Annual, Progress and Final Reports

Part 1 - Summary Details

REPORTS

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: **CSP 138C**

Annual Report: ☐ Due 30-September

Progress Report: ☐ Due 31-January

Final Report: ☒ Due 30-September (or within 3 months of completion of project)

Project Title: Refining crop agronomy for dry season cotton production in NW Australia

Project Commencement Date: 1/7/2001 **Project Completion Date:** 19/12/2003

Research Program: 4 Farming Systems

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Part 3.3 – Final Reports (due 3 months after completion of project)
(The points below are to be used as a guideline when completing your final report. Postgraduates please note the instructions outlined at the end of this Section.)

Outline the background to the project.

Productivity of the Australian cotton industry is constantly threatened by reduced availability of irrigation water in eastern Australia. Consequently there has been considerable interest in the possibility of re-establishing cotton in the Ord River area, and other locations in north western Australia where extensive supplies of water and land are available. The development of a cotton industry in NW Australia would complement production in eastern Australia, providing reliability of supply to maintain valuable markets for high quality lint. In addition to addressing crop adapation issues this project will focus on soil specific production systems and many outputs from the Ord will be directly transferable to other black soil sites in NW Australia that could potentially grow cotton (e.g. Victoria, Roper, Fitzroy and Lennard Catchments).

Previous field work in the Ord has identified guidelines for many aspects of the production system as follows:

1. Sowing date – March/April is the desired time, with yield and lint quality (weathering) reductions possible with later sowings.
2. Plant density - As with most irrigated cotton, about 100,000 plants/ha are ideal. There was no difference between 1 row and 2 row bed configurations.
3. Growth regulator - It was expected that growth regulators would be an important part of crop management but most results have shown no yield advantage. Recommendations are for low rates to be applied prior to flowering. High rates often reduce yield.
4. Irrigation studies have highlighted the importance of precise application as too frequent or prolonged irrigation can reduce yields in cold weather. During flowering sheduling at 50% depletion of plant available water or an accumulated pan evaporation of 90 to 110mm was optimal for yield.
5. Nutrition - Optimum rates of N and P on previously fertilised soil have been determined as well as guidelines for fertilizer placement. No response to K has been obtained.
6. It has been found that full season heat tolerant cultivars are most suitable for the Ord (at least for April sowings). Fibre length is reduced by cool minimums during flowering and selection for cultivars on the basis of fibre length is ongoing.

Cotton CRC reviews on research gaps have identified a number of key priorities:

1. Determining compensation for insect damage. The winter season may change the pattern of compensation when compared with that obtained from eastern Australia. This is a key issue in insect management.
2. Further refinement of growth regulator management strategies. This includes interactions with irrigation, nutrition, cultivars, sowing date and compensation for insect damage.
3. Farming system issues: rotation crops, wet season cover crops, weed management and soil preparation, particularly in relation to the wet season.
4. Irrigation scheduling to maximise water use efficiency, avoid waterlogging and minimise offsite environmental impacts.
5. Nutrient requirments of virgin soils.
6. Futher evaluation of crop adapatation and production risk issues that relate to the tropical dry season (e.g. manipulation of time to maturity, mid season cold shock, managing

weathering risk, OZCOT model validation and calibration).
7. Combining agronomic and pest management research outputs by testing at a commercial scale and then collecting feed-back from large-scale tials managed by commecial farmers to identifiy new problems and research issues.

List the project objectives and the extent to which these have been achieved.

- Continue to investigate the effects of specific agronomic/ physiological factors on cotton growth and performance in the dry season and integrate those factors into a robust agronomic package. Of importance are fertiliser requirements, irrigation scheduling, growth regulator management and sustainable rotations/wet season cover crops, particularly in combination with appropriate IPM strategies.
- Integrate appropriate cultivars, agronomy and pest management to provide a technological package for the establishment of an irrigated dry season cotton production system in NW Australia. This will involve larger scale farmer-managed trials.

Detail the methodology and justify the methodology used.

Compensation from insect damage

This project was performed in conjunction with Tom Lei (CSP124C) and focused on how compensation ability of cotton plants in northern Australia may differ from those grown in traditional cotton growing areas in eastern Australia. Research in the past three seasons has built on work conducted in the previous three seasons, which found greater yield compensation to simulated heliothis damage than temperate Australia, due to higher end-of-season temperatures. The objective over three years (2001 to 2003) was to measure the impact of temperature (sowing date) and mepiquat chloride on compensation as fruit removal during high temperatures was observed to produce rank growth. The 2002 trial was dropped due to a heavy infestation of Lepidoptera after cut-out. Treatments were as follows…

2001 Two sowing dates; early (8th of April) and late (17th of May)

Undamaged
Undamaged + Mepiquat chloride
Tipped out + early season damage
Tipped out + early season damaged + Mepiquat chloride
Tipped out + mid season damage
Tipped out + mid season damaged + Mepiquat chloride
Tipped out + early and mid season damage
Tipped out + early and mid season damaged + Mepiquat chloride

The cultivar used was Sicot 289i and there were four replicates per treatment. The mepiquat chloride was applied when the plants had produced 10 nodes (15th of May and 7th of July respectively) at a rate of 14g ai ha^{-1} (assuming 60% intercepted).

2003 One sowing date (22nd of March)

Undamaged
Undamaged + Mepiquat chloride
Tipped out (at 5 nodes)
Tipped out (at 5 nodes) + Mepiquat chloride
Tipped out (at 5 nodes) + early fruit loss (800DD)
Tipped out (at 5 nodes) + early fruit loss (800DD) + Mepiquat chloride
Tipped out (at 5 nodes) + mid fruit loss (1200DD)
Tipped out (at 5 nodes) + mid fruit loss (1200DD) + Mepiquat chloride
Early fruit loss (800DD)

Early fruit loss (800DD) + Mepiquat chloride
Mid fruit loss (1200DD)
Mid fruit loss (1200DD) + Mepiquat chloride

The cultivar used was CSX 405B and each treatment was replicated four times. The mepiquat chloride was applied when the plants had produced 10 nodes (30^{th} of April) at a rate of 11.25g ai ha^{-1} (assuming 60% intercepted).

The level of artificial damage was based on an estimate of what eight *Helicoverpa* larvae per m would inflict as determined by Ted Wilson's model. Measurements for both years involved the partitioning of biomass samples from 0.5m of row taken prior to first fruit damage (i.e. pre 800DD), prior to second fruit damage (i.e. pre 1200DD) and at first open boll as well as maturity picks every second day.

Irrigation scheduling and Growth regulator management strategies

Investigation of growth regulator management strategies was included with irrigation management to form an experiment which involved the interaction with cultivars. The experiment was conducted over two growing seasons (2001 and 2002). There were four irrigation treatments

Frequent early (emergence to first flower)/ Frequent late (post cut-out)
Extended early/Frequent late
Extended early/Extended late
Frequent early/ Extended late;

two 'pix' treatments

No mepiquat chloride
Mepiquat chloride applied at 10 nodes at 14g ai ha^{-1} (assuming 60% intercepted);

and two cultivars

Sicot 289i
Siokra V-16i.

There were four replicates per treatment. Irrigation events up to first flower were scheduled on 70mm pan evaporation for the 'frequent' treatments, while irrigation events for the 'extended' treatments took place after 140mm of pan evaporation. During flowering irrigations were scheduled on 90mm of pan evaporation and after cut-out they were scheduled at 140mm pan evaporation (therefore two for the remainder of the season) for the 'frequent' treatment and after 280mm of pan evaporation (therefore one for the remainder of the season) for the 'extended' treatment. Measurements taken throughout the growing season included heights, nodes and nodes above white flower as well as biomass and partitioning and maturity picks. Yields were determined using a small plot picker and fibre quality was analysed at ACRI. Soil water levels were determined using a neutron moisture meter (NMM) and a Sentek Diviner, with an attempt to calibrate the later with the former. In the 2002 season, trapezoidal and weir flumes placed at the top and bottom of the fields were used to determine volumes of water applied and drainage from the field.

Wet season cover crop / weed management / soil preparation

This project had the aim of investigating the use of a wet season cover crop and then preparing the bed prior to sowing a cotton crop at the beginning of the dry season. Three trials were conducted. In 2001/02 eight different crop species (dwarf pearl millet, brassicas, forage sorghum sorghum, Japanese millet, lab lab, soybean, Rhodes grass and pigeon peas) were sown on the 4^{th} of December, 2001 and sprayed out at three different times during the wet season (early - 18th of January, mid – 25th of January, and late – 4th of February). This was compared to a control treatment where no cover crop was grown. Crop biomasses were determined at sprayout and on the decomposing crop material just prior to cultivation. Soil N was recorded shortly after sowing. Cotton was sown on the 26th of April and yield and fibre quality were determined.

For the 2002/03 wet season two trials were planned. The first was a repeat of the 2001/02 wet season trial although this was abandoned due to lack of funds and poor germination by some of the crops. The other trial, which was designed to investigate the potential of Roundup Ready cotton in conjunction with several different tillage strategies, was watered up on 22nd of March 2003 and involved ten treatments

- Cover crop (dwarf pearl millet) over wet season, seed direct drilled, Stomp (455 ai g/l @ 3l/ha surface applied) + Roundup (690 ai g/kg @ 800g/ha) when 3rd leaf was expanding
- Cover crop (dwarf pearl millet) over wet season, seed direct drilled, Stomp
- Dry season sorghum stubble retained, seed direct drilled, Stomp + Roundup
- Dry season sorghum stubble retained, seed direct drilled, Stomp
- Wet season fallow, cultivated, Stomp + Roundup
- Wet season fallow, cultivated, Stomp
- Wet season fallow, cultivated, Roundup
- Wet season fallow, cultivated, no herbicides
- Wet season fallow, cultivated, no cotton sown, Roundup
- Wet season fallow, cultivated, no cotton sown, no herbicides

The purpose of the last two treatments was to determine the level of weed seeds present in the weed seed bank and to determine the competitive ability of the cotton plants and weeds on one another. Weed and crop biomass levels were determined throughout the growing season as well as heights, nodes and NAWF. Yields were determined by a small plot picker.

In addition to yield and physiology measurements, bed slumping over the wet season was also compared between beds which had been cultivated after the previous dry season crop (sorghum) had been harvested with others that had had their stubble retained. Measurements were taken in early December (start of the wet season) and just prior to sowing in mid March (end of the wet season).

<u>Virgin soil nutrition</u>

This trial was conducted on a Cununurra cracking clay soil at the Frank Wise Institute for Tropical agriculture that had never had fertiliser applied or crops grown on it. The Cununurra cracking clay is the predominant soil type in Ord stage II. Indigenous available soil P was 3ppm which was considered extremely low. In 2002 five rates of P (0, 40, 80, 120 and 160 kg ha^{-1}) were applied to the soil as double superphosphate in addition to standard rates of N, Zn and S. In 2003 these plots, from here-on referred to as ‘old area’, were split into five and differing rates (i.e. 0/0, 0/40, 0/80 etc). An additional area was used to repeat the 2002 experiment, from hereon referred to as ‘new area’. In both trials, leaves and petioles of the most recently expanded leaves were collected throughout the season and heights, nodes and NAWF were also recorded. Levels of arbuscular mycorrhiza fungi (AMF) colonisation was also determined in both years 17 days after watering up. In both years yields were taken using a small plot picker and fibre analysis performed at ACRI. In the ‘new area’ trial in 2003 plants displayed a pronounced lack of vigour and 1kg ha^{-1} of $ZnSO_4$ hepta was applied as a foliar fertiliser. Shortly after plants appeared to recover somewhat from their deficiency symptoms.

Crop adaptation to dry season growing conditions

Variety and Progeny trials

The main focus of this trial was to determine which cultivars are best suited to dry season growing conditions in the ORIA. Variety trials were conducted using CSIRO and DeltaPine cultivars. In 2001 Ingard cultivars were examined, in 2002 Ingard and Bollgard II cultivars, both with and without Roundup Ready, were investigated while in 2003 only Bollgard II with and without Roundup Ready were used. In all three years conventional cultivars were used as checks There were 20 entries in both 2001 and 2002 and 18 entries in 2003. In 2001 a progeny trial was also conducted containing 35 Ingard lines derived from Sicala 35 to identify which may be adapted to local conditions.

Fibre quality and physiology

Unlike cotton crops grown during the summer in most temperate/subtropical areas around the world, cotton grown in northern Australia during the winter/dry season experiences the coolest temperatures of the year around flowering with the average July temperatures in Kununurra of 30.7/14.4°C max/min and with an average of six cold shocks (nights below 12°C) every July. A trial to investigate the effect of cool night temperatures on fibre quality was investigated by placing insulated tents at various stages during fibre formation over the crop every night. The trial consisted of four reps of the following treatment

Control (no tents)
Tents placed over the crop nightly for three weeks starting 10 days after first flower
Tents placed over the crop nightly for two weeks starting 31 days after first flower
Tents placed over the crop nightly for two weeks starting 45 days after first flower

The trial was conducted over two years (2002 and 2003). Bolls were tagged for their date of flowering and when the boll cracked open, were hand picked and fibre quality assessed at ACRI. The insulated tents consisted of a steel ‘A’ frame encased with 2.5 rating insulation bats and covered with sisiliation. The tents were able to buffer the night temperature by an average of 3.3°C.

Application of research results at a larger scale

This objective was approached two ways. Up until 2003 ‘commercial scale’ trials were conducted on local growers fields and agronomic advice was offered whenever possible in conjunction with entomological advice from the Western Australian department of Agriculture entomologist Amanda Annells. In 2003 however there was no interest shown by local farmers in growing cotton and a 7.5ha field at Frank Wise Institute was used to conduct a ‘best bet’ trial. This trial was grown using what at the time was considered to be the best cultural practices for growing cotton in the Ord River Irrigation Area.

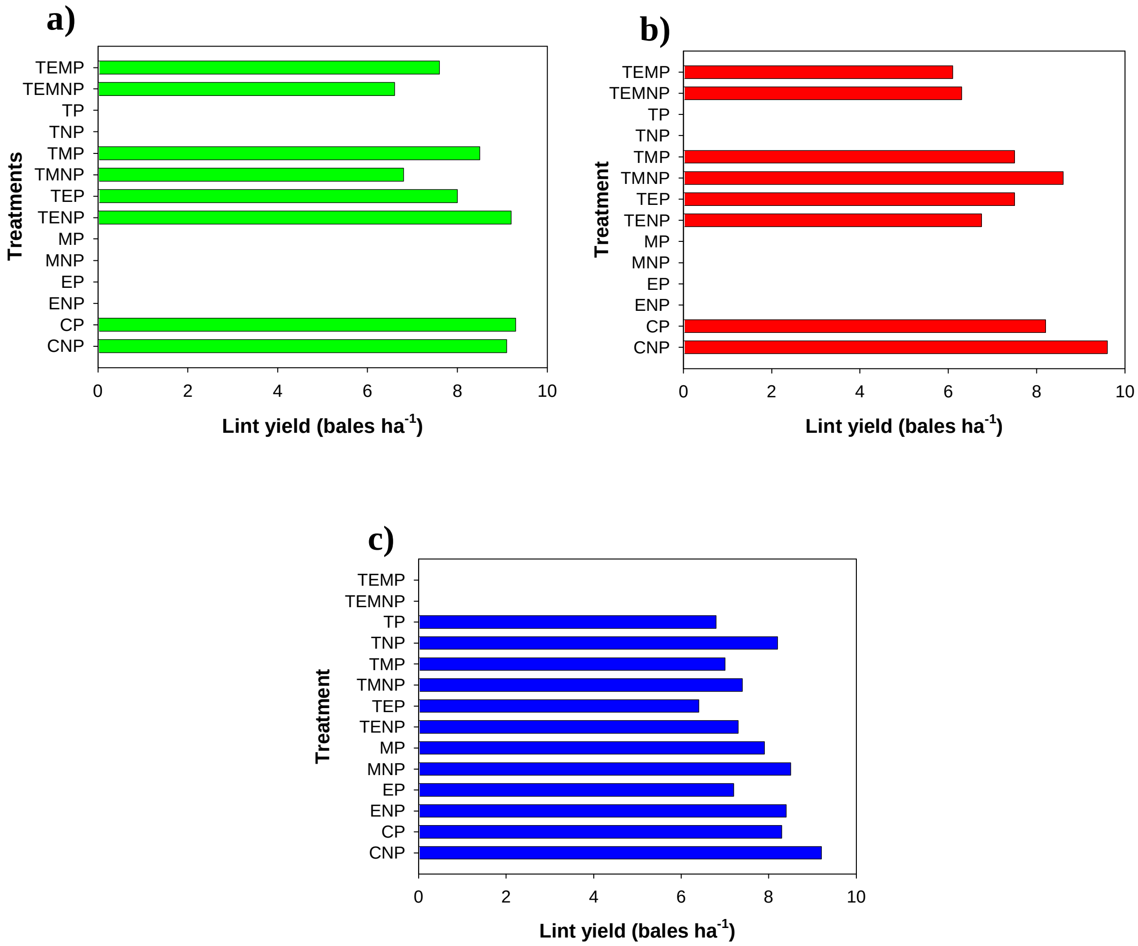
1. Detail and discuss the results including the statistical analysis of results.

Compensation from insect damage

In both the early and late sown plots trials in 2001 the control plots produced significantly greater yields than the damage plots while overall the application of mepiquat chloride had no effect (Fig 1). The lowest yields were produced by those treatments which sustained the most severe damage (i.e. tipped out with both early and mid season damage) in both the early and late sowings. In 2003 yield was reduced by tipping out but not by the loss of fruit (although it should be noted that the extreme combination of early and mid season removal of fruit was not included in this season). This trial was sown earlier than both 2001 trials and thus the ability to replace fruit would have taken place in the warmer months of

May and June rather than June and July when cooler temperatures and lower irradiance may have made fruit replacement more difficult. Certainly the closer to the coolest time of the year (i.e. July) that fruit loss occurred the greater the reduction in the plant's ability to compensate.

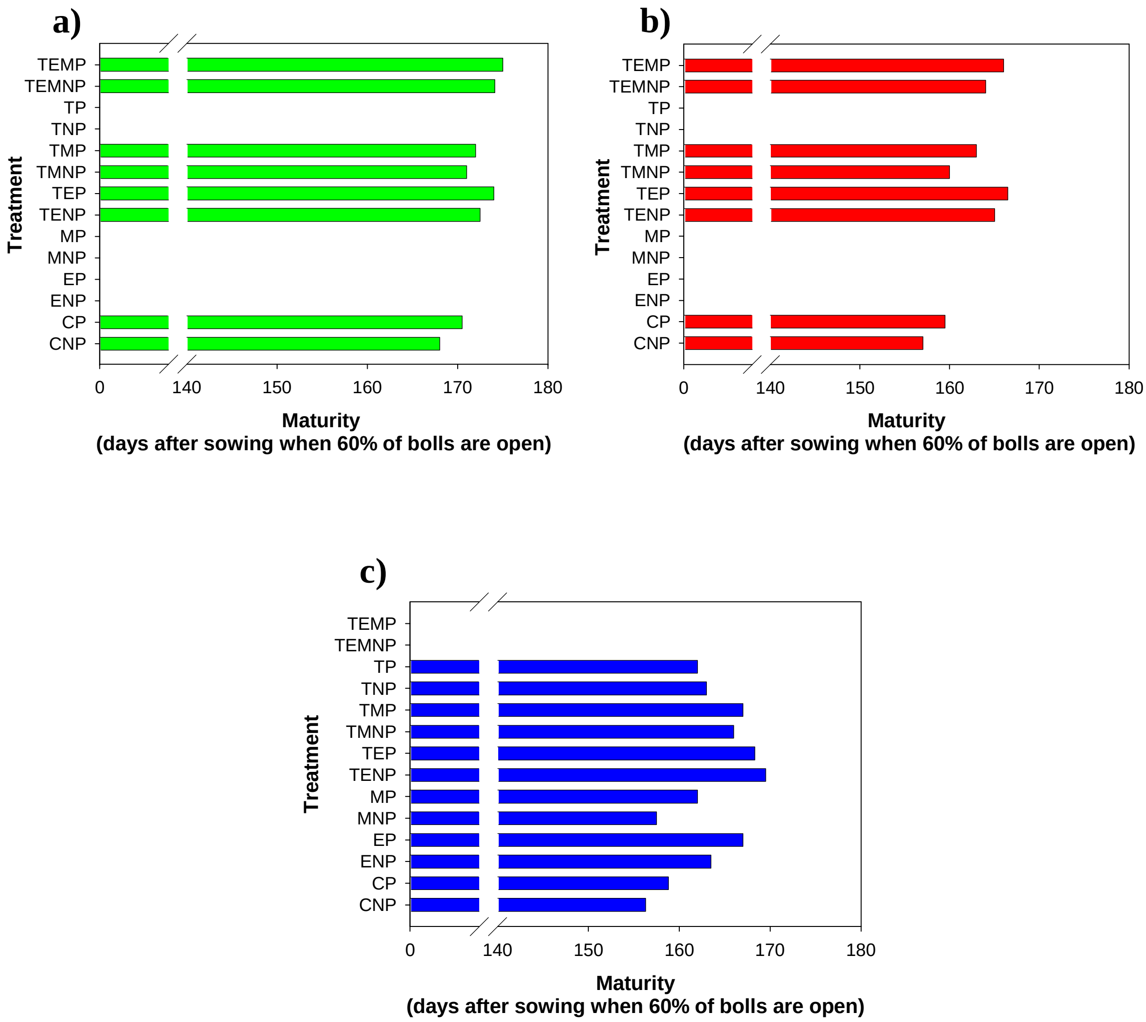
Figure 1. Lint yield (kg ha^{-1}) from various damage treatments in combination with mepiquat chloride for crops sown on a) 8th of April, 2001; b) 17th of May 2001; and c) 22nd of March 2003



T=tipped out at 800DD after sowing; E=early (800DD after watering up) damage; M=mid (1200DD after watering up) damage; C=control; P=mepiquat chloride applied at 10 nodes; NP=no mepiquat chloride applied

The application of mepiquat chloride delayed maturity for both sowings in 2001 but made no impact in 2003 (Fig 2). In 2001 the combination of early plus mid season damage delayed maturity compared to the early damage which was significantly later maturing than the mid season damage treatments. All damage treatments were significantly later in maturing compared to the control. In 2003 both damaging and tipping out resulted in the plants maturing later in the season while damaging the plants early extended maturity more than damaging the plants mid season in a similar manner to the 2001 season.

Figure 2. Days from watering up to maturity from various damage treatments in combination with mepiquat chloride for crops sown on a) 8th of April, 2001; b) 17th of May 2001; and c) 22nd of March 2003



For description of damage treatment codes see Figure 1.

Irrigation scheduling and Growth regulator management strategies

Siokra V-16i produced on average over half a bale more cotton per hectare than Sioct 289i, while the application of mepiquat chloride and extending of late season irrigation events had a deleterious affect on yield (Table 1). There was a significant interaction (P=0.009) between cultivar and irrigation frequency on yield with Siokra V-16i responding more to the application of more frequent late season irrigation events than Sicot 289i (an average increase of 317kg ha^{-1} *c.f.* 154kg ha^{-1}). Turnout was unaffected by the choice of cultivar although it was reduced by the application of mepiquat chloride, and it increased when more late season irrigation events were provided. Fibre length, micronaire and strength were all greater for Sicot 289i compared to Siokra V-16i, while there was no difference between the two cultivars for short fibre index or uniformity. The application of mepiquat chloride had no effect on fibre quality except for length which was increased significantly when it was applied, while the only impact of irrigation frequency on fibre quality was on micronaire which was greater for treatments which were exposed to more irrigation events after cut-out.

Table 1. Yield, turnout (small gin) and quality data from the Cultivar*Mepiquat chloride*Irrigation trial at Kununurra, average of two years (2001 and 2002).

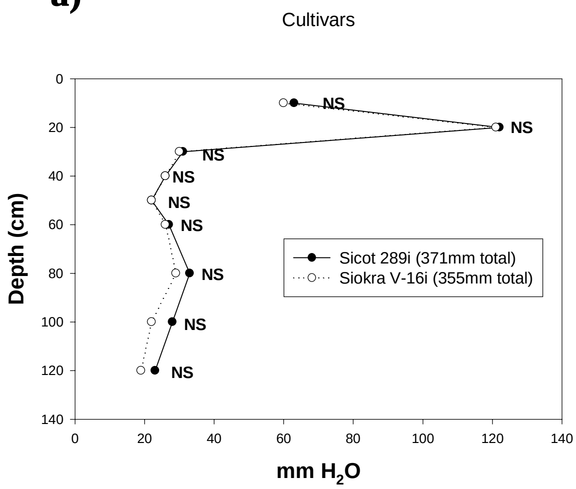
Treatment	Yield	%	Len	Mic	SFI	Str	Uni
Sicot 289i	1549	43.21	1.122	4.250	6.806	29.14	82.86
Siokra V-16i	1687	43.27	1.097	3.936	6.948	27.65	83.00
LSD (0.05)	77	0.34	0.007	0.109	0.244	0.34	0.22
P value	<0.001	NS	<0.001	<0.001	NS	< 0.001	NS
No M.C.	1656	43.50	1.104	4.085	6.852	28.45	82.89
M.C.	1579	42.98	1.115	4.100	6.903	28.33	82.98
LSD (0.05)	77	0.34	0.007	0.109	0.244	0.34	0.22
P value	0.053	0.003	<0.001	NS	NS	NS	NS
Freq/Freq	1681	43.37	1.115	4.187	6.681	28.70	83.02
Ext/Freq	1790	43.72	1.108	4.181	7.041	28.48	82.83
Ext/Ext	1560	42.97	1.111	4.003	6.850	28.28	83.06
Freq/Ext	1440	42.90	1.105	4.000	6.938	28.10	82.82
LSD (0.05)	109	0.48	0.010	0.154	0.345	0.48	0.31
P value	<0.001	0.003	NS	0.014	NS	NS	NS

M.C. – mepiquat chloride

No significant difference in water use was detected at any depth for any treatment, nor was overall water use different for any treatment in the 2001 season (Figure 3). However, in 2002 Sicot 289i used significantly more water than Siokra V-16i between 20 and 50cm as well as using an additional 62mm of water from throughout the profile (Figure 4). Of the four irrigation scheduling treatments neutron probes were only installed in the extended early/frequent late and frequent early/extended late treatments. The used an additional 75mm of soil moisture from throughout the profile, the majority of this coming from between 30 and 120cm deep in the profile, although no single depth was significantly different between the treatments. It should be noted that the installation of the probes took place after the first irrigation in 2001 while they were installed earlier in the season in 2002, hence the differences in water use between the two seasons.

Figure 3. Season water use (18/5 - 14/9/2001)

a)



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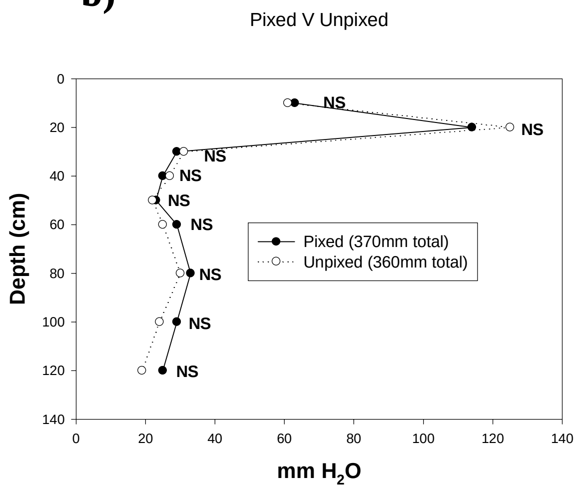

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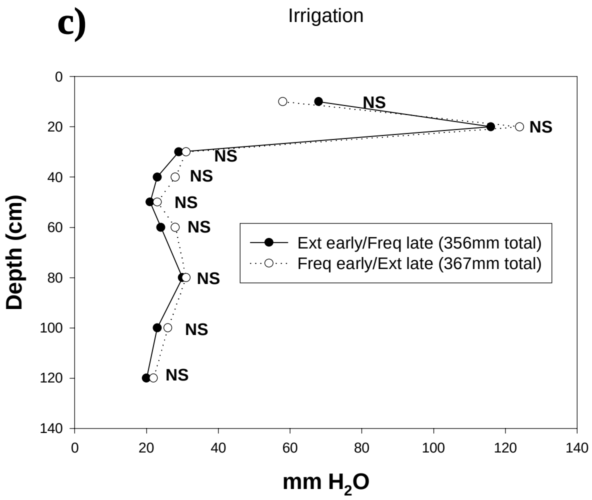
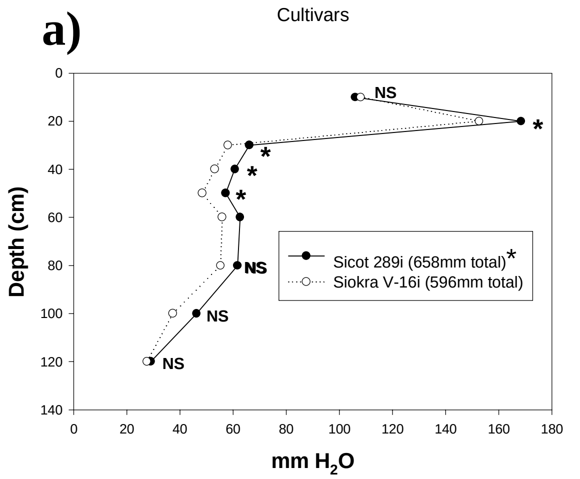
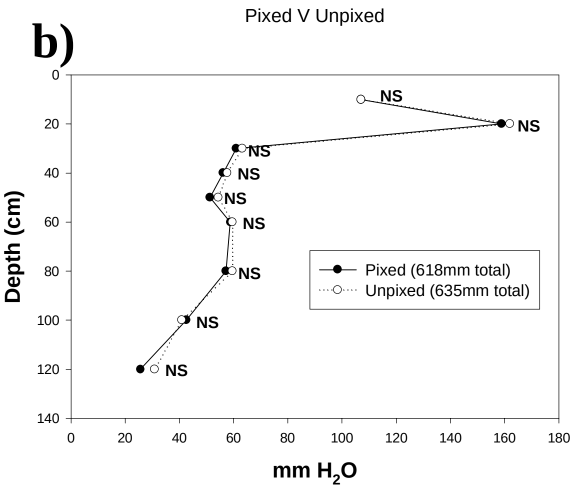
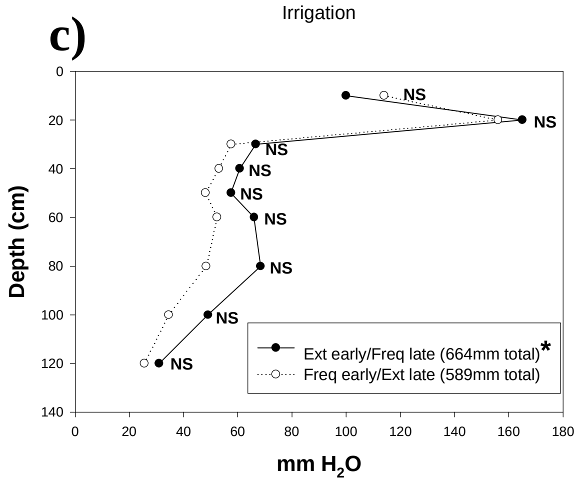


Figure 4. Season water use (21/5 - 31/10/2002)



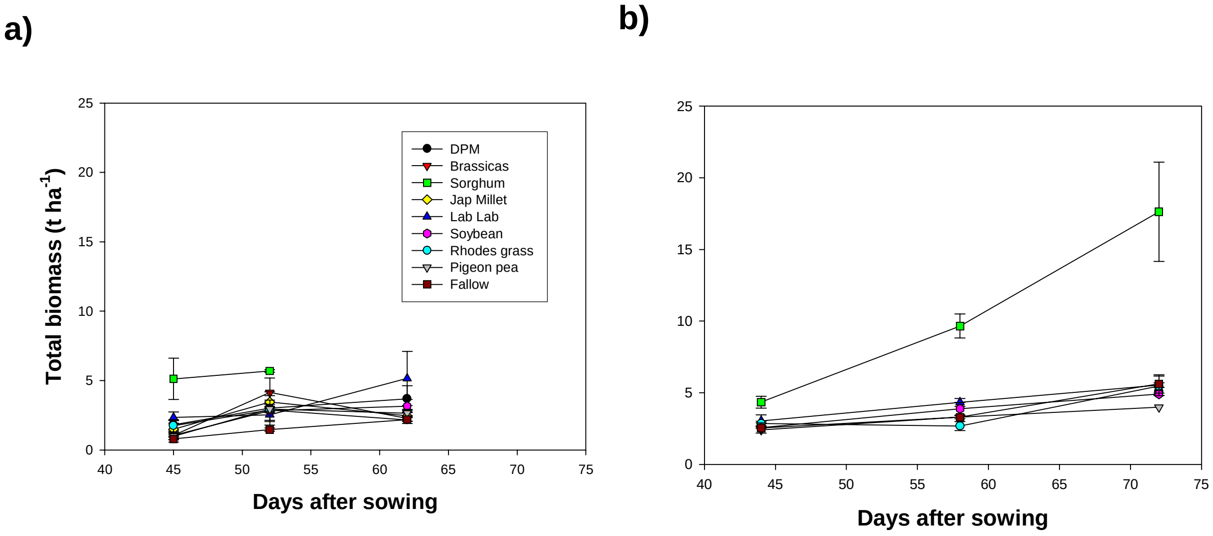




<u>Cover Crop / weed management / soil preparation</u>

Extremely high temperatures and erratic rainfall patterns in December 2002 and 2003 resulted in a steep learning curve on how to establish wet season cover crops in the ORIA. The brassicas suffered from poor establishment in 2001/2002 and resulted in their omission from the 2002/2003 experiment. It became obvious that one of the most important considerations of this trial would be determining how well the various species establish and compete with both grass and broadleaf weeds. In both 2001/2002 and 2002/03 wet season the forage sorghum produced the greatest total biomass (Fig 5.) and was highly competitive against weeds. The most common weeds in both years across all treatments were barnyard grass (*Echinochloa colona*) and giant pigweed (*Trianthema portulacastrum*).

Figure 5. Biomass accumulation of various cover crops grown over the a) 2001/2002 and b) 2002/2003 wet seasons in Kununurra.



The forage sorghum was also one of the best crops trialled at competing against both grass and broadleaf weeds, particularly as the season progressed and it was able to grow taller and shade both species. Dwarf pearl millet was also able to produce sufficient biomasses and compete with the weeds, although poor germination in the 2002/2003 season meant that there is only data available for the last sprayout date for this crop. All the leguminous crops were found to be poor competitors against weeds in this trial (Fig 6 and 7) and the Lab lab did not contribute any more nitrogen or organic carbon to the soil than the sorghum or fallow (Table 2).

Lint yield (Fig 8), turnout and fibre quality (data not shown) of the dry season cotton crop were all unaffected by the previous wet season cover crop, although it should be remembered that many of these plots were dominated by weeds (see figure 6). Results from 2003 indicate that the highest yields were achieved when the cover crop was sprayed out in mid January i.e. when approximately 4 to 5 t ha^{-1} of biomass had been produced and there was at least two months for the residues to breakdown. However, when the biomass rose to above 5 tonnes ha^{-1}, managing the stubble became difficult. As a result it would appear that allowing forage sorghum to grow for approximately 50 days during the wet season before spraying it with glyphosate may be the best way of managing a forage sorghum wet season cover crop in the ORIA.

While there was some slumping and movement of soil, there was no difference between the two treatments in the change in soil height at any point across the beds (Fig 9a and b). The net effect across the beds was a 1.5 cm increase in the height of the soil over the wet season which could be attributed to the swelling capacity of the soils in the ORIA.

Figure 6. Composition of biomass from 2001/2002 wet season cover crops from harvests taken on a) 16/1/2002; b) 23/1/2002 and c) 30/1/2002.

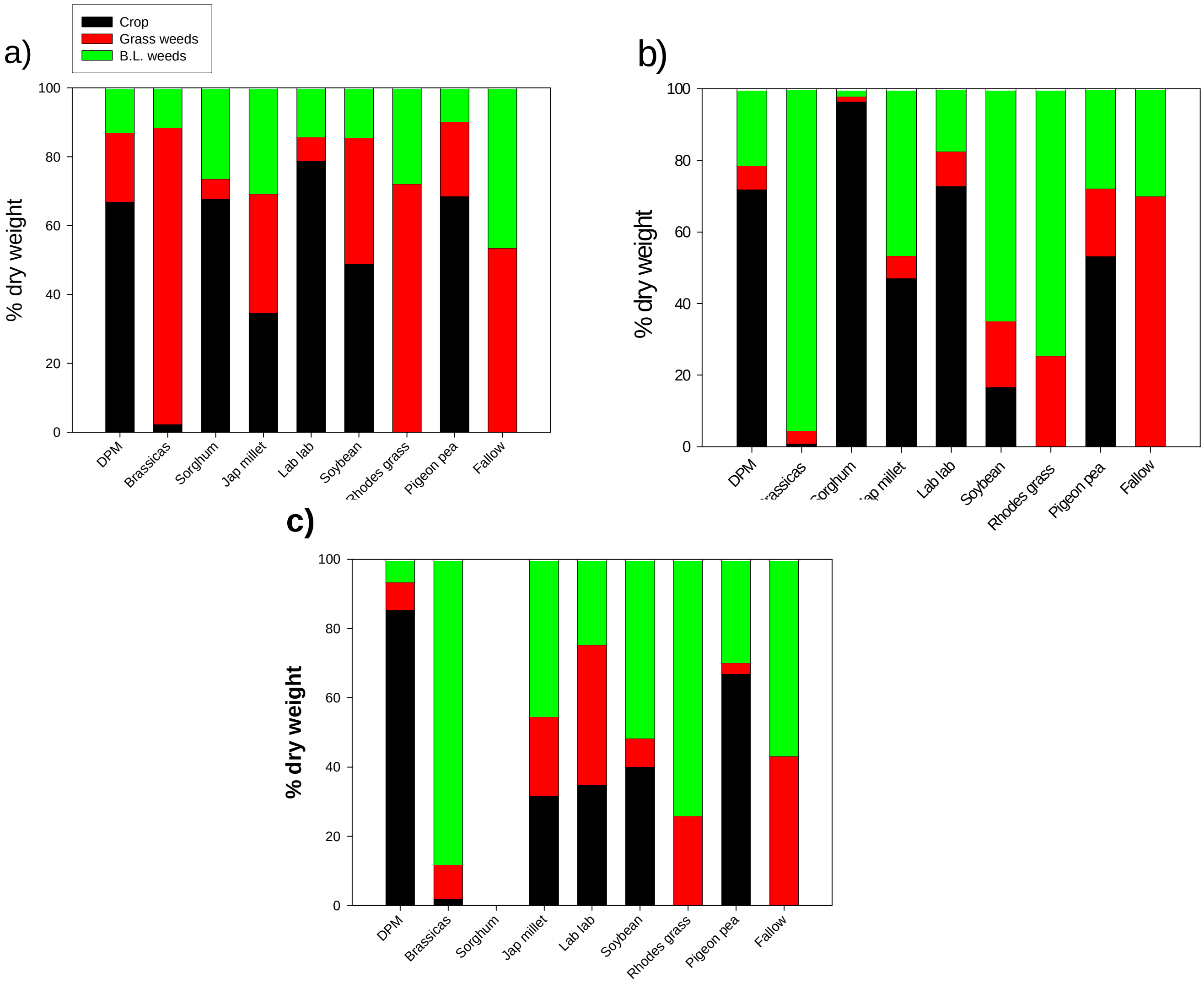


Figure 7. Composition of biomass from 2001/2002 wet season cover crops from harvests taken on a) 2/1/2003; b) 16/1/2003 and c) 30/1/2003.

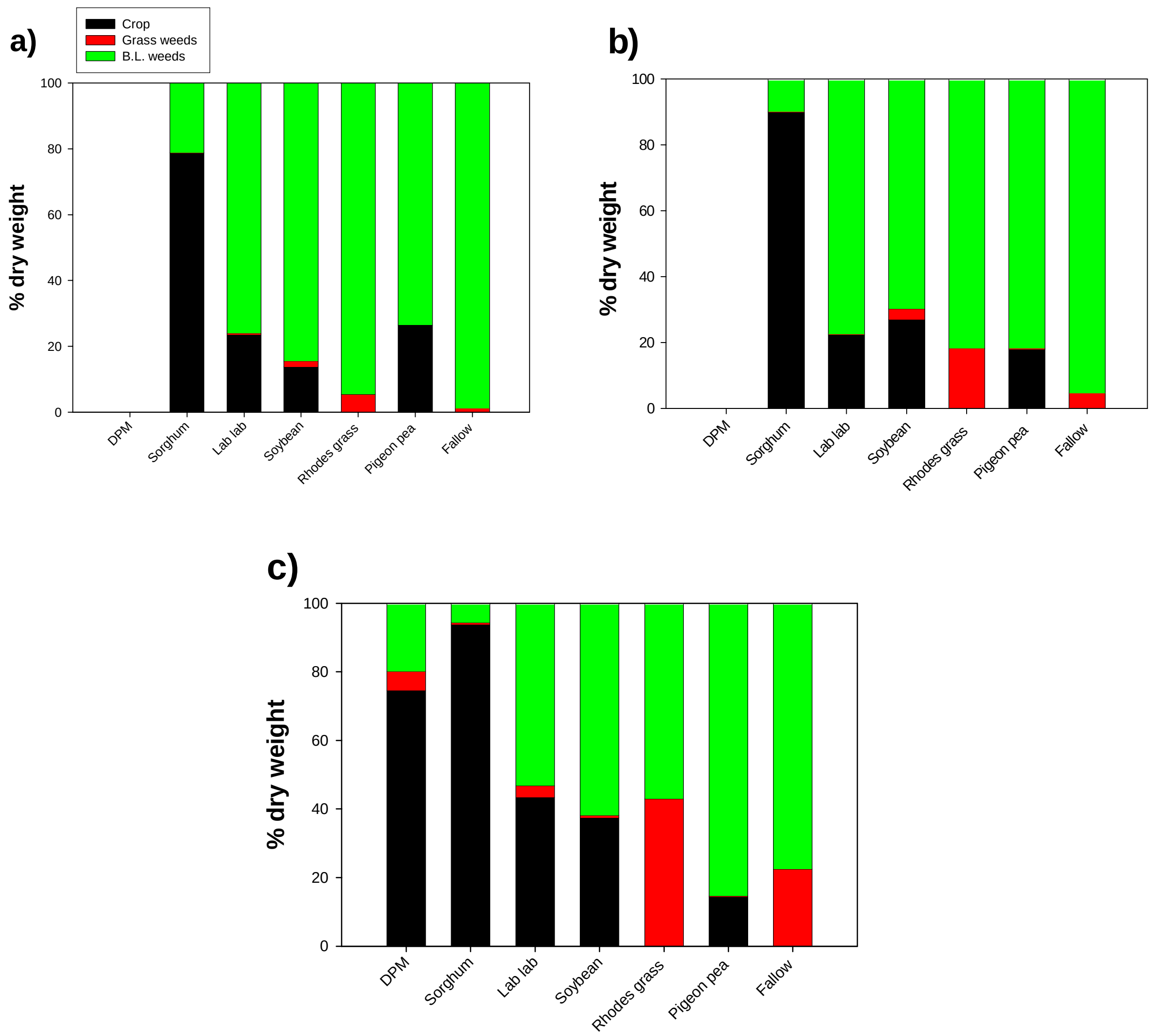


Table 2. Nitrate and ammonium levels at 0-30 and 30-60cm deep and % organic C in the 0-30cm zone were determined for fallow, lab lab bean and sorghum plots in April 2002.

0-30cm	Organic C (%)	Nitrate N (mg kg^{-1})	Ammonium N (mg kg^{-1})
Sorghum	0.61	41	4.2
Lab lab	0.62	39	3.8
Fallow	0.65	38	4.0
LSD (0.05)	NS	NS	NS
30-60cm		**Nitrate N (mg kg^{-1})**	**Ammonium N (mg kg^{-1})**
Sorghum		4	2.3
Lab lab		3	2.2
Fallow		4	2.4
LSD (0.05)		NS	NS

Figure 8. Cotton lint yield (kg ha^{-1}) from plots that over the 2001/2002 wet season contained the eight cover crops and one fallow treatment over three spray-out dates.

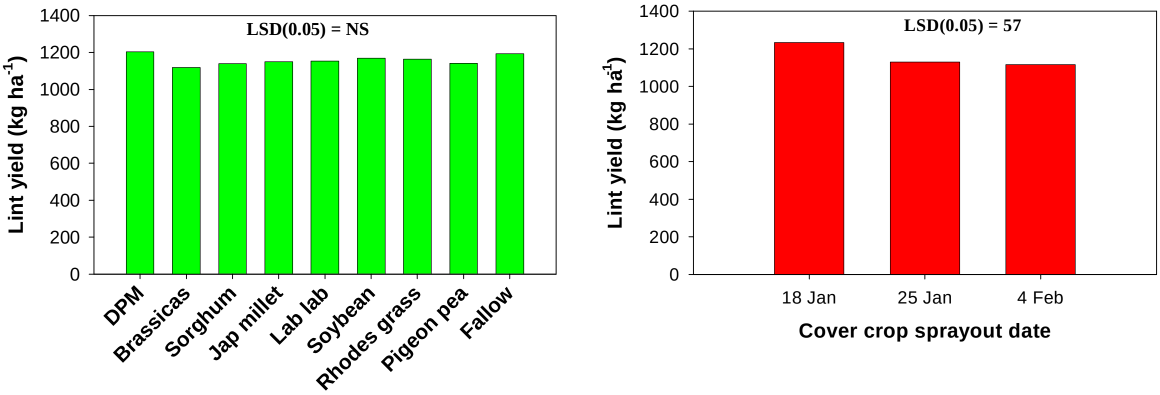
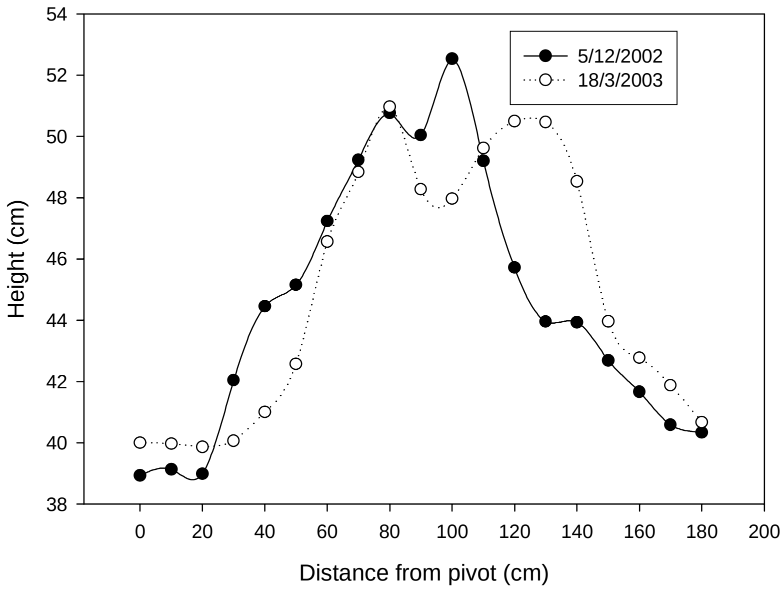


Figure 9. Bed movement between the 5th of Dec 2002 and 18th of march 2003 on a) fallow beds and b) beds on which a cover crop of dwarf pearl millet was grown over the wet season.

a)



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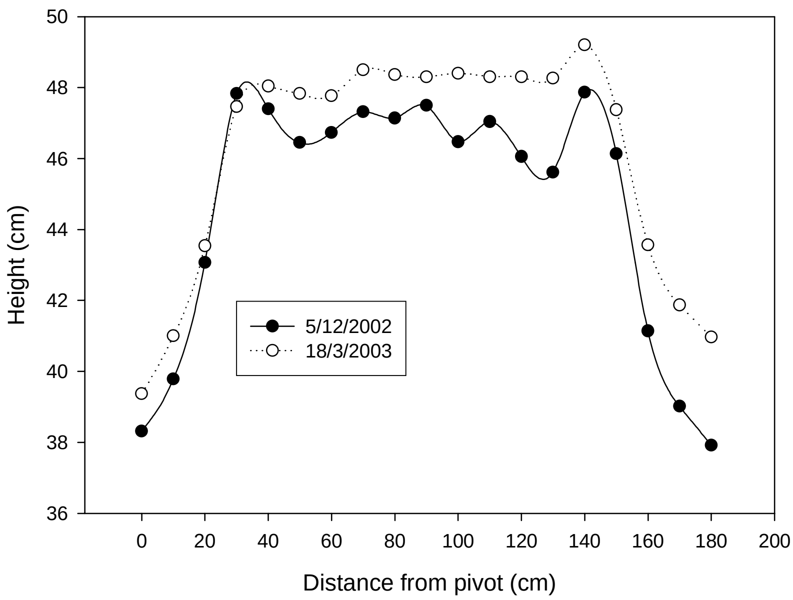
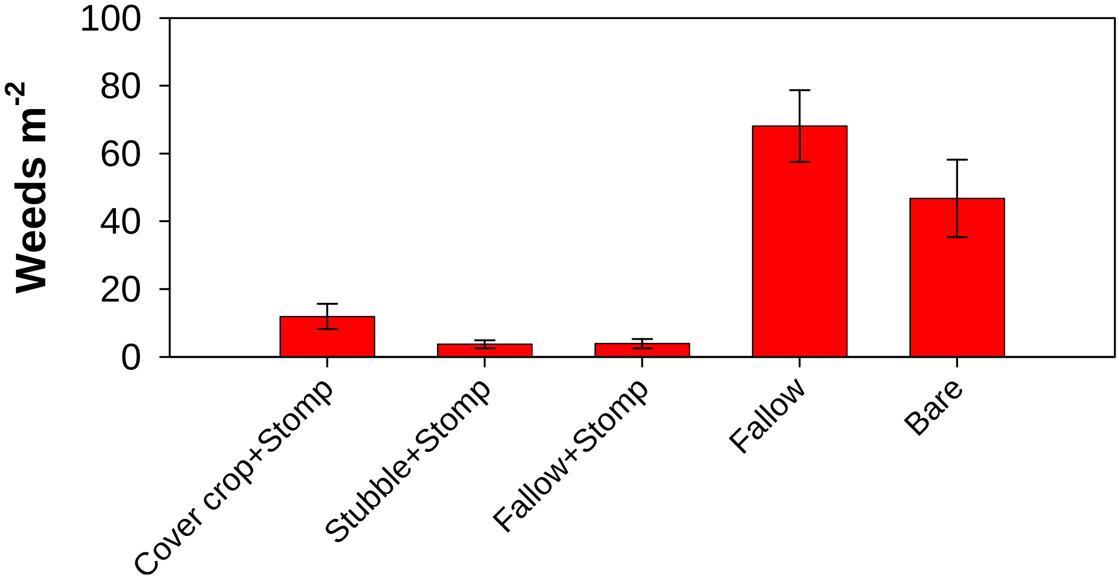


Comparison of Roundup Ready and convential weed management systems.

The application of Stomp successfully controlled weeds (Fig 10) with no significant difference between treatments where Stomp was applied in the presence of weeds emerging shortly after the crop was watered up. However, large numbers of weeds did emerge in the treatments where Stomp was not applied and in particular the cultivation of the fallow treatment saw more weeds emerge compared to the bare area which was not cultivated.

Figure 10. Weed density in five treatments of the Roundup Ready trial 13 days after beds were watered up and prior to the application of Roundup.

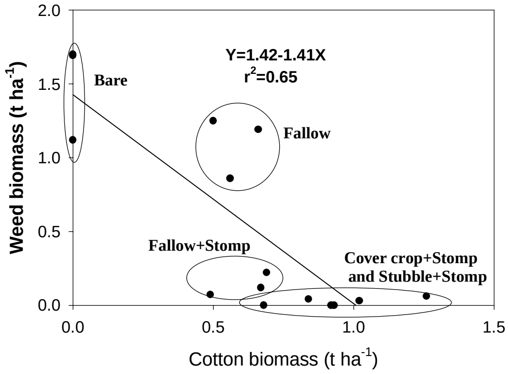


Measurements taken 32 days after watering up indicate that for the fallow and fallow+Stomp treatments where no Roundup was applied there was no difference in cotton plant biomass despite there being considerably more weed biomass (Fig 11a), and there did appear to be much weed suppression associated with the cotton as there was almost as much weed biomass in the fallow compared to the bare treatments. However, where the crops had been sown under minimum till conditions (i.e. cover crop + Stomp and sorghum stubble + Stomp conditions, both with and without Roundup) there appeared to be a greater production of cotton biomass compared to the conventionally tilled (i.e. fallow) treatments

Figure 11. Relationship between weed and cotton biomass 32 days after watering up and 19 days after the application of Roundup to those plots requiring it as part of the treatment. The graph is derived from data from treatments not treated with Roundup while the table displays the cotton biomass only as there was no significant weed biomass in any of the Roundup treated plots (number in brackets indicates standard error).

a) **b)**

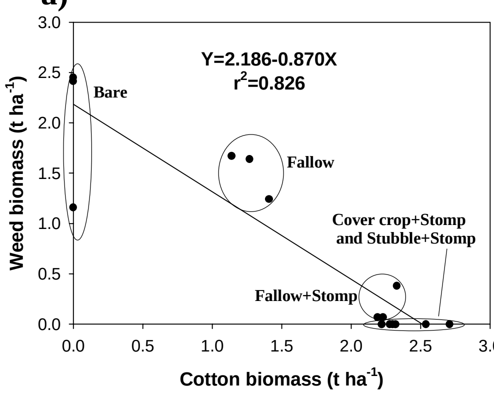
	Cotton biomass (t ha^{-1})
Cover crop+Stomp	0.89 (0.08)
Sorghum stubble+Stomp	0.86 (0.04)
Fallow+Stomp	0.70 (0.09)
Fallow	0.62 (0.04)
Bare	0.00 (0.00)



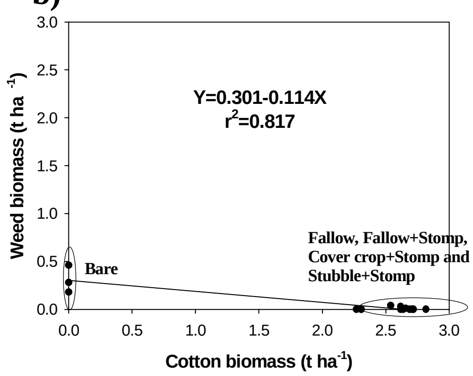
The effect of weed competition on cotton growth was more observable 61 days after watering up in the treatments where Roundup was not applied with the cotton biomass of the fallow treatment significantly lower than that of the fallow+Stomp treatment (Fig 12). However, where Roundup was applied there was no difference between these treatments as weeds had been suppressed early in the season. At this stage in the season, where weeds had been suppressed in the fallow treatments, there was no difference in cotton biomass compared with the minimum tillage treatments.

Figure 12. Relationship between weed and cotton biomass 61 days after watering up and 48 days after the application of Roundup to those plots requiring it as part of the treatment; a) treatments where Roundup was not applied; b) treatments where Roundup was applied 13 days after watering up.

a)

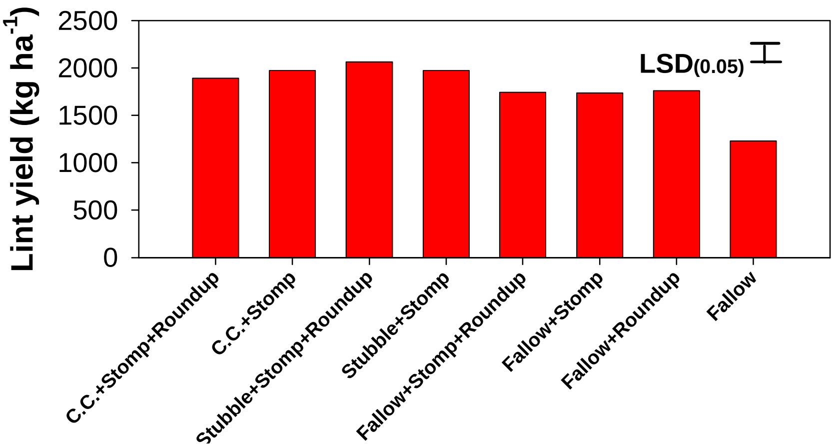


b)



Lint yield for the minimum tillage treatments was significantly greater than the conventional tillage treatments which were all significantly higher yielding than the fallow treatment.

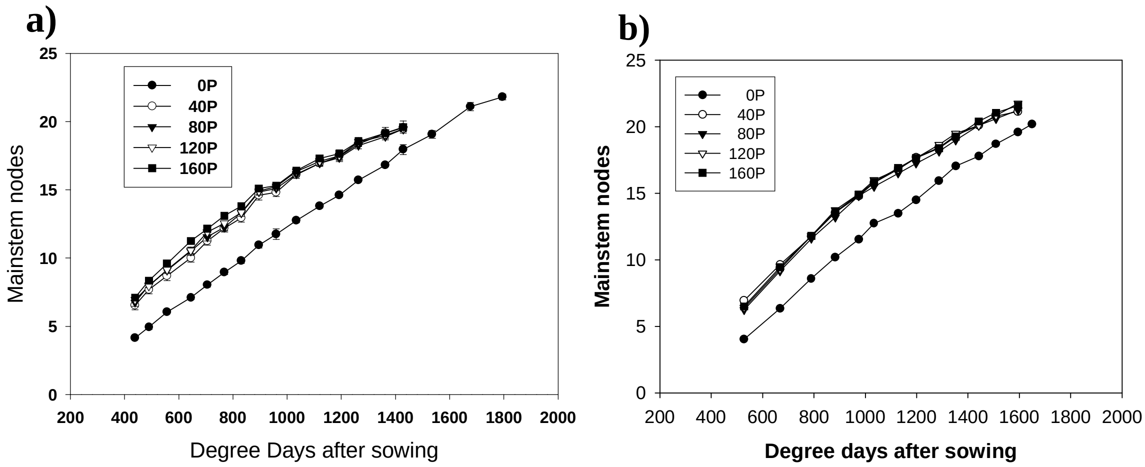
Figure 13. Lint yield (kg ha^{-1}) for the eight treatments were cotton was sown in the Roundup Ready trial.



<u>Virgin soil nutrition</u>

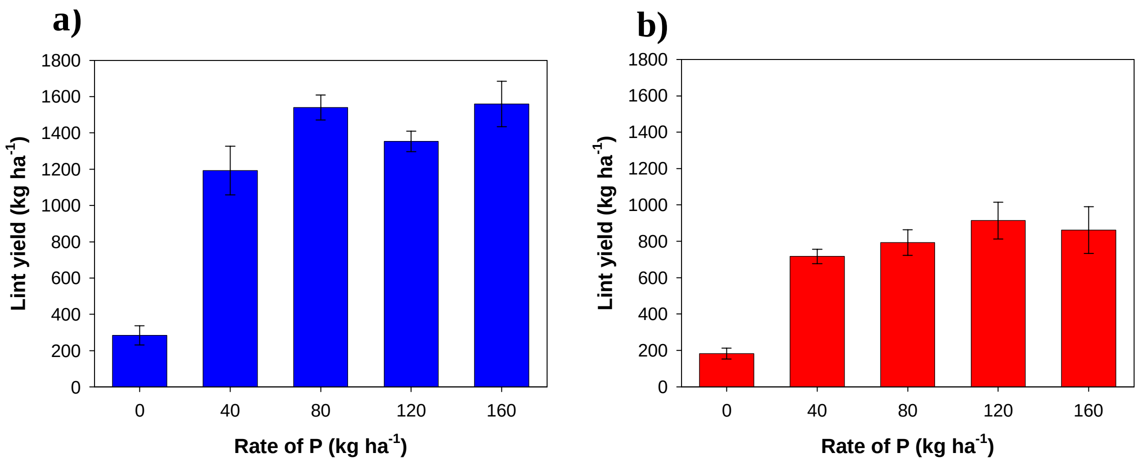
The morphological response the crop of to even the smallest rate of phosphorus fertiliser was spectacular with the initial number of nodes produced by the 0P treatment significantly lower than those when any rate of P fertiliser was applied in both years of the trial (Fig 14 a and b). However, it should be noted that after this initial difference the rate of node production of all treatments was the same until cut-out.

Figure 14. Mainstem node production for five rates of phosphorus fertiliser in a) 2002 and b) 2003



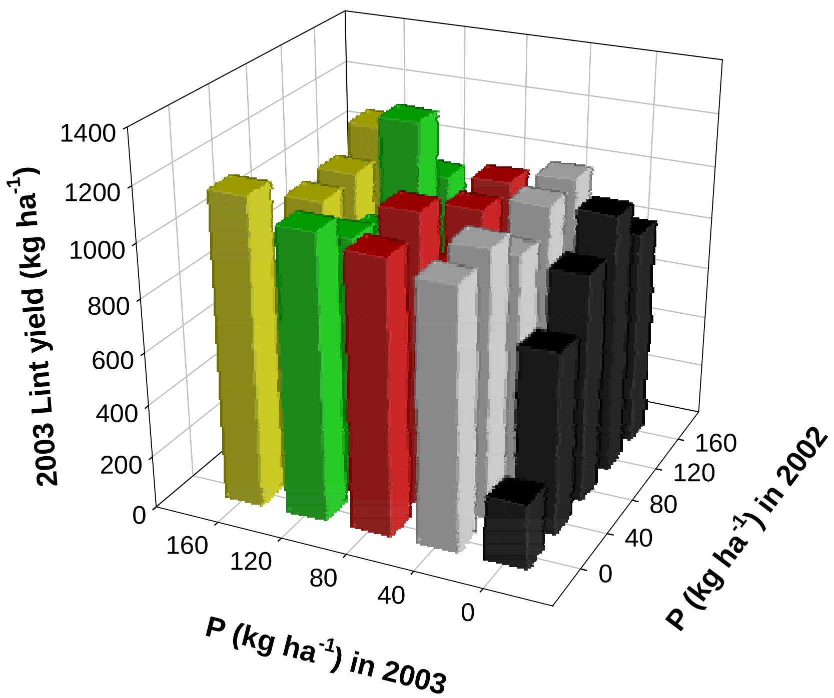
There was a yield response to phosphorus fertiliser up to a rate of 80kg ha^{-1} in both 2002 and 2003, although the yields in the later were much lower (Fig 15a and b). This may have been due to the lack of vigour observed in these plants early in the season. Although 40kg ha^{-1} of zinc was applied to the crop as $ZnSO_4$ (mono) prior to sowing the plants may have not been able to access it early in the season.

Figure 15. Lint yield (kg ha^{-1}) for five rates of phosphorus fertiliser in a) 2002 and b) 2003



As with results from both 2002 and new area trial in 2003, there was a yield response in the old area trial in 2003 up until 80 kg ha^{-1} of P, although in which year it was applied appeared irrelevant (Fig 16). The treatments which had had five different rates of phosphorus applied in 2002 yet none applied in 2003 displayed a yield response curve which plateaued at 80kg ha^{-1} while the plots that had received no phosphorus fertiliser in 2002 but five different rates in 2003 displayed the same trend. These results indicate that 80 kg ha^{-1} of P, if applied as double superphosphate, is required in the first season of production and in following seasons replacement levels of P are all that is required. While only supported by one year of data, it also appears as though fields should not be left fallow for too long otherwise plants may not be able to take-up elements such as zinc.

Figure 16. Lint yield (kg ha^{-1}) in 2003 for the various combinations of phosphorus fertiliser rates applied in the 2002 and 2003 growing season.



AMF colonisation in 2002 was low and variable (Table 3). The higher than expected value for the 40P treatment was possibly due to weedy shrubs such as *Abelmoschus ficulneus* or *Hibiscus panduriformus* which may have been growing in the sampling area during the 2001 dry season.

Table 3. AMF colonisation of transgenic cotton grown on virgin soil in 2002

Fertiliser treatment	Root length colonised by AMF (%)
0P	0.4
40P	11.2
80P	1.1
120P	1.9
160P	1.9
LSD (P=0.05)	NS

In 2003, AMF colonisation was as low or lower in the 'new area' as in 2002 (Table 4). Above ground dry matter and node production were lower for the 0P treatments compared to those treatments that had received any amount of phosphorus fertiliser.

Table 4. AMF colonisation and plant development of transgenic cotton on virgin soil in 2003 ('new area')

Fertiliser treatment	Root length colonised by AMF (%)	Above ground dry matter (g / plant)	Nodes
0P	2.0	0.37	2.8
40P	1.5	0.57	3.3
80P	0.8	0.58	3.3
120P	0.5	0.68	3.5
160P	1.2	0.67	3.5
LSD (0.05)	NS	0.08	0.3

Sampling from the ‘old area’ in 2003 demonstrated that AMF readily colonised the roots of cotton plants in the second year in which they were grown at this site (Table 5). However, plants that had not been exposed to any phosphorus fertiliser in the two years had less colonisation than those that had received some phosphorus fertiliser and, in addition, produced less above ground biomass and fewer nodes at sampling.

Table 5. AMF colonisation and plant development of transgenic cotton in 2003 on soil previously sown to cotton in 2002 (‘old area’). Variable fertiliser rates were applied in 2002, no fertiliser was applied in 2003.

Fertiliser treatment	Root length colonised by AMF (%)	Above ground dry matter (g / plant)	Nodes
0P	25.0	0.37	2.9
40P	63.7	0.64	3.7
80P	70.5	0.55	3.4
120P	67.7	0.62	3.9
160P	62.2	0.71	3.8
LSD (0.05)	26.8	0.18	0.4

Conventional cotton also displayed significantly greater AMF colonisation when grown in the ‘old area’ than the ‘new area’ (Table 6). Both of these areas were well fertilised with phosphorus and displayed no difference in above ground dry matter production or node production.

Table 6. AMF colonisation and plant development in conventional cotton grown in ‘old’ and ‘new’ areas in 2003. Both areas had 160P applied in the first year cotton was grown. Numbers in brackets are transformed data (X+1).

Fertiliser treatment	Root length colonised by AMF (%)	Above ground dry matter (g / plant)	Nodes
‘New area’	0.0 (1.00)	0.76	3.9
‘Old area’	50.0 (7.05)	0.86	4.0
LSD (0.05)	(2.09)	NS	NS

<u>Crop adaptation to dry season growing conditions</u>

<u>I) Cultivars</u>

The variety trials conducted at the Frank Wise Institute over the years 2001 to 2003 build on the knowledge that already existed about which cultivars were best suited to dry season growing conditions. Siokra V-16i and Sicot 289i (and their Bollgard II equivalents in 2003) were the standard checks given their performance in previous years while the conventional check was Sicot 189 along with Siokra V-16 in 2001. Unfortunately, Ingard cultivars were prohibited from being grown in the 2003 season by the OGTR.

In 2001, Sicot 289i failed to yield as well as had been anticipated while Siokra V-16i yielded as well as any cultivar tested and continued to demonstrate that it is well adapted to local conditions (Table 7). Amongst the highest yielding lines was line 96480 which had previously identified as being high yielding as a conventional line when tested during the dry season in the ORIA prior to the release of Ingard lines. As anticipated, the conventional lines, which were managed identically to the transgenic lines, yielded poorly. The lint from Sicot 289i was good quality although there were several other cultivars which displayed similar quality.

Table 7. 2001 variety trial

Cultivar	Yield (kg ha^{-1})	% turnout	Length (")	Micronaire	Strength (g tex^{-1})
Sicot 51i	1560	41.98	1.130	3.84	27.18
Sicot 289i	1207	40.92	1.148	4.04	28.86
Siokra V-16i	1639	41.39	1.120	3.72	28.24
Siokra S101i	1539	43.11	1.135	3.73	26.82
Siokra 201i	1472	42.44	1.142	3.46	27.76
95443	1551	41.00	1.142	3.62	28.78
96459	1659	41.20	1.126	3.76	29.80
96465-32	1695	41.99	1.114	3.96	29.02
96478-139	1463	41.69	1.134	3.74	28.65
96480	1641	39.14	1.135	3.70	26.72
97421	1633	40.34	1.142	3.64	30.25
99421	1582	38.21	1.146	3.72	28.48
99423	1477	36.68	1.138	3.54	27.42
99424	1623	36.32	1.128	3.44	27.94
99425	1481	37.00	1.144	3.86	26.74
NuCOTN 37	1521	40.69	1.132	3.98	27.60
NuPEARL	1473	39.29	1.138	3.62	29.42
Sicot 189	276	43.05	1.136	4.10	27.62
Siokra V-16	387	44.27	1.088	4.22	30.26
Average	1418	40.56	1.133	3.77	28.29
LSD (0.05)	171	1.09	0.051	0.51	2.38
P value	<0.001	<0.001	=0.034	<0.001	<0.001

The yield from the 2002 variety trial was disappointing compared to the 2001 and 2003 trials with the highest yielding line producing just under 6 bales ha^{-1} (Table 8). Fibre length was also considerably shorter than in other years while micronaire tended to be higher than for the same cultivars in other years although still within an acceptable range. It was interesting to note the considerably lower small gin turnout values for the Bollgard II compared to the Ingard lines.

Table 8. 2002 variety trial

Cultivar	Technology	Yield (kg ha^{-1})	% turnout	Length (“)	Micronaire	Strength (g tex^{-1})
Sicot 189	Conventional	233	45.10	1.102	4.42	29.08
Sicot 289i	Ingard	741	42.64	1.087	4.73	28.58
Siokra V-16i	Ingard	1031	43.37	1.042	4.22	28.23
96479-161	Ingard	1088	42.86	1.028	4.00	26.72
NuCOTN 37	Ingard	1139	44.69	1.067	4.75	28.03
NuTOPAZ	Ingard	690	43.57	1.062	4.95	28.23
96480-71	Ingard	1079	41.11	1.072	4.70	29.55
97421-152	Ingard	1098	43.33	1.075	4.27	26.53
96456-185	Ingard	1322	43.54	1.057	4.43	29.58
96459-42	Ingard	813	42.64	1.042	4.55	27.47
96465-32	Ingard	938	43.37	1.043	4.53	28.77
95443-9	Ingard	1036	41.86	1.065	4.30	29.15
97608-43	RR/Ingard	1068	43.65	1.057	4.95	29.22
96482	RR/Ingard	1046	44.85	1.038	4.33	27.22
99425-68	Bollgard II	1060	41.08	1.058	4.67	27.53
20405	Bollgard II	951	39.80	1.078	4.62	27.48
20401	Bollgard II	705	37.65	1.038	4.80	26.62
20404	Bollgard II	979	40.88	1.075	4.70	26.77
20415	RR/Bollgard II	877	39.61	1.075	4.78	27.37
20410	Bollgard II	863	38.28	1.073	4.65	26.87
Average		938	42.20	1.062	4.57	27.95
LSD (0.05)		251	1.51	0.021	0.38	1.14
P value		<0.001	<0.001	<0.001	<0.001	<0.001

In the 2003 variety trial yields averaged close to 7 bales ha^{-1} with the highest yielding lines producing 9 bales ha^{-1} (Table 9). At writing fibre quality analysis had not yet been performed but was anticipated to be completed within the next few weeks.

Table 9. 2003 variety trial

Cultivar	Technology	Yield (kg ha^{-1})	Turnout (%)
Sicot 189	Conventional	177	48.70
Sicot 12B	Bollgard II	1449	40.34
Sicot 11B	Bollgard II	1633	40.95
Sicot 14B	Bollgard II	1672	41.43
Sicot 13B	Bollgard II	1716	40.32
20405	Bollgard II	1654	42.39
20415	RR/Bollgard II	1599	41.28
20401	Bollgard II	1713	41.42
20413	RR/Bollgard II	1568	42.05
20404	Bollgard II	1725	42.08
20414	RR/Bollgard II	1665	42.42
20407	RR/Bollgard II	1468	40.28
20409	Bollgard II	1812	42.33
20416-2	Bollgard II	2034	42.43
20410	Bollgard II	1616	40.82
20458	Bollgard II	1401	39.47
20420	Bollgard II	1701	43.34
20422	Bollgard II	1675	41.40
Average		1571	41.86
LSD (0.05)		230	1.00
P value		<0.001	<0.001

The progeny trial conducted in 2001 was used to provide information as to which Ingard lines, developed from a conventional line (Sicala 35) which had proven to be high yielding in early dry season trials in the ORIA, should be progressed further (Table 10). Some lines, such as 97421-152 proved to be significantly higher yielding in this trial than Siokra V-16i while having fibre qualities that were comparable to Sicot 289i.

Table 10. 2001 Progeny trial

Cultivar	Yield (kg ha^{-1})	% turnout	Length (")	Micronaire	Strength (g tex^{-1})
Siokra V-16i	1586	41.47	1.108	3.74	28.30
Sicot 289i	1491	40.83	1.152	3.82	30.48
96456-52	1385	38.40	1.162	3.30	29.88
96456-66	1357	40.72	1.132	3.42	32.04
96456-91	1497	42.78	1.140	3.64	30.82
96456-115	1645	41.40	1.140	3.88	30.44
96456-143	1618	42.11	1.138	3.54	28.90
96456-185	1657	39.71	1.170	3.42	31.86
96456-199	1441	43.69	1.142	3.58	30.90
96459-7	1599	42.00	1.122	3.62	30.38
96459-42	1665	41.00	1.136	3.74	29.76
96459-96	1570	39.78	1.124	3.56	29.60
96459-140	1565	41.29	1.096	3.52	29.60
96459-155	1560	40.78	1.110	3.48	28.60
96480-17	1505	39.62	1.096	3.78	30.66
96480-24	1367	37.97	1.136	3.62	31.08
96480-37	1515	38.37	1.136	3.44	30.00
96480-42	1383	38.65	1.140	3.42	33.38
96480-49	1361	38.72	1.124	3.58	30.94
96480-52	1481	39.33	1.115	3.63	29.75
96480-71	1467	38.13	1.185	3.73	30.25
96480-75	1423	39.45	1.090	3.62	30.46
96480-91	1550	39.55	1.150	3.78	29.55
96480-99	1459	40.14	1.140	3.66	31.30
96480-100	1597	38.22	1.135	3.58	30.13
97421-42	1355	37.61	1.202	3.34	30.28
97421-115	1567	41.97	1.194	3.46	30.04
97421-132	1369	40.87	1.146	3.54	29.12
97421-136	1623	41.26	1.155	3.70	30.15
97421-147	1279	40.00	1.144	3.76	29.44
97421-152	1781	41.46	1.154	3.72	28.68
97421-167	1629	41.14	1.118	3.92	29.52
97421-172	790	39.61	1.198	3.55	29.48
Average	1489	40.24	1.140	3.61	30.17
LSD (0.05)	189	1.11	0.038	0.29	1.67
P value	<0.001	<0.001	<0.001	<0.001	<0.001

II) The effect of cold nights on fibre quality

The cold temperature experiment was conducted over to years (2002 and 2003), however only data from the first year has been analysed. The 2003 samples are currently at ACRI and are awaiting testing. In contrast to what was expected, the length of the fibres was unaffected by insulating plants immediately after flowering (Table 11). Instead, when plants were insulated at night for the first four weeks after flowering they produced lint that had a smaller micronaire, greater short fibre index, were weaker and were less uniform than lint from the control plants. Plants that were insulated later during fibre formation produced lint with quality that was not significantly different from the control plants.

Table 11. Lint quality from plants protected from cool overnight temperatures at various stages during fibre formation.

	Elong' (%)	Length (")	MIC	S.F.I.	STR (g tex^{-1})	UNI (%)
Control	6.80	1.153	4.00	8.825	31.13	84.45
Treatment 1	7.25	1.150	3.72	9.989	28.41	82.45
Treatment 2	6.98	1.154	4.08	8.376	32.49	84.91
Treatment 3	7.08	1.155	3.73	9.100	31.78	84.28
LSD (0.05)	*N.S.*	*N.S.*	*0.29*	*0.507*	*1.25*	*1.14*

Treatment 1 - Tents placed over the crop nightly for three weeks starting 10 days after first flower; Treatment 2 - Tents placed over the crop nightly for two weeks starting 31 days after first flower; Treatment 3 - Tents placed over the crop nightly for two weeks starting 45 days after first flower.

III) Manipulation of crop maturity

The length of growing season is critical in the tropical dry season and rainfall at the seasonal transitions (end of 'wet season' and start of the 'dry season') can impact on the timing of sowing and picking operations. Hence, an understanding of how much the time-to-maturity could be changed by management was required. Management options were compared in several experiments (1) a sowing date by cultivar experiment grown in 2000 and 2001, (2) the effect of late season irrigation and mepiquat chloride and (3) seed bed and weed management systems. The results are summarised in Table12. Note the seed bed and weed management systems work was not complete by the termination of the project.

Table 12. Effect of management Options on time-to-maturity and yield.

Management Option	Decrease in time-to-maturity (days)	Effect on yield
Early Maturing cultivars at late (i.e. May) sowing	5 to 10 days	Not significant
Extending late season irrigation	1 to 2 days	Significant decrease
Mepiquat chloride	1 to 2 days	Variable, response affected by cultivar and sowing date.
Water up + Roundup Ready	8 –10 days earlier planting	Unlikely

The results show some earliness can be achieved by planting an early maturing cultivar when sowing is delayed (i.e. May). However, a system that can ensure the earliest possible sowing after the wet season end has the greatest potential to ensure timely maturity. Unfortunately, it was not possible to continue with research evaluating a permanent beds combined with reduced tillage, watering up and Roundup Ready.

Application of research results at a larger scale and integration with pest management research.

Research cotton crops were grown at a larger scale by farmers in both 2001 (385ha producing an average yield of 5.09 bales ha^{-1}) and 2002 (167ha producing an average of 4.45bales ha^{-1}) as well as in years prior to this project in the ORIA. However, in 2003 there was no interest shown by local farms and instead a 7.5ha block at the Frank Wise Institute was used for growing a crop of CSX405B under what was considered 'best bet' options, given what is currently known about growing cotton during the dry season in the ORIA. The majority of the advice regarding the management of this crop was provided by Stephen Yeates while John Moulden measured water use. The crop yielded 8.6 bales ha^{-1} and 7.47Ml of water ha^{-1} was applied to the crop. At writing the amount of water running off the field had not been determined while quality of the lint from this trial was being assessed at ACRI.

2. Provide a conclusion as to research outcomes compared with objectives. What are the "take home messages"?

Compensation from insect damage

The overall effect of mepiquat chloride application was neutral although in some instances it did prevent excess vegetative growth due to fruit removal without affecting yield. Tipped out plants were unable to compensate to the extent that yield was significantly different compared to the controls when crops were sown late in the season. Fruit loss had a slightly negative effect on yield which was worse for later sown crops.

Irrigation scheduling and Growth regulator management strategies

The fact that yield was impacted upon by irrigation scheduling treatments indicates that two irrigations post cut-out are desirable when growing dry season cotton in the ORIA. This result has been incorportated into the current draft of NORpak.

Growth regulation management strategies would appear to be minimise the use of in most situations as its use is associated with a yield penalty. While it did increase fibre length, it had an adverse effect on several other fibre quality characteristics. Current recommendations in NORpak suggest that it should only be considered for early sown (i.e. pre mid-April) crops and not for cultivars such as Sicot V-16i which is relatively determinant.

Wet season cover crops / weed management / soil preparation

While it is difficult to make 'take home messages' regarding due to only one full year of data it appears as though sorghum or dwarf pearl millet would make suitable wet season cover crops and that they should be sprayed out earlier rather than later in the wet season to allow time for the crop to die and stubble to decompose. Roundup Ready certainly seems to have a place in weed management and the release of Roundup Flex cultivars in the future should be of increased benefit. Also, minimum tillage cotton into wet season cover crop mulch seems possible although again there is only one year of data to support this. The current use of Stomp to control weeds is adequate provided that resistant weeds such as native rosella (*Abelmoschus ficulneus*) and native hibiscus (*Hibiscus panduriformus*) are not a problem. Certainly the use of both Stomp and Roundup Ready technology combined is not required.

Virgin soil nutrition

From the two seasons of data it would appear that 80 kg ha^{-1} of phosphorus is required in the first season in which cotton is grown on virgin soil in the ORIA and in subsequent years replacement levels are required. The new area section of the trial in 2003 highlighted the importance of not leaving field fallow for too long as cotton sown into land left fallow for two years displayed zinc deficient symptoms early in the season and failed to yield well.

AMF colonization rates on virgin soil were low although this was dramatically increased in the second year that crops were grown in that area. The application of phosphorus fertiliser increased the colonisation by AMF in the second year of cropping although at the early stages of growth plants did not appear to be relying on AMF for their uptake of phosphorus.

Crop adaptation to dry season growing conditions

The variety trials over the years 2001 to 2003 showed the adaptation of Siokra V-16i and Sicot 289i and their Bollgard II equivalents to ORIA dry season growing conditions.

However, other lines show promise. Sicala 35i lines were evaluated in a progeny trial in 2001 with some lines producing greater yields that the check cultivar Siokra V-16i while still maintaining excellent fibre quality characteristics. The 2002 variety trial was low yielding and fails to provide much insight into true yield potential while the 2003 variety trial demonstrated the potential of several Bollgard II lines for local conditions. Fibre from cold temperature experiments are still being analysed but data from the 2002 trial indicates that fibre length was unaffected by cold night temperatures during fibre formation but micronaire was adversely affected. Earlier maturity could best be achieved by systems that ensure sowing as soon as the wet season finishes and machinery is able to access fields. Research had commenced into permanent bed/reduced tillage systems using Roundup Ready cultivars. Sowing early maturing cultivars when sowing is delayed to late April / early May can reduce time-to-maturity by 5 to 10 days without affecting yield. Extending the final irrigation interval and mepiquat chloride treatment had minimal effect on time-to-maturity and could adversely affect yield.

Application of research results at a larger scale

Results from 2001 and 2002 growing season indicate that commercial yields are variable for the ORIA, although the best bet trial in 2003 and yields achieved prior to this project have shown that yields in excess of 8 bales ha^{-1} are possible with good crop management. It is hoped that the production of NORpak, the production manual for northern Australian dry season which is currently in draft form, will assist future growers in producing consistently high yielding crops.

3. Detail how your research has addressed the Corporation's three Outputs - Economic, Environmental and Social?

This project aimed to address the first two of the CRDC's outputs. The reasoning behind the funding of the Northern cotton project was to investigate the potential of an alternate production system for the Australian cotton industry so as to stabilise and make more reliable exports of Australian cotton. Lake Argyle is an enormous water resource and guarantees the availability of water for irrigation during the winter/dry season. This project aimed to develop the agronomy for dry season cotton production to determine whether a production system is viable. In conjunction with this, previous attempts at growing cotton in the ORIA during or partly during the wet season ended in disaster due to the heavy reliance on broad spectrum insecticides. This project aimed to investigate ways in which agronomic resources could be best utilised to provide an environmentally sustainable cotton production system for the ORIA during the dry season.

4. Provide a summary of the project ensuring the following areas are addressed:

a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.)

b) other information developed from research (eg discoveries in methodology, equipment design, etc.)

c) are changes to the Intellectual Property register required?

Results from this project should not affect the first or last areas mentioned above. However, changes in methodology have been discovered, particularly in relation to land preparation, compared with what is done in traditional cotton growing areas of Australia. The Roundup Ready trial highlighted the fact that the window for application of Roundup in northern Australia is narrower than in traditionally cotton growing areas of Australia due to higher temperatures at sowing. Management of beds will also become an issue if minimum tillage is to become standard in a northern cotton production system. There will always be some slumping of the beds and furrows will need to be cleaned out. In the minimum tillage treatments in the Roundup Ready trial the furrows were cleaned out and beds levelled but not cultivated at the beginning of the dry season and this may need to become standard practice. Many other methodologies (eg managing a wet season cover crop) would be unique to a northern production system and guidelines for how these would be undertaken have been outlined above.

Detail a plan for the activities or other steps that may be taken:

(a) to further develop or to exploit the project technology.

(b) for the future presentation and dissemination of the project outcomes.

(c) for future research.

a) Future plans to exploit the project technology are currently limited due to the winding up of the northern cotton project. In 2004 it is hoped that there will be some trials at the Frank Wise Institute, namely another 'Best bet' trial and possibly a Roundup Ready trial. There has been some interest from locals in commercial scale trials of cotton in 2004 although nothing is certain at time of writing. Stephen Yeates and Geoff Strickland have also produced a draft of NORpak using information gathered during this project.

b) Future plans to disseminate information regarding this project include a seminar at ACRI to other cotton researchers about this project, articles for the Australian Cottongrower magazine (one should appear in the April-May edition), presentations at the ACGRA conference and International Crop Congress later this year and the writing up of experiments for publication in peer-reviewed journals in the near future.

c) As stated earlier there are currently no plans to continue this research in the foreseeable future.

List the publications arising from the research project and/or a publication plan. (NB: Where possible, please provide a copy of any publication/s)

Duggan, B., Yeates, S., Gaff, N. and Constable, G. (2003). Robust farming system challenges for cotton production in the Ord River Irrigation Area of North Western Australia. p 95-97. Proceedings of the 11th Australian Cotton Conference, Brisbane, Queensland. Australian Cotton Growers and Researchers Association.

Duggan, B., Gaff, N., Singh, D., Yeates, S. and Constable, G. (2003). Cotton yield response to sources, rates and placement of P fertilizers in tropical Australia. p 2150-2153. *In* Proc. Beltwide Cotton Res. Conf., Nashville TN. National Cotton Council of America., Memphis TN.

Duggan, B.L. and Ryan, M (2004) Mycorrhizal colonisation of dry season cotton grown on virgin soil in northern Australia. *In* Proceedings of the 4th International Crop Congress, Brisbane, Australia. 26 Sept – 1 Oct. *In Press*

7. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry or the Australian community.

The purpose of this project was to investigate agronomic production system to support a dry system cotton production system in north-western Australia, namely the ORIA although there are implications for other potential cotton growing areas in northern Australia. This has been achieved by investigating the compensation ability following insect damage, the management of growth regulators and irrigation, crop rotation and land preparation, nutritional requirements particularly on virgin soil and crop adaptation to dry season growing conditions. Ord stage II is an area of 42,500 hectares with the potential to produce over 200,000 bales of cotton during the dry season. However, while Ord Stage II is currently under a native title claim there can be no development of this area and the benefits for the

Australian cotton industry are limited. If however the area is to be developed in the future and cotton is the main crop then not only would a significant part of the Australia cotton crop originate from the ORIA but the production would not be influenced by the environmental conditions such as drought and flood that affect the current Australian cotton industry and should insure a more reliable supply of cotton to countries to which Australia exports cotton.

Part 4 – Final Report Executive Summary

Provide a one page Summary of your research that is not commercial in confidence, and that can be published on the World Wide Web. Explain the main outcomes of the research and provide contact details for more information. It is important that the Executive Summary highlights concisely the key outputs from the project and, when they are adopted, what this will mean to the cotton industry.

Refining crop agronomy for dry season cotton production in NW Australia

Limitations on the availability of irrigation water in eastern Australia has created interest in the possibility of re-establishing cotton in the Ord River Irrigation Area (ORIA) of NW Australia, where extensive supplies of water are available and there is potentially the area of Ord Stage II available for development. This project was undertaken to assess what agronomic management practices may be required for a dry season cotton production system in the ORIA.

The ability of plants to compensate after insect damage was investigated and compared to what happens in traditional cotton growing areas of eastern Australia by removing fruit, tipping out plants and applying a growth inhibitor (mepiquat chloride). Mepiquat chloride had no effect on the ability of the plant to compensate for fruit loss while tipping the plant out (removing the mainstem apex) had a negative impact on yield. Plants that lost fruit later in the growing season were also unable to compensate and were later matuing than the controls.

Irrigation scheduling experiments concluded that irrigation scheduling should consist of irrigating every 21 days/125mm pan evaporation between emergence and mid-squaring, after 110mm of pan evaporation between mid-squaring and cut-out and at least once between cut-out and defoliation. The use of growth inhibitors such as mepiquat chloride should be minimised as there appears to be little benefit in terms of lint yield or quality. It is suggested that it only be considered on early sown (i.e. pre mid-April) crops and on relatively indeterminant cultivars such as Sicot 289i and their Bollgard II equivalents.

Wet season cover crops appear to have a place in rotation with dry season cotton production in the ORIA with dwarf pearl millet or sorghum being the prefered crops. This should be sown at the start of the wet season and sprayed out after approxiamtely 55 days after sowing to allow time for thecrop to die and stubble to break down. Roundup Ready cotton also appears to be a possible weed management option, particularly in a minimum tillage situation where the cotton can be sown into the wet season stubble and weeds controlled after the crop has emerged.

Fertiliser trials indicate that 80 kg ha^{-1} of phosphorus is required when sowing cotton into land that has previously been unfertilised followed by replacement levels in subsequent years. If fields are left fallow for extended periods of time (i.e. in excess of one dry season) plants may have difficulty accessing zinc.

Cultivars currently recommended for growing on the ORIA are Siokra V-16i and Sicot 289i and their Bollgard II equivalents. Both have a high yield potential and produce satisfactory lint quality. However, variety trials have identified several promising lines with potential for dry season production on the ORIA. In particular, lines derived from Sicala 35i has shown themselves to be well adapated to ORIA dry season growing conditions.