Earliness Management Systems for Cotton Production

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ABSTRACT

Strategies to reduce the time from cotton planting to crop maturity were examined in a systems approach. It was necessary to utilise a systems approach in order to examine many management factors in one package (cultivar, nitrogen, growth regulator, insect management and irrigation timing). Large commercially managed cotton fields were divided into thirds and two 'earliness' systems (management for earliness and the use of an early variety) were compared against standard commercial management strategies at five locations, Goondiwindi (3 sites), Bourke and Boggabri. The cooler season in 1999/2000 influenced yield comparisons at the different sites. Earliness strategies had higher yields and earlier maturity than standard practice at cooler locations such as Boggabri, but at warmer locations, earliness strategies gained little earliness and had lower yields than standard practice. We conclude additional factorial experiments as well as modelling will assist with this type of systems research.

KEY WORDS

Cotton, earliness, farming Systems, growth regulator, nutrition.

INTRODUCTION

The concept of 'earliness' - managing cotton crops to reduce the time between planting and crop maturity, is often practiced throughout the cotton industry as a way to avoid late season irrigations, insecticide sprays and potential weather damage. Analysis of seasonal rainfall patterns has shown that each region has specific periods of reduced rainfall in which cotton picking should be targeted (1). These periods are sometimes earlier than standard crop management allows and consequently managing the crop for earliness may be beneficial.

There are many individual components (nitrogen, irrigation management, insect control, growth regulators) that can be managed to contribute to earliness, but often individually, these management strategies only make small gains. While these individual components have been researched extensively few experiments combine more than two or three factors together and most exclude insect management (and hence plant compensation) from their trials. The experiment by Gaylor *et al* (2) is one of the few that attempted to examine complex interactions on cotton in one experiment. Interpreting the results of herbicides, nitrogen, tarnished plant bugs (*Lygus lineolaris*) and planting dates on yield and maturity was difficult but highlighted the importance of interdisciplinary research in designing optimum production systems.

In Australia, planting before the optimum planting window, does not contribute greatly to earliness and is associated with higher levels of climatic risk (3,4). In addition there is a relatively narrow range of maturity between current Australian cultivars compared to many other crops. Analysis of field trials has shown that early maturing cultivars often suffer a yield penalty when grown in the current Australian cotton geographic regions (5). With limited scope to advance maturity through time of planting or cultivar selection, 'in crop' management becomes critical in the pursuit of earliness. The most common methods of advancing crop maturity are optimising or limiting plant available nitrogen (6), timing of irrigation (7), the use of growth regulators, particularly mepiquat chloride (MC) (8) and insect control strategies (9). There is no data in Australia comparing early managed cotton systems to standard managed cotton systems in terms of yield, quality, gross margin or risk associated with weather damage. This paper reports preliminary data from the first season to highlight trends and problems with the topic of farming systems research. The full project has replication of large-scale experiments in time (season) and space (site). Other replicated factorial experiments are being done on a smaller scale.

Materials and Methods

An experimental design was chosen that attempted to test a management package for early maturity against standard management, rather than a complete factorial of individual factors. The simplicity of the design allowed it to be conducted on cotton farms utilising commercial management, with minimal risk of insecticide drift across treatments due to the large size of treatment areas. Five large fields (80 ha or greater) were selected on commercial cotton farms in the Goondiwindi, Bourke and Boggabri cotton growing regions. Each of these fields was divided into thirds and three treatments were imposed. The treatments were:

1) Standard management- full season cultivar, standard N, standard MC, standard early season fruit retention (through insect management) and standard last irrigation timing.

2) Early management- full season cultivar, reduced N, high MC, high early season fruit retention (through insect management) and omitting last irrigation if possible.

3) Early cultivar – short season cultivar, reduced N, standard MC, standard early season fruit retention and standard last irrigation timing.

'Standard' management was based on the current commercial practices on each cotton farm. Nitrogen applications were monitored and adjusted using petiole nitrate analysis based on the recommendations by Constable *et al* (10) and MC applications were based on vegetative growth rate index recommendations (11). The cotton grower and consultant at each site managed the inputs associated with these treatments according to table 1. In addition the management of yield protection through insecticides and the timing of the last irrigation were initially intended to be part of the management packages of each treatment. There were small differences in insecticide applications between treatments but this did not alter the yield potential and because of rainfall patterns irrigation timing was not altered on any treatment. The method of determining maturity in this paper was the same as that used by Constable *et al* (12) and refers to the time from planting until 60% harvestable bolls. Analysis of variance was conducted using location as replicates.

Table 1. Cultivar selection, nitrogen and MC management inputs for the five experimental sites.

Treatment	Inputs	Riverview (Goondiwindi, Qld)	Oonavale (Goondiwindi, Qld)	Warendi (Goondiwindi, Qld)	Benalabri (Boggabri, NSW)	Darling farms (Bourke, NSW)
Standard Management	Cultivar	Sicot 189	Sicot 189	Sicala V2	Siokra V16	Sicot 189
	Nitrogen kg/ha	170	175	140	110	175
	MC L/ha	0.4	0.4	0.3	0	0.8 + 1
Early Management	Cultivar	Sicot 189	Sicot 189	Sicala V2	Siokra V16	Sicot 189

	Nitrogen kg/ha	140	110	90	110	128
	MC L/ha	0.4	0.6	0.4	0.35 + 1.5	1 + 1.4
Early cultivar	Cultivar	Sicala 40	Sicala 40	Sicala 40	Siokra 101	Sicala 40
	Nitrogen kg/ha	130	110	90	110	135
	MC L/ha	0.4	0.4	0	0	1.4

RESULTS

The management systems achieved differences in fertiliser rate and variety as intended (Table 1). Not all sites had wide variation in MC application; insect management was similar for all treatments because of low insect pressure; and rainfall patterns meant there were no late season irrigation schedule differences. However at Benalabri, the early variety system was 15 days earlier than the standard that potentially would have saved irrigation (data not shown). When averaged over all sites there was significant earliness achieved with the early variety system (Table 2). This was expected, although the mean earliness of 8 days was less than expected, probably because of the lack of opportunity to manage late season irrigation cutoff. The early management system only achieved 3 days earliness (not significant). Yields were not significantly different on average, but since the early variety system had less fertiliser and MC, the gross margin would be slightly improved based on those two inputs. Reduced yield and similar costs with early management treatments would mean a reduced gross margin when compared with standard management.

Table 2. Means of the five sites for maturity and yield. (L) = long season cultivar and (S) = short season cultivar. Mean of five sites.

Treatment	Maturity (days from planting to 60% harvestable bolls)	Yield* (bales/ha)
Standard management (L)	177	8.7
Early management (L)	174	8.4
Early variety (S)	169	8.7
LSD = 5%	4	NS

*A bale = 225 kg of lint.

Yield response to management system for individual sites was in three groups in comparison with standard management: Benalabri and Warendi had higher yield with both variety and management for earliness; Oonavale and Darling Farms had lower yield with both variety and management for earliness; and Riverview had lower yield with early management but higher yield with early variety (Fig. 1). These

responses are likely to have been due to the temperature and rainfall patterns at each site. The 1999/2000 was a ‘shorter’ season than average, especially at Benalabri and Bourke (Fig. 2). In addition the Bourke site received a severe water logging event (4 times average rainfall in February) which would have contributed to the lower than average yields.

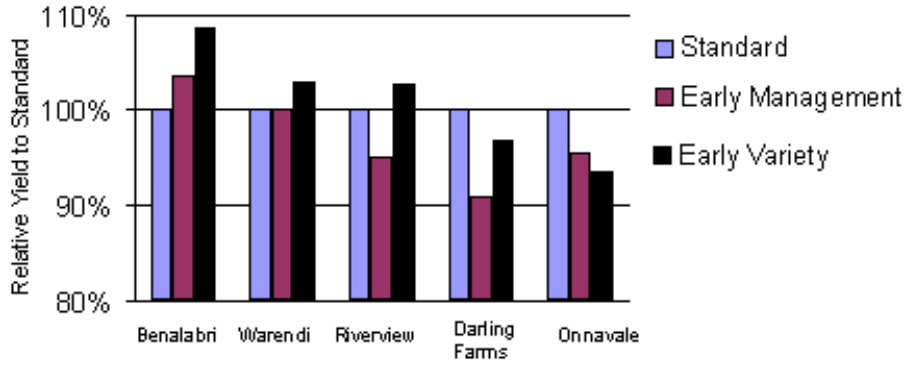

Figure 1. Relative yield of early management and early variety compared to standard management at five locations.

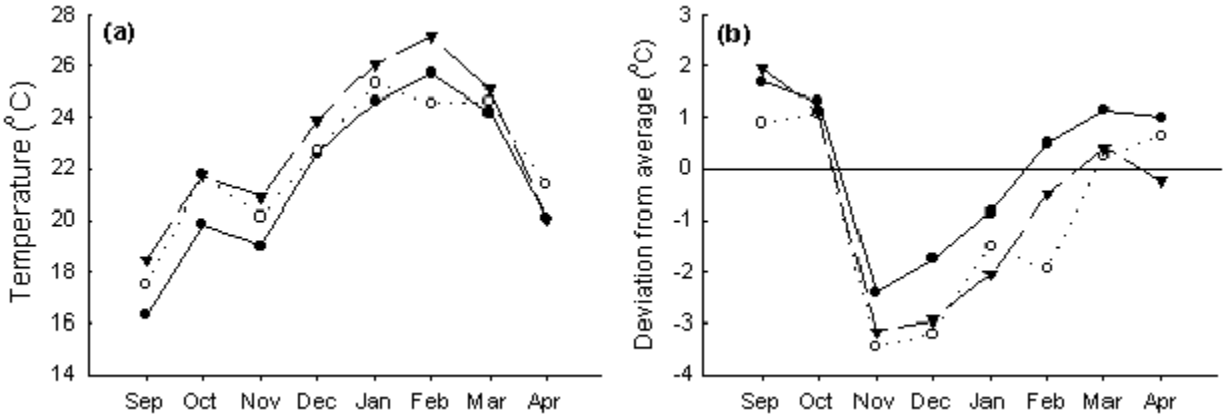

Figure 2. Growing season average monthly temperature for Bourke (triangles), Boggabri (open circles) and Goondiwindi (closed circles), a) 1999/2000 monthly average and b) monthly deviation from the long term average for 1999/2000.

DISCUSSION

The cooler than average growing season conditions of 1999/2000 had a marked influence on the results and highlights the need for repetition in time (seasons). The trend was for the early variety to be superior in short season locations. This was expected as the crop development was delayed and hence the early variety will retain and hold its bolls earlier. The indeterminate nature of cotton means that long season varieties will try and exploit optimal (temperature) irrigated growing conditions and under these situations will yield more due to their ability to add additional bolls late in the season. These differences were evident in this experiment with the ‘shorter’ season location (Boggabri responding) to earliness treatments, while the relative yield differences were reduced for the Goondiwindi sites (Figure 1). It is also possible that short season cultivars are also more ‘cool’ tolerant as they are bred for these environments which may contribute to them having a yield advantage. The data showed promising trends for early systems to maintain gross margins.

One of the reasons that commercial field sized plots were chosen on cotton farms was to allow commercial management to be conducted across each treatment, particularly insect control, which requires large buffer areas when aerial application is utilised mid to late season. The importance of insect management was shown by Brook *et al* (13) who suggested that the loss of early season fruit under high yield conditions could cause excessive vegetative growth possibly delaying maturity. In the 1999/2000 season the numbers of *Helicoverpa* spp. was lower than average that resulted in the reduced ability to alter early season fruit retention through insecticide applications. Growers and consultants were reluctant (understandably) to apply insecticides below industry thresholds, and were more interested in adjusting crop maturity through the use of growth regulators (mepiquat chloride), nitrogen and water management.

A result of this experiment is the need to conduct smaller controlled factorial experiments that separate the components of insect management and agronomic management to determine the level each is contributing to crop maturity. These types of experiments also highlight the difficulty in researching complex multi-factor problems like crop maturity in an indeterminate, resource/climate responsive crop such as cotton. The conventional approach of factorial replicated designs does not suit itself well to these type of questions and Galyor *et al* (2) has already identified the problems associated with trying to explain more than three-way interactions. Our future approach will be to utilise smaller factorial experiments to identify the principles and rules of achieving earliness and then confirm the results with larger targeted systems experiments. With the improvement of the maturity component in the OZCOT model (1) the use of site and year simulation will be an additional tool in assessing earliness strategies.

CONCLUSIONS

Earliness in cotton is advantageous in the cooler short season regions where yield potential is limited by climate and the opportunity for compensatory growth is reduced. In long season regions the potential yield reductions associated with earliness systems and the negative effect this has on gross margins reduces the usefulness of this strategy in favourable climatic conditions. Pursuit of earliness in these areas may not be suitable and other reasons such as insect resistance management or water savings may be the impetus for any changes in maturity timing. The use of modelling linked with long term climatic data will provide an estimate of the percentage of years that earliness strategies are likely to be beneficial and will ultimately reduce the need to conduct large field based programs for these types of multi-factor systems experiments. The ability to analyse earliness strategies across a number of sites and years has been demonstrated by Richards *et al* (1) but this concept requires more development.

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