management programme, a genetically resistant cultivar is the base over which other tactics are pyramided to have an effective pest management system. Identification and use of a resistant cultivar is of great relevance these days as it is eco- friendly and cost effective. Hence present investigation was undertaken to study biochemical and morphological factors responsible for jassid resistance in cotton.

Materials and Methods
The field experiment was conducted during *kharif* season for three consecutive years during 2015-16 to 2017-18 at All India Coordinated Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, and Rahuri. Experiment was conducted in a Randomized Block Design with ten cotton genotypes replicated thrice. One set of experiment was sown under net house and another same set was sown outside net under natural condition. The observations were recorded on infestation of jassids at the peak infestation in natural condition and artificial bombarding condition. The values were then transformed to square root transformation for

Number. The data were subjected to statistical analysis and the results are presented in table 1 to 3. The data regarding biochemical parameters *viz*; gossypol, total phenols, peroxidase and polyphenol oxidase activity ash, nitrogen, phosphorus and potassium content were estimated from leaf at 120 days after sowing. Morphological characters like trichome density (no/cm^2), Thickness of leaf midrib (mm), Thickness of leaf lamina (mm), leaf colour and leaf texture were also recorded.

Result and Discussion

Jassid population comparison on different cotton cultivars: Results indicated that (Table 1) that more number of jassids were recorded inside net condition on cotton genotypes than natural condition. Inside net GISV 272 recorded lowest number of jassids/3 leaves i.e. 5.88 jassids/3leaves. In susceptible check DCH 32 recorded highest number of jassids (16.30jassids/3 leaves) and in resistant check DHY 286 recorded lowest number of (4.63 jassids/3leaves). In natural condition GISV 272 lowest number of jassids/3 leaves i.e. 3.71 jassids/3leaves. In susceptible check DCH 32 recorded highest number of jassids (13.09 jassids/3 leaves) and in resistant check DHY 286 recorded lowest number of (3.13 jassids/3 leaves) jassids. The genotype GISV 272 was found resistant to jassids as it recorded lowest number of jassids inside net condition and natural conditions.

Morphological characters

GISV 272 recorded higher number of trichomes (107.64/cm^2) and it was at par with resistant check DHY 289 (113.23/cm^2). GISV 272 recorded (Table -2) lowest midrib thickness (1.24 mm) and highest thickness of leaf lamina (0.32 mm) which is responsible for jassid resistance. Results projected that more the thickness of leaf lamina, less the jassid population. These results are confirmed by Ashfaq *et al* (2010) [2] and Khan *et al* 2017. Dense hairy leaves cotton varieties showed negative impact on feeding and reproduction of Jassid as reported by Murugsen and Kavita 2010. Pale green and waxy leaves were found in GISV 272, while in susceptible check DCH-32 recorded minimum trichomes (48.45/ cm^2)

Biochemical characters

Relatively high gossypol content was noticed (Table -3) in GISV 272 which was less susceptible to jassids (7.82 mg/gm). Maximum amount of total phenols was recorded in GISV 272 (10.59 mg/gm) while susceptible check DCH-32 recorded lower gossypol and total phenol content i.e. 2.38 and 8.62 mg/gm, respectively. Maximum peroxidase and polyphenol oxidase activity was noticed in cotton genotype GISV-272 (3.19 and 2.52 ΔO.D./min/gm) while less activity was noticed in DCH-32 (1.14 and 1.57 ΔO.D./min/gm), respectively. High phenol and gossypol content in GISV- 272 impart resistance against Jassid. Rohini *et al* (2011) [11] reported about role of phenols and gossypol in resistance.

Correlation of Jassid population with morphological and biochemical traits: Correlation studies from table 4 revealed that trichome density of cotton genotype had negative direct effect (-0.996) on jassid infestation. Thickness of leaf midrib has positive and direct effect (0.947) on jassid infestation. Thickness of leaf lamina, gossypol content and total phenols showed significant and negative correlation with jassid incidence. The peroxidase activity and polyphenol oxidase activity was higher in GISV-272. Nitrogen and phosphorus content showed significant and positive correlation with jassid incidence. While potassium content indicated significant negative (-0.965) correlation with jassid incidence (Kanher *et al*, 2016) [5].

The use of the resistant genotype is the familiar tool for the bio-intensive pest management. The physiomorphic plant characters of the plant are associated with attraction, feeding and egg laying of the insect pests. Development of the resistant varieties to insect pest is an important strategy of the pest management. The physical and morphological characters of the resistant variety may lead to the introduction of resistance character to favored genotype. Resistance mechanisms related to morphological and structural plant features that impair normal feeding or oviposition by insects, or action of other mortality. The morphological characteristics of the host plant may also influence the nutrition of the insect by limiting the amount feeding due to shape, colour or texture of the nutritive material and influence the digestibility and utilization of food by insect. (Bhatti *et al*, 2015) [3].

In conclusion, the present studies showed those biochemical and morphological factors are considered to play major role in the resistance mechanism against Jassid. The studies on mechanism of resistance revealed that jassids discriminate cotton entries for orientation, settling and feeding. Highly susceptible entries are preferred for settling and feeding whereas varieties less preferred for settling are less preferred for oviposition too. This study would help in pest management of cotton by growing those cotton varieties showing minimum numbers of jassids.

Table 1: Incidence of jassids on different cotton genotypes (Pooled w.e.f. 2015-2017)

SR. no.	Genotypes	Jassids/3 leaves In Net	Jassids/3 leaves Outside Net	Jassid injury grade	Yield (q/ha) Inside net	Yield (q/ha) Outside Net
1	GISV 272	5.88 (2.53)*	3.71 (2.05)	I	7.37	8.39
2	AKH-13-51	8.25 (2.96)	5.07 (2.36)	I	6.50	7.52
3	P-388	12.85 (3.65)	11.01 (3.39)	III	4.05	5.07
4	P-492	12.59 (3.62)	9.36 (3.14)	III	5.93	6.95
5	P-688	12.00 (3.54)	8.13 (2.94)	III	5.44	6.46
6	Ajeet 155	12.80 (3.65)	10.49 (3.31)	IV	9.78	11.80
7	MRC 7351	9.66 (3.19)	7.82 (2.88)	IV	8.12	9.14
8	DCH 32 (SC)	16.30 (4.10)	13.09 (3.69)	IV	3.24	4.26
9	DHY286 (RC)	4.63 (2.27)	3.13 (1.91)	I	8.17	9.19
10	Phule Yamuna	11.08 (3.40)	8.66(3.03)	III	6.67	7.69
	SE ±	0.13	0.14		0.30	0.28
	CD at 5%	0.39	0.42		0.91	0.85
	CV %	7.47	8.58		9.87	8.42

(*Figures in parenthesis are √x+0.5 transformed values for numbers)

Table 2: Morphological traits related to jassid resistance in cotton genotypes.

Sr no.	Genotypes	Trichome density/cm^2	Thickness of leaf midrib (mm)	Thickness of leaf lamina (mm)	leaf colour	leaf texture
1	GISV 272	107.64	1.24	0.32	Pale green	waxy
2	AKH-13-51	102.45	1.27	0.31	Pale green	waxy
3	P-388	46.15	1.28	0.26	green	rough
4	P-492	46.15	1.43	0.29	green	smooth
5	P-688	75.23	1.38	0.30	green	smooth
6	Ajeet 155	96.84	1.20	0.33	Pale green	waxy
7	MRC 7351	88.84	1.26	0.32	Pale green	waxy
8	DCH 32 (SC)	48.45	1.46	0.27	green	smooth
9	DHY286 (RC)	113.23	1.25	0.33	Pale green	waxy
10	Phule Yamuna	82.61	1.32	0.30	Pale green	smooth
	SE ±	1.18	0.02	0.03		
	CD at 5%	3.53	0.06	0.09		
	CV %	4.16	3.78	4.37		

Table 3: Biochemical characters responsible for jassid resistance in cotton genotypes.

Sr. No.	Genotypes	Gossypol (mg/gm)	Total phenols (mg/gm)	Peroxidase activity (ΔO.D./min/gm)	Polyphenol oxidase activity (ΔO.D./min/gm)	Ash Content (%)	Nitrogen (%)	Phosphorous (%)	Potassium (%)
1	GISV 272	7.82	10.59	3.19	2.52	7.79	3.64	1.05	2.02
2	AKH-13-51	7.11	10.57	3.11	2.27	7.86	3.68	1.21	2.83
3	P-388	2.36	8.78	1.13	1.52	3.78	5.32	1.43	1.47
4	P-492	3.07	8.92	1.73	1.69	4.17	5.29	1.36	1.67
5	P-688	5.10	3.08	2.54	2.17	5.37	4.15	1.30	1.68
6	Ajeet 155	6.78	10.57	3.03	2.49	7.03	4.00	0.89	2.06
7	MRC 7351	6.22	10.47	2.75	2.15	7.77	4.03	0.94	1.83
8	DCH 32 SC)	2.38	8.62	1.14	1.57	3.72	5.42	0.98	1.49
9	DHY286 (RC)	7.96	11.02	3.27	2.67	7.87	3.29	1.04	2.06
10	PhuleYamuna	5.72	3.38	2.68	2.23	6.10	4.12	1.34	1.75
	SE ±	0.64	0.11	0.16	0.15	0.25	0.11	0.03	0.07
	CD at 5%	1.91	0.32	0.48	0.46	0.75	0.33	0.08	0.22
	CV %	4.15	5.17	3.26	4.11	4.65	3.56	3.72	4.17

Table 4: Correlations of different biophysical and biochemical plant characters of cotton Genotypes with jassid incidence.

Sr. No.	Characters	Correlation with jassid infestation
1	Trichome density /cm^2	-0.996**
2	Thickness of leaf midrib (mm)	0.947*
3	Thickness of leaf lamina (mm)	-0.973*
4	Gossypol content (mg/gm)	-0.974*
5	Total phenols (mg/gm)	-0.928**
6	Peroxidase activity (ΔO.D./min/gm)	0.977*
7	Polyphenol oxidase activity (ΔO.D./min/gm)	0.938*
8	Ash content (%)	-0.938*
9	Nitrogen (%)	0.854*
10	Phosphorous (%)	0.986*
11	Potassium (%)	-0.965**

* Significant at 5% ** Significant at 1%

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