Screening brinjal genotypes for resistance to jassid (*Amrasca biguttula biguttula* [Ishida])

C.D. Malini[1], K.P. Prasanna*[2] and T.R. Gopalakrishnan[3]

[1]*Agricultural Officer, Krishi Bhavan, Valapad.,* [2]*Professor, Department of Olericulture, College of Horticulture, Kerala Agricultural University, Thrissur.,* [3]*Director of Research, Kerala Agricultural University, Thrissur.*

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Abstract

An investigation was carried out in the Department of Olericulture, College of Horticulture, Kerala Agricultural University, Vellanikkara for screening brinjal genotypes for tolerance/ resistance to jassids. The accessions SM 363, SM 364, SM 366, SM 384 and SM 385 were found resistant to jassid infestation in the field screening as well as in artificial screening in cages. The morphological and anatomical bases of resistance were also unraveled. High midrib hair density and longer midrib hairs were found to impart resistance to jassids in the resistant accessions. Anatomical studies of midrib of susceptible and resistant accessions revealed variation in cuticle thickness, cell wall thickness of epidermal cells and intercellular space of hypodermal cells. These characters, either alone or in combination, may be contributing resistance to oviposition or feeding of jassids in brinjal.

Key words : Brinjal, Jassids, Resistance, Morphology, Anatomy

Introduction

Brinjal (*Solanum melongena* L.), also called as egg plant or aubergine is one of the most important vegetable crops of India, for the production of which the country occupies the second position in the world. The main constraint in cultivation of brinjal is the occurrence of pests and diseases. During summer season, cultivation of brinjal is limited in Kerala due to severe incidence of sucking insects especially jassids or leaf hoppers (*Amrasca biguttula biguttula*) which affect the yield considerably. Jassids cause debilitatory effects even at early stage of crop growth. In addition, it disrupts transportation in conducting vessels and apparently introduces a toxin that impairs photosynthesis in proportion to the amount of feeding (Sharma and Chander, 1998). Chemical control measures are not fully effective since jassids are highly mobile and they concentrate more on the ventral surfaces of leaves. Moreover, the harmful effects of chemical pesticides have to be considered seriously. It is therefore imperative to think of developing jassid resistant/tolerant varieties which can be the most economical, eco-friendly, and sustainable method of pest control. Utilization of host resistance for the population management of crop pests is one of the well known approaches in crop production research. Even a low level of resistance could be effective by way of reducing the viability of pests and favouring the activity of natural enemies to the extent of effective natural control. Identification of sources of resistance by screening the germplasm and related species and working out the mechanisms of resistance are essential steps in developing genotypes with desired levels of resistance. So a study was conducted to select jassid resistant brinjal accessions from the available brinjal accessions and related species. An effort was also made to unravel the morphological and anatomical bases of this resistance.

*Author for correspondences: Phone +919446071362; E-mail: <prasannaoleri@yahoo.co.in>.

Materials and Methods

Field screening for jassid tolerance/resistance was carried out during rabi and summer seasons, 2005 in the Department of Olericulture, College of Horticulture, Vellanikkara. During rabi season, 29 accessions were evaluated from November to April and during summer season 36 accessions were evaluated from February to July along with a related species, *Solanum macrocarpon,* during both the seasons. The experiment was laid out in randomized block design with two replications.

Jassid population on plants was assessed by noting the number of nymphs on top, middle and lower leaves of five plants each from the starting of pest infestation. Since the adult leaf hoppers are highly mobile, their count on individual leaves will not give a reliable estimation of pest infestation intensity. Counting of nymphs was continued at weekly intervals until there was a sharp decrease in the number of nymphs.

Based on the intensity of hopper burn symptoms on leaves, brinjal accessions were categorized into different resistant/susceptibility classes. The visual assessment of hopper burn intensity was converted into numerical values by calculating the per cent intensity of infestation, adopting the formula given below.

$$\text{Per cent intensity} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of leaves assessed}} \times \frac{100}{\text{Max. grade}}$$

Scoring of plants for hopper burn symptoms on the leaves was done using 0 - 4 scale as suggested by Singh and Rai (1995) and the grades are given below.

Grade	Intensity of infection
0	Healthy green leaves
1	Slight yellowing of leaf margin
2	Yellowing and necrosis of leaf margin
3	Intensive yellowing and necrosis of leaves
4	Complete necrosis of leaves

Based on the per cent intensity of infection, the accessions were grouped into five categories as suggested by Singh (1996).

Per cent intensity	Category
0	Immune
1 - 10	Highly resistant
10.1 - 25	Moderately resistant
25.1 - 50	Moderately susceptible
Above 50	Highly susceptible

Artificial infestation and screening of plants under cages

The brinjal accessions, identified as resistant to jassid infestation in the field trials on the basis of hopper burn symptoms and nymphal population during rabi season, were subjected to artificial infestation under cages during summer season. One plant each was maintained in a pot covered with an insect proof cage. When plants reached eight to ten leaf stage, 10 nymphs of medium size were released on each caged plant. Survival and reproductive ability of the nymphs were noted by recording the number of surviving nymphs after four days, and number of adults and newly emerged nymphs after 10 and 16 days. The frequency of observations was fixed based on the report that leaf hoppers take eight days for nymphal development (Mahal and Singh, 1982). Insect release was repeated three times on the same plants for confirmation.

Morphological and anatomical bases of resistance

Morphological characters like leaf thickness, midrib thickness, density and length of midrib hairs and anatomical parameters like cuticle thickness and epidermal cell wall thickness of midrib were observed at flowering stage for unraveling the mechanisms of jassid resistance.

Results and Discussion

Results of the experiment revealed that jassid infestation was absent in the nursery stage during rabi (November - April) as well as summer (February - July) seasons. In the rabi season, jassid infestation was noticed from 45th day after transplanting (DAT). The infestation started with more or less same population density on all the accessions. Weekly observations were recorded from 48 DAT up to 90 DAT, when the jassid population started to decrease. The statistical analysis of the data showed significant variation in jassid infestation on different accessions.

Weekly observations at 48 DAT, 55 DAT, 64 DAT, 72 DAT, and 80 DAT showed a steady increase in jassid population reaching its peak at 80 DAT (Fig. 1). Number of nymphs per leaf was as high as 7.16 in SM 343 followed by SM 344 and SM 362 with on par values (7.03 and 7.00 respectively). The accessions like SM 364, SM 365, SM 366 and SM 384 recorded significantly lower jassid population than all others tested. The related species, *S. macrocarpon,* recorded lowest number of jassids per leaf at all the stages.

At 90 DAT the intensity of jassid infestation came down to 3.95 nymphs per leaf in SM 362, which had the highest count at this stage. SM 363, SM 364, SM 365, SM 366, SM 384 and SM 385 recorded significantly lower nymphal count than the rest of the lines except *S. macrocarpon,* which recorded the lowest nymphal count per leaf (0.6) throughout the study.

During summer season observations were recorded from 20 DAT, i.e., the day on which jassids first appeared, to 62 DAT when there was a significant reduction in nymphal count. At 20 DAT highest jassid infestation was recorded on SM 354 and SM 362 (3.85 nymphs per leaf). Number of nymphs were minimum on SM 363 (1.25) followed by SM 384 (1.55). On *S. macrocarpon,* nymphal count was significantly lower (0.85) than on *S. melongena* lines.

Jassid infestation reached its peak at 35 to 40 DAT. At 36 DAT the jassid count was as high as 9.85 nymphs per leaf in SM 389 and SM 343. As in the previous season, the accessions SM 363, SM 364, SM 365, SM 366, SM 384 and SM 385 recorded significantly lower nymphal count at the peak infestation stage also (3.35, 3.75, 3.45, 3.75, 3.45 and 3.9 nymphs/leaf respectively). During summer the jassid population came down drastically by about 60 DAT when SM 364 and SM 384 recorded the lowest values of nymphal count per leaf among *S. melongena* accessions (1 and 1.4 respectively). Here also the lowest count was recorded in *S. macrocarpon* (0.2 nymphs/leaf).

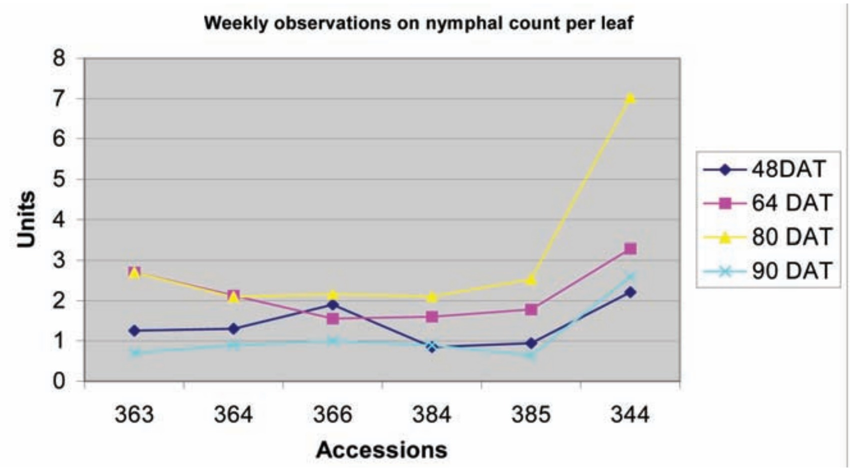


Figure 1. Weekly observations on number of nymphs per leaf on jassid resistant (SM 363, SM 364, SM 366, SM 384, SM 385) and susceptible (SM 344) accessions.

The aggregation of jassid population on susceptible varieties and consequently a lower jassid infestation on resistant plants during the field trials of rabi and summer seasons hints that a type of non-preference or antixenosis mechanism may be acting. Non-preference or antixenosis is the avoidance of plants by the insects in search of food, shelter or ovipositional site (Painter, 1951).

Based on the intensity of hopper burn symptoms, the brinjal accessions were categorized into resistant /susceptibility classes (Table 1). Six *S. melongena* accessions *viz.,* SM 363, SM 364, SM 365, SM 366, SM 384 and SM 385 and *S. macrocarpon* were categorized as immune. Even though immunity is a generic or species-specific character and not a varietal character, since the above *S. melongena* accessions recorded a percentage intensity value of zero, they had to be included under the immune class. SM 348, SM 350, SM 351, Neelima and Surya were categorized as moderately resistant. Most of the accessions *viz*., SM 337, SM 345, SM 347, SM 354, SM 355, SM 356, SM 360, SM 361 and SM 369 were classified as moderately susceptible. SM 339, SM 343, SM 344, SM 362, Swetha and Haritha were highly susceptible to jassid attack with an intensity value of more than 50 per cent.

Table 1. Categorization of brinjal accessions based on % intensity of Jassid infestation

Accessions	% intensity	Category	Nymphs/leaf
Neelima	16.66	MR	3.13
Surya	16.25	MR	4.65
Swetha	55.00	HS	6.37
Haritha	50.10	HS	6.78
SM 337	41.66	MS	4.86
SM 339	58.33	HS	6.78
SM 343	62.50	HS	7.16
SM 344	56.25	HS	7.03
SM 345	33.33	MS	4.73
SM 347	30.00	MS	4.08
SM 348	18.75	MR	3.50
SM 350	25.00	MR	3.99
SM 351	20.00	MR	3.69
SM 353	37.50	MS	4.99
SM 354	50.00	MS	6.30
SM 355	45.00	MS	5.40
SM 356	43.75	MS	5.90
SM 360	31.25	MS	6.10
SM 361	37.50	MS	6.10
SM 362	58.30	HS	7.00
SM 363	0.00	I	2.70
SM 364	0.00	I	2.09
SM 365	0.00	I	2.08
SM 366	0.00	I	2.16
SM 369	31.25	MS	4.00
SM 384	0.00	I	2.11
SM 385	0.00	I	2.54
Swetha X Haritha	25.10	MS	4.75
Solanum macrocarpon	0.00	I	1.85

I – Immune; MR – Moderately resistant; MS – Moderately susceptible; HS – Highly susceptible

Six *S. melongena* accessions *viz.,* SM 363, SM 364, SM 365, SM 366, SM 384 and SM 385, which were rated as immune to jassid attack during field trials, were further subjected to confirmation test under protected environment along with a susceptible accession SM 343 during summer season. The data are presented in Table 2.

The nymphal count at four days after release were 9, 10, 10, 8, 8, 7 on the resistant accessions SM 363, SM 364, SM 365, SM 366, SM 384 and SM 385 respectively and 10 on the susceptible accession SM 343. On the 10^{th} day after release the number of surviving nymphs was found to be less on resistant lines (6, 5, 4, 5 and 5 on SM 363, SM 364, SM 366, SM 384 and SM 385 respectively) compared to the susceptible accession SM 343 (9). However SM 365, which was rated as immune in the previous field trials, gave a better support to jassids inside the cage (8 adults per plant after 10 days of release) indicating its failure in the confirmation test. After 16 days of release the number of surviving adults and newly emerged nymphs were recorded on each plant. SM 363, SM 364, SM 366, SM 384 and SM 385 retained only 3, 2, 3, 3 and 2 adults respectively per plant. On SM 365 comparatively higher adult survival was observed (6 adults per plant) indicating its susceptibility. SM 343, which was a susceptible accession during field trials, retained 7 adults up to 16^{th} day of release. The number of emerged nymphs was 1, 0, 1, 2 and 1 on resistant accessions SM 363, SM 364, SM 366, SM 384 and SM 385 respectively and 6 on susceptible accession SM 343. Thus intensive screening of plants under cages revealed that the survival ability and reproduction capacity of nymphs were reduced on resistant plants. This indicated a strict antibiosis mechanism functioning in brinjal against jassids. Ruzzel (1978) and Lit and Bernardo (1990) also had reported that non-preference and antibiosis were together working to resist jassid attack in brinjal, in tune with the present result.

In the present study, no correlation between thickness of leaf or midrib and jassid resistance could be observed. But midrib hair density varied significantly from as high as 44.4 hairs per 25 mm^2 to as low as 2.13 hairs per 25 mm^2. The midrib hair length also showed significant difference between accessions (Fig. 2). The resistant accessions, namely SM 363, SM 364, SM 366, SM 384 and SM 385, were found to have higher midrib hair density as well as hair length than susceptible ones (Table 3).

Pubescence of leaf is a function of both hair length and hair density. More number of lengthy hairs will result in higher pubescence and consequently a better resistance towards jassids. Thus it was evident from the study that mid rib hairs of inadequate length or long hairs without adequate hair density is not fully effective in imparting resistance to oviposition of jassids in brinjal. According to Deole (2008) brinjal cultivars with smooth textured leaves were preferred more by the jassids compared to the cultivars with leaves having leathery texture or leathery texture with spines. Ali et al. (2012) also reported that the hair density and length of hair on

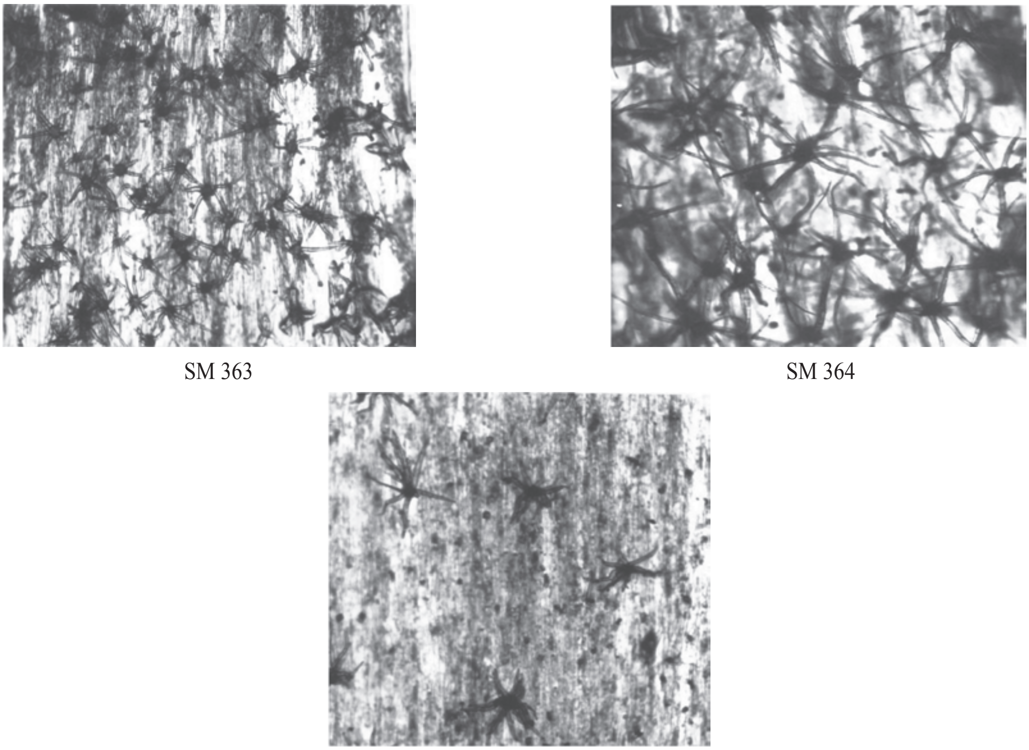
Table 2. Count of nymphs and adults per plant at different intervals during cage studies of jassid resistant accessions

Accessions	Nymphs released in cages	Count of jassids on plants under cages		
		After 4 days	After 10 days	After 15 days
SM 363	10	9 nymphs	6 adults	3 adults+1 nymph
SM 364	10	10 nymphs	5 adults	2 adults+0 nymph
SM 365	10	10 nymphs	8 adults	6 adults+4 nymphs
SM 366	10	8 nymphs	4 adults	3 adults+1 nymph
SM 384	10	8 nymphs	5 adults	3 adults+2 nymphs
SM 385	10	7 nymphs	5 adults	2 adults+1 nymph
SM 343	10	10 nymphs	9 adults	7 adults+6 nymphs

Table 3. Comparison of midrib hair length and hair density with jassid population on selected brinjal accessions

Variety/ accession	Length of mid rib hairs (mm)	Midrib hair density (no./ 25 mm^2)	No. of jassids: (80 DAT)	Jassid resistance category
SM 363	0.416	44.40	2.70	I
SM 364	0.463	34.22	2.09	I
SM 365	0.286	30.50	2.08	I
SM 366	0.540	18.20	2.16	I
SM 384	0.619	14.25	2.11	I
SM 385	0.543	15.45	2.54	I
Neelima	0.370	13.66	3.13	MR
SM 347	0.303	19.30	4.08	MS
SM 348	0.240	20.25	3.50	MS
SM 353	0.280	10.56	4.99	MS
SM 355	0.183	12.25	5.40	MS
SM 337	0.302	12.21	4.86	MS
SM 339	0.311	12.85	6.78	HS
SM 343	0.096	10.66	7.16	HS
SM 344	0.272	2.13	7.03	HS
CD	0.043	2.64	0.47	
CV	0.11	9.00	4.98	

I – Immune; MR – Moderately resistant; MS – Moderately susceptible; HS – Highly susceptible



SM 363 SM 364

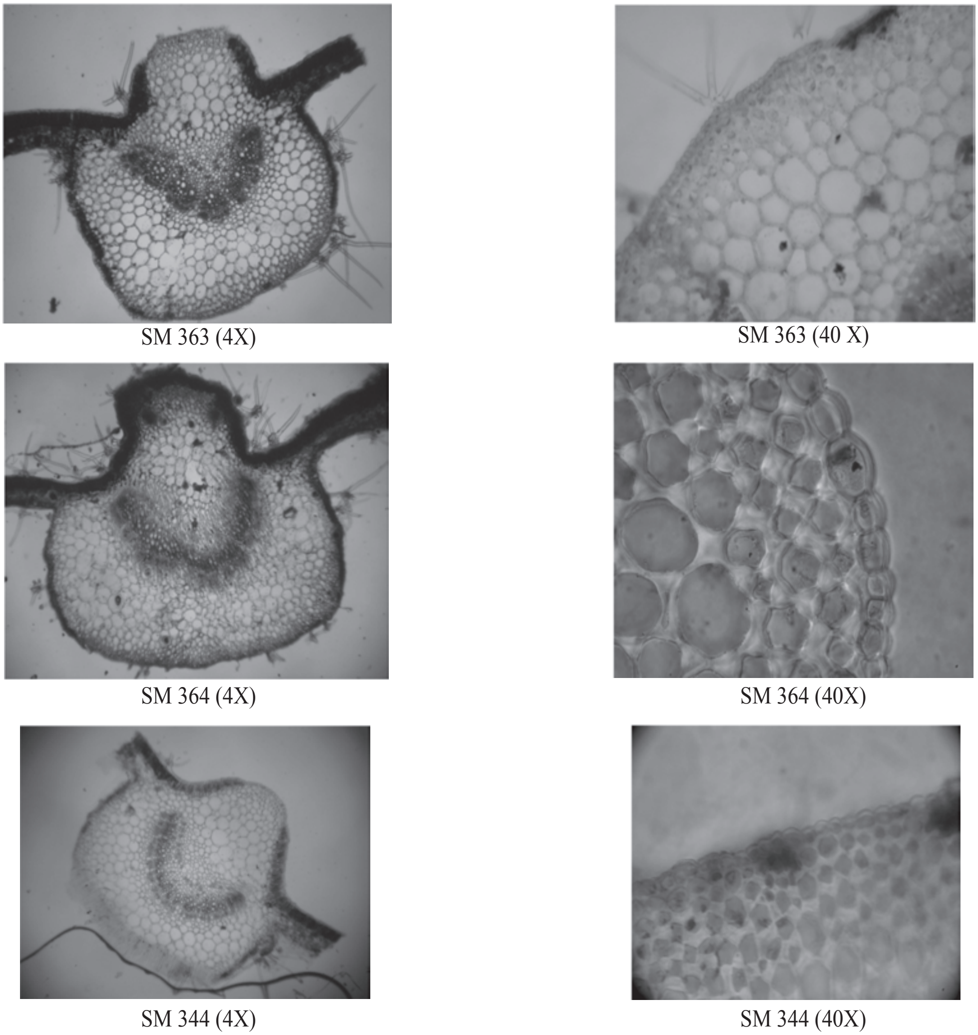
SM 344

Figure 2. Enlarged view of ventral surface of midrib showing mid rib hair length and density (25mm^2) in resistant (SM 363 and SM 364) and susceptible (SM 344) accessions

lamina, midrib, and veins of brinjal had highly significant and negative correlation with the jassid population. Uthamasamy (1985) also reported the influence of hairiness on the resistance of bhindi to the leaf hopper. All these reports were in conformity with the present findings.

The cuticle thickness of the resistant accessions *viz*., SM 363, SM 364, SM 366, SM 384 and SM 385 were 2.89, 3.40, 3.13, 3.46 and 3.47 microns respectively while the susceptible accessions SM 343 and SM 344 recorded a lesser cuticle thickness of 2.3 and 2.63 microns respectively (Table 4). Significant difference could not be observed between the cell wall thickness of all the resistant and susceptible accessions. However, the cell wall thickness of resistant lines SM 363, SM 366 and SM 385 was comparatively higher (1.74, 1.70 and 1.76 microns respectively). Similarly, the cuticle thickness of SM 363 and SM 366 was comparatively less but their hypodermal cells were more compactly packed with considerably less intercellular space (Fig. 3 and 4).

The study revealed five *Solanum melongena* accessions *viz.* SM 363, SM 364, SM 366, SM 384 and SM 385 as comparatively resistant to jassid attack. The possible reasons for their resistance may

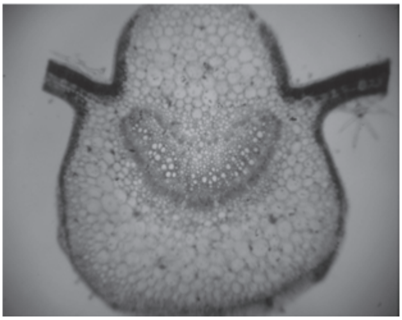


SM 363 (4X) SM 363 (40 X)

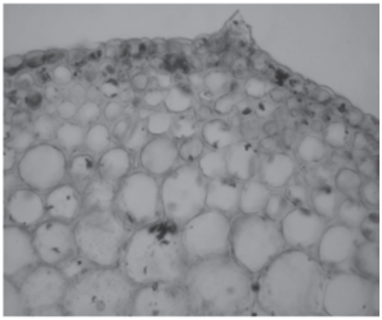
SM 364 (4X) SM 364 (40X)

SM 344 (4X) SM 344 (40X)

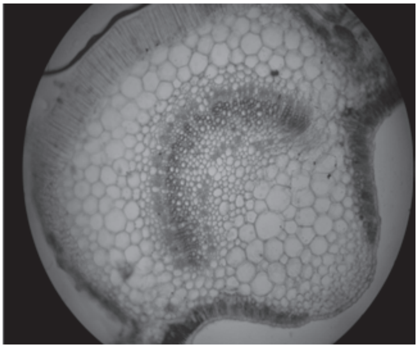
Figure 3. Cross sectional view of midrib of jassid resistant (SM 363, SM 364) and susceptible (SM 344) brinjal accessions



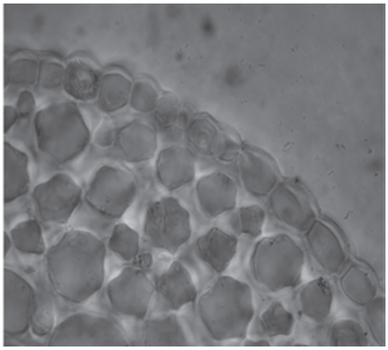
SM 366 (4X)



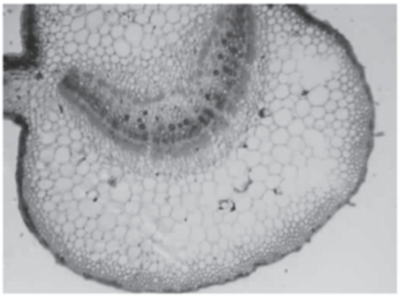
SM 366 (40X)



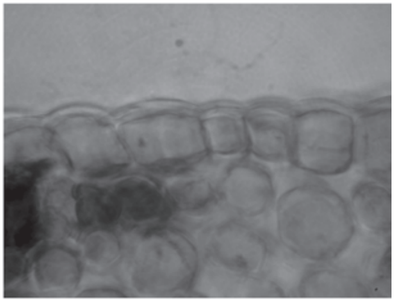
SM 384 (4X)



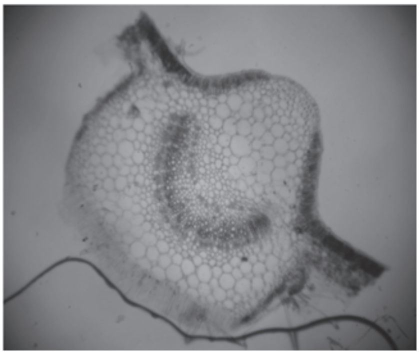
SM 384 (40X)



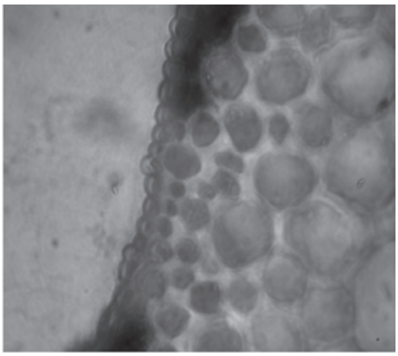
SM 385 (4X)



SM 385 (40X)



SM 343 (4X)



SM 343 (40X)

Figure 4. Cross sectional view of midrib of jassid resistant (SM 366, SM 384, SM 385) and susceptible (SM 343) brinjal accessions

Table 4. Cuticle thickness and cell wall thickness of resistant and susceptible accessions

Accessions	Category	Cuticle thickness (Microns)	Cell wall thickness (Microns)
SM 363	Immune	2.89	1.74
SM 364	Immune	3.40	1.43
SM 366	Immune	3.13	1.70
SM 384	Immune	3.46	1.26
SM 385	Immune	3.47	1.76
SM 343	Highly susceptible	2.30	1.31
SM 344	Highly susceptible	2.63	1.56

be their high midrib hair density, longer mid rib hairs, thick cuticle and cell wall and compactly packed hypodermal cells. According to Ananthakrishnan (1992), pubescence and tissue hardiness limit insect mobility, thus acting as structural barriers. Jassids are phloem feeders on the midrib area and they oviposit along the midrib, and so the above factors may act as inhibitors to better feeding and oviposition.

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