Cotton growth in UNR systems

By Rose Roche[1,2], Michael Bange[1], Stephen Milroy[1] and Graeme Hammer[2,3]

Detailed studies to improve our understanding of differences in the growth and development of cotton in conventionally spaced (one metre) and ultra narrow row (UNR) production systems have been conducted over the past two cotton seasons. Results so far have indicated that although these systems are different in terms of planting density, individual plant size and the light environment, these variations are not translated into significant differences in yield or maturity.

Now we are looking at ways the crop can be manipulated to optimise UNR production systems. Our aim is to better quantify the opportunities for using alternative row configurations in the higher input Australian production systems across regions that differ greatly in climate.

UNR cotton (rows spaced less than 40cm apart) has long been seen as a potential alternative system for Australian cotton, especially in regions with shorter growing seasons. The main emphasis has been on reduced harvesting costs and achieving earlier maturity without substantial yield loss.

Recent advances in harvesting technology to allow spindle picking of UNR crops has generated further interest in these systems, with claims of improved yield and earlier maturity while avoiding discounts for fibre quality associated with harvest.

There is limited understanding of cotton's growth response to different row configurations in Australia. Most understanding of the growth, development and yield of UNR systems has come from research conducted in the US.

Rose Roche.

UNR systems in the US are low-input production systems aimed to improve yields on marginal soils to compensate for small plant size. But in Australia, UNR is grown commercially in high-input systems in areas with a shorter growing season.

Conceptually, in high-input systems, the high density planting of UNR reduces the time to crop maturity, as fewer bolls per plant need to be produced to achieve yields comparable to conventionally spaced cotton crops.

In practice, this earliness has been difficult to achieve consistently in UNR trials in both Australia and the US despite the level of crop inputs.

Commercial UNR crop at Merrowrie, Hillston.

THE ULTRA NARROW ROW THEORY

The general theory of how cotton growth responds in UNR is based on a few key assumptions:

- Closer spaced cotton closes the canopy faster than conventionally spaced cotton, leading to greater light interception and better efficiency, with higher use of light earlier in the season.
- Smaller plants in UNR are less vegetative and will allocate a greater proportion of photoassimilates to boll production.
- A smaller plant with fewer bolls will mature earlier than a larger more vegetative plant.
- A higher plant density compensates for smaller plants with fewer bolls.

But these assumptions have not consistently held true. The assumption of greater yield potential through increased early light interception can only be achieved if additional growth is partitioned into fruiting structures.

Greg Constable's work in the 1970s found that maturity and yield advantages were inconsistent — fruit shedding was significantly higher and bolls smaller in UNR. He also showed that higher leaf area early also did not favour rapid crop setting and that control of vegetative growth might be necessary to achieve earliness.

Advances in technology and positive commercial experience in shorter season production systems where Pix, Bt and RR technology are available has renewed interest in UNR.

Why do we need to know how UNR grows?

In order to tailor management to optimise any system it is important that we understand the differences in the way the crop responds to its environment. Identifying the important changes in the way the crop grows in ultra narrow rows and the influence on maturity and yield will help us better tailor cropping systems to the desired outcome, whether it be yield or maturity.

Once we know clearly how the crop responds we can manipulate agronomy (such as varieties, water, growth regulators and nutrition) to better take advantage of

58 ▷

◁ 57...COTTON GROWTH IN UNR

any benefits that UNR may confer (Figure 1). Measuring the growth of UNR cotton in comparison with conventionally spaced cotton without the confounding effects of different approaches to crop agronomy is the first step in gaining this understanding. Ultimately though, to optimise the UNR cropping system may mean developing a complete agronomic package that may differ from current agronomic practices in a number of ways.

Early and frequent use of Pix is often considered as part of a UNR systems package. To date most trials in Australia comparing UNR to conventionally spaced systems have included differences in Pix applications — confounding comparisons that may identify any advantages of UNR for earliness and yield. As it is the aim of the project to understand the crop physiological factors that drive yield and maturity in the UNR system, none of the trials so far have had any Pix applications.

METHODS

Two field experiments in the 2001–02 and 2002–03 seasons have been conducted at Narrabri and a further two field experiments in 2002–03 were conducted at Breeza and Hillston. These trials were specifically aimed at quantifying the differences in the growth, development, maturity and yield of the crop between the different row configurations.

The experiments compared UNR (25cm row spacing) and conventionally spaced cotton (one metre) grown together. The same variety (Sicala V-3RRi) was used at all sites and for both treatments. Full irrigation and commercial insect control was used.

Frequent measurements were taken of crop growth (biomass), light interception and plant development (fruit mapping, node counts and height). At the end of the season, crop maturity (60 per cent bolls open), yield and fibre quality were measured. Treatments were replicated at least three times at each site.

RESULTS

There were no statistical differences in maturity, yield and fibre quality in any of the growth analysis trials at Narrabri, Hillston and Breeza. The UNR treatment generally had smaller final boll size and fewer bolls per plant. The increased number of plants compensated for smaller boll size and yield was numerically (but not statistically) higher in UNR treatments across all trials.

Overall fruit retention per plant in the UNR treatments was also less. There was no evidence to suggest that the UNR treatments were more efficient at harvesting light, although canopy closure was earlier. This early canopy closure did not translate into faster growth or development.

After canopy closure the UNR treatments had less light penetration through the canopy. Leaf area development continued after canopy closure, which meant the crop was producing new leaves that were not increasing light interception and were shading leaves lower in the canopy (Figure 2). So less light was available to leaves lower in the canopy that are important for supporting boll growth. This may be one reason why boll size is smaller despite there being fewer bolls per plant.

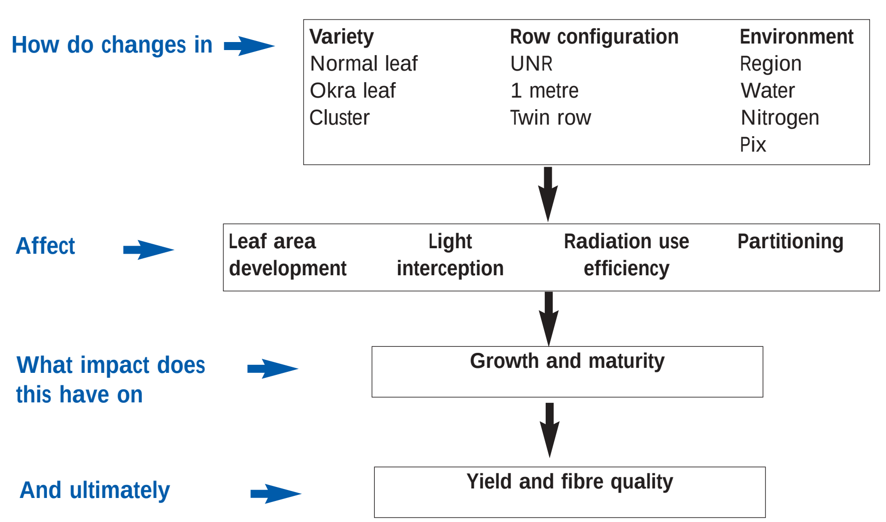
One of the reasons no significant differences in maturity and yield responses were observed in these studies may have been the high populations (250,000 plants per hectare), which may have led to excessive competition for resources (photoassimilates) needed for fruit development.

60 ▷

TABLE 1: Comparing UNR and conventionally spaced cotton

	Conventional	UNR	Difference
Narrabri 2001–02			
Lint (g/m^2)	243	338	n.s.d
Days to 60% maturity (DAS)	149	144	n.s.d
Fibre length (inches)	1.14	1.13	n.s.d
Micronaire	3.93	3.93	n.s.d
1st position fruit retention	49.9	37.1	0.030
Narrabri 2002–03			
Lint (g/m^2)	402	434	n.s.d
Days to 60% maturity (DAS)	148	146	n.s.d
Fibre length (inches)	1.11	1.12	n.s.d
Micronaire	4.37	3.97	n.s.d
1st position fruit retention	58.4	47.0	0.040
Hillston 2002–03			
Lint (g/m^2)	236	257	n.s.d
Days to 60% maturity (DAS)	174	172	n.s.d
Fibre length (inches)	1.15	1.14	n.s.d
Micronaire	4.58	4.73	n.s.d
1st position fruit retention	54.5	52.0	n.s.d
Breeza 2002–03			
Lint (g/m^2)	181	220	n.s.d
Days to 60% maturity (DAS)	154	155	n.s.d
Fibre length (inches)	1.04	1.07	n.s.d
Micronaire	4.00	4.03	n.s.d
1st position fruit retention	48.5	35.6	0.043

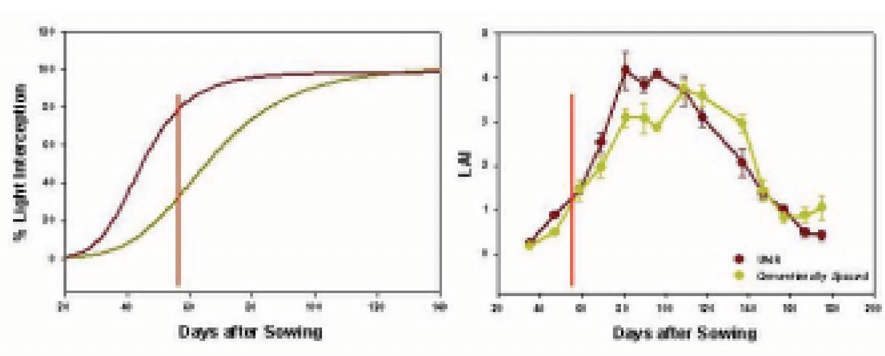
FIGURE 1: Process to develop understanding of cotton's responses to different production system



As high population densities are required to facilitate easy harvesting with a specialised UNR finger stripper harvester, further studies into UNR production systems with different population densities and environments are continuing. Manipulation of the distribution of resources to fruit production with growth regulators or lowering the plant population per hectare may increase light penetration to allow more resources for fruit development lower in the canopy which may increase retention or boll size.

Trial comparing 25 cm UNR with conventional spacings at Hillston in 2002–03.

FIGURE 2: Light interception and leaf area development over the 2001–02 season. Canopy closure in UNR crop indicated by red line



SUMMARY AND FURTHER WORK

Detailed trials conducted in 2001–02 and 2002–03 comparing UNR and conventionally spaced cotton indicated no significant differences in terms of yield, maturity or quality. The potential of UNR as an alternative production system in terms of achieving higher yields or earlier maturity has not been realised using conventional production practices.

Numerically higher yield and boll numbers suggest that there is some potential, but ways of optimising this system need to be explored. Further studies looking at ways to manipulate UNR crops to enhance early fruit retention or increase boll size will be conducted in the 2003–04 season. We will look at different row spacings (including 38cm 'narrow row'), plant populations and the effect of growth regulators (Pix) to manipulate canopy development to increase availability of resources (photoassimilates) to those early bolls which are crucial in achieving an earlier maturing crop.

Thanks to CRDC for partial funding of this project and to grower co-operators.

[1]CSIRO Plant Industry Cotton Research Unit, Australian Cotton CRC, [2]The University of Queensland, [3]Queensland Department of Primary Industries.