Do ultra-narrow row cotton systems offer any benefits to Australian farmers?

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Abstract

Ultra-narrow row cotton (UNR - rows spaced less than 40cm apart) has long been seen as a potential alternative system to conventional systems (100 cm row spacing) for Australian cotton. The perceived benefits include improved yield and earlier crop maturity, which are especially beneficial in shorter season areas. In addition, recent advances in harvesting technology allowing spindle picking of cotton crops grown with 38cm row spacings may increase the benefits of these systems by avoiding the risk of discounts for fibre quality normally associated with stripper harvesters through increased trash. Recent research in Australia indicates that cotton crops grown with 25 cm row spacings, at three times the population of conventionally spaced cotton is too high, leading to a crop that is too dense. This prevents adequate light penetration in the lower canopy to support early bolls, thus providing no benefits in earlier maturity. 38 cm spacing may provide a compromise. In 2004/05 and 2005/06 we compared the yield and maturity of cotton in three different row spacings (25 cm, 38 cm and 100 cm) with different plant populations. Neither lint yield nor maturity was affected by row spacings. More significantly, reducing the planting density did not lead to enhanced yield or earlier maturity. The benefits of UNR systems compared with conventional consequently remain uncertain, though careful manipulation of crop growth through nutrition, irrigation and growth regulators may help realise the theoretical benefits of UNR systems.

Key Words

UNR cotton, *Gossypium hirsutum*, yield, maturity, row spacing.

Introduction

Cotton production in Australia is expanding into areas with shorter growing seasons. This and increasing production costs have fuelled interest in exploring production methods that reduce time to crop maturity. Cold temperatures affect crop establishment early in the season and fibre quality at the end. A shorter crop cycle means the crop can be planted later and harvested earlier, allowing these affects to be avoided. An alternative to conventionally spaced cotton (1 m rows) is ultra-narrow row (UNR) cotton. UNR is a production system with rows spaced less than 40 cm apart, which has potential for earlier maturity.

The indeterminate habit of the cotton plant enables it to compensate its fruiting patterns in response to plant populations, allowing it to be grown at a wide range of populations depending on soil, climate and cultivar (Silvertooth *et al.* 1999). In Australia, the optimum population for 1 m row spacing is around 8-12 plants per metre of row. Increasing or decreasing this row spacing can give a more equidistant spacing between individual plants. Conceptually, in high-input systems, growing cotton at higher plant populations using UNR spacings reduces the time to crop maturity, as fewer bolls are needed per plant to achieve yields comparable to conventionally spaced cotton crops (Lewis 1971). The fruit on the smaller plants should set and mature over a shorter period than a larger more vegetative plant (Lewis 1971).

Detailed experiments comparing UNR and conventionally spaced cotton in Hillston, Breeza and Narrabri in New South Wales found no significant differences in yield, maturity or fibre quality using current production practices (Roche *et al.* 2004a; Roche *et al.* 2003a; Roche *et al.* 2003b; Roche *et al.* 2004b). However, numerically higher yield and boll numbers in UNR systems suggest that there is some potential for increasing yields and new management options need to be explored to optimise this system.

Previous work into narrower row spacings has suggested that UNR spacing (25cm) at three times the density of conventionally spaced cotton may not allow enough light into the canopy to support early bolls leading to delays in maturity (Roche *et al.* 2003a). Those experiments were primarily focused on 25 cm UNR spacings. More work is needed to look at 38 cm UNR spacing to see if the slightly wider row spacings and lower populations respond differently. It is important to maintain a balance between a plant population which maximises resource use, and one that is too high causing over-crowding and insufficient carbon resources for the plant to achieve consistent yields and retain fruit.

We compared three different row spacings with a lower plant population in the 25 cm row spacing than recent experiments to see if reducing plant population or using 38 cm row spacings gave a yield or maturity advantage over wider row spacings.

Methods

Two experiments were conducted in 2004-05 and 2005-06 in Narrabri, NSW to compare yield and maturity in three row configurations. All plots were sown onto 2 m beds. The row spacings were 25 cm UNR (6 rows spaced 25 cm apart per bed), 38 cm UNR (4 rows spaced 38 cm apart per bed) and conventionally spaced (2 rows spaced 100 cm apart per bed). Standard on-farm sowing and crop management practices were used.

The experiment in 2004-05 was sown into moisture on 26 October 2004. A randomised complete block design with four replicates was used. The cultivar Sicala V-3BR was used. Established plant populations were 12 plants/m^2 for 100 cm, 24 plants/m^2 for 38 cm and 18 plants/m^2 for 25 cm spacing. There were five irrigations and nine insecticide applications. Nitrogen was applied as anhydrous ammonia at 146 kg N/ha two months before planting.

The experiment in 2005-06 was sown into moisture on 4 November 2005. A randomised complete block design with five replicates was used. The cultivar Sicot 71BR was used. Established plant populations were 12 plants/m^2 for 100 cm, 24 plants/m^2 for 38 cm and 24 plants/m^2 for 25 cm spacing. There were six irrigations and four insecticide applications. Nitrogen was applied as anhydrous ammonia at 200 kg N/ha two months before planting.

At the end of the season, yield and crop maturity (60% bolls open) were determined from weekly hand picks. The yields reported in these experiments are handpicks and are approximately 10% higher than those reported for machine picks in Australian irrigated cotton production.

Statistical analyses were conducted using Genstat[?] software.

Results

Yield and Yield Components

There were no significant differences in yield, boll number, boll size or lint percentage between the three row spacings in 2004-05. In 2005-06 the only significant differences were higher lint percentages in the 25 cm and 38 cm row spacings compared to the 100 cm spaced treatments (Table 1). The amount of lint per boll was not significantly different between row spacings in 2005-06 but there was less seed cotton per boll in the 38 cm and 25 cm row spacing treatments compared to the 100 cm treatments indicating that the difference in lint percentage was due to lower seed weight per boll in the narrower row spacings. Although not significant, lint yield and boll number per m^2 increased numerically as row spacing decreased.

Table 1. Lint yield, lint percentage, boll number and boll size (lint/boll and seed cotton/boll) for 100 cm, 38 cm and 25 cm row spacing treatments in 2004-05 and 2005-06. (Significant differences indicated by ** - 99% confidence level)

	Lint yield (g/m^2)	Lint percentage (%)	Boll number/m^2	Lint/boll	Seed cotton/boll
2004-05					
100 cm	228	40.5	103.0	2.21	5.47
38 cm	257	41.0	115.2	2.23	5.44
25 cm	268	39.5	136.8	1.94	4.90
LSD	85	4.0	27.5	0.32	0.508
2005-06					
100 cm	287	42.4	138.4	2.07	4.95
38 cm	288	43.2	146.5	1.96	4.55
25 cm	304	43.6	152.4	1.99	4.55
LSD	38	**0.3	17.1	0.098	**0.136

Crop Maturity

The time to crop maturity (60% open bolls) was not significantly different between row spacings in 2004-05 or 2005-06 (*P*=0.784 and *P*=0.122 respectively). There was no consistent trend in maturity over the two experiments (Figure 1). In 2004-05 days after sowing to crop maturity increased numerically in the 38 cm and 25 cm row spacings compared to 100 cm row spacing treatments, in 2005-06 maturity decreased numerically (Figure 1).

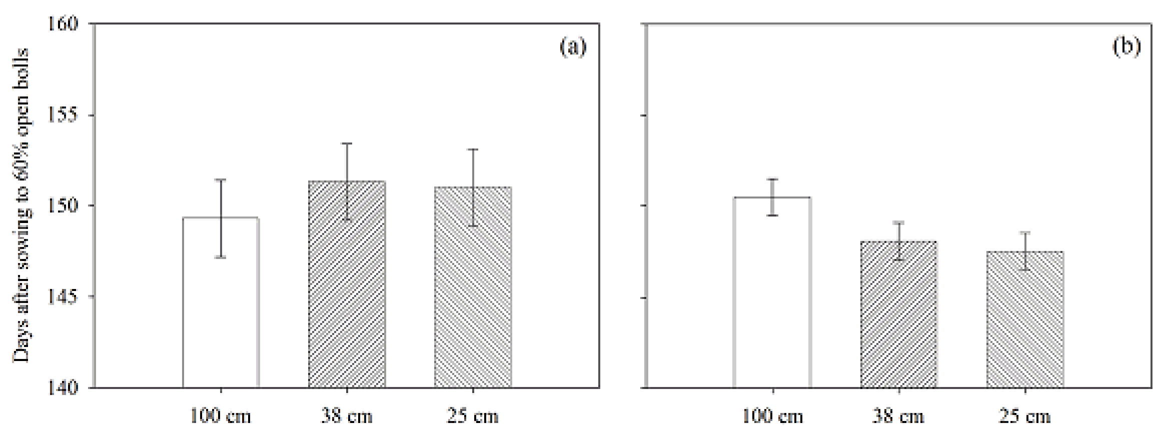

Figure 1. Days after sowing to 60% open bolls (crop maturity) for 100 cm, 38 cm and 25 cm row spacing treatments in 2004-05 (a) and 2005-06 (b). Error bars are two standard errors of the mean.

Discussion

Yield and maturity were not significantly different between row spacings in either of the experiments. The results agree with our previous data comparing 25 cm UNR spaced cotton to conventionally spaced cotton which also found no differences in yield or maturity (Roche *et al.* 2004a; Roche *et al.* 2003a; Roche *et al.* 2003b; Roche *et al.* 2004b). Yield and boll numbers were higher in the UNR spaced crops with a trend to increased yield as row spacing decreased. This increase was offset by a decrease in boll size as row spacing decreased. Lint yield was not affected by a decrease in boll size as the percentage of lint in each boll was not significantly lower and there was a numerical increase in boll number.

The smaller boll size in the 25 cm and 38 cm UNR spaced treatments in 2005-06 suggests that there may have been limited assimilates for boll development, which may have a negative effect on fibre quality attributes (maturity and strength) as found in other studies (Baker 1976). Several studies have found a decrease in boll size as row spacing decreases although the reasons for smaller bolls have not explicitly been explored (Bednarz *et al.* 2000; Constable 1977a; Galanopoulou-Sendouka *et al.* 1980). Constable (1977a) found that the smaller boll size in the narrow row (18 cm row spacing) treatments in his experiments was due to fewer seeds per boll compared to conventionally spaced rows. This indicated that conditions at flower bud formation and ovule fertilization were important in the narrower row crops as these stages determine the number of seeds per boll (Constable 1977a).

There were no differences in time to maturity between the three row spacing treatments. A smaller plant with fewer bolls would be expected to set and mature bolls earlier. Although not measured in this study, other studies into UNR cotton have found that boll retention is significantly less in UNR crops than conventionally spaced cotton(Constable 1977a; Constable 1977b; Galanopoulou-Sendouka *et al.* 1980; Kerby *et al.* 1990; Roche *et al.* 2004a; Roche *et al.* 2003a). Retention of early first position bolls is very important to avoid delaying maturity. If early fruit were shed, the UNR plants would compensate by producing fruit later.

Previous work into narrower row spacings suggested that UNR spacing (25cm) at three times the density of conventionally spaced cotton may not allow enough light into the canopy to support early bolls leading to delays in maturity (Roche *et al.* 2003a). Those experiments primarily focused on 25 cm UNR spacings, and we were interested to see if the slightly wider row spacings and lower populations using 38 cm UNR spacings responded differently to 25 cm cotton production. Lowering the plant population per ha from 300 – 360 000 plants/ha to 180 – 240 000 plants/ha did not change the yield and maturity response of 25 cm UNR, nor did using a wider row spacing.

Conclusion

These experiments were initial investigations into the yield and maturity response of a range of row spacings using different plant populations and we found that at lower plant populations, 25 cm and 38 cm row spacings do not have the expected maturity benefits compared to 100 cm row spacings. This study and other previous studies have shown a consistent trend to numerically higher yields using narrower row spacings, however these benefits may be negligible if fibre quality, nutrient use and water use are impacted by these systems. Research is continuing to examine why narrower row spacings do not achieve theoretical yield and maturity benefits and whether careful manipulation of crop growth through nutrition, irrigation and growth regulators may help realise the theoretical benefits of UNR systems.

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