MEASURING COTTON PLANT RESISTANCE TO *Helicoverpa armigera*

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INTRODUCTION

The aim of this project was to develop a mass screening technique for the selection of cotton plant antibiosis resistance (AR) to *H. armigera*.

Antibiosis is one of the three recognised plant resistance mechanisms associated with Host Plant Resistance, along with morphological and tolerance characteristics. Of the complex array of non nutritional chemicals (allelochemicals) involved with AR, Terpene Aldehydes (Gossypols) and Condensed Tannins are two recognised major groups. If AR could be measured accurately and easily, plant breeders could select for these traits and develop cotton varieties more resistant to insect pests and less dependant on insecticides. Ideally a mass screening technique needs to be accurate, simple, economic, dependable and fast.

A traditionally used '8 day feeding on squares' larval bioassay was the 'standard' to which all other techniques were compared for accuracy while costs, man hours involved and duration of trial were also considered.

LARVAL BIOASSAYING

Biological assays have traditionally been considered the most accurate way of measuring a relationship between two organisms. The '8 day' larval bioassay is one such assay traditionally adopted for measuring *Helicoverpa* spp. responses to cotton plants however man hours involved render this technique unsuited to a mass screening programme.

Of nine larval bioassay techniques trialled, including the 'standard', each varied in duration of feeding time (8 day, 24 and 48 hours), larval maturity (2nd, 3rd and final instar) and plant material used (squares, leaves and seedlings). Larvae were weighed before and after feeding with weight gains calculated as percent weight gains (ie final weight/initial weight x 100) and correlated with the 'standard' for accuracy. A range of both experimental and commercial cotton varieties, of similar morphological characteristics, were tested.

Results

An experimental line HT35-14-3 demonstrated greatest resistance by inducing the lowest larval weight gains, DPL 90 showed moderate resistance, while an old commercial variety Deltapine 16 was least resistant.

When comparing all techniques with the 'standard' (Figure 1), most correlated significantly while the '48 hour feeding on squares using final instar larvae' bioassay correlated best. The assays using leaves, although more energy efficient and easier to use, produced some marked significant differences to the square assays (Figure 1) with CS8310 proving more resistant in the leaves than squares while Sicala was more resistant then DPL 90 in the leaves than squares. Because squares are more commonly the larval diet of *Helicoverpa* spp., using leaves as a measure of AR would not be as accurate as using squares.

Assaying glasshouse seedlings, while more time efficient then waiting for the plants to mature, failed to correlate with the 'standard', inaccurately reflecting the true antiobiotic potential of the mature field plant.

LINT YIELD ANALYSES - is AR expressed in the field?

For AR to be of any benefit, it is essential that it be positively expressed in the field.

To measure this expression in the field, we recorded lint yields per hectare of a range of cotton cultivars tested under two different levels of *Helicoverpa* spp. pressure - moderate (semi chemical control) and maximum (control of sucking insects only). Yield losses, calculated as a percentage of the true lint yielding potential of the cultivars, were recorded and correlated with the measure of **AR** from the 'standard' assay.

Results

Of the commercial cultivars trialled, Siokra performed best with a 60% lint yield loss compared to 77% for DPL 90 and 79% for Sicala under maximum *Helicoverpa* pressure. The glandless varieties consistently performed badly under maximum pressure with NM838(gl) suffering a massive 93% loss of yield.

When compared with the 'standard', yield losses under moderate *Helicoverpa* pressure correlated significantly (Figure 2) indicating AR is expressed in the field. This relationship however deteriorated under maximum pressure with an insignificant correlation suggesting **AR** breaks down under heavy *Helicoverpa* infestations.

MITES - Can *Tetranychus urticae* demonstrate cotton AR to *H. armigera*?

A technique, ideal for the purpose of mass screening seedling cotton for resistance to the twospotted mite *T. urticae*, was developed in the USA. If *Helicoverpa* spp. demonstrate a similar response to the plants resistance mechanisms as do the mites, then this technique would prove useful as a mass screening tool for resistance to *Helicoverpa* as well.

Mites were placed on 5 day old glasshouse reared cotton seedlings of various cultivars for 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' (MDI).

Results

Some marked visual differences in mite damage between the different cultivars resulted. DPL 90, with most seedlings destroyed, demonstrated significantly the least resistance (MDI=4.99) of all cultivars tested. Two experimental lines, HT35-14-3 (MDI=2.40) and CS8310 (MDI=2.42) were the most resistant showing only slight damage.

Although this technique was ideal for mass screening it failed to correlate with the 'standard' ($r=0.05$).

There was however a significant negative correlation with condensed tannin content of the seedlings ($r=-0.60$) suggesting these tannins are an important AR factor to *T. urticae*.

CHEMICAL ANALYSES - Which plant chemicals are important?

Analyses of cotton squares and seedlings for gossypols and condensed tannins were performed in association with the trials to observe which chemicals were important to AR and whether these laboratory analyses could be suitable as mass screening techniques. Chemical concentrations were expressed as a percentage of the plant dry matter.

Results

Chemical analyses of squares demonstrated the variability of chemical concentrations between the cultivars with DPL 16(gl) and CS8310 recording relatively high levels of condensed tannins (10.5% and 10.2%) and low gossypol levels (0.04% and 0.53%) while HT35-14-3 showed high levels of both tannins (11.1%) and gossypols (1.07%).

Gossypol levels in the squares correlated significantly with the 'standard' assay while condensed tannins did not (Figure 3).

Concentrations of gossypols recorded in the seedlings were small, difficult to measure and not accurately representative of the mature plant.

CONCLUSIONS

- When considering both accuracy and energy efficiency, the most suitably technique for mass screening was the '48 hour feeding on squares' using final instar larvae (Figure 4).

- Laboratory analyses of gossypol levels in the squares correlated well with the 'standard' assay supporting previous widely reported findings. However gossypols are not the only chemical factors involved. Adopting this technique to mass screen for AR would select specifically for gossypols and prejudice against other important antibiotic factors.

- AR was expressed in the field under moderate *Helicoverpa* pressure but seemed to break down under heavy infestations.

- The mass screening technique using the twospotted mite was found to be unsuitable for measuring AR to *Helicoverpa* spp.

- Condensed tannins were found to be of little importance as an AR factor against *Helicoverpa* spp. but important against the twospotted mite, findings supported in the field.

ACKNOWLEDGEMENTS

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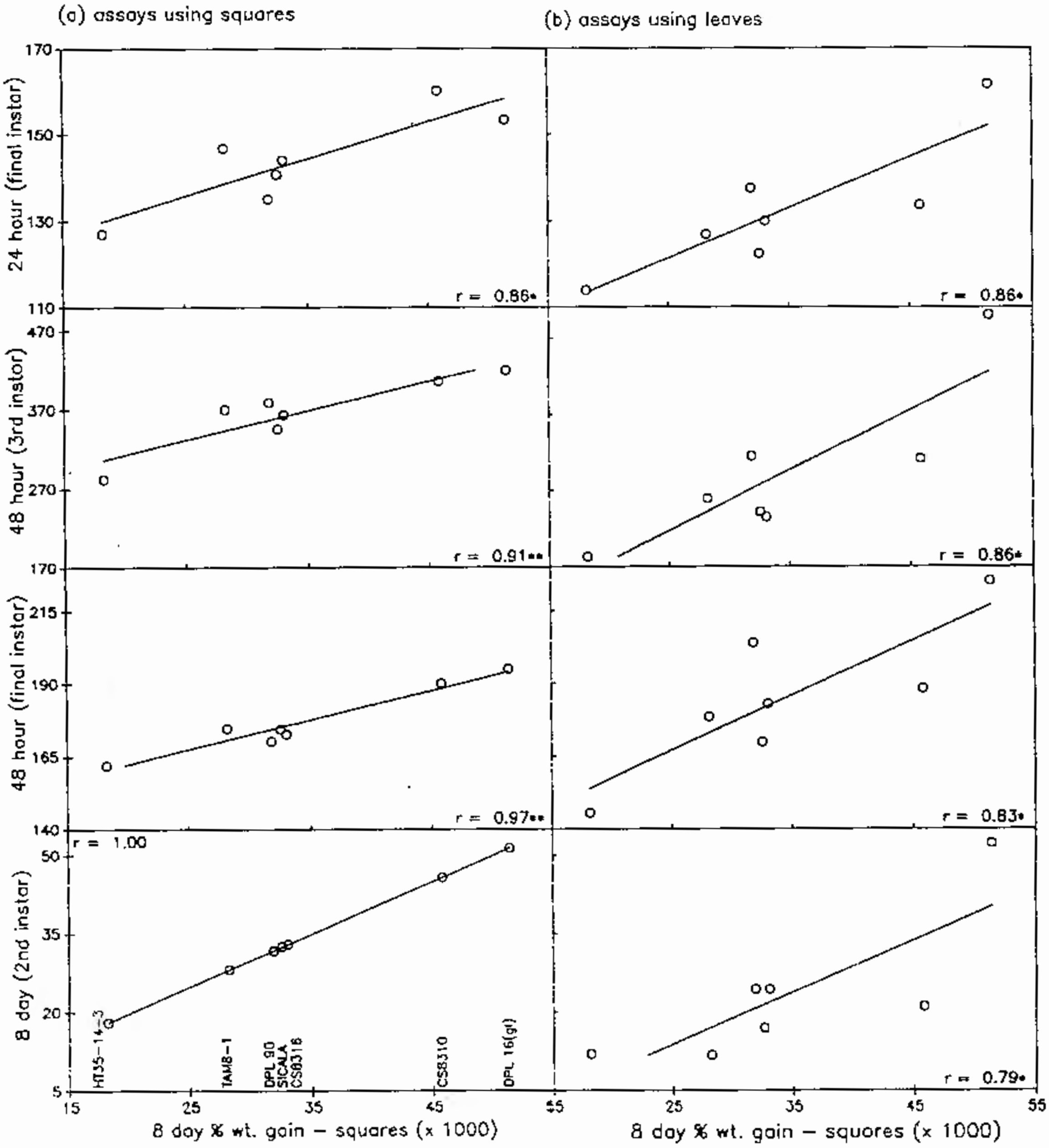

Figure 1 - Correlations and lineal regressions of all the larval bioassays with the 'standard'.
* significant at 5% level
** significant at 1% level

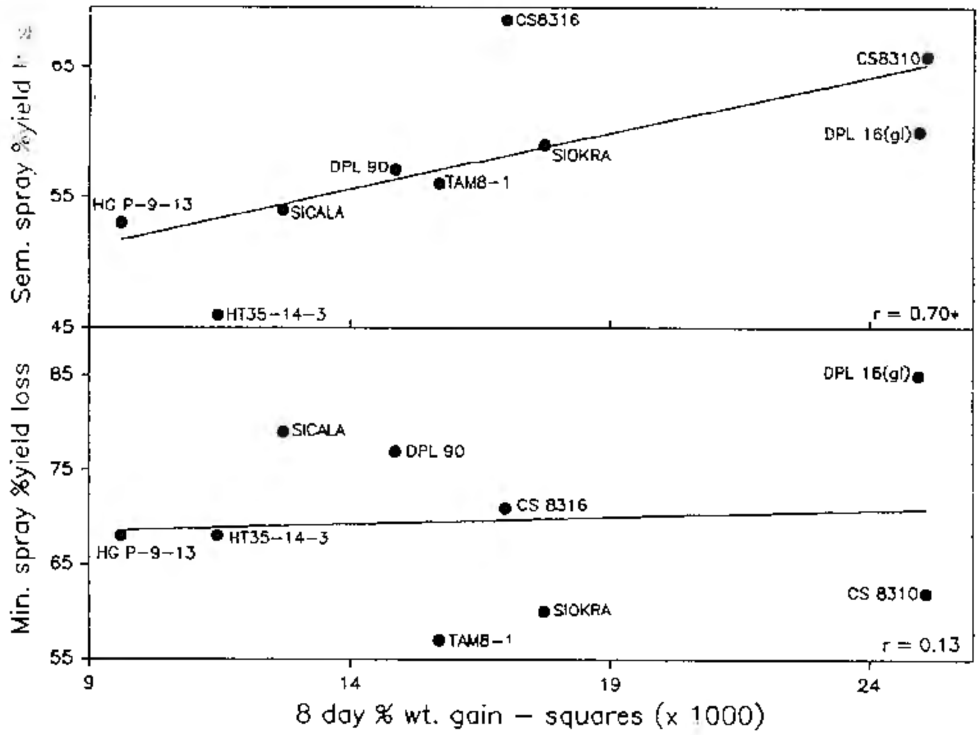

Figure 2 - Correlations and lineal regressions of the field trial lint yield losses with the 'standard'.
* significant at 5% level

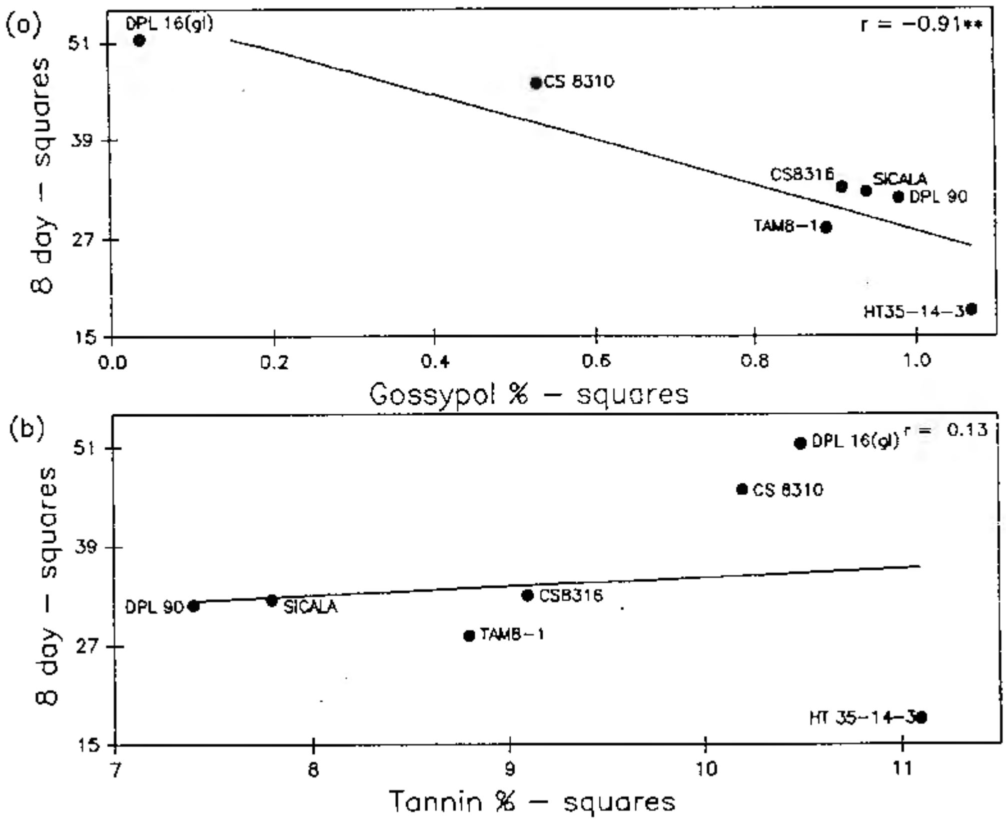

Figure 3 - Correlations and lineal regressions of the gossypols (a) and condensed tannins (b) analyses with the 'standard'.
** significant at 1% level

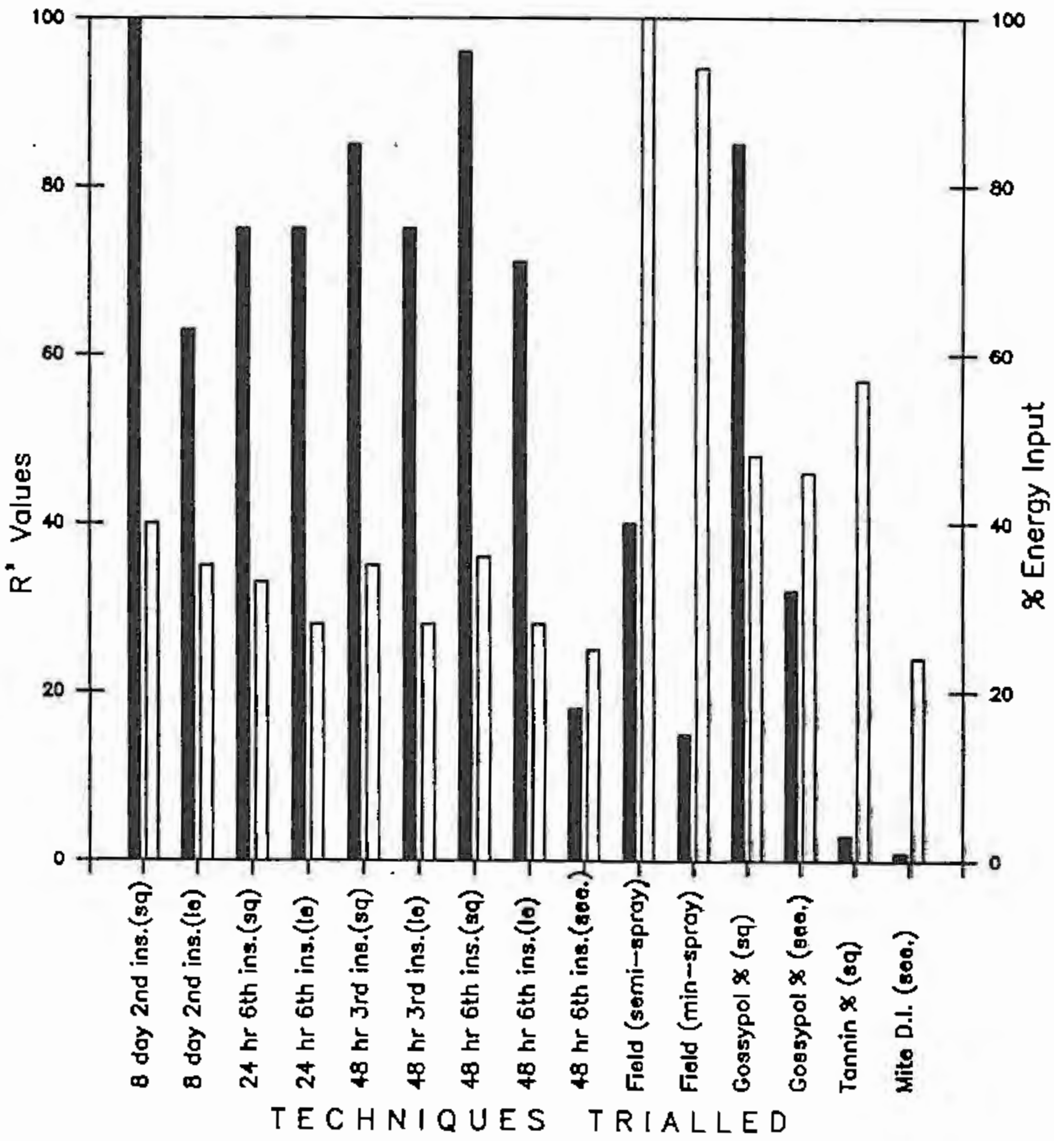

Figure 4 - Graphic Summation of the comparison between each of the techniques trialled.
■ Accuracy (correlation with the 'standard')
□ Energy Input (cost, manhours, trial length)