



**COTTON RESEARCH AND DEVELOPMENT  
CORPORATION**

## **FINAL REPORT**

**DAN 131C Evaluation of ultra narrow row cotton production in cool season irrigated  
areas**

**October 1998 to June 2001**



Mr J. L. Cooper, Agricultural Research Centre, Trangie, NSW 2823



**NSW Agriculture**

I-2001



# January, August & Final Reports

## REPORTS

### Part 1 - Summary Details

Please use your TAB key to complete part 1 & 2.

CRDC Project Number: DAN 131C

January Report:  Due 29-Jan-01  
August Report:  Due 03-Aug-01  
Final Report:  Due within 3 months of project completion

**Project Title:** Evaluation of ultra narrow row cotton production in cool season irrigated areas

**Project Commencement Date:** 1/10/98      **Project Completion Date:** 30/6/01

**Research Program:** Farming Systems Agronomy

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**Signature of Research Provider Representative:** \_\_\_\_\_

## **Part 3 – Final Report Format**

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### **1. Outline the background to the project.**

Ultra narrow row (UNR) cotton, is cotton with row spacings of 50 cm or less. The rationale for investigating narrow row cotton production was that it had the potential to reduce season length, provide a better spatial arrangement, and produce the same yield by having fewer bolls on a greater number of plants. Early Australian trial work in the Murrumbidgee Irrigation Area by Low and McMahon (1973), and by Low, McMahon and Pistillo (1975) did show yield benefits with narrow rows. However, there were several limitations to the development of the system. These included the development of varieties, cultural practices and harvesting machinery adapted to narrow row production.

Currently in the USA there has been a resurgence of interest in the UNR system. The reason for revisiting UNR is producers are looking to improve profit margins by controlling production costs and/or enhancing yield (Gwathmey 1998). To try and achieve these objectives producers are employing technologies such as early maturing varieties, no-till production methods, over the top herbicide systems and growth regulators (Gwathmey 1996).

New technologies, not available in the 1970's, and which are now likely to make the UNR system more attractive include:

1. Varieties better adapted to high density planting. Varieties display differing degrees of sensitivity to high density, and experience with UNR cotton in the USA implies that local adaptation may play an important role in finding the most suitable variety. A wider range of varieties are available today than in the 1970's, and most have better yield, quality and disease resistance.

2. Growth regulants. When the studies on UNR were done in the 1960's and 1970's, researchers could only influence plant height by with-holding or applying irrigations and nutrients. With growth regulants the growth of UNR can be free of the water or nutrient stress that was previously important to influence plant height, hence yields will be optimised without the risk of plants becoming rank. The ideal UNR crop does not end up taller than 70 cm (Kerby 1997). Growth regulants which reduce plant height also facilitate the easier harvesting of the crop. The finger fronts that harvest UNR cotton work best when the plants are main stem plants, with a high proportion of bolls in the first fruiting position and an absence of vegetative branching.

3. Over the top herbicide systems. With UNR cotton, the closeness of the rows prevents inter-row cultivation, and banded herbicide applications. Without these techniques weed control in early UNR research was challenging, and the main approach was to apply pre-emergent herbicides. Now however, there are many more herbicides available which can be applied over the top of cotton e.g. Staple and numerous herbicides active on grasses. Recent advances with transgenics has led to the release of herbicide tolerant cotton varieties (e.g. Roundup Ready cotton). These technologies mean that weed control is not the problem that it was when UNR was tried initially.

4. Better harvesting equipment. The design of the finger type stripping front has not changed much, but the machines that the fronts are fitted to have seen major advances. The fronts are fitted to machines used for dryland cotton which have pre-cleaner gins. Several UNR stripper fronts have been developed in the USA, and commercial fronts to suit John Deere strippers are now available.

With cotton production in Australia moving into cooler regions such as the Lachlan and Murrumbidgee valleys, early maturity is of increasing importance, and UNR cotton is one way to achieve this. This project aimed to test the potential for using UNR cotton in Australia, especially in cool season irrigated areas, and to find out how best to grow UNR cotton in those areas.

## **2. List the project objectives and the extent to which these have been achieved.**

- a) Evaluate UNR cotton in the cool season irrigated areas. Trials comparing UNR and conventional cotton were conducted at Breeza, the Macquarie valley, and the Lachlan valley in 1998-99, 1999-2000, and 2000-01. Data from 3 sites over 3 seasons has provided good information on the potential of UNR cotton.
- b) Determine whether UNR can deliver earliness, yield and economic benefits in these areas. The trials produced good yield and quality data which allow the economic benefit to be calculated. There is anecdotal evidence of earliness with UNR cotton, but measurements such as % open bolls, could not substantiate any difference.
- c) Screen local and overseas germplasm to identify the most suitable varieties for UNR production. The 2 main cotton breeding organisations (CSD and Deltapine) regularly test material in UNR trials, and there are now variety recommendations specifically for UNR cotton.
- d) Investigate the response of varieties to high density. The trials at Breeza, the Macquarie valley, and the Lachlan valley, which compared UNR and conventional cotton, also included a range of plant densities for the UNR system. Over 3 seasons, these trials have produced good data on the optimum plant density for UNR cotton.
- e) Investigate growth regulant strategies suitable for UNR. All the trials were conducted in commercial cotton fields, so they used the same rates of growth regulant as the surrounding crop. No comparison of different strategies was possible, and this is a field which needs further research.
- f) Investigate weed control strategies suitable for UNR production. Because most trials were on commercial cotton farms there was limited scope to compare weed control strategies. In addition weeds were not a problem at most sites. The Roundup Ready varieties which are now commercially available, should overcome most weed problems.
- g) Evaluate modern methods of harvesting UNR cotton. The evaluation was done by several methods. The quality of lint harvested by UNR machines was compared with that from conventional spindle pickers. Comparison of hand pick and machine pick yields gave another measure of harvesting efficiency. The main problem with UNR cotton was the availability of harvesting equipment.
- h) Compare yield, fibre quality, and economic viability of UNR to traditional cotton production techniques. This was done at 3 sites over 3 seasons, providing good data on which to base comparisons and conclusions.
- i) Examine the economic return of UNR on a per megalitre basis. Data from this project, along with commercial grower experience were used by NSW Agriculture economists to produce farm enterprise budgets for UNR cotton. The information is available in NSW Agriculture publications, and on the NSW Agriculture internet site.

## **3. How has your research addressed the Corporations three outputs: Sustainability, profitability and international competitiveness, and/or people and community?**

The main output which this project addressed was profitability and international competitiveness. One of the main benefits expected with UNR cotton is earlier maturity. This is of particular benefit in cool areas where wet weather at harvest often causes delays, and down grades quality. Yields should also be higher in cool areas, because these locations often do not receive enough heat units for the plants to achieve complete ground cover when planted in one metre rows. UNR cotton will achieve complete ground cover quicker than conventional cotton.

The early maturity of UNR cotton may also benefit sustainability and the community. By maturing earlier, UNR cotton may need less insecticide sprays, and less irrigation water.

#### 4. Detail the methodology and justify the methodology used.

The main experiments in this project were field trials, mostly on commercial properties, which compared conventional cotton in 1 metre rows, with several densities of UNR cotton on beds. Trials were conducted over 3 seasons (1998-99, 1999-2000, and 2000-01), at 3 cool season sites from Breeza in the north to Hillston in the south. In the final season, extra trials were established to look at other aspects of UNR cotton production. Details of the trials conducted each season are presented below.

**Table 1.** Summary of experiments conducted as part of the project.

Year	Location	Treatments and design
1998-99	Breeza	3 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 30cm rows
	Warren	4 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 30cm rows
	Hillston	3 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 30cm rows
1999- 2000	Breeza	3 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 30cm rows
	Warren	3 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 30cm rows
	Hillston	3 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 25cm rows
2000-01	Breeza	3 replicates, 5 treatments - conventional cotton in 1m rows, twin row cotton, 3 densities of UNR cotton in 25cm rows
	Warren	4 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 30cm rows
	Hillston	3 replicates, 5 treatments - conventional cotton in 1m rows, 4 densities of UNR cotton in 25cm rows
	Narromine	3 replicates, 5 treatments - 5 densities of UNR cotton in 25cm rows
	Trangie	6 replicates, 4 treatments - row spacings of 20, 30, 40, and 50 cm

All trials except the row spacing trial at Trangie used large plots, which were harvested by commercial pickers. Most management operations were done at the same time, and using the same equipment, as the rest of the field. Every effort was made to do things on a commercial scale to increase acceptance and adoption of the results. In 1998-99 a machine from Trangie Research Centre was used to plant all the trials. The machine had tine openers which proved unsuitable for cotton, and plant stands were poor. The following season a research seeder was built and used at Breeza and Warren, while a commercial Monosem seeder was used at Hillston. The UNR cotton plant stands achieved in 1999-2000, and 2000-01, were much better than those in 1998-99.

The Warren site was at the warmer end of the Macquarie Valley, but it was selected because the property used beds, which are essential for UNR cotton. In 2000-01 the opportunity arose for another trial near Narromine, which is in the cooler part of the Macquarie Valley, and therefore better suited to UNR cotton. Because machinery to sow and harvest conventional cotton were not available at this site, the trial only compared different densities of UNR cotton.

Wider row spacings for UNR cotton are of interest because they would allow more options when harvesting. To look at this in a commercial situation is almost impossible because changing the row spacing on commercial seeders is difficult, and bed width also needs to change as row spacing changes. The seeder built as part of this project allows row spacing to be changed easily. Therefore, it was used to sow a small plot trial at Trangie Research Centre to study the optimum row spacing for UNR cotton.

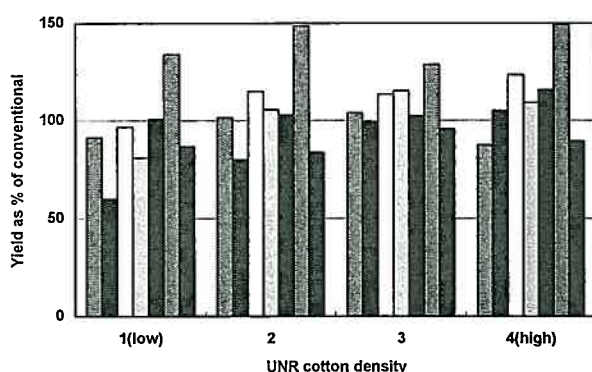
## 5. Detail results including the statistical analysis of results.

### A. Ultra narrow row (UNR) versus conventional cotton

This comparison was made at 3 sites over 3 seasons. Background data for these trials are presented in appendix 1 and yield data in appendix 2. Averaged over all sites and seasons, there was little difference in the yield of conventional and UNR cotton (Table 2).

**Table 2.** Hand picked, seed cotton yield, and machine picked, lint yield, averaged for all sites and seasons.

	Conventional	UNR
Seed cotton (g/sq m hand picked)	396	381
Lint (bales/ha machine picked)	6.81	7.18



**Figure 1.** The machine pick lint yield of UNR cotton at several densities, as a percentage of the yield of conventional cotton at the same site and in the same season. Data from 7 trials spread over 3 sites and 3 seasons.

As shown in Figure 1, there was a lot of variation in lint yield between sites and seasons. At the lowest seeding rate for UNR cotton (Density 1), the yield of UNR cotton was less than conventional cotton in 5 cases out of 7. As the density of UNR cotton increased, its yield improved. At density 3, UNR cotton yields were equal to, or better than, conventional cotton in 6 cases out of 7. While at density 4, UNR cotton yielded more than conventional cotton in 5 cases out of 7. At density 4, one of the instances where UNR cotton yielded less than conventional cotton was due to damage by mites.

There were significant differences in the gin turn out % of UNR and conventional cotton (Appendix 3). Averaged over all sites and seasons, the turn out % for conventional cotton was almost 3% higher than that for UNR cotton (38.95% v 36.02%). This is to be expected because the stripper picker used to harvest UNR cotton puts more leaf and stem trash into the sample than a spindle picker.

Despite the differences in trash levels and gin turn out %, there were few differences between UNR and conventional cotton in lint quality (Appendix 3). In 1999-2000 the colour grade for conventional cotton was better than UNR cotton, but at the Warren site this may be due to a different time of picking. Because of difficulties in obtaining an UNR cotton picker, the UNR cotton was harvested 18 days later than the conventional cotton and received additional rain during that period. At Hillston the UNR and

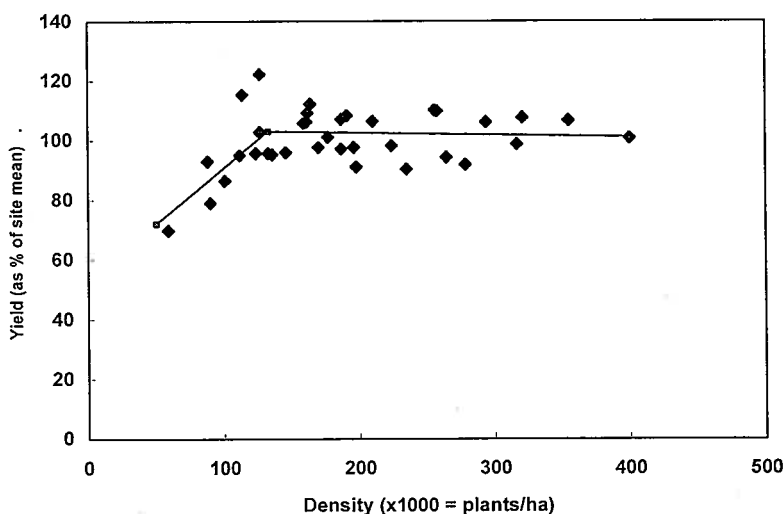
conventional cotton were harvested on the same day but the colour grade of conventional cotton was better than UNR cotton. For the other 2 seasons, 1998-99 and 2000-2001, there were no differences in colour grade. There were significant differences ( $P < 0.05$ ) in micronaire at the Warren site in 2000-2001, but all values were in the range which would not attract any discount. In 1998-99, again at Warren, there were significant differences ( $P < 0.05$ ) in fibre uniformity. However, the uniformity of all treatments were in the high, to very high, range and would not be penalised.

Earlier maturity is one of the main objectives with UNR cotton, but this has proven difficult to document. Growers report UNR cotton maturing up to 20 days earlier than conventional cotton, but quantitative measurements in these experiments found little difference (Appendix 5). The main measure of maturity was percentage of open bolls. If at a given date, one treatment has a greater % of open bolls, that indicates earlier maturity. In most instances there was no significant difference between treatments in the % of open bolls. The one significant difference which did occur (29.3.1999 at Warren) had conventional cotton maturing quicker than UNR cotton. However, at that site, in that season, establishment of the UNR cotton was poor and the treatments with slow maturity had low plant populations. The other measure of maturity was the Julian date for 60% open bolls. At Breeza in 1999-2000 the % of open bolls for each plot was recorded at approximately weekly intervals. These data were then plotted, and the day on which each plot reached 60% open bolls estimated. The UNR treatments did mature several days earlier than conventional cotton, but the differences were not statistically significant.

#### B. Optimum plant density for UNR cotton

The trials which compared UNR and conventional cotton included a range of plant densities for UNR cotton, and therefore, also provided information on the optimum density for UNR cotton. In addition to those trials, an experiment at Narromine in 2000-2001, compared 5 densities of UNR cotton. Details of the design and results from this experiment are presented in Appendix 4.

With the low plant densities in 1998-99, there was an increase in lint yield as UNR plant density increased at the Warren site. The Breeza and Hillston sites showed similar trends that year, but the differences were not statistically significant (Appendix 2). However, in the following seasons (1999-2000, and 2000-2001), with better establishment and higher plant densities, there was no clear association between plant density and yield. In some cases yield actually fell at the highest plant density.

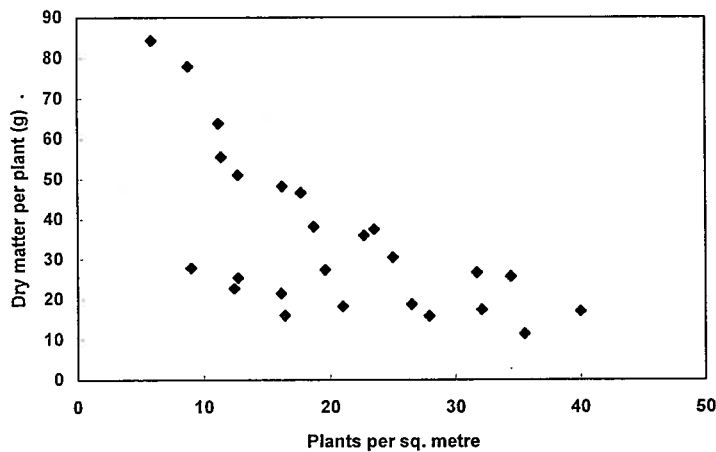


**Figure 2.** The effect of plant density on UNR cotton yields. Data from 4 sites and 3 seasons. Yields are expressed as a percentage of the mean yield for that site and season.

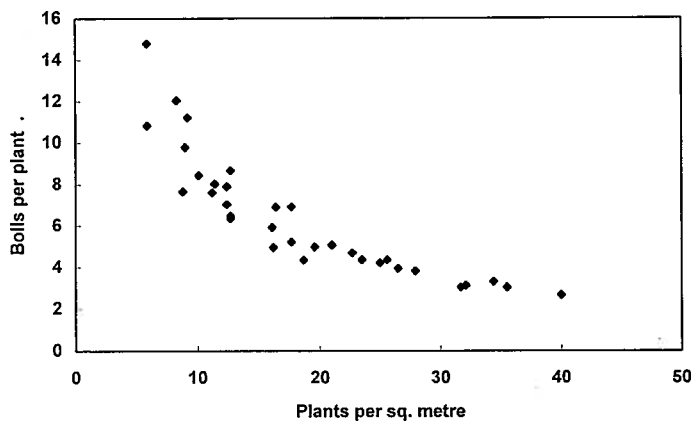
To study the trends in UNR cotton yield as plant density increased, yield as a percentage of site mean yield, was plotted against plant density (Figure 2). Site mean yield is used to take out the variation between sites and seasons which would otherwise mask differences due to plant density. This figure shows that yield increased with plant density up to approximately 150,000 plants per ha, but above that, yields remained constant.

All the plant densities in this report assume that the plants are spread across a 2 metre bed. In practice, the cotton is on top of the bed, with a wheel space between adjacent beds. The area occupied by the cotton on each bed is actually 1.5 metres wide (5 rows x 30 cm, or 6 rows x 25 cm). When expressed on this basis, the plant densities are 33% higher, and 150,000 plants/ha assuming 2 metre beds = 200,000 plants/ha based on row spacing.

At 1 date, for 1 site, in 1 season, there was a significant reduction in plant height as density increased, but in most instances plant density had no significant effect on plant height. Total dry matter increased as plant density increased, but the amount of dry matter per plant fell (Figure 3), and there was a corresponding reduction in the number of bolls per plant (Figure 4).

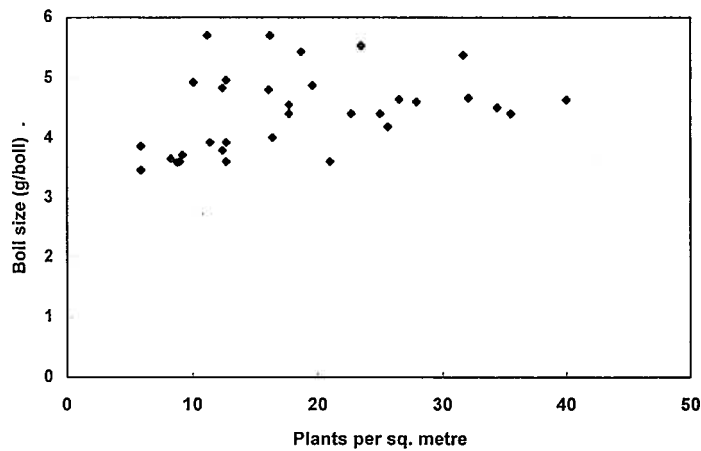


**Figure 3.** The effect of plant density on dry matter per plant in February.

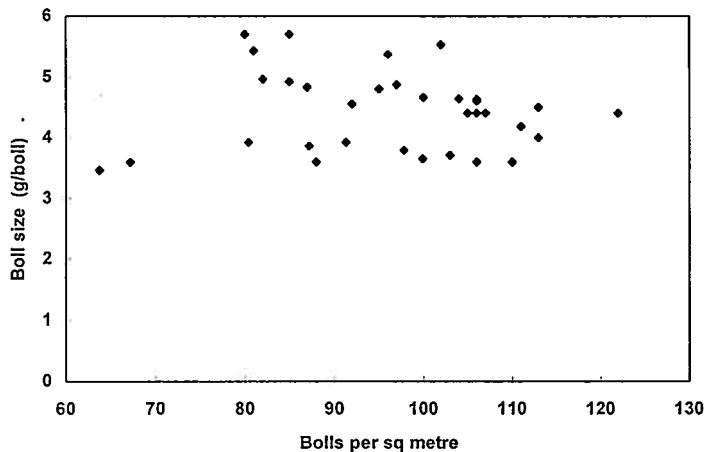


**Figure 4.** The effect of plant density on bolls per plant.

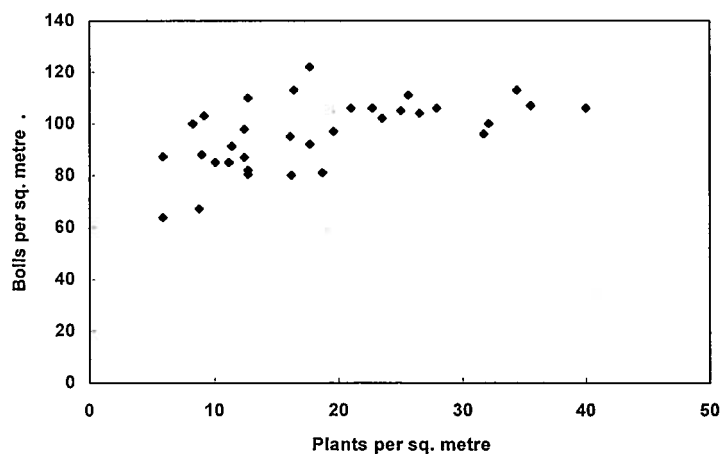
The mechanisms responsible for the change in yield as plant density increased are not clear. Seed cotton yield was strongly correlated with boll size ( $R^2=0.63$ ,  $P<0.001$ ) and bolls per square metre ( $R^2=0.49$ ,  $P<0.001$ ). However, plotting boll size (grams of seed cotton per boll) against plants per square metre (Figure 5), or bolls per square metre (Figure 6), shows little change in boll size over a wide range of plant and boll densities. The change in bolls per square metre with increasing plant density (Figure 7), followed a similar pattern to yield, but the correlation between boll number and yield was not as strong as that for boll size and yield.



**Figure 5.** The effect of plant density on boll size (g of seed cotton per boll).



**Figure 6.** The relationship between bolls per square metre and boll size.



**Figure 7.** The relationship between bolls per square metre and plants per square metre.

### C. Row spacing for UNR cotton

Most commercial UNR cotton growers have little opportunity to try different row spacings. The row spacing used is largely determined by their seeding equipment, and bed forming equipment. If row spacings of 40 or 50 cm could be used, instead of 25 cm, there are opportunities to use different harvesting and weed control techniques. The new UNR cotton seeder built as part of this project allows row spacing to be changed quickly and easily. Therefore, in 2000-2001, a trial was established at Trangie Agricultural Research Centre to compare row spacings of 20, 30, 40, and 50 cm. Details of the design and results from this experiment are presented in Appendix 6.

The seeding rate (seeds per metre of row) was adjusted to give the same number of seeds per ha despite different row spacings. Plant stands of over 200,000 plants per ha were obtained for all row spacings, but plant populations in the 20 and 30 cm plots were higher than in the 40 and 50 cm plots. Plant height and nodes per plant were similar for all row spacings. However, the narrow row spacings had more dry matter per square metre, more bolls per square metre, and produced more seed cotton per square metre. The higher yield with narrow row spacing was largely due to more bolls, because there was no significant difference in boll size. Observations of flowering dates, and the % of open bolls at various dates, indicated that row spacing had no effect on time of maturity.

The results of these trials have addressed most of the objectives of the project, although some aspects need further research to provide adequate answers. The yield of UNR cotton was equal to, or in many cases, better than conventional cotton with little or no penalty in quality. This shows there is good potential for widespread production of UNR cotton, especially if it can give earlier maturity. Many growers report quality problems with UNR cotton, but these are probably due to late harvesting, rather than any inherent problem. In these trials UNR cotton was no earlier than conventional cotton, but they were managed for maximum yield. Commercial experience suggests that with different management strategies, UNR cotton can give earlier maturity. No variety trials were conducted, but testing of germplasm under UNR conditions is now done regularly by Deltapine Australia and Cotton Seed Distributors, the two main cotton breeding organisations in Australia. The results of this work are presented in variety trial results booklets produced by both organisations.

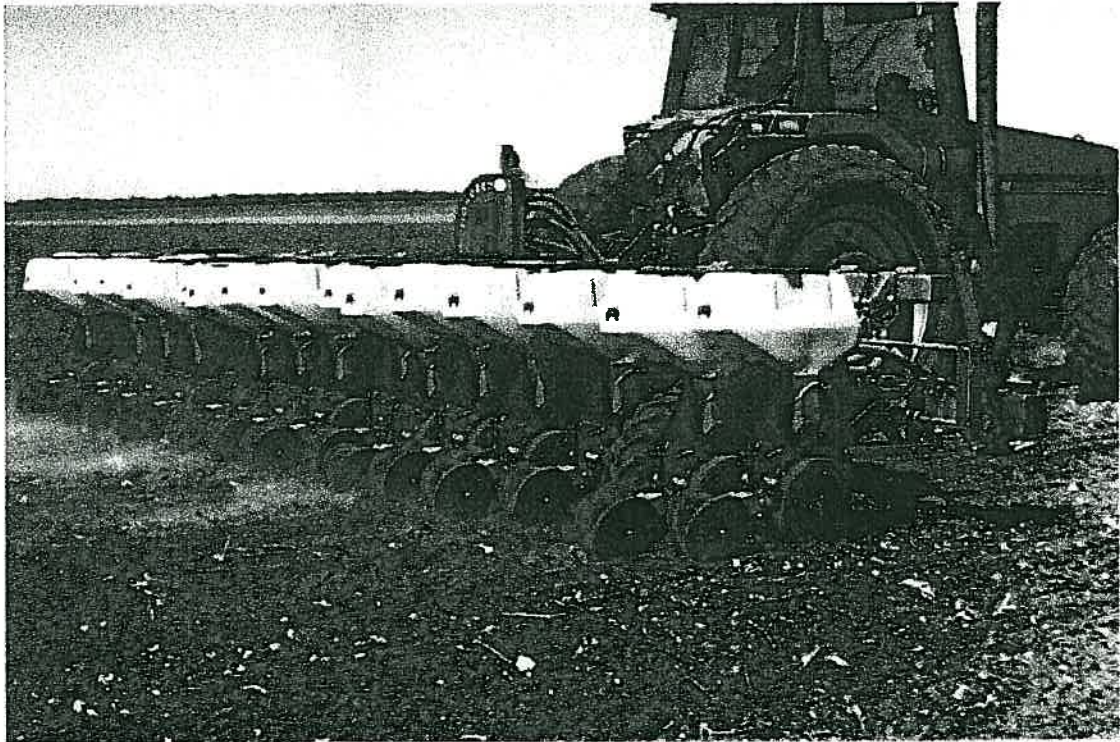
#### **Acknowledgments**

I would like to thank the following property owners who provided land and assisted in the conduct of the trials; Twynam Pastoral Co., Merrowie Station, Hillston; Twynam Pastoral Co., Buttabone Station, Warren; and Mr P. McCann, Valhalla, Narromine. The trials at NSW Agriculture, Breeza Field Station, were organised and supervised by Mr M. Hickman with assistance from the manager. Deltapine Australia provided seed for several of the trials, and helped with quality assessments on samples from the trials. Advice and assistance from Mr Tony Hely, and Mr Tony Heckendorf, was also greatly appreciated.

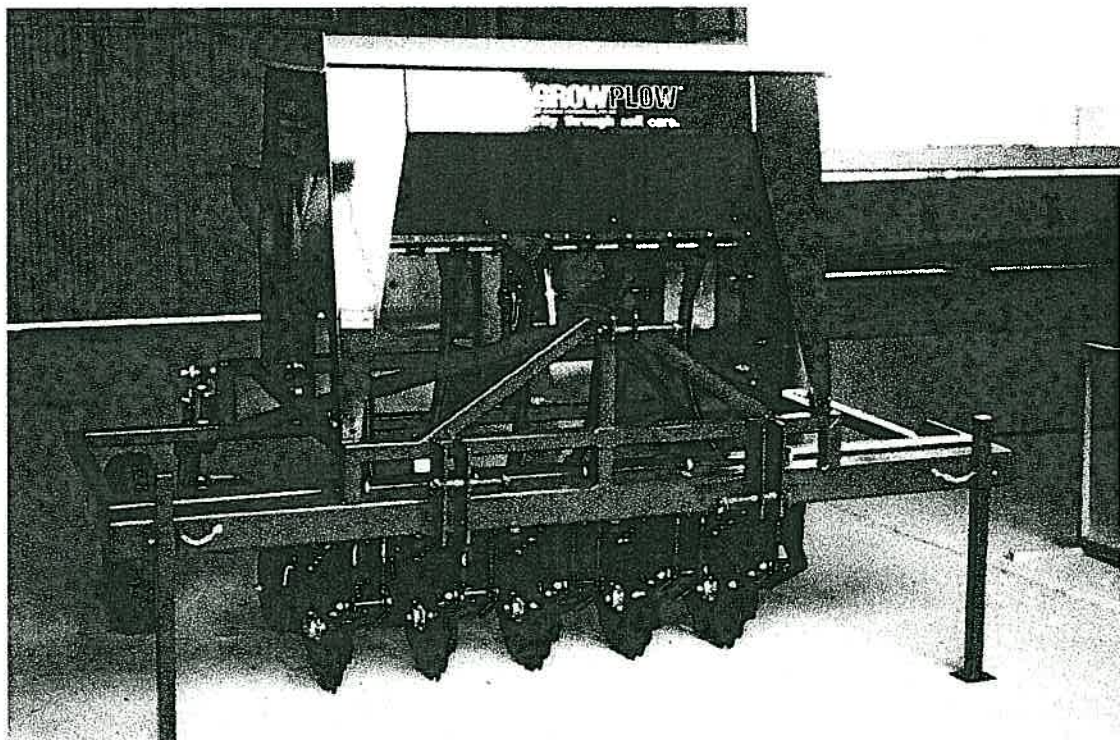
#### **6. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry and future research needs.**

This project has confirmed the potential of UNR cotton production in cool season irrigated areas, but there is unlikely to be any dramatic increase in adoption until a better system of picking UNR cotton is devised. Yields from UNR cotton were usually equal to or slightly better than conventional cotton, while quality was equal to conventional cotton. There are many reports of quality problems with UNR cotton, but this is probably a result of late harvesting, rather than any inherent problem.

Most UNR cotton growers are spending more than they need to on seed. Seed rates of 250,000 plants per ha are common, but the trial results show there is no advantage in rates much beyond 150,000 plants per ha, which would save \$26 per ha. The row spacing work suggests there are advantages in using row spacings less than 25 cm which is the current standard for the UNR cotton industry. However, this is only based on one years data and further research should be conducted as narrower spacing would need more planter units and hence additional costs.



Commercial seeder sowing ultra narrow row cotton at Hillston.



Experimental ultra narrow row seeder built as part of this project. This seeder was used to sow trials at Breeza and Warren, plus row spacing trials at Trangie Agricultural Research Centre.

7. Describe the project technology (eg. commercially significant developments, patents applied for or granted licenses etc).

Not applicable

8. Provide a technical summary of any other information developed as part of the research project. Include discoveries in methodology, equipment design, etc. The seeding equipment used in year 1 of the project proved unsatisfactory. A new seeder was built for the second and subsequent years of the project (photograph in this report). Despite the limited time and funds available to build the seeder, it proved very successful. The only subsequent modification necessary was a change in the position of the depth wheels. Without this seeder, the row spacing research would not have been possible.

9. Detail a plan for the activities or other steps that may be taken;

**a) to further develop or to exploit the project technology.**

Harvesting equipment is seen as the main limitation to further expansion of UNR cotton production, so any developments in this area should be pursued. However, some growers have successfully grown and harvested UNR cotton for several years. This indicates that good management is important for the successful production of UNR cotton, and there is still much that can be done to improve management. Research areas which warrant further work are: the timing and rates of growth regulant applications, chemicals used to defoliate the crop and prepare it for harvest. Even with existing harvesting machinery, good defoliation and a dry mature crop, increases the speed of harvesting and the quality of seed cotton produced. There is also scope to develop low input cotton production systems growing UNR cotton in border check bays.

**b) for the future presentation and dissemination of the project outcomes.**

The results of this project will be written up in scientific journals, but dissemination of the outcomes to growers is probably best done by articles in magazines such as Australian Cottongrower, and by written plus poster presentations at the 2002 Australian Cotton Conference.

**10. List the publications arising from the research project.**

Cooper, J. 1999. 1998-99 UNR Cotton Trials Results. *Deltapine Australia Ultra Narrow Row Cotton Conference, Dubbo, August 20, 1999: 21-22.*

Cooper, J. 1999. Ultra Narrow Row (UNR) Cotton. *Macquarie Cotton Field Day Booklet, 24 March 1999: 29-31.*

Cooper, J. 2001. Optimum Plant Density for Ultra Narrow Row (UNR) Cotton. *Narrow Row Cotton Conference, Hillston/Griffith, March 5 and 6, 2001: 4 pages.*

Cooper, J. 2001. Valhalla UNR. *Macquarie Valley Cotton Trial Reports 2000/2001 compiled by K. Rourke*

Cooper, J. 2001. Buttabone UNR. *Macquarie Valley Cotton Trial Reports 2000/2001 compiled by K. Rourke*

Cotton Seed Distributors. 2001. Variety trial results book 2000-2001. *Booklet produced by Cotton Seed Distributors Ltd, Wee Waa, New South Wales. 96 pages*

Deltapine Australia. 2001. 2001 variety trial results. *Booklet produced by Deltapine Australia, Narrabri, NSW, 48 pages*

Hely, A. 1999. Deltapine UNR Variety Trial Program for 1998-99. *Deltapine Australia Ultra Narrow Row Cotton Conference, Dubbo, August 20, 1999: 10-20.*

Hickman, M.. 1999. 1998 Ultra Narrow Row Cotton Evaluation for the Upper Namoi Valley. *Upper Namoi Valley Cotton Trials 1999, Report Prepared by NSW Agriculture Gunnedah: 80-83.*

Hickman, M. A. 2000. Issues for Ultra Narrow Row Cotton in Australia: Agronomy, Machinery and Ginning. *Conference Proceedings, 10th Australian Cotton Conference, 16-18 August 2000, Brisbane: 261-75.*

Marshall, J., M. Hickman, and A. Kay. 1999. The Pros and Cons of Ultra Narrow Row Cotton. *The Australian Cottongrower 20, No 2: 18-22.*

**11. Are changes to the Intellectual Property register required?**

No

## ***Part 4 – Final Report Plain English Summary***

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Provide a half to one page Plain English Summary of your research that is not commercial in confidence, and that can be published on the World Wide Web.

Ultra narrow row (UNR) cotton is claimed to give earlier maturity and lower production costs than conventional cotton grown in 1 metre rows. Recent years have seen a big increase in UNR cotton production in the USA, and increasing interest in Australia. This project compared the performance of UNR and conventional cotton at several sites in eastern and southern NSW. It also investigated the optimum density and row spacing for UNR cotton production under Australian conditions.

The results show that there is great potential for UNR cotton in Australia, especially if it can deliver early maturity or lower production costs. Averaged over all treatments, sites and seasons, UNR cotton lint yield was equal to that of conventional cotton. With a plant population of 150,000/ha and above, UNR cotton yielded more than conventional cotton in most situations. Gin turn out % for UNR cotton was 3% less than conventional cotton, but this was compensated for by higher seed cotton yields.

Most measures of cotton quality were the same for UNR and conventional cotton. Fibre length, uniformity and micronaire were all in the desired range, and would not attract any price penalty in UNR or conventional cotton. In the 1999-2000 season, the colour grade of conventional cotton was better than that of UNR cotton, but this was due in part to harvesting delays with UNR cotton. Amongst commercial UNR cotton growers there are many reports of low quality, but the research indicates there is no inherent problem with UNR cotton, and the problems encountered are probably due to delays in harvesting. Currently there are a limited number of machines to harvest UNR cotton, and the amount of cotton harvested per day by these machines is less than with a spindle picker in conventional cotton. Consequently much of the UNR cotton has been harvested late.

Growers at Menindee in western NSW, and in the Lachlan Valley, found that UNR cotton matured up to 20 days earlier than conventional cotton. However, in this project we could find no conclusive evidence of earlier maturity with UNR cotton. The research found the optimum seeding rate for UNR cotton to be 150,000 plants/ha, as above this cotton lint yield plateaued. Many growers now plant 300,000 seeds/ha, so there are potential savings on seed. With only one season's results, any comments on row spacing are tentative, but the findings so far suggest that the narrower the row spacing the better.

Although there is considerable scope for improvements to the UNR cotton system, it does offer advantages in cool season areas, particularly if the harvest method can be improved.

Appendix 1. Background information for each trial site and season comparing UNR and conventional cotton.

	Site	Sown	Variety	Plant population ( x 1000 = plants per ha)					Machine picking date	
				Conv.	UNR1	UNR2	UNR3	UNR4	Conv	UNR
1998-1999										
Breeza	NSW Agriculture	14.10.98	Nucot 37	120	136	158	191	197	1.6.99	1.6.99
Warren	Buttabone station	3.11.98	Sicala V2	150	59	88	114	127	25.6.99	24.6.99
Hillston	Merrowie station	23.10.98	DP Jewel	105	59	83	92	124	Only hand pick data	
1999-2000										
Breeza	NSW Agriculture		DP 5490RR	109	101	127	177	256	14.5.00	14.5.00
Warren	Buttabone station	14.10.99	Siokra V15	108	90	127	164	210	8.6.00	26.6.00
Hillston	Merrowie station	16.10.99	Sicala 40	117	177	227	250	344	7.6.00	7.6.00
2000-2001										
Breeza	NSW Agriculture	11.10.00	Sicala V3RR	87	146	224	294	*	Only hand pick data	
Warren	Buttabone station	8.10.00	Siokra V16	119	124	161	279	355	3.5.01	13.5.01
Hillston	Merrowie station	7.11.00	Sicala 40	155	196	265	321	400	26.4.01	26.4.01

\* only 3 ultra narrow row treatments at Breeza in 2000-2001

Appendix 2. Seed cotton and lint yields of conventional cotton and 4 densities of ultra narrow row cotton at 3 sites over 3 seasons.

	Conv Cotton	Ultra Narrow Row Cotton Plant Density				lsd
		1 (low)	2	3	4 (hi)	
1998-99 Hand pick seed cotton yield (grams per square metre)						
Warren	353	222	242	358	314	66.8
Hillston	351	337	365	382	371	ns
1998-99 Machine pick lint yield (bales per ha)						
Warren	5.76	3.46	4.61	5.72	6.06	0.87
Breeza	5.78	5.29	5.87	6.01	5.06	ns
1999-2000 Hand pick seed cotton yield (grams per square metre)						
Breeza	439	413	404	418	463	ns
Warren	325	239	293	339	287	39.5
Hillston	334	402	348	350	376	ns
1999-2000 Machine pick lint yield (bales per ha)						
Breeza	7.08	6.86	8.15	8.04	8.75	ns
Warren	4.45	3.61	4.70	5.13	4.86	ns
Hillston	7.03	7.10	7.25	7.21	8.15	ns
2000-2001 Hand pick seed cotton yield (grams per square metre)						
Breeza	613	578	591	639	*	ns
Warren	461	418	459	488	472	35.7
Hillston	507	472	481	463	492	ns
2000-2001 Machine pick lint yield (bales per ha)						
Warren	8.18	10.97	12.16	10.53	12.21	2.52
Hillston	9.37	8.15	7.86	8.97	8.40	ns

ns not significant ( $P>0.05$ )

\* only 3 densities of UNR cotton at Breeza in 2000-2001

**Appendix 3.** Gin turn out % and fibre quality data, for UNR cotton with 4 plant densities and conventional cotton, at several sites over 3 seasons. Gin turn out figures were obtained using a 20 saw experimental gin and 10 kg samples.

	Conv.	Ultra Narrow Row Cotton Plant Density				lsd
	Cotton	1 (low)	2	3	4 (hi)	
<b>Warren 1998-99</b>						
Gin turn out %	37.0	33.2	33.8	34.7	34.2	2.00
Fibre length (inches)	1.20	1.18	1.21	1.25	1.25	ns
Uniformity %	84.8	83.8	84.1	85.1	85.6	1.05
Strength (g/ tex)	31.3	31.5	32.1	32.1	31.5	ns
Micronaire	3.79	3.77	3.81	3.93	4.01	ns
Colour grade	61	61	61	61	61	ns
<b>Warren 1999-2000</b>						
Gin turn out %	37.2	34.1	34.0	34.3	34.0	2.16
Fibre length (inches)	1.13	1.12	1.14	1.13	1.14	ns
Uniformity %	82.9	82.2	82.0	82.6	83.1	ns
Strength (g/ tex)	28.7	29.2	29.9	29.6	31.2	ns
Micronaire	3.73	3.37	3.40	3.47	3.230	ns
Colour grade	51	61	61	61	61	P=0.016
<b>Hillston 1999-2000</b>						
Gin turn out %	38.8	35.3	35.0	35.8	36.2	ns
Fibre length (inches)	1.16	1.16	1.14	1.13	1.17	ns
Uniformity %	83.7	84.0	84.2	84.0	84.0	ns
Strength (g/ tex)	30.5	30.8	30.1	31.6	31.9	ns
Micronaire	4.30	4.13	4.23	4.13	4.03	ns
Colour grade	41	51	51	51	51	P=0.020
<b>Breeza 1999-2000</b>						
Gin turn out %	40.3	34.6	34.9	37.0	35.2	2.50
Fibre length (inches)	1.13	1.15	1.16	1.10	1.12	ns
Uniformity %	82.6	83.5	84.4	82.4	82.7	ns
Strength (g/ tex)	30.0	31.2	32.2	30.4	30.6	ns
Micronaire	3.77	3.40	3.43	3.37	3.43	ns
Colour grade	no	data				
<b>Warren 2000-2001</b>						
Gin turn out %	39.3	37.5	38.0	37.6	37.9	0.80
Fibre length (inches)	1.19	1.21	1.21	1.19	1.18	ns
Uniformity %	84.7	84.4	84.7	84.7	84.6	ns
Strength (g/ tex)	33.7	33.1	33.0	33.7	33.2	ns
Micronaire	4.50	4.50	4.45	4.30	4.23	0.199
Colour grade	61	61	61	61	61	ns
<b>Hillston 2000-2001</b>						
Gin turn out %	41.1	39.3	39.3	39.8	38.6	1.27
Fibre length (inches)	1.21	1.18	1.18	1.17	1.19	ns
Uniformity %	84.0	83.8	83.9	83.4	83.9	ns
Strength (g/ tex)	32.7	32.6	32.7	32.0	32.9	ns
Micronaire	3.93	4.07	3.97	4.13	3.80	ns
Colour grade	31	31	31	31	31	ns

**Appendix 4.** Design and results of UNR cotton plant density experiment at 'Valhalla', Narromine in 2000-2001.

Date sown 24.9.2000  
 Variety Sicala 40  
 Soil type Red brown earth, prone to crusting  
 Configuration 2 metre beds, 6 rows per bed at 25 cm spacing  
 Harvest date 9.4.2001 hand pick  
 28.4.2001 machine pick

	Treatment					lsd P=0.05
	Density1	Density2	Density3	Density4	Density5	
Plant popln (x1000=plants/ha)	112	162	187	235	317	50
Dry matter (g/sq. m) at various dates						
15.12.2000	84.3	77.1	104.0	77.4	94.2	ns
19.1.2001	613	653	671	662	707	ns
19.2.2001	1193	1030	1210	1062	1036	ns
Plant height (cm) at various dates						
15.12.2000	29.6	31.0	31.3	29.7	32.7	ns
19.1.2001	53.8	47.9	49.0	51.5	47.3	ns
19.2.2001	51.9	46.3	53.4	51.2	45.2	ns
Nodes per plant at various dates						
15.12.2000	10.6	10.9	10.6	10.9	10.7	ns
19.1.2001	17.5	15.8	14.9	15.3	15.0	1.31
19.2.2001	16.5	15.9	16.3	15.8	14.5	ns
Bolls per square metre at various dates						
19.2.2001	107.7	104.7	114.0	99.3	114.7	ns
7.3.2001	106.9	98.3	109.3	92.0	90.3	ns
22.3.2001	103.1	96.4	108.5	111.1	103.6	ns
9.4.2001	84.7	79.8	81.1	101.9	96.4	11.6
Open boll % at various dates						
19.2.2001	10.5	7.4	10.4	4.8	4.6	ns
7.3.2001	38.8	41.7	49.5	39.1	47.4	ns
22.3.2001	81.5	81.3	89.0	91.9	80.0	ns
Hand pick data						
Seed cotton (g/sq. m)	484.5	455.4	439.1	560.7	517.1	56.1
Seed cotton (g) per boll	5.70	5.70	5.43	5.53	5.37	ns
Machine pick data (gin turn out assumed to be 38.5%)						
Lint yield (bales/ha)	3.08	3.54	3.47	2.93	3.20	ns

**Appendix 5.** Percentage of open bolls for conventional cotton and 4 densities of UNR cotton at various dates and sites over 3 seasons. Also the Julian date when 60% of bolls in each treatment were open at Breeza in 1999-2000.

	Conv. Cotton	Ultra Narrow Row Cotton Plant Density				lsd
		1 (low)	2	3	4 (hi)	
Warren 1998-1999						
10.3.1999	4.9	5.1	4.4	3.5	3.1	ns
29.3.1999	71.3	56.5	56.6	67.5	66.7	9.94
15.4.1999	91.7	89.2	89.7	88.4	92.1	ns
Breeza 1999-2000						
29.3.2000	3.4	5.1	2.7	6.0	2.6	ns
4.4.2000	49.1	50.8	55.8	61.0	54.0	ns
12.4.2000	62.5	80.1	66.8	75.3	69.3	ns
60% open bolls (Julian days)	136.7	125.3	129.0	129.3	124.3	ns
Hillston 1999-2000						
29.3.2000	8.6	9.9	16.8	20.6	13.3	ns
Hillston 2000-2001						
14.3.2001	13.9	13.1	14.8	9.4	8.1	ns
29.3.2001	40.9	41.2	47.9	36.8	35.4	ns

**Appendix 6.** Design and results of UNR cotton row spacing experiment at Trangie Agricultural Research Centre in 2000-2001.

Date sown 11.10.2000  
 Variety DP 5690 (Ingard and Roundup Ready)  
 Seed rate 300,000 per ha  
 Soil type Red brown clay  
 Layout 6 replicates in randomised blocks  
 Sown on the flat in a border check irrigation bay.  
 Harvest date 2.4.2001 hand pick

	Row spacing				lsd P=0.05
	20cm	30cm	40cm	50cm	
Plant popln (x1000=plants/ha)	240	246	208	211	27.6
Plant height (cm) at various dates					
11.12.2000	27.4	28.9	30.0	28.4	ns
22.12.2000	42.6	44.1	42.7	46.9	3.26
16.1.2001	58.3	57.3	56.5	57.3	ns
30.1.2001	64.9	63.4	62.7	64.1	ns
21.2.2001	65.4	65.5	62.2	62.8	ns
Nodes per plant at various dates					
11.12.2000	7.5	7.5	7.6	7.6	ns
22.12.2000	11.2	11.2	11.0	11.6	0.36
16.1.2001	13.9	13.5	13.0	13.5	ns
30.1.2001	16.0	15.7	15.5	15.7	ns
21.2.2001	17.1	17.3	17.2	16.5	ns
Dry matter (g/sq. m) at various dates					
11.12.2000	93.6	79.9	60.8	60.4	19.6
15.1.2001	545	382	352	364	121.0
5.2.2001	991	688	688	651	198.0
Bolls per square metre at various dates					
30.1.2001	175.8	120.5	96.5	82.0	39.3
21.2.2001	145.4	83.5	73.0	63.9	18.2
1.3.2001	99.2	78.1	68.8	57.8	16.3
6.3.2001	134.8	84.9	77.3	65.5	18.8
23.3.2001	144.4	100.4	86.1	75.8	28.2
2.4.2001	174.2	125.5	105.4	106.6	23.0
Open boll % at various dates					
21.2.2001	2.9	5.8	1.4	8.2	ns
1.3.2001	17.4	16.7	13.5	20.6	ns
6.3.2001	33.3	40.2	33.5	46.6	ns
23.3.2001	90.7	84.3	84.9	89.3	ns
Hand pick data					
Seed cotton (g/sq. m)	772	572	479	474	106
Seed cotton (g) per boll	4.43	4.62	4.58	4.43	ns