Irrigated Bollgard®3 cotton performance in the Gilbert catchment of north Queensland

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Abstract
There is significant interest in the development of broadacre cropping systems in northern Australia, with cotton as the potential pillar crop. An understanding of the variability in performance of cotton and other crops in this environment is needed to better inform future investment by landholders in cropping and governments in the necessary infrastructure to support future development. The Queensland Department of Agriculture and Fisheries, with the support of the CRC for Developing Northern Australia and the GRDC, are conducting on-farm replicated irrigated trials of several crop species at Forest Home Station, west of Georgetown in Queensland. The results of three seasons clearly show that Bollgard® 3 cotton varieties vary in their adaptability, with yields ranging from 8 to 11 bales/ha. There was little consistent variation in yield between varieties across seasons. The season to season variation in yield reflected seasonal variability. At this time a reasonable risk management strategy in this variable environment is to plant a proportion of each variety.

Keywords
cotton, irrigation, North Queensland, cropping system, APSIM

Introduction
North Queensland's Gilbert Catchment, comprising around 46,000 km^2, drains into the southern Gulf of Carpentaria. Pastoralism is the major industry in the region, with tourism, mining and commercial fishing also important contributors to the economy (Petheram et al, 2013).

In 2013 CSIRO completed, for the Australian Government, an investigation of opportunities for water and Agricultural development in the Flinders and Gilbert catchments of north Queensland. This report identified within the Gilbert catchment, sites for large instream dams capable of supporting 20,000 to 30,000 ha of irrigation in 85% of years. The study reported that the precise area under irrigation would, in any year, vary depending upon factors such as irrigation efficiency, water availability, crop choice and risk appetite. It suggested that this potential area of production may be sufficient to sustain local processing facilities such as a cotton gin. It suggested that if crops were grown to their full potential. The regional gross margin of crop production could exceed $60 million annually.

Raingrown cropping production is sensitive to the very high year-to-year variability of rainfall in the Gilbert catchment. Break-even yields of most crops can be achieved only two to three years in ten. However, it is expected that dryland cropping is likely to be a component of irrigation development within the region (Petheram et al, 2013).

A key issue limiting investment in cropping systems within the Gilbert catchment is an understanding of the yield variability (and hence risk profile) and profitability of crops that could be grown within existing extensive grazing systems. There is also limited knowledge and experience amongst landholders and the agribusiness sector with the agronomy of potential broadacre crops within the region.

In 2018 the Department of Agriculture and Fisheries (DAF) Broadacre Farming Systems team initiated replicated research trials at "Forest Home Station", 50 km to the west of Georgetown on the Gilbert River. The aim was to examine the irrigated yield potential of four crops of particular interest – cotton, mungbeans, soybeans and sesame- on the sandy and loamy soils best suited to future irrigated production within the region. In 2020 DAF secured funding from the CRC for developing Northern Australia and GRDC to continue this research.

This paper presents the results of the assessment of irrigated Bollgard®3 cotton varieties at Forest Home Station in 2018, 2019 and 2020.

Methods

Preliminary APSIM modelling for the crops of interest was undertaken by Dr Keith Pembleton, USQ. The outputs from this modelling suggested average lint yield in the order of 8 to 9 bales/ha should be possible with a 15 January planting. The required irrigation would be around 700mm, with a range of 300 850mm. It should be noted that the APSIM model has not been validated for this region (one of the aims of the research being undertaken).

Replicated cotton experiments comprising three Bollgard®3 varieties (selected in consultation with Cotton Seed Distributors) were planted in a fenced field at Forest Home Station in 2018, 2019 and 2020. The sandy loam soil at the site was sampled for nutrient availability prior to each season – the results (to 30 cm depth) and details of the cotton trial agronomy is summarised in Table 1.

Table 1 Cotton trial agronomy at Forest Home Station – 2018, 2019 and 2020.

Year	2018	2019	2020
Varieties	Sicot 714B3F Sicot 746B3F Sicot 748B3F	Sicot 714B3F Sicot 746B3F Sicot 748B3F	Sicot 714B3F Sicot 746B3F Sicot 748B3F
Replicates	8	8	6
Nutrient status (30cm depth)	pH 6.5 77 kg Nitrate N/ha 152 kg P/ha 590 kg K/ha	pH 6.6 149 kg Nitrate N/ha 203 kg P/ha 1807 kg K/ha	pH 6.4 251 kg Nitrate N/ha 122 kg P/ha 1239 kg K/ha
Nutrients Applied	104 kg N/ha 26 kg P/ha 83 kg K/ha	95 kg N/ha 9 kg P/ha 62 kg K/ha	162 kg N/ha 98 kg P/ha 35 kg K/ha
Planting Date	10 January 2018	22 January 2019	20 February 2020
Harvest Date	18 June 2018	3 July 2019	5 August 2020
Season length (days)	159	162	167
In-crop Rainfall (mm)	713	313	164
Irrigation Applied (mm)	50	250	476
Herbicide	2 x glyphosate	2 x glyphosate	1 x glyphosate
Insecticide	1 x methomyl 1 x dimethoate	3 x dimethoate	3 x dimethoate
Growth Regulant (mepiquat chloride)		0.5 L/ha (58 das) 0.70 L/ha (79 das)	0.25 L/ha (34 das) 0.50 L/ha (56 das) 0.70 L/ha (69 das)

Results

Table 2 summarises the plant and crop development measures, yields and lint quality characteristics for the three tested cotton varieties in 2018, 2019 and 2020.

The variety Sicot 714B3F has demonstrated exceptional yield performance in a wide range of environments and is best suited to regions with shorter growing seasons (Lee and Curckpatrick, 2020). Sicot 746B3F and Sicot 748B3F perform well in full season environments. These varieties are reported to have similar yield, quality and disease tolerance, Sicot 748B3F is more vigorous than Sicot 746B3F and is recommended for fields that produce shorter cotton – where there is a history of soil constraints or full water supply is not guaranteed.

Table 2 Crop development, yield and lint quality characteristics for three cotton varieties at "Forest Home Station", Georgetown– 2018, 2019 and 2020

Year	2018			2019			2020		
Variety	714 B3F	746 B3F	748 B3F	714 B3F	746 B3F	748 B3F	714 B3F	746 B3F	748 B3F
Plants/m	8.4 a	8.8 a	9.4 a	10.3 a	9.4 ab	8.3 b	12.4 a	13.1 a	12.6 a
Height (cm)	126 a	131 a	134 a	139 a	121 b	129 ab	109 a	92 b	105 ab
Nodes (no.)	21.2 a	20.9 ab	22.9 b	23 a	22.3 ab	21.9 b	16.0 a	14.6 b	16.0 a
Yield (b/ha)	11.1a	10.4 ab	8.7 b	10.0 a	11.2 a	10.7 a	7.9 a	9.0 a	8.5 a
Lint %	45.5 a	47.5 b	44.7 a	43.4 a	44.9 a	43.6 a	n/a	n/a	n/a
Micronaire	4.6 a	4.4 b	4.3 b	4.3 a	3.8 b	4.0 b	4.4 a	4.0 b	4.3 a
Fibre length (in)	1.18 a	1.21 ab	1.26 b	1.23 a	1.28 a	1.28 a	1.23 a	1.28 a	1.25 a
Short fibre index	6.2 a	6.1 a	5.9 a	5.6 a	5.2 a	5.2 a	5.4 a	5.2 a	6.1 a
Strength (g/tex)	29.5 a	31.4 b	31.9 b	30.5 a	32.2 b	31.7 b	30.4 a	30.2 a	29.3 a

Means followed by the same letter in each row in each year are not significantly different at $P \leq 0.05$

Discussion

Crop establishment in all years and for all varieties met or exceeded the desirable established plant population considered for optimal yields of 8-12 plants per metre for fully irrigated conditions (Quinn and Petty, 2019).

There were no significant differences in crop height between varieties in any one year. Growth regulant was applied in the second and third season to manage crop growth. Although more and earlier growth regulant was applied in 2020 its impact on crop growth may be confounded by the delayed planting (due to the late wet season break) and the poorer seasonal rainfall conditions that year. This is reflected in the lower node counts in 2020 and the subsequent lower yields achieved.

The yields achieved in 2018 (8.7 to 11.1 bales/ha) and 2019 (10 to 11.2 bales/ha) are respectable. The varieties 714B3F and 746B3F produced the highest yields in 2018 where there was significant rainfall from planting until the end of March 2018 (when 430mm of rain associated with ex-tropical cyclone Nora fell) and little irrigation was applied. In 2019 yields were similar across varieties (ranging from 10 to 11.2 bales/ha). In this year there was 313mm of in-crop rainfall falling from after planting through to the end of March 2019 – all in falls of less than 35mm. In that year 250mm of irrigation was applied.

The yields achieved in 2020 were lower than those of the previous two years. In 2020 the wet season break did not eventuate until mid-January 2020. This delayed ground preparation at a new trial site and limited pre-plant management of weeds. This delayed planting until the 20 February 2020. This planting delay and the dry seasonal conditions (a total of 164mm of in-crop rain) is most likely responsible for the poorer yields that year (ranging from 7.9 to 9.0 bales/ha).

The fibre characteristics of varieties across all years indicated:

- gin turnouts were similar to or exceeded the relative gin turnouts expected for these varieties (Sicot 714B3F of 42%, Sicot 746B3F of 45% and Sicot 748B3F of 44%) in 2018 and 2019 (data not available for 2020)
- Micronaire values were within the optimal range between 3.8 and 4.5 for all varieties and in all years.
- Fibre length exceeded the desired upper half mean length of 1.125 inch or 36/32nds for all varieties and years
- Short fibre index measures the proportion by weight of fibre shorter than 0.5 inch or 12.7 mm. Ideally this should be below 8 %. All varieties and years produced less than this quantity of short fibre.
- The fibre strength is defined as the breaking force required for a bundle of fibres of a given weight and fineness. Ideally this should exceed 29 grams/tex. Fibre strength exceeded this level in all varieties in all years.

Conclusion

The results of three years of evaluation of the three Bollgard®3 cotton varieties under irrigation in the Gilbert River catchment of north Queensland demonstrated similar yield and quality performance between these varieties. The lower yields achieved in the 2020 season was most likely the result of the later planting date in this year and the more difficult growing conditions experienced that season. At this stage the results provide insufficient evidence to recommend one variety over another in this region. It appears appropriate that a reasonable risk management strategy in this variable environment is to plant a proportion of each variety.

Based on research to date it appears yield expectations of 8 to 11 bales/ha are possible in this environment. This reflects the earlier APSIM modelling undertaken. Research trials at this site will continue for another two seasons. The data collected will be used to validate the performance of the cotton model within APSIM in this environment. If successful, the APSIM model will then be used to further examine potential cropping practices in cotton within this environment.

Assuming a yield of at least 8 bales/ha under irrigation in this environment, the potential production of on at least 50 percent of the potential irrigable soils within this region (12,500ha) would equal 100,000 bales annually. This would generate revenue of at least $50 million and produce around 50,000 tonne of cottonseed which would benefit the grazing industry within the region. Research on other potential cropping options is continuing within the region with the aim of further developing a viable broadacre cropping sector to complement existing agricultural production and the regional economy of north Queensland.

References

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