Management for ultra early cotton systems

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Abstract

There is strong interest in the Australian cotton industry to develop systems that reduce the time to maturity (i.e. shortening the time between planting and harvest), which can lead to savings in irrigation water and late season insect pest spray costs. However, there is generally a trade off in seeking earlier maturity in that for each day that maturity is brought forward, there is a yield loss (0.6 to 1.0 bales/ha per week). This paper presents results of ongoing studies which aim to integrate different approaches to reduce the time to cotton crop maturity and increase efficiency of resource use (eg. water). Three field experiments were conducted over two seasons to assess the impact of maturity and yield of varieties differing in their crop maturity grown in systems with different sowing times, row configurations and irrigation management. Across the two seasons there was no consistent effect of variety, plant population and sowing time on lint yield or maturity. Delaying sowing time had the greatest effect on maturity (15 d shorter), without penalising yield.

Media summary

Research investigating management options to grow earlier maturing cotton with resource limitations.

Key Words

Cotton, maturity, earliness, ultra narrow row

Introduction

There is strong interest in the Australian cotton industry to develop systems that reduce the time from planting to maturity which can lead to savings in irrigation water and late insect pest season spray costs. Earlier maturity in cotton has also become important as production in Australia expands into areas with shorter growing seasons. However, there is generally a trade off in seeking earlier maturity (i.e. shortening the time between planting and harvest), in that for each day that maturity is brought forward, there is a yield loss of between 20 and 35 kg/ha lint per day, that is between 0.6 to 1.0 bales/ha per week (Bange and Milroy 2004).

It is generally understood that the timing of crop maturity in cotton is not determined solely by temperature and day length as in many other crops, but by the balance of supply and demand of resources to the developing fruit and growing points. The timing of crop maturity is determined by when the plant stops producing the new fruit ('cut-out') due to the demand on the resource supply by growing fruit leaving none for the initiation of new fruiting sites (Mason 1922, Hearn 1994). Therefore, timing of crop maturity can be manipulated by a range of management factors. Fruit retention, and hence insect control, is a key driver. Variety, nitrogen, water, plant population (eg. ultra-narrow row spacing), sowing date and the use of growth regulants (eg. mepiquat chloride) are other factors. The means of using these management factors and the degree to which these affect maturity in Australian cotton production have been summarised by Milroy et al. (2002) and Roberts and Constable (2003).

This paper presents results of ongoing studies which aim to integrate different approaches to reduce the time to cotton crop maturity and increase efficiency of resource use (eg. water). That is rather than yield being the only objective, the efficiency of resource use (especially when limited) is also equally important. These studies explored the use of varieties differing in their crop maturity (through earlier fruiting) and their ability to resist fruit loss from insect damage (Bollgard II?, varieties expressing *Bacillis thuringiensis* proteins). Following this, a selection of these varieties were evaluated in systems with different sowing times, row configurations and irrigation management.

Methods

Three field experiments were conducted at Narrabri (30? S 150? E), Australia in the 2001-02 and 2002-03 seasons. The experiments were grown on a grey-clay soil utilising commercial high input management and insect control as described in Hearn and Fitt (1992). The first experiment (Exp. 1) a variety screening trial was conducted in 2001-02 to find a variety that exhibits early maturity without substantial yield loss. Eight varieties were selected – seven early maturing varieties that varied in growth characteristics that confer early maturity (eg. node to first fruiting branch, crop determinacy) and potential to retain fruit causing earlier cut-out. A long season variety (Siokra V-16) was included for comparison (Table 1).

Table 1. Description of lines used in field experiments exploring crop maturity 2001-2003

Name	Origin	Description
CSX 233B	CSIRO Australia	Experimental Bollgard II ? line - early maturing, high fruit retention
CSX 242B	CSIRO Australia	Experimental Bollgard II ? line - high fruit retention, high yielding
Chirpan	Bulgaria	Early fruiting, low first fruiting branch
Siokra S-102	CSIRO Australia	Commercial variety - early maturing
Sicala 40	CSIRO Australia	Commercial variety - early maturing, determinate
CSX 402B	CSIRO Australia	Experimental Bollgard II ? line - early maturing, high fruit retention
Strumica	Yugoslavia	Early fruiting, low first fruiting branch
Siokra V-16	CSIRO Australia	Commercial variety – full season, indeterminate

A second experiment (Exp. 2) also conducted in 2001-02 comparing Siokra S-102 and Chirpan at two times of sowing, 15 Oct (Normal) and 16 Nov (Late) with different plant populations (Ultra narrow row – (UNR) and conventional). UNR consisted of six rows spaced 0.25 m apart on a 2 m bed with an established population of 36 plants/m^2 and conventional with two rows spaced 1 m apart on a 2 m bed (12 plants/m^2).

A third experiment (Exp. 3) conducted in 2002-03 comparing CSX 242B, Siokra S-102 and Strumica at two times of sowing, 10 Oct (Normal) and 11 Nov (Late) with the same plant populations as Exp. 2 (UNR and conventional). Water was deliberately limited below optimum for the first sowing (as per trial protocol, the final irrigation was not applied). Each sowing had six irrigations over the season.

Maturity picks were hand harvested weekly to determine maturity (days after sowing to 60% open bolls), final lint yield and fibre quality (except Exp. 1). Statistical analyses were conducted using Genstat? software. Significant differences were considered at 95% confidence intervals ($P < 0.05$).

Results

In Exp. 1 there were significant differences in yield and maturity between varieties. Siokra S-102 was the highest yielding variety followed by CSX 242B. Chirpan was the lowest yielding variety and this was not unexpected given that it is poorly adapted to Australian conditions. In terms of maturity Strumica was the earliest maturing while Siokra V-16 was the latest (a difference of 10 d). Comparing yield versus maturity (Fig. 1) Siokra S-102, CSX 402B and CSX 242B had the highest yields with early maturity. Siokra S-102, CSX 242B and Strumica were chosen for use in Exp. 3 in 2002-03.

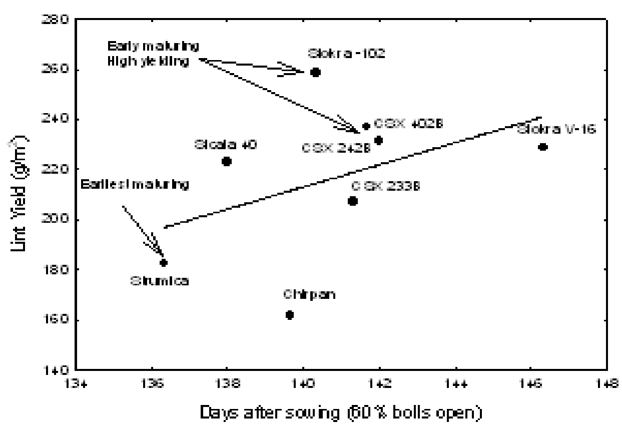

Fig. 1. Relationship between yield and maturity in Exp. 1 variety screening trial.

In the systems experiment, Exp. 2, there were no significant differences in lint yield, micronaire or maturity across plant populations and sowing dates (Table 2). There were no interactions for yield, maturity or fibre length, however there were treatment effects. Siokra S-102 was earlier maturing and higher yielding than Chirpan across plant populations and sowing dates ($P < 0.001$). Earlier planting, UNR plant population and Chirpan independently reduced fibre length ($P < 0.05$).

Table 2. Lint yield, maturity and fibre quality of Exp. 2 systems trial (means of 3 replications).

	Sowing	Conventional		UNR	
		Chirpan	Siokra S-102	Chirpan	Siokra S-102
Lint Yield (g/m^2)	Normal	156	211	214	189
	Late	184	255	172	258

Maturity (DAS)	Normal	153	147	150	147
	Late	145	144	146	142
Micronaire	Normal	4.00	4.33	4.03	3.87
	Late	4.00	4.27	3.87	4.03
Length (inches)	Normal	1.13	1.16	1.11	1.14
	Late	1.17	1.19	1.11	1.15

In Exp. 3 in both conventional and UNR populations, Strumica had the lowest yield but there were no significant differences in time to maturity between varieties (Table 3). UNR population yielded 9% higher than the conventional population, however there were no significant differences in maturity (UNR 193.7 g/m^2; 137 DAS and conventional 177.2 g/m^2; 135 DAS respectively). Although there were no differences in yield between the two sowing dates, the late sowing matured an average of 15 d earlier than the normal sowing. There were significant differences in micronaire and length between varieties across both plant populations. Strumica had higher micronaire in the UNR population in the early sowing but in the late sowing there were no differences in micronaire. In the conventional plant population CSX 242B had the lowest micronaire. In the conventional population Strumica had the shortest fibre length and in the UNR population all varieties had significantly different fibre lengths with Strumica having the shortest and CSX 242B the longest.

Table 3. Lint yield, maturity and fibre quality of Exp. 3 systems trial (means of 3 replications).

	Sowing	Conventional			UNR		
		CSX 242B	Siokra S-102	Strumica	CSX 242B	Siokra S-102	Strumica
Lint Yield (g/m^2)	Normal	200	196	129	165	205	151
	Late	179	194	165	209	248	184
Maturity (DAS)	Normal	144	147	139	145	147	141
	Late	130	128	126	135	129	125
Micronaire	Normal	3.25	3.67	3.83	3.13	3.20	3.70
	Late	3.57	4.20	3.83	3.93	3.87	4.00

Length (inches)	Normal	1.16	1.17	1.07	1.17	1.13	1.08
	Late	1.19	1.16	1.08	1.18	1.15	1.05

Discussion

The genotypes in the variety screening experiment (Exp. 1) only produced a difference of 10 d in maturity even though a range of germplasm (early fruiting, high retention and full season) were deliberately chosen. The early fruiting (low first fruiting branch) line, Strumica was the earliest maturing genotype however it was not significantly different from the well adapted commercially available line Sicala 40 in either maturity or yield. However, Strumica was used in subsequent experiments to determine if its early fruiting characteristics would provide different results in different systems (plant populations, sowing dates). The relationship between yield and maturity is similar but not as strong as previous studies on crop maturity in Australia (Bange and Milroy 2004; Roberts and Constable 2003).

As experiment 1 and 2 were conducted concurrently Chirpan (an early fruiting genotype) was selected without the results of Exp. 1, which unfortunately showed it to be lower yielding than Strumica. Experiment 2 was designed to investigate any interaction between early fruiting genotypes and different systems. There were no interactions between varieties, plant populations or sowing dates. There was a significant difference in maturity with Siokra S-102 maturing 3 d earlier than Chirpan, but this is unlikely to be useful.

In the second systems experiment (Exp. 3) Strumica was still the earliest maturing, but again was only 4 d earlier than Siokra S-102. As there were no interactions in terms of maturity between varieties, plant populations or sowing times, this indicates that adaptation may be a more important factor than genotypic variation in fruiting time. Sowing time had the biggest impact on maturity in experiment 3, where the later sowing was 15 d shorter. This result was different to the previous season (Exp. 2) where the mean difference between crop maturity (DAS) was only 5 d between sowing times. This was achieved with the same agronomy as the early sowing, including number of irrigations, without yield penalty. This experiment showed the potential to delay sowing by one month, maintain yield and fibre quality and yet only harvest two weeks later. Advantages of this approach include improving plant establishment and reduced agronomic inputs similar to crop maturity studies by Roberts and Constable (2003).

Plant population did not affect maturity across the two systems experiments, but did have an affect on fibre quality (Exp. 2 only) and yield (Exp. 3 only). The UNR plant population had reduced fibre length in Exp. 2 which is common in UNR cotton crops (Baker 1976). The lint yield increase (16 g/m^2) in UNR in Exp. 3 was due to higher boll number (data not shown). Similar inconsistencies in the effect of plant population (UNR and conventional) on both yield and maturity have been recorded by Roche et al. (2003) for high input cotton systems.

Conclusion

Across the two seasons there was no consistent effect of variety, plant population and sowing time on lint yield or maturity. Genotypic characteristics for earliness do not necessarily confer a maturity advantage over current commercial short season varieties. Sowing time had the greatest effect on maturity with potential to delay sowing while maintaining yield. Further studies are continuing to look at combinations of management options to find an ultra early cotton system with limited agronomic inputs.

References

Baker SH (1976) Response of cotton to row patterns and plant populations. Agronomy Journal 68, 85-88.

Bange MP and Milroy SP (2004) Timing, growth and dry matter partitioning of diverse cotton genotypes. Field Crops Research 87, 73-87.

Mason TG (1922) Growth and abscission in sea island cotton. Annals of Botany 36, 457-484.

Milroy SP Bange MP and Roberts GN (2002) Is earliness really next to Godliness? Proceedings of the 11th Australian Cotton Conference, Brisbane, Queensland, (Australian Cotton Growers Research Association). 473-476.

Hearn AB (1994) OZCOT: A simulation model for cotton crop management. Agricultural Systems 44, 257-299.

Hearn AB and Fitt GP (1992) In 'Field Crop Ecosystems'. (Ed. C.J. Pearson) pp. 85-142 (Elsevier, Amsterdam).

Roberts GN and Constable GA (2003) Impact of crop management on cotton crop maturity and yield. Proceedings of the 11th Australian Agronomy Conference, Geelong, Victoria, (Australian Society of Agronomy). http://www.regional.org.au/au/asa/2003/p/4/roberts.htm

Roche R, Bange MP, Milroy SP and Hammer, GL (2003) Crop growth and maturity in ultra narrow row and conventionally spaced cotton. Proceedings of the 11th Australian Agronomy Conference, Geelong, Victoria, (Australian Society of Agronomy). http://www.regional.org.au/au/asa/2003/c/5/roche.htm