Part 1 - Summary Details

CRDC Project Number: **CRDC 260**

Project Title: Evaluation of yield component changes in Australian cotton cultivars

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CRDC Program: On Farm

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Part 3 – Final Report Guide (due 31 October 2008)

Background

Large scale cotton (*Gossypium hirsutum* L.) production began in Australia during the early 1960s following the construction of Keepit Dam to regulate the water flow along the Namoi River. Australian farmers tend to focus primarily on obtaining the highest yields possible. When higher yields are achieved, the farmer has the potential to make more money, assuming various quality parameters are met. Plant breeders have responded accordingly by continually striving to breed cultivars that produce higher yields.

The yield of any crop can be broken down into its components to determine how yield is obtained. Wheat for example can be broken down into the number of kernels per spike and cotton can be broken down into plants per meter, bolls per plant and lint weight per boll.

Wells *et al.* (1984) conducted a yield component study in America comparing modern cotton cultivars at that time to varieties from as early as 1900. The largest contributor to yield variation was the number of bolls produced. The varieties from 1950 to 1982 produced an increasing number of bolls which was responsible primarily for the increased yields. They also produced a greater proportion of their total lint and bolls earlier than older varieties. The same study indicated that until 1982, breeders concentrated little on fibre quality and focused more on yield by increasing the number of bolls per unit area. Worley *et al.* (1974) suggested that bolls per metre assumed the major role in determining yield.

The yields of the Australian cotton industry have increased considerably since the 1970s. Integrated Pest Management (IPM) in combination with transgenic technology has seen a reduction in insecticide use. Improvements in agronomic practices have resulted in increased yields and more efficient use of water and fertilisers.

However, the yield potential of current cultivars is considerably higher that of cultivars grown in the 1970s (i.e. DP 16 and Namcala). Research has shown that the inclusion of transgenic genes has not reduced the yield of cotton (Wilson *et al*. 1994), but it has not been shown that yield can be increased in Australia. More information is required on how yield components have changed from early cultivars to current cultivars.

Objectives

The aim of this project is to examine the effects that genotype and environmental interactions have on the yield components of Australian cotton cultivars. This also allows us quantify whether the breeders have been selecting for the correct yield traits over time.

This project will test the hypothesis: "Has yield potential of Australian cotton cultivars been raised primarily through an increase in fruiting sites and retention?"

Methods

Treatments:
Six cotton (*Gossypium hirsutum*) cultivars were used. Namcala and DP 16 represent cultivars from the early 1970s, Sicala 40 and Sicot 189 represent cultivars from the early 1990s, while Sicot 71 and its Bollgard®II equivalent Sicot 71B represent current cultivars. These were grown as part of CSIRO's variety trials in a randomised block design. The three locations used were "Royston" at Boggabilla, ACRI at Myall Vale and "Long Acres" at Carroll (near Breeza) which represent hot, intermediate and cool climates, respectively for cotton growing in NSW. Sicot 71B was also grown at ACRI under dryland conditions.
Two Pima (*Gossypium barbadense*) cotton lines, cultivar S7 and Sipima were also evaluated at ACRI. S7 has been the only pima cotton variety grown in Australia for some time and SiPima is a CSIRO variety that will be released in the near future.

Measurements:
Plant mapping was conducted over a six week period throughout the growing season. The same plants were measured for each variety in four replicates at each site so that an accurate comparison could be made. The measurements taken included:

- Height
- Total nodes
- Vegetative nodes
- Fruiting nodes
- First position retention
- Total squares
- Total flowers
- Total bolls

Final harvest data was also collected including boll counts, lint weight per boll and seed percentage. Some fibre quality data will also be obtained from the breeders. Daily maximum and minimum temperatures and solar radiation measurements were also recorded.

Cultural methods:
Irrigation and nutrients were supplied to the trials to ensure that non-limiting conditions were maintained. Insects, diseases and weeds were managed using best management practices. A questionnaire was sent out to growers so that the management regime can be recorded.

Results

At the time of writing this report, harvest of the trial plots was just being completed and as yet the harvest yield data had not been collated. Only the data from the plant mapping was available.

The Bollgard plants were tipped out significantly less than the other conventional varieties examined (Figure 1). Tipping out is usually caused by *Helicoverpa* or other insects removing the growing tip of the plant. The Bollgard plants control *Helicoverpa* insects, and thus help to prevent tipping out of the plants. Other insects such as Mirids however can also cause tipping out.

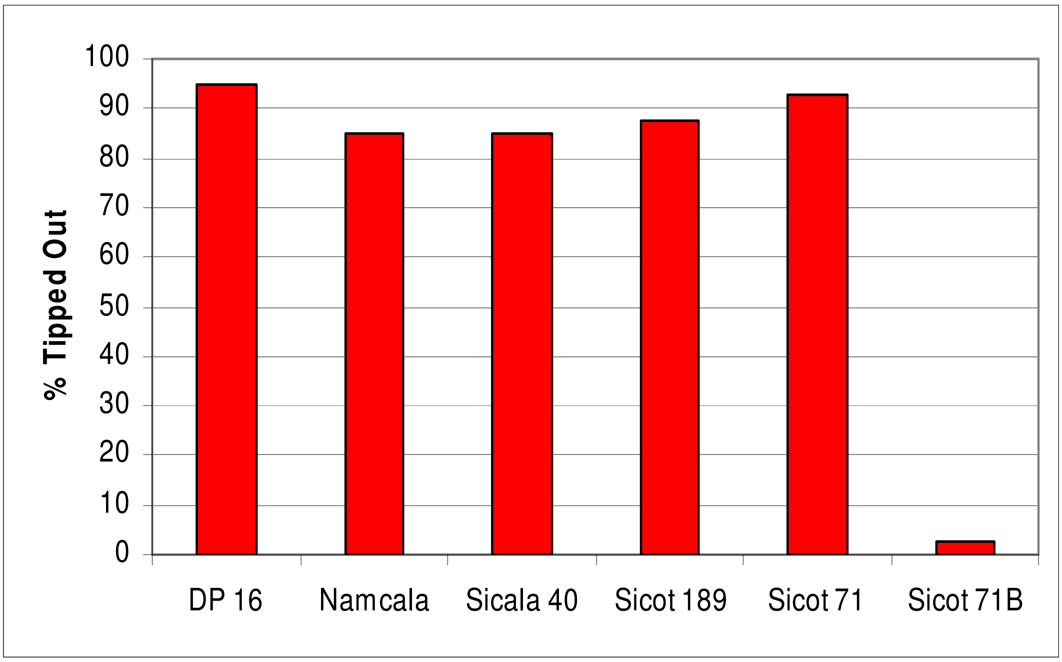

Figure 1: Percentage of plants tipped out during the growing season across three sites

Both Sicot 71 and Sicot 71B shed squares much earlier than the other cultivars *(?)* (Figure 2).

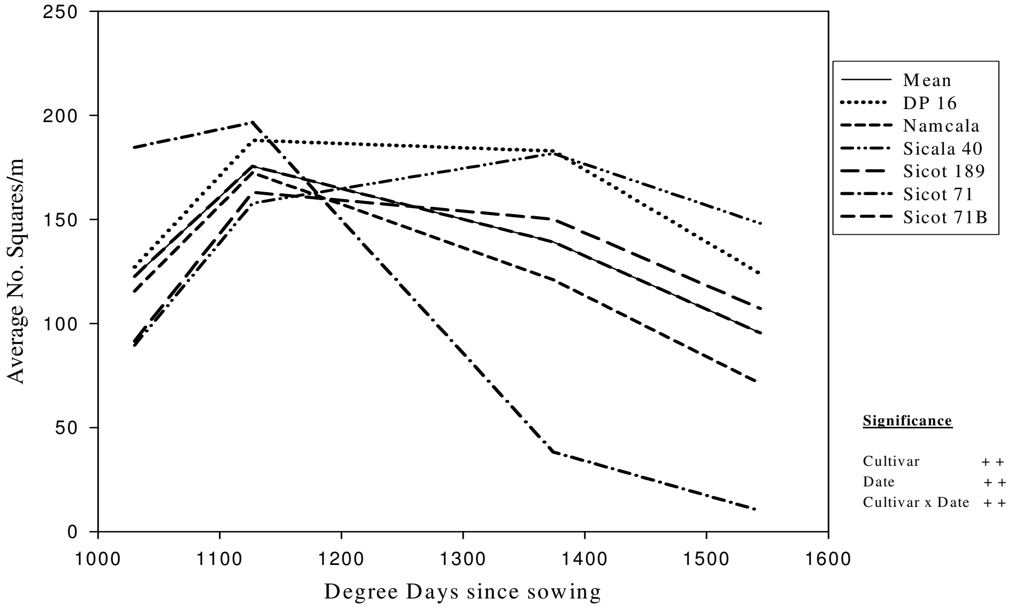

Figure 2: Average number of squares per metre at ACRI

The Bollgard variety, Sicot 71B set more bolls earlier in the season than all of the other conventional cultivars (Figure 3). If these high numbers of bolls are retained throughout the season until harvest, this variety could possibly yield more than the conventional varieties by producing a greater number of bolls. The average boll numbers per metre for Sicot 71 is lower ($P<0.05$) than that of the Sicot 71B. Since the cultivars, Sicot 71B and Sicot 71 are similar to each other, except for the two inserted Bt genes in Sicot 71B, it allows a good comparison for the impact that the Bollgard genes have on the plants growth, development and yield composition.

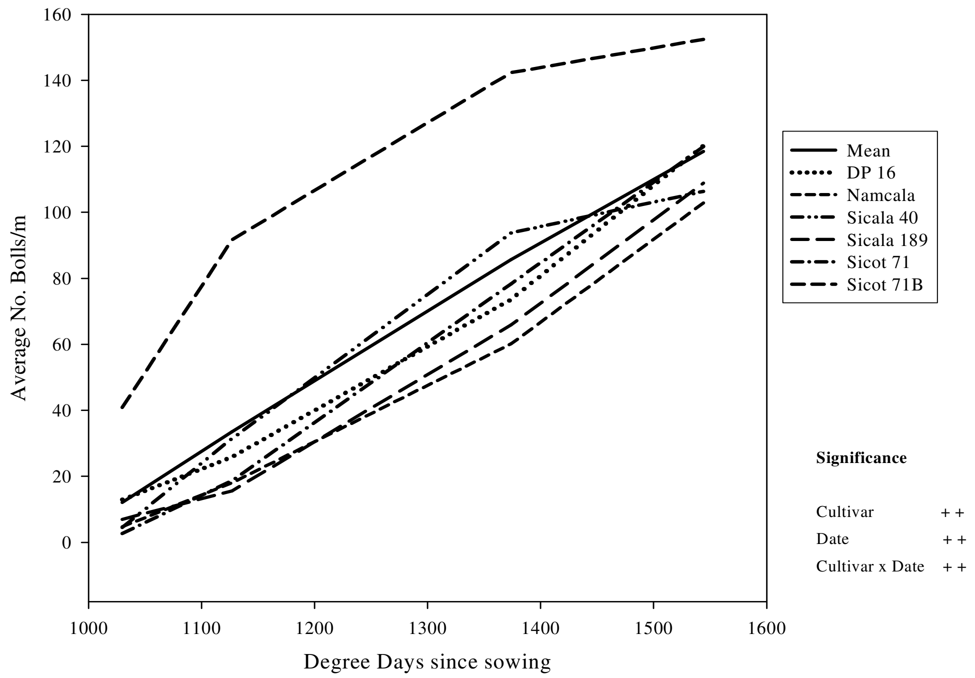

Figure 3: Average number of bolls per meter at ACRI

Sicot 71B produced a similar number of squares per metre in both the intermediate (ACRI) and cool (Carroll) cotton growing climates. The conventional Sicot 71 variety produced a more variable number of squares per metre between the two sites. This suggests that Bollgard is more consistent in its production of squares across locations.

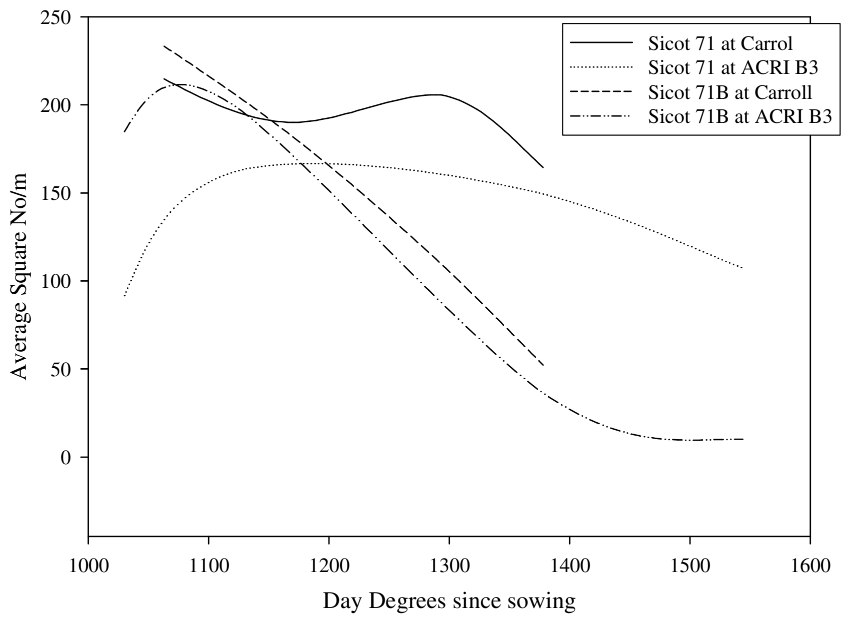

Figure 4: Average number of squares per meter at ACRI vs Carroll

Conclusion

Preliminary results from the plant mapping data indicate that the Bollgard variety, Sicot 71B significantly differed in its yield retention and mapping structure to all the conventional varieties. The conventional varieties performed similarly in square development and retention, however the Bollgard variety, Sicot 71B developed squares earlier and retained more of them as bolls throughout the season. Final harvest data will allow for determination of how the components have changed over time.

Part 4 – Final Report Executive Summary

The aim of this summer scholarship project was to measure the changes that have occurred in the yield components of Australian cotton cultivars including environmental impacts. It also allows for the importance of each component to be determined in terms of contribution to overall yield. Trials were conducted using six cultivars(DP 16, Namcala, Sicala 40, Sicot 189, Sicot 71 and Sicot 71B) grown in three locations(Boggabilla (near Goondiwindi), ACRI (Narrabri) and Carroll (near Breeza)) representing hot, intermediate and cool climates for growing cotton respectively.

Plant mapping was carried out during the growing season and final harvest data was also measured, but is yet to be collated. Preliminary results from the plant mapping show that the Bollgard® II cultivar was less tipped out than the other conventional cultivars. These conventional cultivars were tipped out over 85% of the time across all three sites. The Bollgard® II cultivar acquired bolls earlier and retained more bolls throughout the season than any of the other cultivars measured. The Bollgard® II cultivar also showed greater reliability at producing a greater number of squares across all three environments. Final harvest will provide data to show whether the Bollgard® II cultivar will yield more than the conventional cultivars, as well as demonstrating how the yield components of Australian cotton cultivars have changed over time.

Kellie Gordon plant mapping cotton

Chris Kilby plant mapping cotton

CSIRO variety trial at "Royston" Boggabilla