Susceptibility of cotton varieties to whitefly, aphids and mites.

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Introduction

Host plant resistance has long been a focus of the CSIRO cotton breeding program with emphasis on both morphological (okra leaf, frego bract) and biochemical factors (high gossypol) for resistance to insects. Some of this work was reported at the last cotton conference (Fitt et al 1994). Conventional breeding for pest resistance makes small incremental improvements in the tolerance of varieties to insect feeding and damage. With the advent of genetically engineered cotton the stage is set for quantum leaps in pest resistance, through the introduction of the INGARD Bt gene. However, this does not mean conventional approaches are no longer useful. Any change to the plant to make it less attractive to pests or more tolerant to damage will only enhance the value of genetically engineered traits by providing a stronger, more stable basis on which to manage those genes.

We have continued our work on conventional pest resistance, though now with the added aim of screening breeding lines and other genotypes for resistance to sucking pests like mirids, in addition to *Helicoverpa* and mites. With increasing concern about the possible emergence of *Bemisia tabaci* Type B (silverleaf whitefly) as a major pest of cotton following its recent introduction to Australia we have also taken the opportunity to evaluate genotypes against whitefly and aphids. This opportunity arose when the unsprayed plots at one of our study sites (Plant Breeding Institute, Narrabri) became quite heavily infested with these pests during the 1995/96 season. Here we report the results of these evaluations for the 36 cotton genotypes grown at the PBI site (Table 1).

Table 1

Cultivar	Description
Siokra 1-4/649	CSIRO commercial, okra leaf
Siokra L23	CSIRO commercial, okra leaf
Sicala V2	CSIRO commercial, vert tolerant
CS8S	CSIRO commercial, short season
Siokra S324	CSIRO commercial, okra, short season
Sicala 34	CSIRO commercial, high quality
CS50	CSIRO commercial, high yield
CS189+	CSIRO commercial, vert tolerant
DP90	DP commercial, normal leaf
Line 114	Okra leaf breeding line, early
OGF	okra/ glabrous/ frego
M8 superokra	superokra
Alltex quickie	Short season, Texas
MHR11	multiple pest resistance
MHR14	multiple pest resistance
Gazuncho	Sth. American commercial, early
Stoneville 213 HG	high square gossypol
Pima S7	*Gossypium barbadense*
HG660	high gossypol
HG063	high gossypol
HT-35-5-1-smooth	high tannin, smooth leaf
CS8310	mite resistant Texan line, glabrous
DP16 Glandless	glandless (no gossypol)
DES119	early, rapid fruiting
Coker 315	Coker type
N73 OG	okra/ glabrous
N73 F	frego bract
N73 FO	frego bract/ okra
N73 GF	glabrous/ frego bract
N73 O	okra
N73 normal	normal leaf, bract, hair
N73 OGF	okra/ glabrous, frego bract
Smiths Red Leaf	red stem, red/green leaves, frego
Reba P279	French African, used in Sth. America
Tamcot CD3H	Texan short season, early, small bolls
Tamcot SP37H	short season, stormproof bolls, mirid tolerance

Whitefly were first noted as adults at PBI in November 1995, with peak densities in late January and during February. The site was visited by Dr. Paul De Barrow (CSIRO Entomology, Canberra) and Dr. Lewis Wilson (CSIRO Plant Industry, Narrabri) who confirmed the presence of several whitefly species including *Trialeurodes vaporariorum* (greenhouse whitefly), *Bemisia tabaci* (native strain) and *Bemisia tabaci* (Type B), the newly introduced pest species. The great majority of whiteflies were *Trialeurodes*, but their abundance on different genotypes is probably reflective of the suitability of each genotype for *Bemisia* spp. as well. It is noteworthy that *Bemisia* spp. were relatively more abundant on the fully sprayed plots at the same site. Aphids (*Aphis gossypii*) and mites was also present.

Whitefly, Aphid and Mite Assessments.

Whiteflies, aphids and mites were routinely checked through the season using presence/ absence sampling. Detailed counts of their abundance on all genotypes were made in early March. The first requirement was to develop a sampling method to provide indices of abundance of whiteflies and aphids. Excellent sampling systems are already available for mites through the work of Lewis Wilson. For whitefly the available literature suggested that counting the number of adults on mainstem leaf 5 was reliable, but our initial observations showed this was not sufficiently informative to discriminate between varieties. So we conducted a preliminary study to record the distribution of whitefly stages throughout the canopy of two varieties (Reba P279 and MHR11, varieties with high numbers of whiteflies). Numbers of nymphs and pupae were recorded on the undersides of mainstem leaves 1 (top) to 8 from 5 plants of each variety. This work showed most pupae on leaves at node 6 or 7, while most nymphs occurred higher up the plants reflecting progressive colonisation of younger leaves as the populations develop. Consequently we chose the number of pupae on node 6/7 leaves as an index of whitefly abundance. We then sampled 10 leaves/ plot with 4 replications for all 36 varieties.

Leaves were brought back to the laboratory and stored in a cool room until assessment. Both live and emerged pupae were counted.

Table 1. Distribution of whitefly (*Trialeurodes* and *Bemisia*) immature stages on two cotton varieties.

	Pupae/leaf		Nymphs/leaf	
Node	MHR 11	Reba	MHR 11	Reba
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	4.0
3	1.2	0.0	3.4	57.4
4	0.0	0.8	7.2	142.6
5	2.0	3.4	8.0	61.0
6	8.0	13.2	4.8	18.6
7	22.6	11.6	7.4	5.2
8	4.8	11.0	0.4	0.4

For aphids we used a scoring system devised at the Chinese Cotton Research Institute, Anyang. Aphid damage was recorded on the mainstem terminals of 75 plants/ genotype spread among 3 replicate plots. Each plant was allocated to one of five damage classes ranging from 0 (no aphids) to 4 (much damage, aphids abundant, leaves rolled more than half way and aphids present on stems). Honeydew levels were also scored using a 4 level system (0 - no honeydew, 3 - most leaves with honeydew).

An aphid damage index was calculated as:

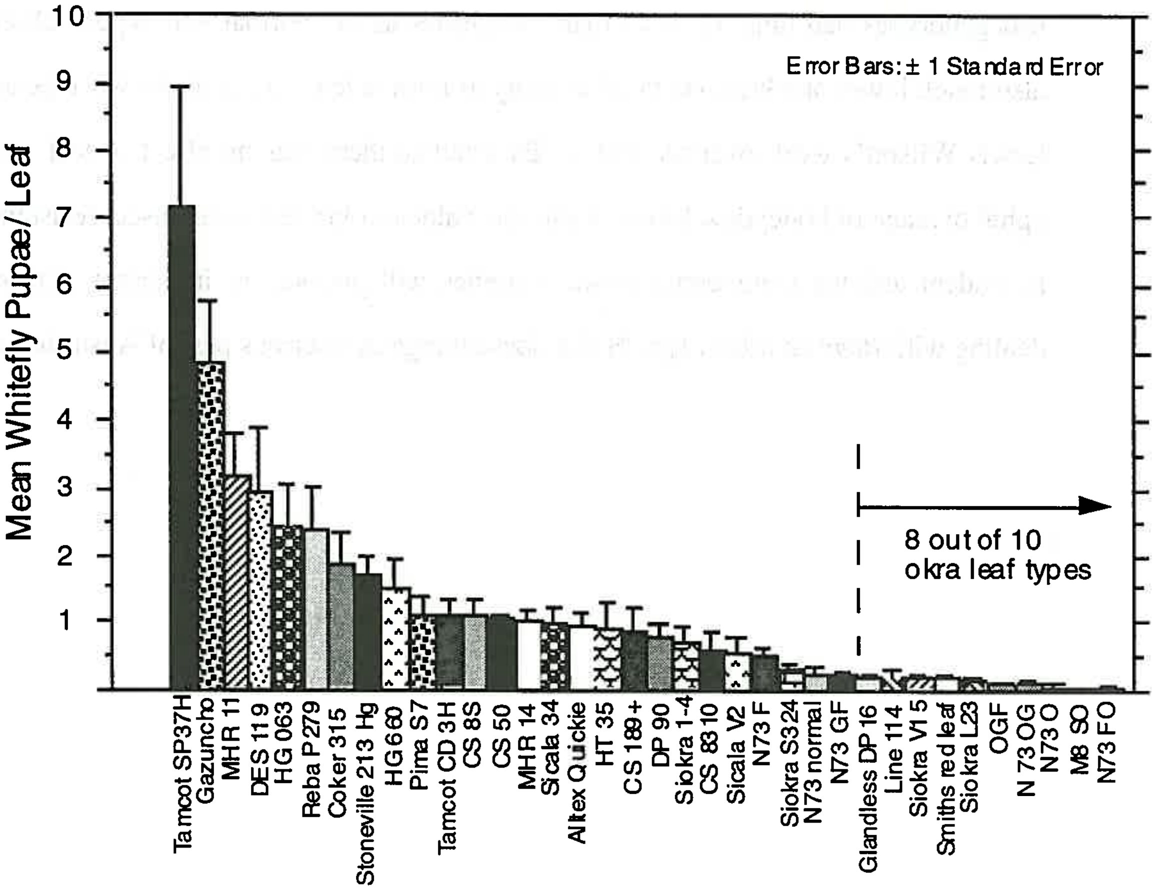
$$\text{Damage Index} = \left(\frac{\text{sum (rating x no. of plants)}}{\text{maximum rating x total no. of plants}} \right) \text{x } 100$$

Mites were assessed by counting the number of adult mites on 10 leaves per plot sampled from node 4 of each plant. Mite damage was also scored by estimating the proportion of leaf area damaged.

Results.

There was considerable variation between varieties in the abundance of whitefly, aphids and mites. Data analysis has been preliminary to date, but some clear trends are evident. Some varieties clearly were more resistant to whitefly (Figure 1). Highest densities (5-7 pupae/ leaf) occurred on Tamcot SP37, Gazuncho and MHR11 (all normal leaf types) while lowest densities (<0.5 pupae/ leaf) occurred on superokra (M8), various commercial okra leaf varieties, and notably on the glandless DP16.

Figure 1. Relative abundance of whiteflies (Trialeurodes and Bemisia) on unsprayed plots of 36 cotton genotypes grown at the Plant Breeding Institute, Narrabri, 1995/96 season.



Analysis showed that this variation between genotypes was due to differences in leaf hairiness and leaf shape. Much higher numbers of whiteflies occurred on hirsute varieties with hair ratings of 7 or above. All current commercial varieties have a hairiness rating of

6 (Deltasmooth), but the more glabrous types (very smooth, with ratings of 2 or less) clearly had fewer whitefly (Figure 2). On the other hand aphids were more abundant, did more leaf and stem damage and produced more honeydew on the more glabrous types. We also know from other work that glabrous types may be more susceptible to mirid damage. Obviously it is difficult to get one varietal characteristic which will impart resistance against all these pests!

Figure 3 shows the dramatic influence of leaf shape on whitefly, mites and aphids. Ten of the 36 genotypes studied had okra leaf. As Figure 1 shows 8 of the 10 varieties with the lowest numbers of whiteflies were okra leaf. Figure 3A shows that overall the 10 okra leaf genotypes had only 11 % as many whiteflies as the normal leaf types. Mites were also much lower on okra (one third as many as normal leaf), a result shown repeatedly in Lewis Wilson's work over the years. By contrast there was no effect of leaf shape on aphid damage or honeydew levels. Again the value of okra leaf as an insect resistance trait is evident and the commercial Siokra varieties will provide an important platform for dealing with *Bemisia tabaci* type B if it does emerge as a serious pest of Australian cotton.

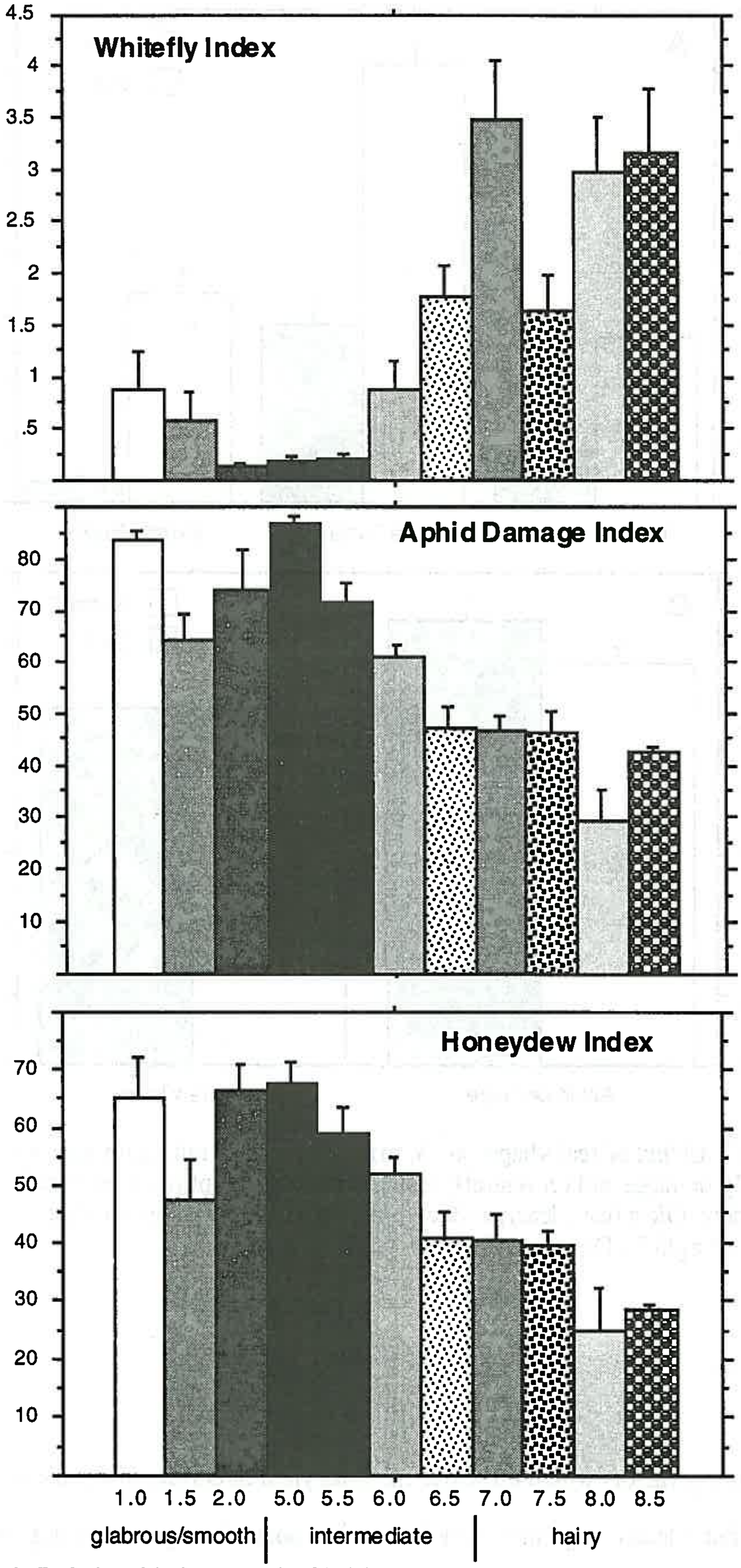


Figure 2. Relationship between leaf hairiness rating and aphid damage aphid honeydew and whitefly abundance. Data are Means ± Standard Error

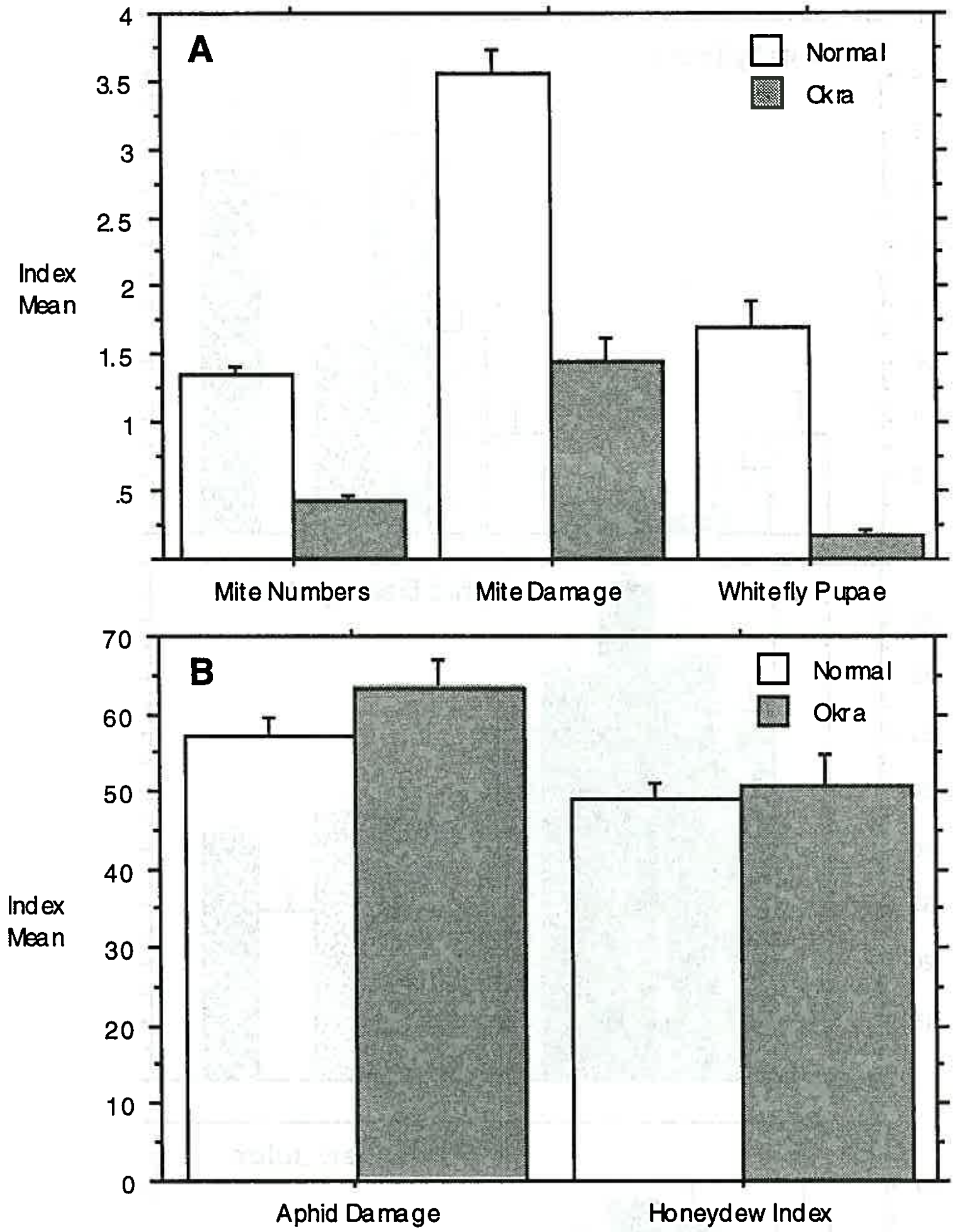


Figure 3 Effect of leaf shape on **A.** mite abundance, mite damage and whitefly damage and on whitefly abundance and **B.** aphid damage and honeydew. Okra leaf clearly reduced mites and whitefly, but did not influence aphids. Data are Means ± Standard Error

The Future

There are many factors which influence the final yield of cotton; insect damage is only one of them, but clearly anything which can be done through breeding to reduce the susceptibility of commercial varieties to insects must help to reduce the pesticide load and assist with sustainable production.

For the future we plan to continue evaluating a broad range of genotypes at several sites with both unsprayed and managed plots. Our focus will now shift more squarely to the sucking pests and we propose to expand our measurements of mirid, whitefly and aphid tolerance next season.

Our work continues to show the value of okra leaf types as an insect resistance/ tolerance trait. As promising genotypes emerge from this work and the mechanisms of their resistance are better understood they, or some of their characteristics, are being integrated into the breeding program, to arrive at high yielding, high quality varieties with better pest tolerance.

Acknowledgments

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References

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