MEASURING COTTON PLANT RESISTANCE TO Heliothis armigera (Cotton Boll Worm)

A.L.McColl, R.M.Noble, F.D.Page,
Department of Primary Industries,
Biloela Research Station.

INTRODUCTION:

Losses to the cotton industry each year due to Heliothis spp. are well documented. Ever since the introduction of chemical control, Heliothis management has been both economically, and environmentally taxing. With insect resistance to chemicals now evident, more attention is being given to alternative control measures to reduce the dependance on insecticides.

Host Plant resistance is one such method and has been adopted in developing plant resistance to a range of plant problems. Plants posses both natural physiological and chemical defence mechanisms. If the plant breeder, through a resistance measuring technique, could select for these traits, he could then develop plant varieties with high levels of resistance factors.

Such techniques are currently being investigated at the Biloela Research Station. Pratically, the techniques need to be capable of mass screening many newly developed cotton lines at once. To allow this, the technique needs to be accurate, simple, economic, dependable and fast.

This project involved trialing traditional and new techniques, then comparing the results with a standard to get a measure of accuracy. Other factors such as cost, duration of trial and man hours involved were considered and comparisons made.

One of the larval bioassays, 8 day feeding on squares, was used as the standard against which all other techniques were compared for accuracy.

LARVAL BIOASSAYS

The most accurate way of assessing plant resistance to Heliothis is to feed the plant material to the larvae and measure their responses. The traditional 8 day larval feeding assay was carried out and correlated with several other shorter and

more convenient bioassays.

METHOD: Each of the bioassays (Table 1) varied in duration of feeding time, larval stage and plant material used. Larvae were weighed before and after feeding. Weight changes were recorded and subjected to covariate analysis. Correlations and lineal regressions were also performed on the data using the '8 day weight gains on squares' as the independant variable.

RESULTS: Of the treatments in the '8 day feeding on squares' bioassay (Table 2), Deltapine 16 was the least resistant and HT 35-14-3 most resistant. Between the assays(Table 1), all correlated significantly with the 8 day feeding on squares at a 5% level. Both the 48 hour feeding trials on squares were significant at a 1% level. This suggests that either of the larval bioassays would be suitable, with the '48 hour' larval assays on squares being most accurate in measuring cotton plant resistance to Heliothis armigera.

LINT YIELD ANALYSIS - HOW DO THEY RESPOND IN THE FIELD?

Lint yield per hectare of a variety of cotton cultivars were tested under three different levels of Heliothis spp. pressure - minimum (full chemical control), moderate and maximum pressure (control of sucking insects only). Yield losses, calculated as a percentage of the true potential of the cultivars, were recorded and used as an expression of resistance.

RESULTS: Of the commercial cultivars trialed, Siokra performed best with a 60% loss compared to 77% for DP90 and 79% for Sicala under maximum Heliothis spp. pressure. HT35-14-3 demonstrated greatest resistance under moderate pressure with a 46% drop while Stoneville 213 was least resistant with a 79% reduction in yield. Under maximum pressure, Tam8-1 was most resistant with a 57% drop while MM838(gl) suffered a massive 93% loss in yield.

When comparing these results with the standard technique, the correlation was insignificant. Typical of field trials, factors emmerged that were impossible to

control. In this case, oviposition preferance, plant tolerance and pink spotted bollworms would have all contributed to the poor correlation. However it is important to have an expression of these responses in the field to substantiate data collected in the laboratory.

MITE TRIAL - WHAT CAN MITES TELL US?

Mites are of world wide importance to the cotton industry . In some cotton growing areas of Australia, the twospotted mite (Tetranychus urticae) has become an important economic problem. A technique, ideal for the purpose of mass screening seedling cotton for resistance to mites, was developed in the U.S.A.. If the Heliothis demonstrate a similar response to the plants resistance mechanisms as did the mites, then this technique may prove useful for mass screening for resisance to Heliothis as well.

Mites were placed on 5 day old cotton seedlings of various cultivars, for a period of 17 days. Leaf damage of each individual plant (approximately 100 per treatment) was assessed and rated from 1(no visible damage) to 5(complete defoliation or death of terminal).

These damage ratings were then converted to a 'mite damage index'.

RESULTS: Deltapine 90 demonstrated significantly less resistance to the mites than all the other cultivars tested (Table 2). Of the commercial cultivars, Sicala showed a greater resistance than Siokra which, in turn, was more resistant than DP90. Two experimental lines, HT35-14-3 and CS8310, were significantly the most resistant.

This technique was very successful in mass screening cotton seedlings for resistance to mites and has real potential in a breeding programme considering the increasing importance of mites as an economic pest. However, correlation with the standard is insignificant suggesting this technique does not accurately demonstrate plant resistance to Heliothis.

CHEMICAL ANALYSIS - WHICH PLANT CHEMICALS ARE IMPORTANT.

Two major chemical groups involved in cotton plant defences are condensed tannins and terpenoid aldehydes (gossypol).

To measure levels of these chemicals in plants, field grown cotton squares were chemically analysed. The results were expressed as a percentage of the plant dry matter.

RESULTS: Gossypol and Tannin levels varied widely. The Deltapine 16gl and CS8310 cultivars demonstrated comparatively high Tannin levels and low gossypol levels while HT35-14-3 showed high levels of both tannins and gossypols. Compared with the 8 day larval bioassays on squares, gossypol levels correlated very significantly while the tannin levels correlated insignificantly. However the tannin levels did show some correlation with the Mite Damage Index.

This suggests that gossypol is very important in the plants resistance mechanisms to Heliothis while tannins are important for mites.

CONCLUSION:

When considering both accuracy and energy required to run the trial (i.e. labour, cost, and length of trial) the most efficient of the techniques is the '48 hour larval feeding on squares' assay using final instar larvae. The chemical analysis for gossypol was just as accurate but energy inefficient making it less suitable. With a refinement of technique and equipment, this assay could be a very suitable 'resistance measuring' tool for the plant breeder.

The mite trial, even though unsuitable for measuring cotton plant resistance to Heliothis armigera, was the most energy efficient and has great potential for mass screening cotton plants for resistance to mites.

ACKNOWLEDGEMENTS:

We wish to gratefully acknowledge the Cotton Research Committee for their support of this project.

TABLE 1: The larval weight gain bioassays performed and the resulting correlations with the standard.

Larval Weight Gain Bioassays	**r values
* 3 day feeding on squares using second instar larvae	
3 " " " leaves " " " "	0.82
24 hour " " squares " final " "	0.83
24 " " " leaves " " " "	0.81
48 hour " " squares " " " "	0.92+
48 " " " leaves " " " "	0.79
48 " " " squares " third " "	0.87+
48 " " " leaves " " " "	0.81

* the technique used as the standard.
+ significant at a 1% level.
** Correlations with the standard

TABLE 2. Results of the chemical and mite assays and their correlation with the standard.

Cultivar	8Dsq(gms)	M.D.I.	Gossypol(%d.w.)	Tannin(%d.w.)
Deltapine 16 (gl)	.2143 a	3.78 a	0.04 a	10.5 a
CS8310	.1863 b	2.42 b	0.53 b	10.2 a
Sicala	.1467 c	3.30 c	0.94 cd	7.8 bc
CS8316	.1446 d	3.04 c	0.91 cd	9.1 d
DP90	.1380 d	4.99 d	0.98 c	7.4 b
TAM8-1	.1108 d	4.27 e	0.89 d	8.8 cd
HT34-14-3	.0809 e	2.40 b	1.07 e	11.1 a
**r values		-0.82	-0.89	0.13

8Dsq = 8 day squares larval weight gains gl = glandless
* Means in columns followed by the same letter are not significantly different at 5% level.
** Correlations with the 8 day larval weight gain bioassay (standard).