ARC-Institute for Industrial Crops

Cotton Project Annual Progress Report

2014/2015

ARC • LNR

Excellence in Research and Development

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PROJECT NUMBER	**:**	TK 208/16 – Part A
PROJECT TITLE	**:**	Minimum input – On farm demonstrations
REPORT YEAR	**:**	2014/2015
PROJECT MANAGER	**:**	HJ Steyn
CO-WORKERS	**:**	MS Magwaza MC Mkhwanazi

INTRODUCTION

The Makhathini Flats area of the Northern KwaZulu-Natal is very dry with an annual rainfall of 450 mm's. The rainfall pattern is also very varied and erratic. Cotton is the only crop which can be grown successfully under these conditions without irrigation assistance. Research was done to determine which cultivation practice will be suitable for dryland cotton small holder farmers in this area. It was determined that the most profitable production method under these climatic conditions is the double skip row - rip on the row method. In this production method no ploughing or discing is done but only a shallow 25 to 30 cm deep ripping action on the plant row. Two rows are ripped one meter apart and two rows skipped. This allows for roots to penetrate deep on the planting line as well as utilize moisture sideways in the open spaces. This method results in more moisture being available to the crop and results in higher yields. It also reduces the input cost drastically. Ploughing and discing are very costly practices. Planting double skip row also uses only half the quantity of seed used in planting inter row spacings of 1 meter resulting in a further reducing of Input costs. The fact that there are only half the usual amount of planted lines, also results in spraying only half the amount of pesticides.   A big challenge is that farmers are very reluctant to practice this very effective dry land cotton production method on their own farms.

OBJECTIVE

The objective of these dry land cotton, double skip row – rip on the row on-farm demonstration plots is to demonstrate to dry land cotton farmers on their own farms and on three different soil types that this method is superior to other dry land cotton production methods on the Makhathini Flats.

EXPERIMENTAL PROCEDURES

The aim was to plant three on farm demonstration plots on three different soil types before 15 December 2014. Unfortunately the rainfall was too low to successfully prepare and plant any of these demonstrations. It rained a total of only 18 mm in October and the biggest shower was 9 mm. In November it rained a total of 48 mm's and the biggest shower was 26 mm. In December it rained a total of 18 mm's and the biggest shower was 7 mm.

RESULTS AND DISCUSSION

Due to the low rainfall no rip cultivations for planting could be made on any of the farms.

CONCLUSION

The Makhathini Flats area is a very dry area which creates the need of a dry land cotton production method that can use every millimetre of rain effectively.

NEXT SEASON

The cotton demonstration trials will be done on three different soil types on farmers' farms.

PROJECT NUMBER	:	TK 208/16 – Part B
PROJECT TITLE	:	Minimum input – Nitrogen Fertilization
REPORT YEAR	:	2014/2015
PROJECT MANAGER	:	HJ Steyn
CO-WORKERS	:	MS Magwaza MC Mkhwanazi

INTRODUCTION

The Makhathini Flats area of the Northern KwaZulu-Natal is very dry with an annual rainfall of 450 mm's. The rainfall pattern is also very varied and erratic. Cotton is the only crop which can be grown successfully under these conditions without irrigation assistance. Research was done to determine which cultivation practice will be suitable for dryland cotton small holder farmers in this area. It was determined that the most profitable production method under these climatic conditions is the double skip row - rip on the row method. In this production method no ploughing or discing is done but only a shallow 25 to 30 cm deep ripping action on the plant row. Two rows are ripped one meter apart and two rows skipped. This allows for roots to penetrate deep on the planting line as well as utilize moisture sideways in the open spaces. This method results in more moisture being available to the crop and results in higher yields. It also reduces the input cost drastically. Ploughing and discing are very costly practices. Planting double skip row also uses only half the quantity of seed used in planting inter row spacings of 1 meter resulting in a further reducing of Input costs. The fact that there are only half the usual amount of planted lines also results in spraying only half the amount of pesticides. The question arose, that seeing that there is now more moisture available to the plants, will a nitrogen topdressing result in a further economic benefit to the farmer and if so, at what quantity must it be applied?

OBJECTIVE

The objective of this dryland cotton, double skip row - rip on the row nitrogen trial is to determine if nitrogen applied as a topdressing would have an economic benefit to the farmer.

EXPERIMENTAL PROCEDURES

The plant – furrows for the experiment was drawn on 17 November 2014 in the double skip row – rip on the row method. The trial was planted on the ripped furrows on 02 December 2014. A Youden Square Design was used with 6 treatments that was replicated 4 times.

Six different Nitrogen levels were applied on 07 January 2015. These levels were:

1. 0 kg N/ha
2. 10 kg N/ha
3. 20 kg N/ha
4. 30 kg N/ha
5. 40 kg N/ha
6. 50 kg N/ha

The cotton variety PM 3225 B2RF from Monsanto/Deltapine was used. The first spray of Roundup Power Max was done between the plant rows on 02 December 2014. On 03 December 2014 an irrigation of 25 mm was applied because of the drought to assist with the germination of the trial. On 10 December 2014 another 25 mm was irrigated. The second Roundup Power Max spray was applied on 13 January 2015.

Scouting for pests was done on:
19 January 2015
26 January 2015
05 February 2015
16 February 2015
23 February 2015 and
02 March 2015.

Mospilan was sprayed for Aphids and Alpha Cypermethrin for bollworms on 17 February 2015. A Second spray of Mospilan for Aphids and Jassids was done on 03 March 2015.

The trial was badly affected by drought as it rained only 290 mm from November 2014 until 30 June 2015.

RESULTS AND DISCUSSION

The 2014/2015 cotton season was very dry. Due to the below normal rainfall the different nitrogen levels applied did not show significant differences. Very interesting observations were made though.

Table 1. Average values for yield, plant height, green bolls and petals, 2014/2015 season

Treatment	*Yield (kg/ha)*	*Plant height (cm)*	*Green bolls*	*Petals (10 plants)*
0	1179	60	87	10
10	1172	58	91	11
20	989	63	116	8
30	1218	68	126	11
40	1272	69	110	12
50	1317	59	107	12
Average	**1191**	**63**	**106**	**11**
CV	**20.6**	**15.17**	**32.1**	**13.5**

Yield

The average yield for the trial was 1191 kg of seed cotton per hectare with the highest treatment yield average coming from 50 kg of Nitrogen applied per hectare, giving 1317 seed cotton per hectare. The tendency was that the yield increased as the nitrogen applied increased.

Plant height

The plant height also increased as the nitrogen level increased except for the 50 kg N/ha treatment that was lower.

Green bolls

The green boll count per treatment was taken after the second pick was done. The green boll count per treatment increased for treatments 0 to 40 kg N/ha but then started going down again for treatments 40 and 50 kg N/ha.

Petals

The average petal count per plant seemed to have increased as the nitrogen applied increased, except for the 20 kg N/ha treatment which was lower than the rest. Significant differences were shown between the treatments 0, 10, 30, 40 and 50 kg N applied per hectare and the 20 N per hectare treatment.

Table 2. Average values for fibre qualities, 2014/2015 season

Treatment	Length (mm)	Strength (g/tex)	Micronaire
0	27.94	33.27	4.42
10	27.43	32.66	4.58
20	27.18	32.88	4.31
30	27.17	32.04	4.23
40	27.68	32.89	4.40
50	27.43	32.92	4.47
Average	**27.43**	**32.78**	**4.41**
CV	**2.19**	**4.32**	**4.32**

FIBRE QUALITIES

Length

The average length was 27.43 mm which is on the low side with the longest fibre coming from the treatment of 0 kg N/ha that measured 27.94 mm.

Strength

The average strength measured was 32.78 g/tex with the treatment of 0 kg N/ha as the highest at 33.27 g/tex.

Micronaire

The average Micronaire measured was 4.41. The treatment of 10 kg N/ha gave the highest Micronaire value of all the treatments at 4.58.

In spite of the abnormal dry season the average trial yield was still fairly good for dryland produced cotton showing the higher yield potential of the applied production method. The fact that the treatment of 50 kg N/ha gave an average of 138 kg seed cotton per hectare more than the 0 kg N/ha treatment shows promise but at a price of R5.00 per kg of seed cotton it means the farmer gets an extra income of only R690.00 per hectare. The cost of 50 kg of N in the form of LAN (28%) is R875.00 and when deducted, results in a lower income of R185.00 per hectare. Transport and application costs must also still be deducted.

CONCLUSION

As a result of the drought no real conclusions can be made. There are however interesting observations that need to be investigated in another season.

NEXT SEASON

The trial will be repeated on the exact same location but on the skipped rows.

PROJECT NUMBER	:	TK 208/20
PROJECT TITLE	:	High temperature tolerance in cotton
REPORT YEAR	:	2014/2015
PROJECT MANAGER	:	MM Pretorius
CO-WORKERS (External)	:	Prof DM Oosterhuis * Dr Fred Bourland* Dimitra Loka* Toby FitzSimons*

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LONG-TERM OBJECTIVES

1. To use physiological measurements to quantify the effect of high temperature stress on reproductive development of cotton genotypes for screening for temperature tolerance.
2. To study the agronomic and physiological effects of high temperature stress on the growth and yield of cotton genotypes in the field.
3. To formulate and test methods of ameliorating the deleterious effects of high temperatures on boll development and yield.

MATERIALS AND METHODS

Cotton trials were planted at the Agricultural Research Council-Institute for Industrial Crops (ARC-IIC), Groblersdal, on 6 and 19 November 2014. Cotton (*Gossypium hirsutum* L.) cultivars planted were VH260 and Arkot 9704 (two cultivars with heat tolerance), DP393 (a heat sensitive cultivar) and DP210 BRF, (a cultivar of unknown tolerance). The trial received a total irrigation of 350 mm. Limestone Ammonium Nitrate was applied to supply 150 kg/ha in two split applications of 75 kg/ha N. Temperatures and rainfall received during January to March 2015 are presented in Figure 1. Measurements were done to obtain two temperatures regimes namely 28.5/21 °C and 33/18 °C day/night. The experimental design was a fully randomized block designs with five replications. Rows were 5 m in length and the inter-row spacing was 1 m and intra-row spacing 20 cm. The middle two rows were used to sample leaves for analysis. Measurements were made of membrane leakage, fluorescence, leaf temperature, seed cotton yield and fibre qualities. Data were analyzed using JUMP.

Measurements

a. Yield

* Total seed cotton yield (kg/ha)
* Fibre percentage
* Fibre yield (kg/ha)

b. Physiological measurements (leaf)

* Membrane leakage
* Fluorescence

c. Quality

* Fibre length (mm)
* Fibre strength (g/tex)
* Micronaire

d. Climatical data

* Daily minimum and maximum temperatures
* Rainfall

RESULTS

Membrane leakage (ML)

The control treatment of 28.5 °C had an electrolyte leakage percentage of 84.4 %, compared to the 72.1 % of the heat stressed measurement (33 °C). Heat stressed plants had lower electrolyte leakages than plants at the cooler temperature of 28.5 °C (Figure 2). The cultivar, Arkot showed the lowest decrease in membrane leakage, from 76.0 % to 75.3 %. Cultivar DP393 leaked the most electrolytes, from 87.5 % to 61.6 % (Figure 3).

Fluorescence

The higher temperature regime of 33 °C gave the lowest fluorescence of 0.670, compared to the 0.773 of the control plants (28.5 °C) (Figure 4). Cultivar VH260 had the lowest decrease in fluorescence, showing it to be a heat tolerant cultivar (Figure 5).

Leaf temperatures

The higher temperature regime of 33 °C gave the highest leaf temperatures of 36.7 °C. The lower temperature regime (28.5 °C) gave significantly lower leaf temperatures of 27.5 °C (Figure 6 and 7).

Seed cotton yield

Cultivars differed significantly. DP210 had the highest yield of 2727 kg/ha. This only differed significantly from DP393. Although planting dates did not differ significantly, the second planting had the highest yield of 2633 kg/ha. The cultivar planting interaction differed significantly with the second planting and VH260 resulted in the highest yield of 2977 kg/ha (Figure 8).

Fibre percentage

Cultivars did not differed significantly. VH260 tended to have the highest fibre percentage of 42.5 %. Planting dates did not differ significantly. The second planting date had the highest fibre percentage of 42.1%. The cultivar planting interaction did not differed significantly, but there was a tendency for VH260 at the second planting date to have the highest fibre percentage of 42.9 % (Figure 9).

Fibre yield (kg/ha)

Cultivars differed significantly. DP210 had the highest fibre yield of 1131 kg/ha. This only differed significantly from DP393, and not from VH260 or Arkot. Although planting dates did not differ significantly, the second planting date had the highest fibre yield of 1107 kg/ha. The cultivar x planting date interaction differed significantly with VH260 at the second planting that resulted in the highest fibre yield of 1273 kg/ha (Figure 10).

CONCLUSION

In the current study different screening methods were used to evaluate heat tolerance in four cotton cultivars in a field study at Groblersdal. The techniques included measurements of membrane leakage, fluorescence and yield in response to two different temperature regimes. Significantly lower membrane leakages were found when cotton had a heat stress of 33.0 °C. This means that plants have a defence mechanism when detecting stress that results in lower membrane leakages. Fluorescence decreased when the cotton had a heat stress, meaning electron transport increased as a defence mechanism to ensure the survival of plants. When ambient temperatures were 33 °C, cotton leaves heated up to 36.7 °C. The highest seed cotton yield of 2977 kg/ha was obtained with the cultivar VH260 planted at the second planting date. All cultivars gave higher yields at the second planting date as a minimum night temperature of 11.8 was experienced 3 days after planting the first trial on 6 November 2014. This resulted in slower emergence and initial growth of the first planting.

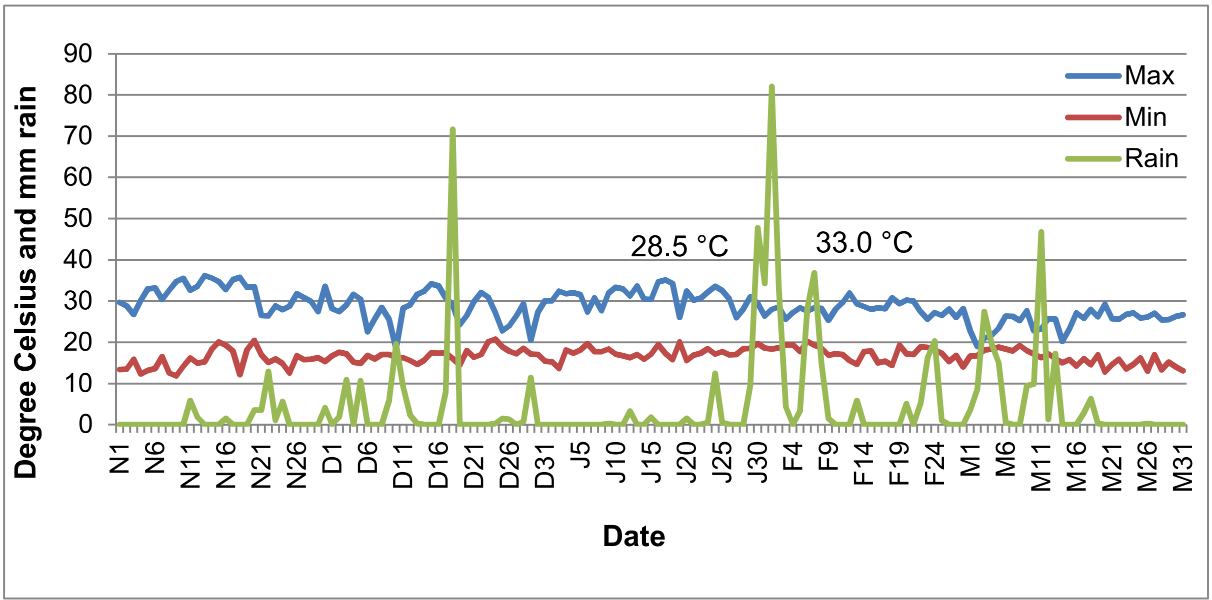

Figure 1. Maximum, minimum temperatures and rainfall data of the field study in Groblersdal (2014/2015)

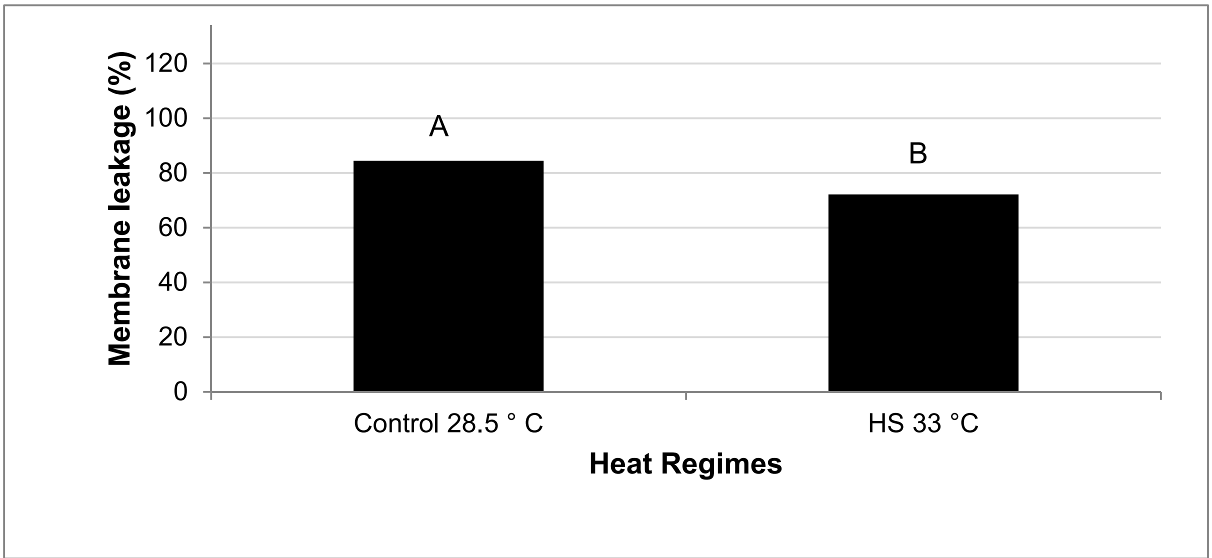

Figure 2. Membrane leakage (%) of two different temperature regimes measured on 20 January 2015 (28.5 ° C) and 9 February 2015 (33 °C) as an indication of the effect of heat stress on cell integrity in a field study in Groblersdal, 2014/15. Dark bars with the same lower case letters are not significantly different (*P*=0.05).

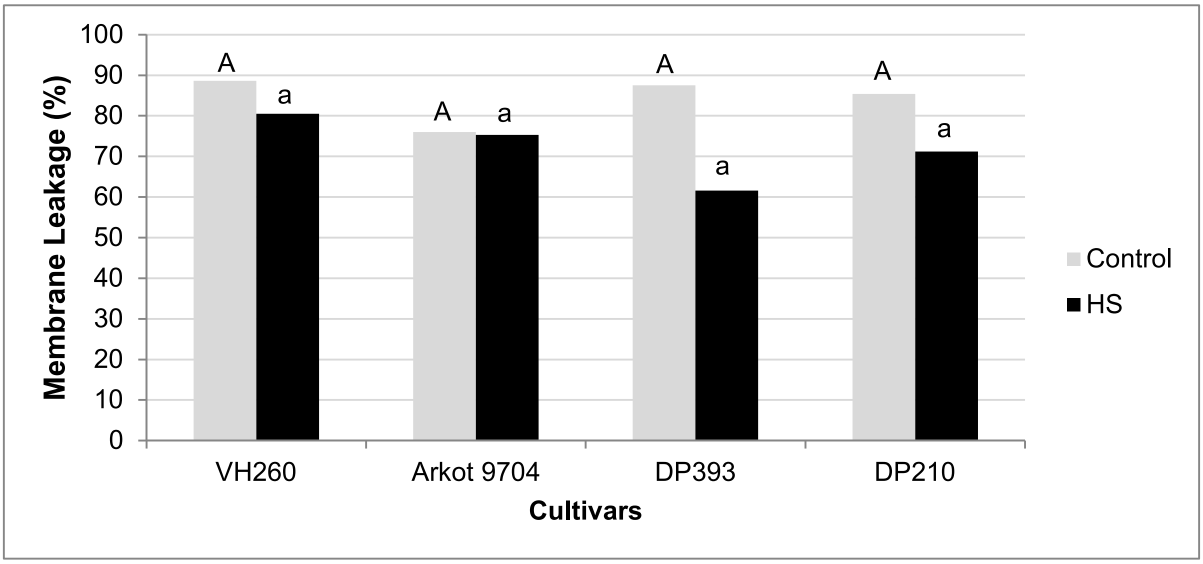

Figure 3. Membrane leakage (%) of four different cotton cultivars measured on 20 January 2015 (28.5 °C) and 9 February 2015 (33 °C) as an indication of the effect of heat stress on cell integrity in a field study in Groblersdal, 2014/15. Light bars with the same capital letters are not significantly different (*P*=0.05). Dark bars with the same lower case letters are not significantly different (*P*=0.05).

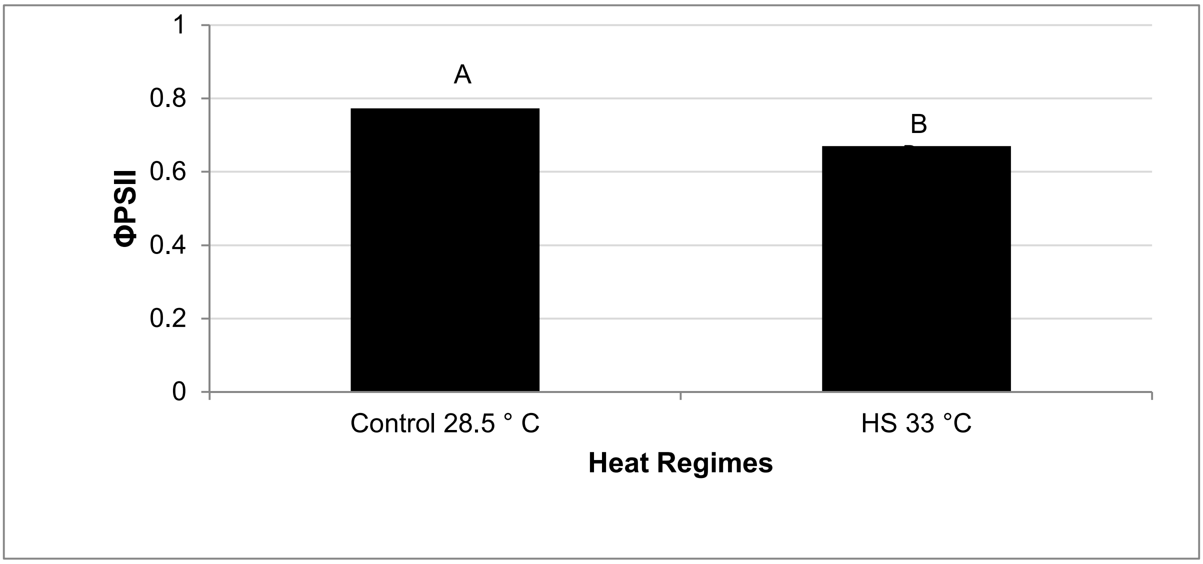

Figure 4. Fluorescence of two different temperature regimes measured on 20 January 2015 (28.5 °C) and 9 February 2015 (33 °C) as an indication of the effect of heat stress on cell integrity in a field study in Groblersdal, 2014/15. Dark bars with the same lowercase letters are not significantly different (*P*=0.05).

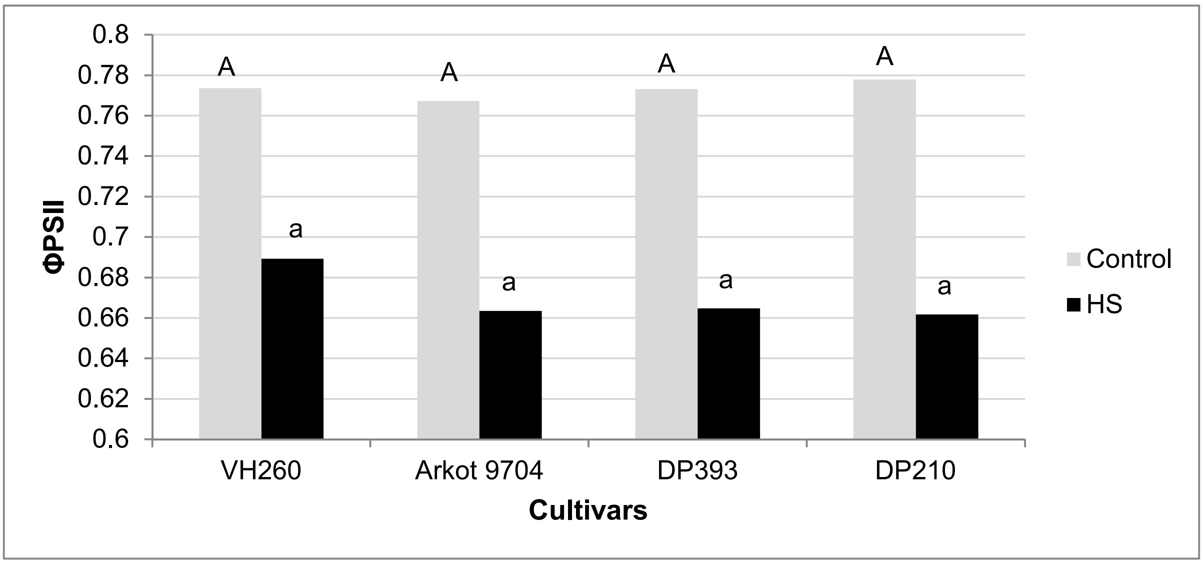

Figure 5. Fluorescence of four different cotton cultivars measured on 20 January 2015 (28.5 °C) and 9 February 2015 (33 °C) as an indication of the effect of heat stress on cell integrity in a field study in Groblersdal, 2014/15. Light bars with the same capital letters are not significantly different (*P*=0.05). Dark bars with the same lower case letters are not significantly different (*P*=0.05).

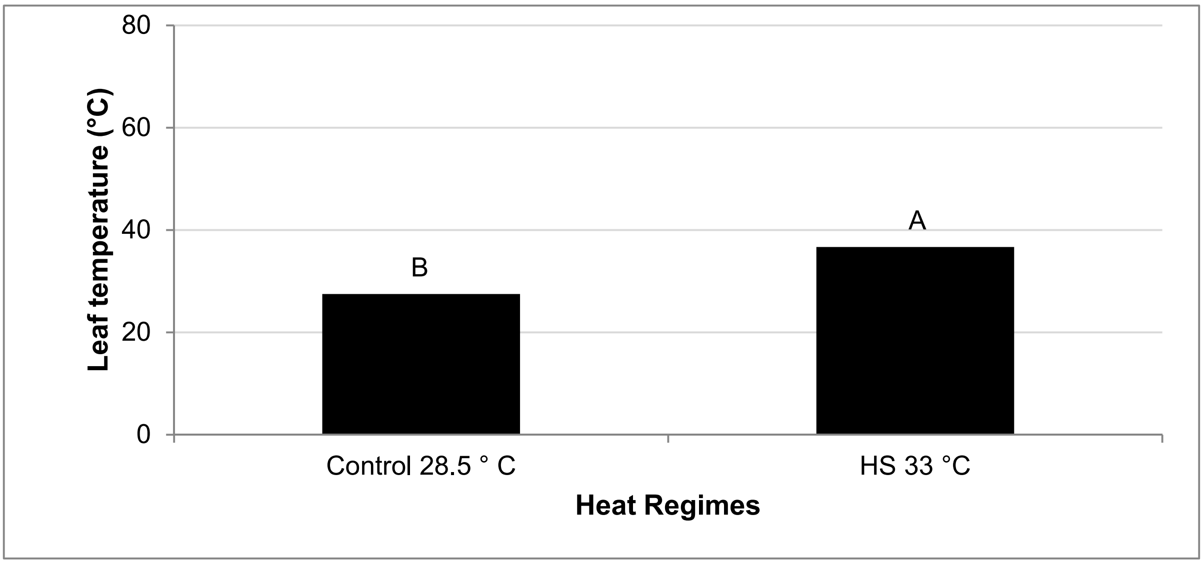

Figure 6. Leaf temperature (°C) of two different temperature regimes measured on 20 January 2015 (28.5 °C) and 9 February 2015 (33 °C) as an indication of the effect of heat stress on cell integrity in a field study in Groblersdal, 2014/15. Dark bars with the same lower case letters are not significantly different (*P*=0.05).

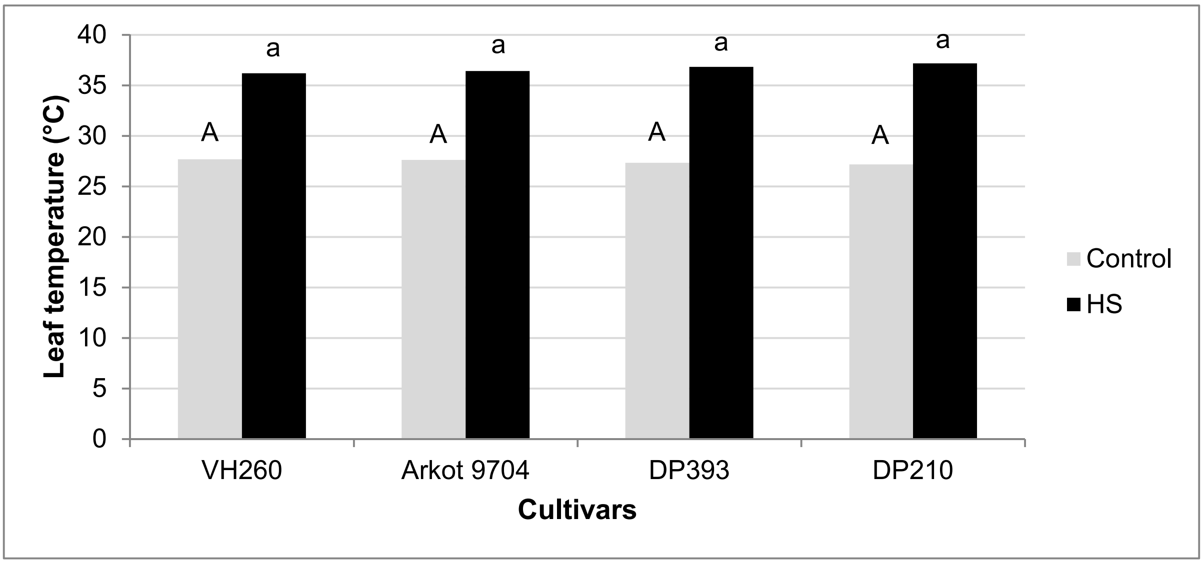

Figure 7. Leaf temperature (°C) of four different cotton cultivars measured on 20 January 2015 (28.5 °C) and 9 February (33 °C) as an indication of the effect of heat stress on cell integrity in a field study in Rustenburg, 2014/15. Light bars with the same capital letters are not significantly different (*P*=0.05). Dark bars with the same lower case letters are not significantly different (*P*=0.05).

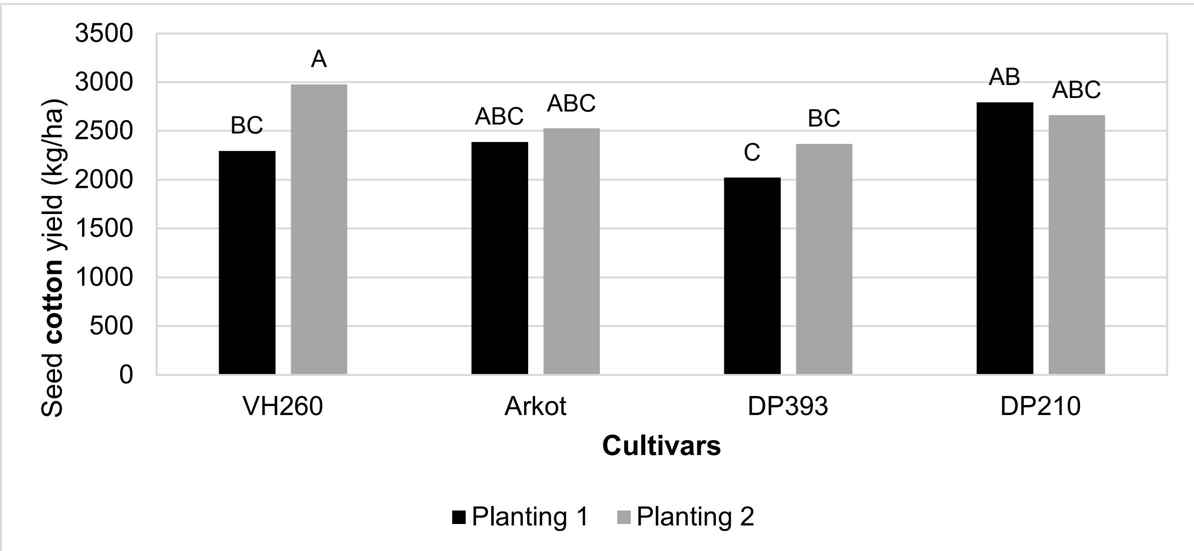

Figure 8. Seed cotton yield (kg/ha) of four different cotton cultivars measured on 20 January 2015 (28.5 °C) and 9 February (33 °C) as an indication of the effect of heat stress on yield in a field study in Groblersdal, 2014/15. Light bars with the same capital letters are not significantly different (*P*=0.05). Dark bars with the same lower case letters are not significantly different (*P*=0.05).

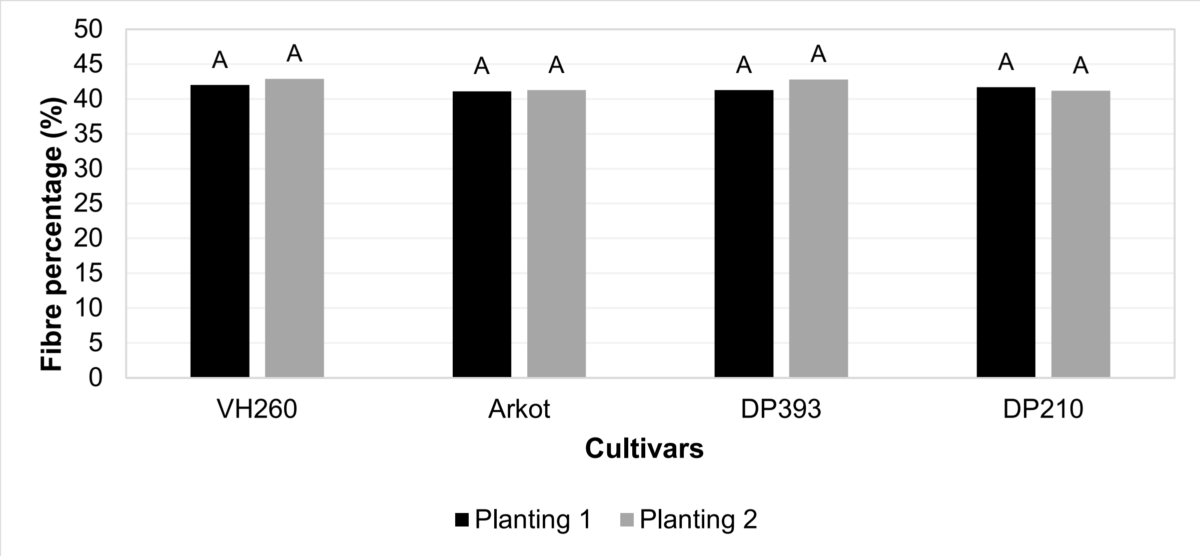

Figure 9. Fibre percentage (%) of four different cotton cultivars as an indication of the effect of heat stress on yield in a field study in Groblersdal, 2014/15. Light bars with the same capital letters are not significantly different (*P*=0.05). Dark bars with the same lower case letters are not significantly different (*P*=0.05).

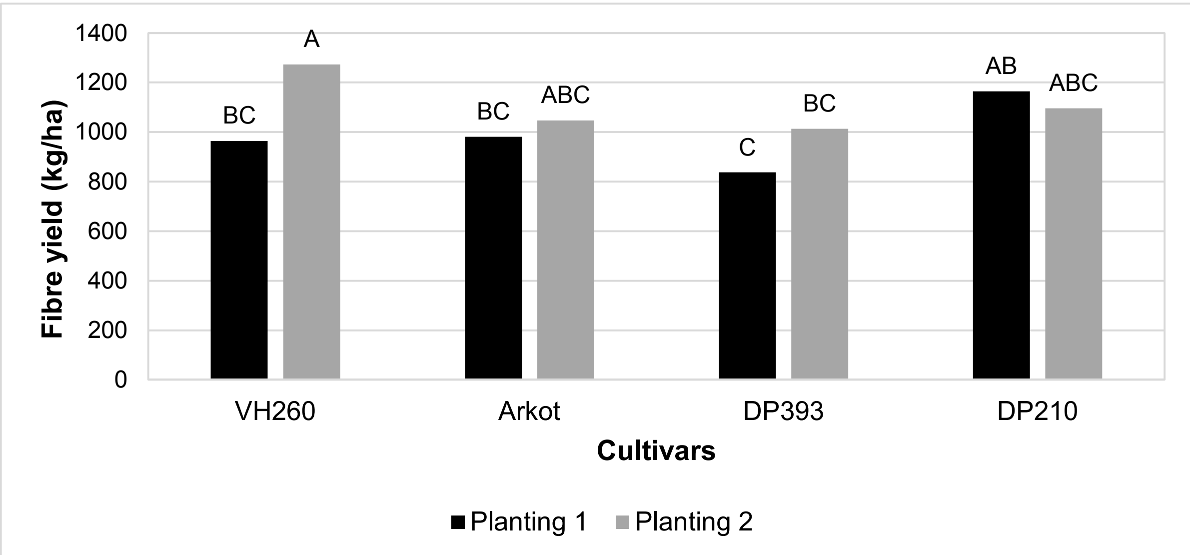

Figure 10. Fibre yield (kg/ha) of four different cotton cultivars measured on 20 January 2015 (28.5 °C) and 9 February (33 °C) as an indication of the effect of heat stress on yield in a field study in Groblersdal, 2014/15. Light bars with the same capital letters are not significantly different (*P*=0.05). Dark bars with the same lower case letters are not significantly different (*P*=0.05).

Table 1. Soil sample analysis of the Groblersdal PhD trial, 2014/2015

Measured parameter	Groblersdal		
	0 – 30 cm	**30 – 60 cm**	**60 – 90 cm**
pH	6.14	6.27	6.22
Resistance (ohms)	780	1580	1070
mg/kg			
N (NH_4)	5.3		
P	28	24	33
K	235	195	253
Ca	558	543	570
Mg	215	210	218
Na	20	18	15
S Value	5.26	5.03	5.37
Ca %	53.1	54.0	53.1
Mg %	33.8	34.5	33.6
K %	11.5	9.9	12.1
Na %	1.7	1.6	1.2
Sand	78		
Silk	3		
Clay	19		

PROJECT NUMBER	:	TK 208/21
PROJECT TITLE	:	Evaluation of planting date on production of cotton cultivars in SA
REPORT YEAR	:	2014/2015
PROJECT LEADER	:	CE Fourie
CO-WORKERS	:	KC Phalane GV Matlala

INTRODUCTION

Obtaining a vigorous and optimal stand is the first step for profitable cotton production. The use of appropriate cultivars and agronomic practices in suitable environmental factors is a prerequisite for such success. Environmental factors such as soil temperature determines the time of planting cotton.

In South Africa, the window for sowing cotton is very narrow and has a major influence on the yield and fibre qualities. Finding the most suitable cultivar for a particular planting date can help to widen the window period for sowing and ultimately optimize the total yield and quality of fibre.

The results of the 2014/15 evaluation of cultivars that are most suitable for a particular planting date are presented in this report.

OBJECTIVE

The objective of the trial is to determine which cultivar is most suitable for a particular planting date. The effect on plant growth, yield, fibre qualities and the degree of whiteness (colour values) of the different cotton cultivars was determined at various planting dates.

LOCALITY

Groblersdal: ARC-Loskop Research Farm

The locality presents one of the 8 different climatic zones experienced for cotton production in South Africa.

GENERAL PRODUCTION CONDITIONS

Maximum and Minimum temperatures

Cultivar adaptation and successful production are influenced by climatic conditions, especially temperatures during specific phases of the growing season. During the planting- and the early growing season for the planting date trial (October 2014 to January 2015) weather conditions fluctuated with wet weather and moderate to hot temperatures but from February 2015 to end of March 2015 weather conditions were extremely hot and dry. Warm to moderate temperatures in April 2015 and May 2015 could have benefitted the November 2014 plantings.

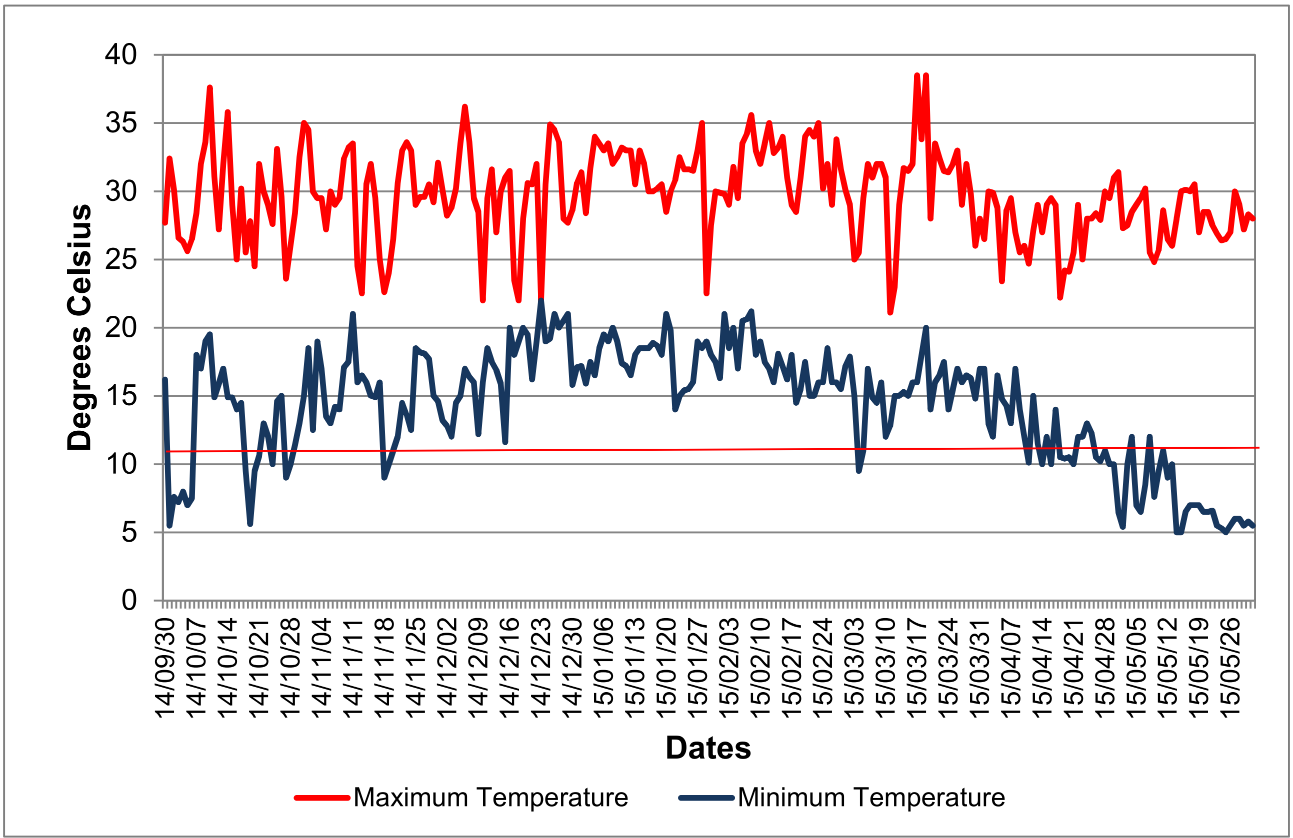

Figure 1. Minimum and maximum air temperatures (°C) at Groblersdal 2014/15

October 2014 Air temperatures

The minimum and maximum temperature data collected from the weather station at ARC-Loskop Research farm indicate that the maximum and minimum temperatures for October were lower than the long-term values. The maximum temperatures varied through-out the month and the minimum temperatures were above the long term average in the first part of October but drop below the long-term values in the second part of October.

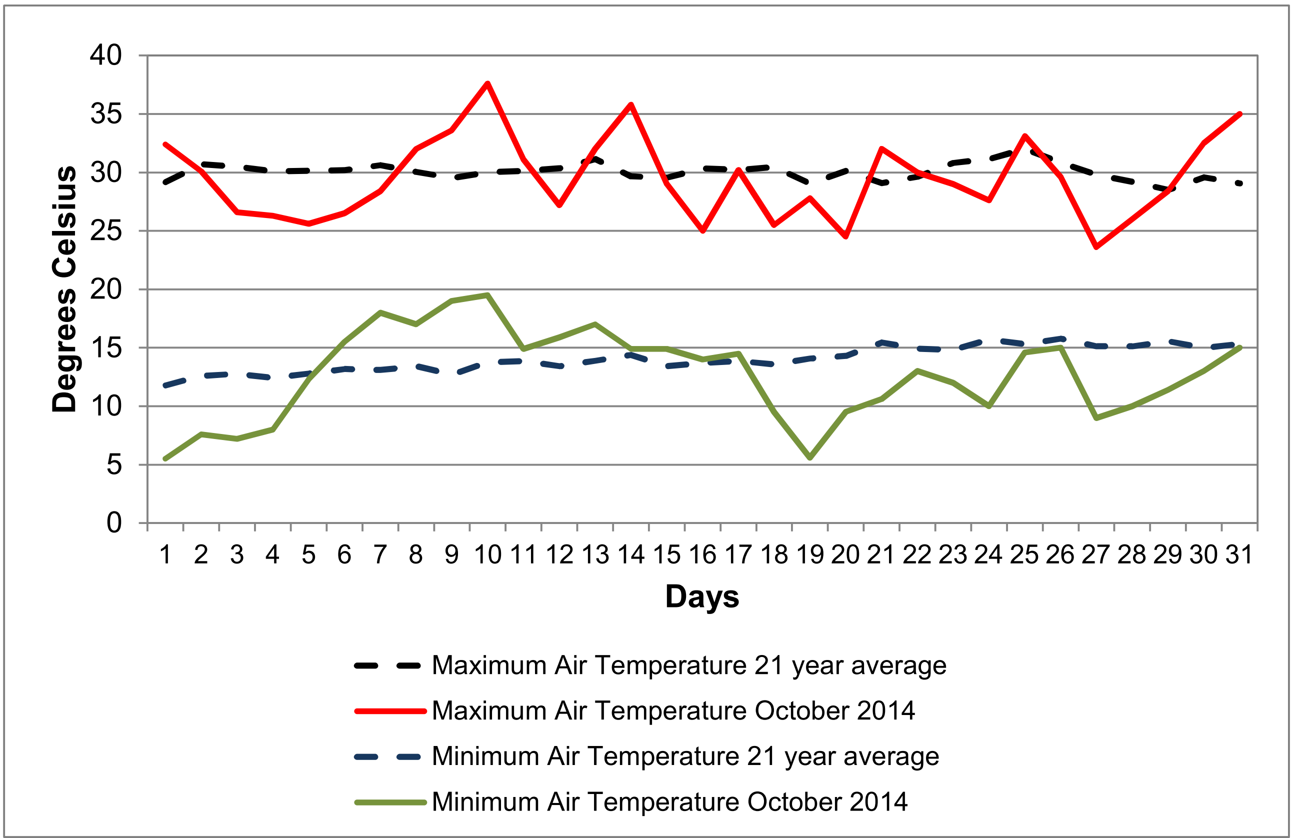

Figure 2. October 2014 Air temperatures (°C)

November 2014 Air temperatures

The minimum and maximum temperature data collected at the weather station for November 2014 indicated a variation in temperatures. Cold weather was experienced on the 17th of November 2014 when minimum temperatures drop below 15°C for eight days before return to normal minimum temperatures on the 25 November 2015.

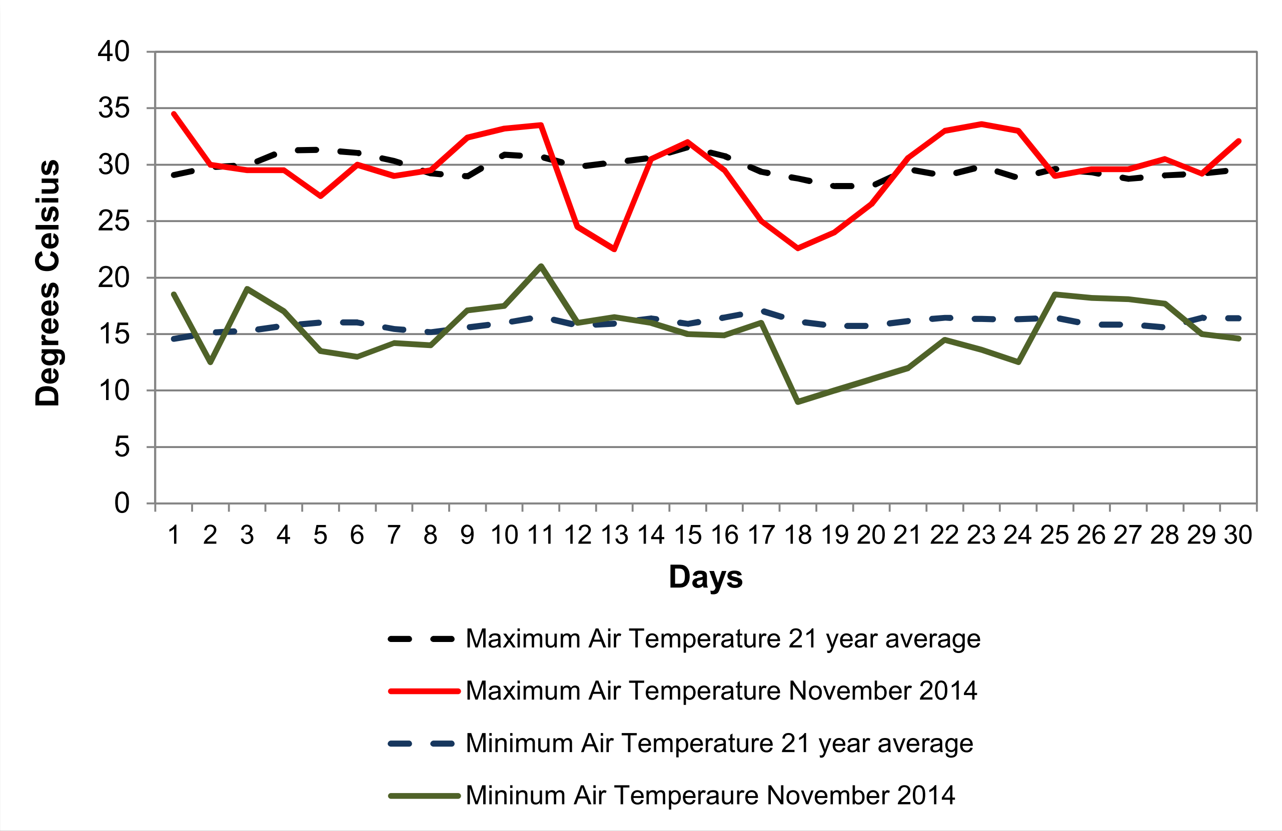

Figure 3. November 2014 Air temperatures (°C)

Soil temperature

A soil temperature meter was installed 30 September 2014 to record soil temperatures during sowing season of the eight planting dates. A figure for the soil temperature is given in Figures 3 and 4 below.

October 2014 Soil temperatures

High seed quality and warm air temperature are not enough for optimum seed germination and emergence if the soil is cold. Cotton should not be planted before the top 30 mm of soil has not maintained a temperature of 16 to 18°C or higher. Soil temperatures were above 15°C from 01 October 2014.

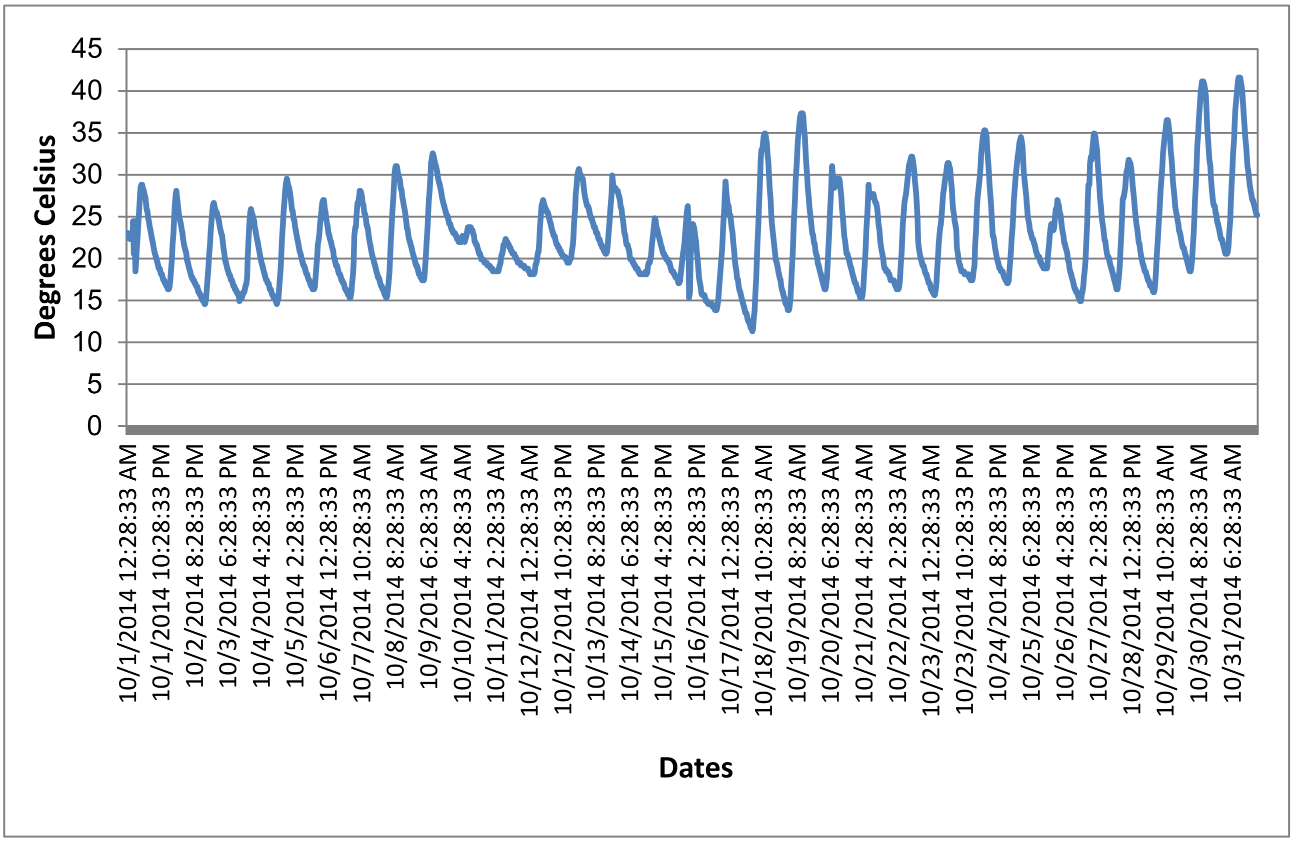

Figure 4. October 2014 Soil temperatures (°C)

November 2014 Soil temperatures

Soil temperatures for November 2014 were normal for sowing of cotton, even when a cold front passed over the country from 17 to 24 November 2014.

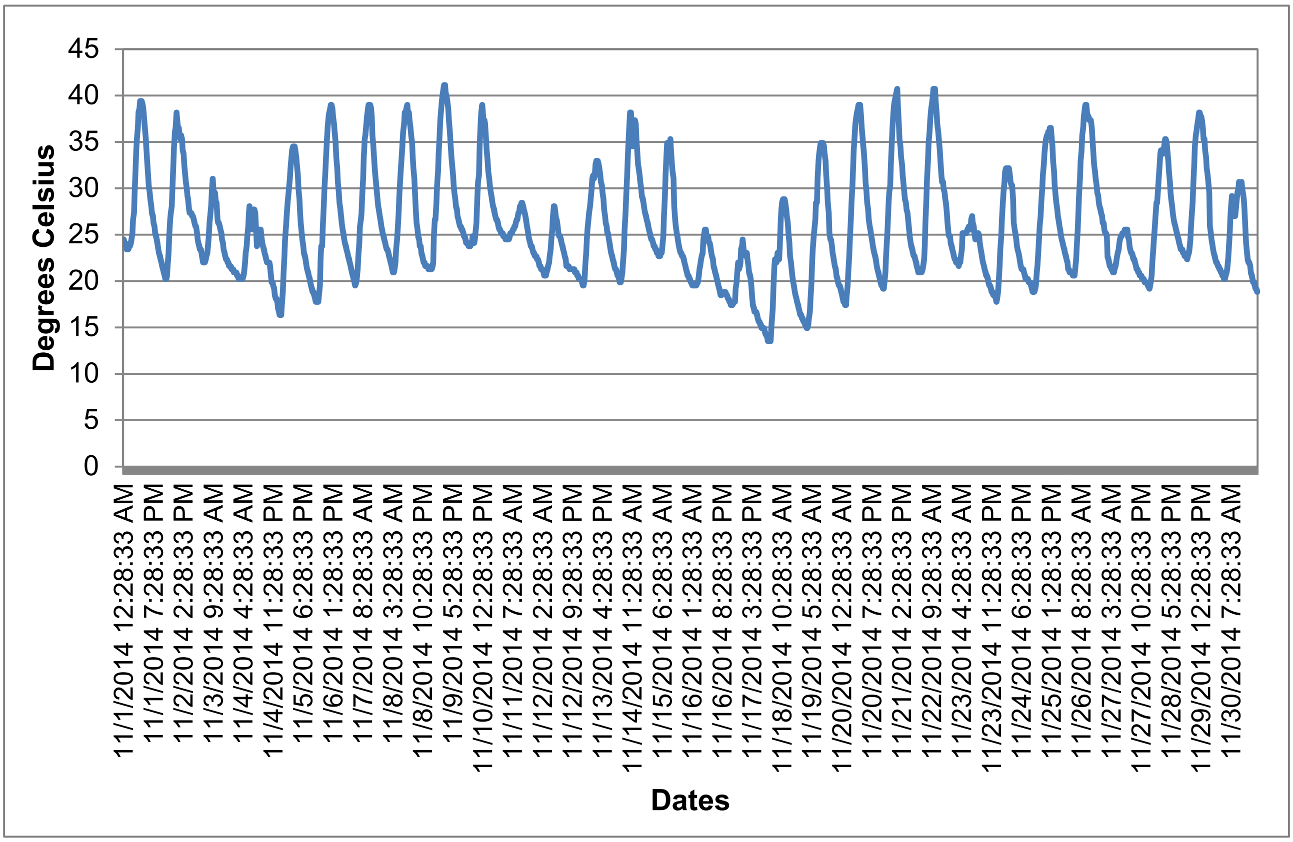

Figure 5. November 2014 Soil temperatures (°C)

Rainfall (mm)

A total of 554 mm rain was recorded during the growing season of the Plant Date Trials. Figure 5 indicates the rainfall for the 2014/15 cotton growing season with the highest rainfall for December 2014 (169 mm) and January 2015 (215 mm). Very dry and hot conditions were experienced during February, March, April and May. A hailstorm and rain (25 mm) just after planting on 17 October 2014 resulted in eroded soil, wash away of cotton seeds and damage to cotton seedlings.

Monthly rain fall measured at ARC-Loskop Research Farm, Groblersdal.

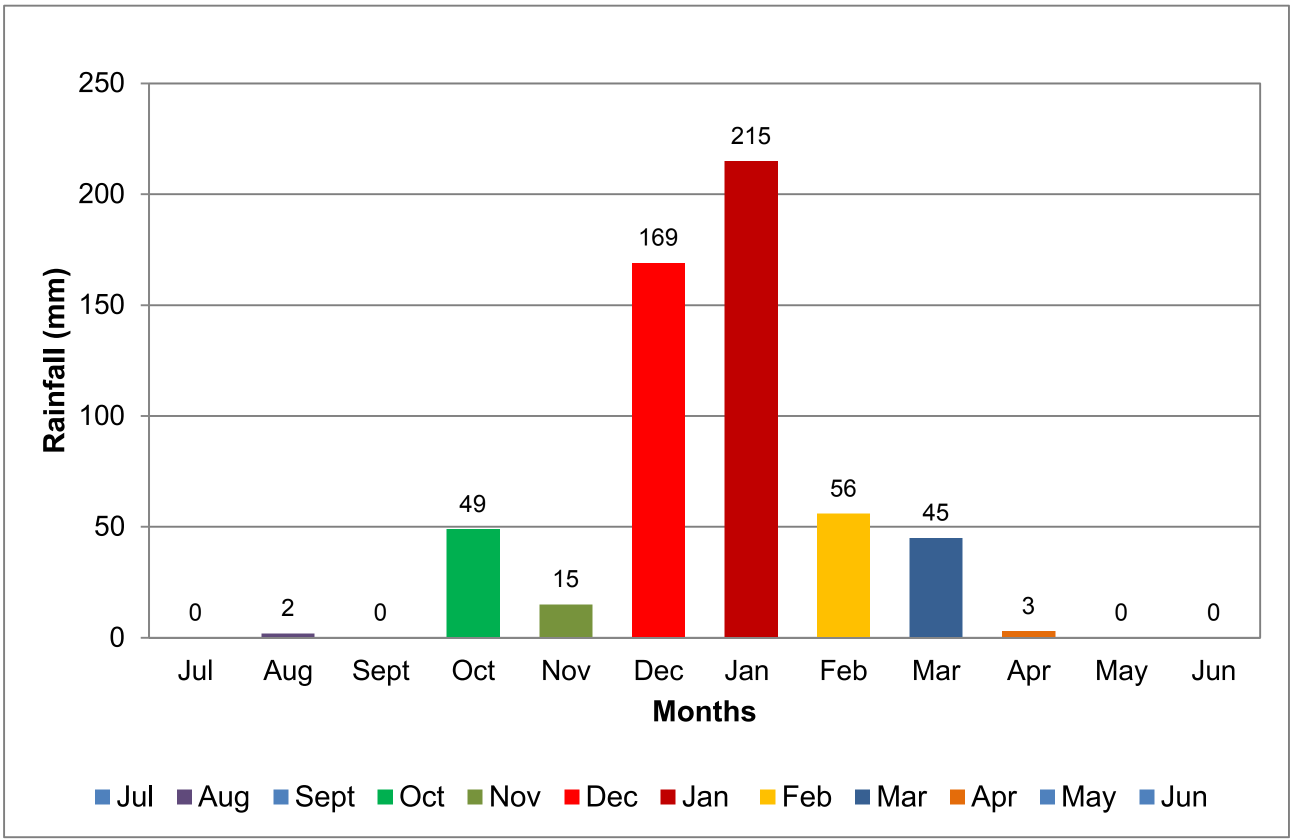

Figure 6. Rainfall (mm)

PLANTING DATES

A field trail was conducted at ARC-Loskop Research Farm, Groblersdal, by planting different cotton cultivars over a period of eight weeks to determine which cultivar is most suitable for a particular planting date. These planting dates were:

1. 07 October 2014 (PD 1)
2. 14 October 2014 (PD 2)
3. 21 October 2014 (PD 3)
4. 28 October 2014 (PD 4)
5. 04 November 2014 (PD 5)
6. 11 November 2014 (PD 6)
7. 18 November 2014 (PD 7)
8. 25 November 2014 (PD 8)

CULTIVARS

Cotton cultivars planted under irrigation consisted of 6 entries namely:

1. Delta12BRF (standard)
2. 13P3001B2R2
3. DP1240B2RF
4. CandiaB2RF
5. 13P3005B2R2
6. DP210BRF (standard)

EXPERIMENTAL PROCEDURE

The trial was conducted under irrigation conditions, following practices that are commonly used in commercial cotton production systems. The effect on planting time on plant growth, yield, fibre qualities and the degree of whiteness (colour values) of the different cotton cultivars was determined.

Each planting date trial was planted in a randomized block design with four replicates, and plots consisted of 2 rows of 5m lengths, at an inter-row spacing of 90cm and intra-row spacing of 15cm.

All cultural practices, including fertilizer regimes, pest control and irrigation were treated the same. Target total fertilizer was 180 kg N/ha, 35 kg P/ha and 85 kg K/ha. Weed and insect control was applied as necessary.

Plant establishments and any yield limiting factors were noted throughout.

Sub-samples of the harvested seed cotton were ginned for turnout data. Lint samples were sent to Cotton SA for HVI fibre quality analysis.

The use of a plant growth regulator, Mepiquat chloride (Pix)

Environmental conditions in January 2015, (rain of 210 mm, hot condition, optimum fertilizer) indicated the necessity the use of Mepiquat chloride (Pix). Two application of 250 ml/ha each were applied with a knapsack on each planting date trial at 1st white flower and then 3 weeks later.

Germination %

Soil temperatures indicated that the soils warmed up from the beginning of October. Other environmental conditions played a part in plant stand. From the compared analysis Planting Date 2 resulted in very low average germination percentage of 1.7 %, and as the soil warmed, more seedlings emerge from the soil, and the average germination percentage at 14 days was low at 82.2%. A hail storm and heavy rain on 17 October 2014 resulted in lower germination % in Planting Dates 1 and 2 due to damage to the seedlings, eroded soil and wash away of seeds just after plant.

After 30 days of plant, the last three November planting dates showed significant better plant stands than the October planting dates.

Table 1. Germination percentage 7 days after planting

Cultivar		Planting dates								Average Germination % - 7 Days after planting	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	52.9	4.3	38.9	79.3	71.8	95.7	89.3	81.4	64.2	2
2	**13P3001B2R2**	43.6	0.0	32.5	76.4	68.6	89.6	88.6	82.9	60.3	4
3	**DP 1240 B2RF**	37.5	2.9	29.3	84.3	68.2	93.9	85.4	82.9	60.5	3
4	**Candia B2RF**	21.1	1.4	35.4	79.6	72.9	92.1	83.6	78.2	58.0	6
5	**13P3005B2R2**	34.3	1.1	33.6	78.9	72.1	94.3	85.7	77.9	59.7	5
6	**DP210BRF**	45.0	0.7	47.5	87.5	75.0	95.4	93.9	86.4	66.4	1
Average		39.0	1.7	36.2	81.0	71.4	93.5	87.7	81.6		
Ranking		6	8	7	4	5	1	2	3		
CV %		2.24									
LSD_t(0.05)(PD x Cult)		6.09									
LSD_t(0.05)(Cult x PD)		2.261									

Table 2. Germination percentage 14 days after planting

Cultivar		Planting dates								Average Germination % - 14 Days after planting	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	77.1	86.1	86.1	85.4	79.6	98.2	100.0	91.4	88.0	2
2	**13P3001B2R2**	72.5	85.7	78.2	86.4	85.7	99.6	98.6	92.9	87.5	4
3	**DP 1240 B2RF**	76.4	74.3	81.4	91.1	80.7	97.5	98.6	94.6	86.8	5
4	**Candia B2RF**	79.6	82.1	91.4	89.3	83.2	97.9	98.9	96.1	89.8	1
5	**13P3005B2R2**	75.0	86.4	82.1	83.9	82.5	98.2	96.8	94.6	87.5	4
6	**DP210BRF**	79.3	78.6	83.6	91.4	81.1	97.1	97.9	92.5	87.7	3
Average		76.7	82.2	83.8	87.9	82.1	98.1	98.5	93.7		
Ranking		8	6	5	4	7	2	1	3		
CV %		1.04									
LSD_t(0.05)(PD x Cult)		4.475									
LSD_t(0.05)(Cult x PD)		10.96									

Table 3. Plant stand percentage 30 days after planting

Cultivar		Planting dates								Average Germination % - One Month after planting	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	76.1	87.5	82.5	85.4	75.4	96.8	100.0	91.4	86.9	3
2	**13P3001B2R2**	71.1	88.9	78.9	88.9	80.0	98.2	98.6	92.9	87.2	4
3	**DP 1240 B2RF**	75.0	76.4	84.3	89.3	80.4	96.8	98.6	94.6	86.9	3
4	**Candia B2RF**	82.5	82.9	93.2	91.1	82.1	96.8	98.9	96.1	90.4	1
5	**13P3005B2R2**	73.9	87.5	81.1	90.0	82.9	97.9	96.8	94.6	88.1	2
6	**DP210BRF**	71.8	79.6	84.6	89.6	78.2	94.3	97.9	92.5	86.1	5
Average		75.1	83.8	84.1	89.0	79.8	96.8	98.5	93.7		
Ranking		8	6	5	4	7	2	1	3		
CV %		1.05									
LSD_t(0.05)(PD x Cult)		4.13									
LSD_t(0.05)(Cult x PD)		10.135									

Final Plant Mapping data

Final Plant mapping data were made to assist in explaining the influence of the cultivar adaptation and climatic conditions, especially temperatures during specific phases of the growing season.

For every Planting Date trial five plants per cultivar in each replication were evaluated.

The Final Plant Mapping data included the following:

a. Plant height
b. Number of vegetative nodes
c. Number of fruit branches
d. Height-to-node ratio
e. Bolls/plant
f. Boll Retention at 95 % zone

Degree-days (base 15.6°C)

The growth of the cotton plant is temperature dependent and growth ceases when the average daily temperature falls below the critical development threshold level of 15.5°C. As the temperature rise above the critical threshold, the growth rate of the cotton plant increase to an optimal level. The relationship between growth and temperature is used to predict the timing of various development stages of the cotton plant.

To calculate degree-days the following formula was used:

([Daily Maximum temperature + Daily Minimum temperature] ÷ 2) – Development threshold (15.6°C).

Figure 7 indicated that when cold weather conditions were experienced in the period 17 to 24 November 2014, Planting Date 6 planted at 18 November 2014 needed significant more Degree-days before the plants start flowering. Planting Date 2, 3, and 4 needed significantly less Degree-days before flowering.

Days to First flower

Days to First flower was calculated to indicate how many days elapsed from planting to first flower. Figure 7 showed significantly that at the beginning of the plant period, 7 October 2014, 77 days were needed for Planting Date 1 to flower, and gradually decreased till Planting Date 8 planted at 25 November 2014 needed 62 days to flower.
Table 4 and 5 indicated that 13P3001B2R2 and Delta 12 BRF flower significant earlier than the other cultivars.

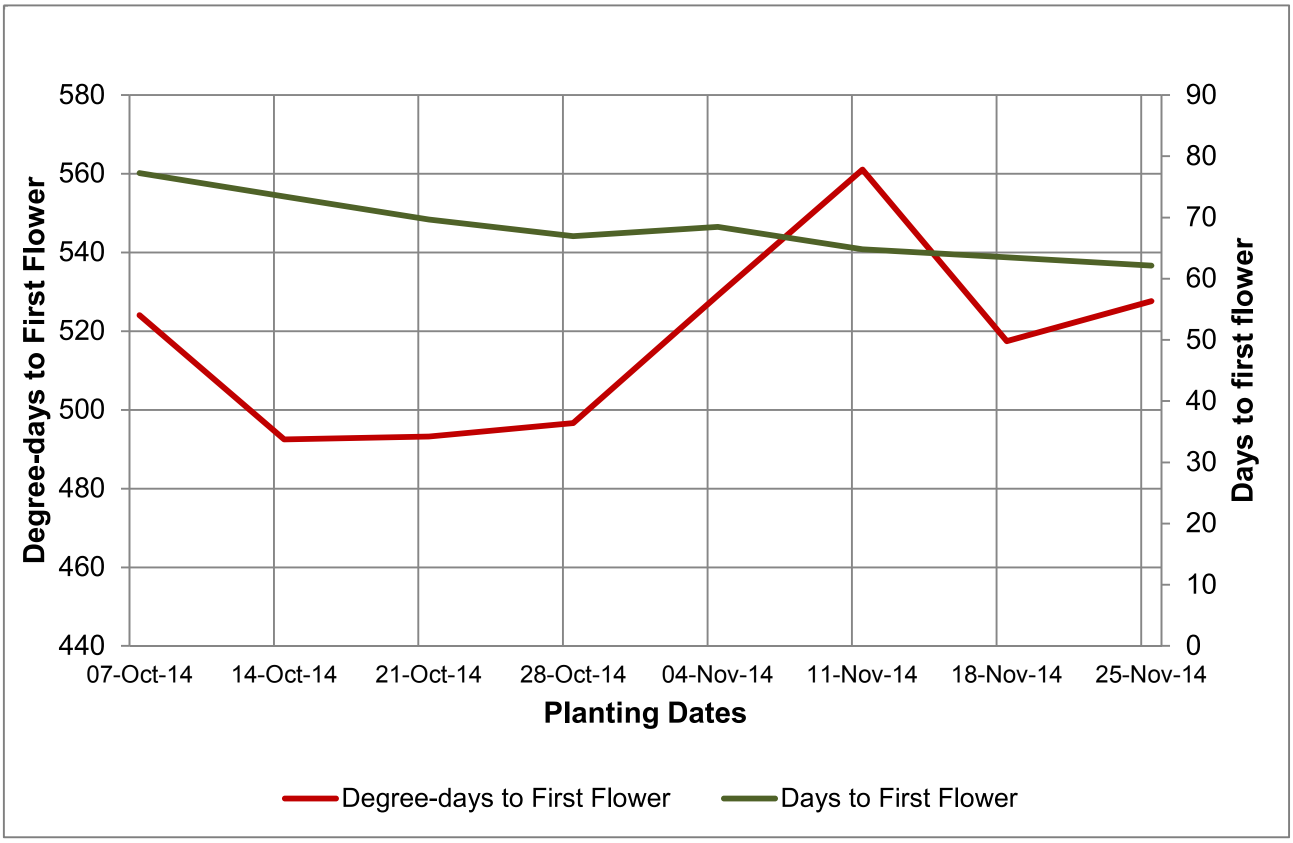

Figure 7. Effect of temperature on flowering

Table 4. Days to First Flower

	Cultivar	Planting dates PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14	Average Days from Plant to First Flower	Ranking
1	Delta 12 BRF	77.3	73.3	68.5	66.3	67.3	64.0	63.8	61.0	67.7	2
2	13P3001B2R2	76.0	71.8	68.5	64.5	67.0	64.0	63.0	60.3	66.9	1
3	DP 1240 B2RF	79.0	75.0	71.0	69.8	70.5	64.0	63.8	62.8	69.5	6
4	Candia B2RF	77.5	73.5	70.5	67.8	68.0	66.8	63.5	63.8	68.9	5
5	13P3005B2R2	76.8	74.3	70.0	67.3	68.5	64.8	64.0	62.3	68.5	4
6	DP210BRF	77.0	72.8	69.5	66.3	69.5	65.3	63.0	62.8	68.3	3
Average		77.3	73.4	69.7	67.0	68.5	64.8	63.5	62.1		
Ranking		8	7	6	4	5	3	2	1		
CV %		2.17									
LSD_t(0.05)(PD x Cult)		0.8478									
LSD_t(0.05)(Cult x PD)		0.7342									

Table 5. Degree-day to first flower

Cultivar		Planting dates								Average Day Degrees to First Flower	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	525.1	490.4	483.1	492.4	518.3	552.4	516.6	517.7	512.0	2
2	**13P3001B2R2**	513.9	474.1	483.2	473.4	514.8	553.7	511.9	512.9	504.7	1
3	**DP 1240 B2RF**	532.9	485.8	503.7	523.6	547.6	554.2	524.4	534.5	525.8	6
4	**Candia B2RF**	527.2	499.9	498.8	506.0	526.2	576.0	520.4	542.1	524.6	5
5	**13P3005B2R2**	521.1	503.9	495.6	497.0	528.2	561.4	519.5	527.7	519.3	3
6	**DP210BRF**	524.0	500.8	495.0	487.5	539.6	568.6	512.0	530.8	519.8	4
Average		524.0	492.5	493.2	496.6	529.1	561.1	517.5	527.6		
Ranking		5	1	2	3	7	8	4	6		
CV %		0.192									
LSD_t(0.05)(PD x Cult)		7.286									
LSD_t(0.05)(Cult x PD)		5.846									

Days to 50 % Open boll

Days to 50 % open boll was calculated to indicate how many days elapsed from planting to 50 % open bolls. Figure 8 showed significantly that, early plant and late plantings took significant longer to reach 50 % open boll. Planting date 1 needed 160 days, Planting Date 7 needed 171 day and Planting Date 8 needed 170.2 day to reach 50 % open boll.

Planting Date 7 and 1 significantly needed 1234.3 and 1231.4 degree-days respectively to reach 50 % open boll, while Planting Date 4 was significant early and needed 1183 degree-days to reach 50 % open boll.

The cultivar13P3001B2R2 needed significantly less time (155 days or 1183.3 degree-days) to reach 50% open boll.

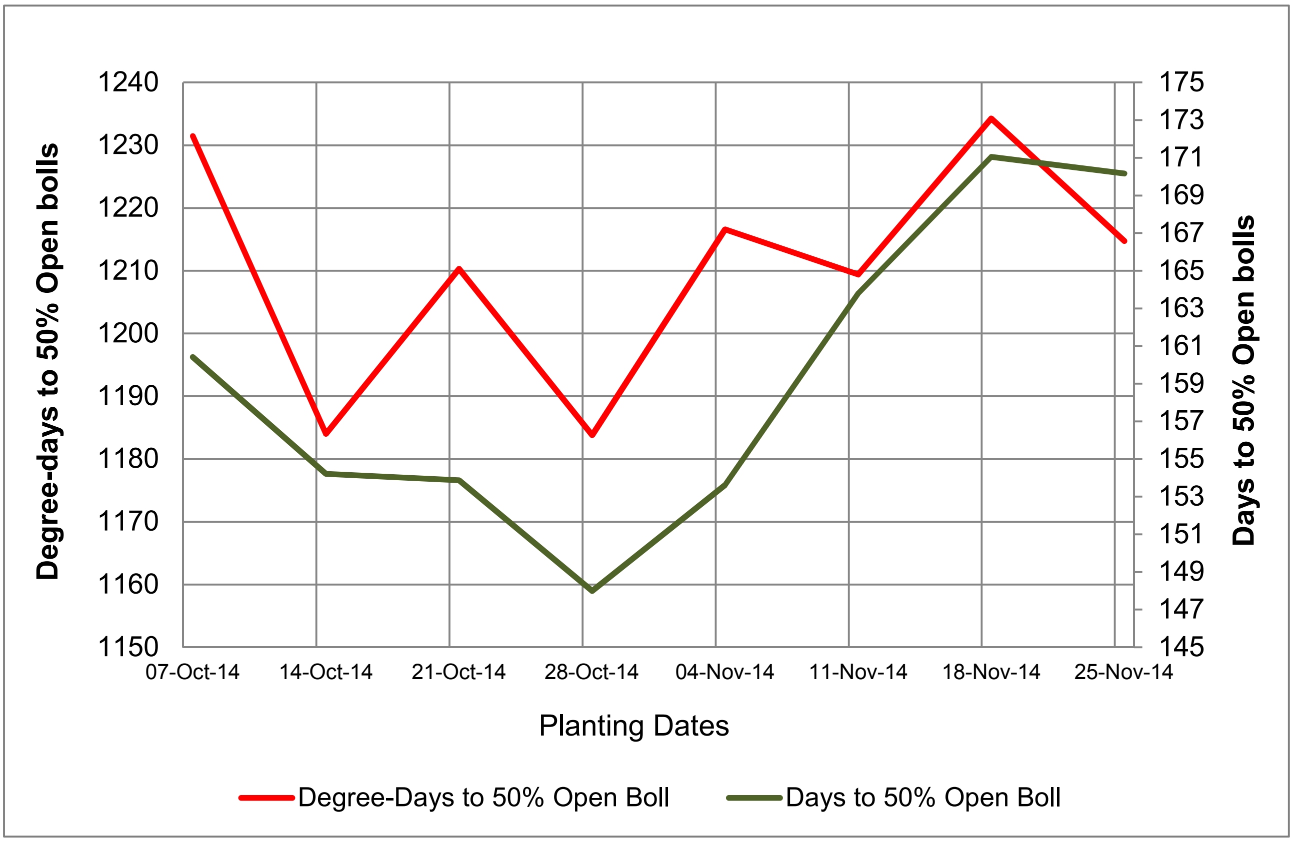

Figure 8. Time to 50 % Open Bolls

Table 6. Days to 50 % Open bolls

Cultivar		Planting dates								Average Days from Plant to 50 % Boll Burst	Ranking
		PD 1 07/10/14	**PD 2 14/10/14**	**PD 3 21/10/14**	**PD 4 28/10/14**	**PD 5 04/11/14**	**PD 6 11/11/14**	**PD 7 18/11/14**	**PD 8 25/11/14**		
1	**Delta 12 BRF**	158.3	154.3	153.5	148.5	155.5	162.0	172.5	169.3	159.2	3
2	**13P3001B2R2**	160.0	150.0	148.0	144.8	151.8	158.3	167.3	165.3	155.7	1
3	**DP 1240 B2RF**	167.5	156.8	156.0	150.0	157.8	167.5	174.3	172.5	162.8	6
4	**Candia B2RF**	158.0	156.3	155.8	148.5	152.0	167.5	168.0	174.5	160.1	4
5	**13P3005B2R2**	156.8	151.8	154.0	146.3	152.3	162.5	172.8	167.0	157.9	2
6	**DP210BRF**	162.0	156.3	156.0	150.0	152.5	165.0	171.5	172.5	160.7	5
Average		160.4	154.2	153.9	148.0	153.6	163.8	171.0	170.2		
Ranking		5	4	3	1	2	6	8	7		
CV %		2.465									
LSD_t(0.05)(PD x Cult)		2.2433									
LSD_t(0.05)(Cult x PD)		1.9428									

Table 7. Degree-days to 50 % Open bolls

Cultivar		Planting dates								Average Day Degrees to 5% Boll burst (HU)	Ranking
		PD 1 07/10/14	**PD 2 14/10/14**	**PD 3 21/10/14**	**PD 4 28/10/14**	**PD 5 04/11/14**	**PD 6 11/11/14**	**PD 7 18/11/14**	**PD 8 25/11/14**		
1	**Delta 12 BRF**	1223.8	1185.5	1207.9	1189.3	1225.1	1204.6	1237.4	1212.7	1210.8	3
2	**13P3001B2R2**	1180.6	1152.1	1157.3	1157.2	1207.5	1189.1	1224.4	1203.0	1183.9	1
3	**DP 1240 B2RF**	1300.7	1205.6	1228.6	1198.6	1235.7	1222.0	1242.7	1220.5	1231.8	6
4	**Candia B2RF**	1222.2	1200.5	1226.8	1189.5	1209.3	1223.4	1227.4	1224.7	1215.5	4
5	**13P3005B2R2**	1205.4	1159.5	1212.3	1170.8	1209.4	1204.0	1238.7	1207.4	1200.9	2
6	**DP210BRF**	1256.1	1200.9	1228.8	1197.5	1212.5	1213.2	1235.0	1220.0	1220.5	5
Average		1231.5	1184.0	1210.3	1183.8	1216.6	1209.4	1234.3	1214.7		
Ranking		7	2	4	1	6	3	8	5		
CV %		2.11									
LSD_t(0.05)(PD x Cult)		14.653									
LSD_t(0.05)(Cult x PD)		12.69									

Plant height at Final Plant Mapping

Figure 9 indicated that the November plantings resulted in significant taller plants. This results may be related to the fact that later plantings develop during warmer weather, resulting in faster vegetative growth, but with less total development time.

The cultivars 13P3005B2R2 and Delta12BRF resulted in significant taller plants at the 8th Planting Date with heights of 132.2cm and 131.7cm respectively. The cultivar Candia B2RF resulted in significant shorter plants over all the planting dates with an average plant height of 91.2 cm (Table 6). The shorter plants of Candia B2RF could be cultivar related and due to the sensitivity of the cultivar to the applications of Mepiquat chloride (Pix).

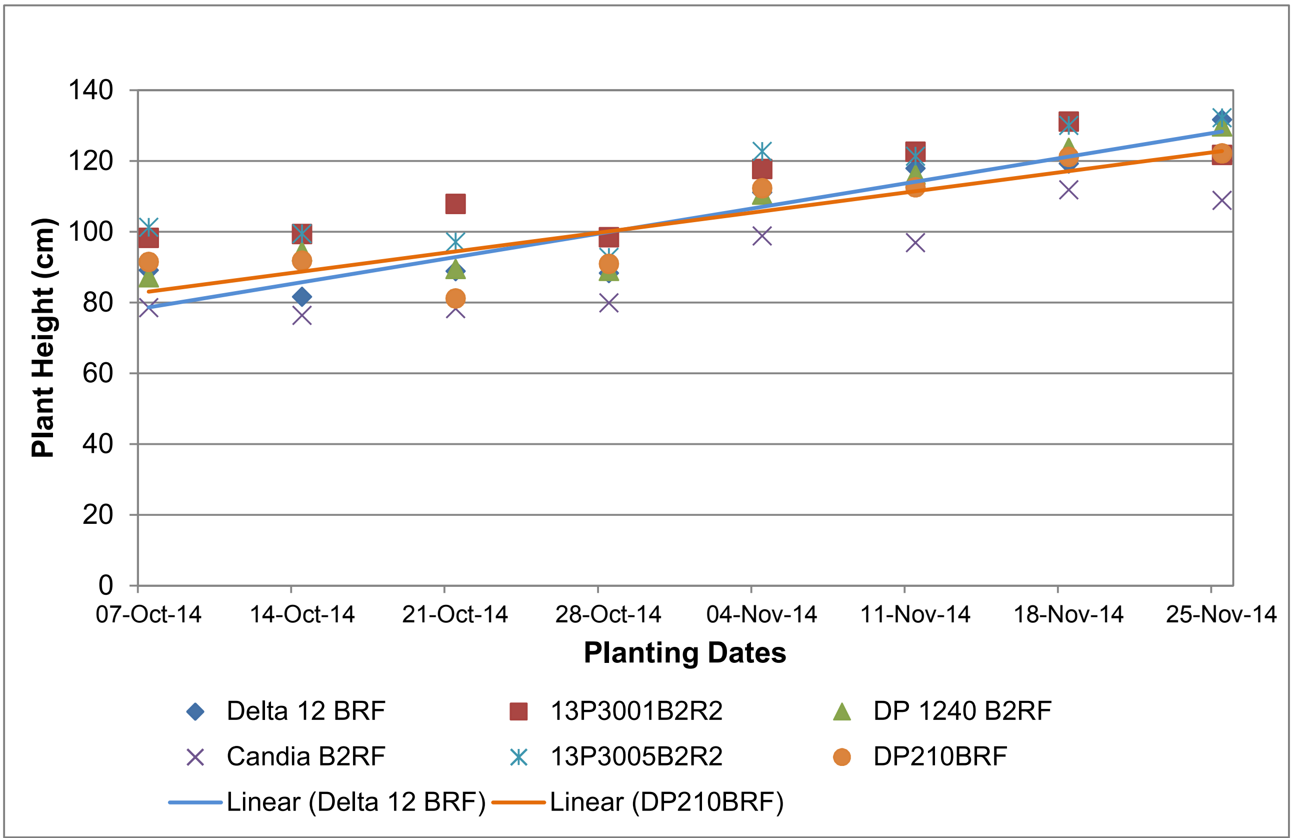

Figure 9. Plant Height at Final Plant Mapping

Table 8. Plant height at Final Plant Mapping (cm)

Cultivar		Planting dates								Average Plant height (cm)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	89.1	81.7	88.9	88.3	111.1	117.9	119.3	131.7	103.5	3
2	**13P3001B2R2**	98.3	99.4	107.9	98.5	117.8	122.7	131.1	121.7	112.2	6
3	**DP 1240 B2RF**	87.1	94.4	89.5	89.0	110.5	116.3	123.7	129.8	105.0	4
4	**Candia B2RF**	78.6	76.4	78.3	80.0	98.8	96.9	111.9	108.9	91.2	1
5	**13P3005B2R2**	101.3	99.5	97.1	92.8	122.7	121.4	130.0	132.2	112.1	5
6	**DP210BRF**	91.5	91.9	81.1	91.0	112.3	112.6	121.1	122.1	103.0	2
Average		91.0	90.5	90.5	89.9	112.2	114.6	122.9	124.4		
Ranking		2	3	3	1	4	5	7	6		
CV %		6.82									
LSD_t(0.05)(PD x Cult)		0.576									
LSD_t(0.05)(Cult x PD)		3.5384									

Number of vegetative nodes

The number of vegetative nodes produced before the first fruiting branches are formed depends on the variety and the environment. There was no significant differences between cultivars (Table 9).

Candia B2RF resulted in significantly more average vegetative node. Planting Date 4 significantly had the highest number of vegetative nodes.

Table 9. Number of vegetative nodes

	Cultivar	Planting dates								Average Number of Vegetative nodes above cotyledons (count)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	4.35	4.20	4.45	4.70	5.20	4.45	4.10	4.55	4.50	4
2	**13P3001B2R2**	4.40	4.45	4.35	4.80	5.00	4.50	4.65	4.50	4.58	3
3	**DP 1240 B2RF**	4.50	4.45	4.60	4.90	4.90	4.75	4.30	5.15	4.69	2
4	**Candia B2RF**	4.60	4.50	5.00	5.90	4.85	5.25	4.55	5.55	5.02	1
5	**13P3005B2R2**	4.15	4.70	4.15	4.70	4.70	4.70	4.35	4.30	4.47	6
6	**DP210BRF**	4.60	4.30	4.45	4.80	4.40	4.50	4.05	4.85	4.49	5
Average		4.43	4.43	4.50	4.97	4.84	4.69	4.33	4.82		
Ranking		6	6	5	1	2	4	7	3		
CV %		7.56									
LSD_t(0.05)(PD x Cult)		0.1996									
LSD_t(0.05)(Cult x PD)		0.4988									

Fruit Branches

The number of fruit branches increased significantly in the November plantings (Table 10). This may be related to the fact that later plantings develop during warmer weather, resulting in faster vegetative growth.

The cultivar, CandiaB2RF, resulted in significant lower fruiting branches over all the planting dates. CandiaB2RF sensitivity to Mepiquat chloride could be the cause for the lower number of fruit branches.

Table 10. Number of fruit branches

Cultivar		Planting dates PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14	Average Number of fruit branches (count)
1	Delta 12 BRF	17	15	16	15	17	18	19	20	17
2	13P3001B2R2	16	14	16	14	17	17	20	17	16
3	DP 1240 B2RF	17	17	16	15	17	18	19	18	17
4	Candia B2RF	15	13	14	13	17	15	18	16	15
5	13P3005B2R2	17	16	15	14	17	17	19	19	17
6	DP210BRF	17	15	15	14	18	18	19	18	17
Average		16	15	15	14	17	17	19	18	
CV %		5.832								
LSD_t(0.05)(PD x Cult)		0.5493								
LSD_t(0.05)(Cult x PD)		0.1729								

Height-to-node ratio (HNR) of cotton cultivars planted at different planting dates.

The height-to-node ratio is a simple determination of the plant's vigor or growth potential. It reflects the degree of stress that plants experience throughout the season. This is the numeric equivalent to the average distance between nodes and is called internode length. The formula used:

Height-to-node ratio = Plant height (cm) ÷ total number of nodes on main stem (vegetative nodes and fruit branch nodes)

Hot and dry weather conditions experienced from February 2015 to middle March 2014 clearly showed the stress the plants experienced in the October plantings which were at peak growth and had significantly shorter internode length (cm). Cooler temperature from middle March and April benefitted the November 2014 plantings. Plants were growing more vigorously and the internode lengths (cm) were significant longer.

Cultivar 13P3001B2R2 and 13P3005B2R2 had the longest significant internode lengths of 5.38 cm and 5.23 cm respectively. The two cultivars is both strong growers and improved management of the cultivar is needed. CandiaB2RF had the shortest significantly internode length of 4.52 cm and careful use of Mepiquat chloride is needed.

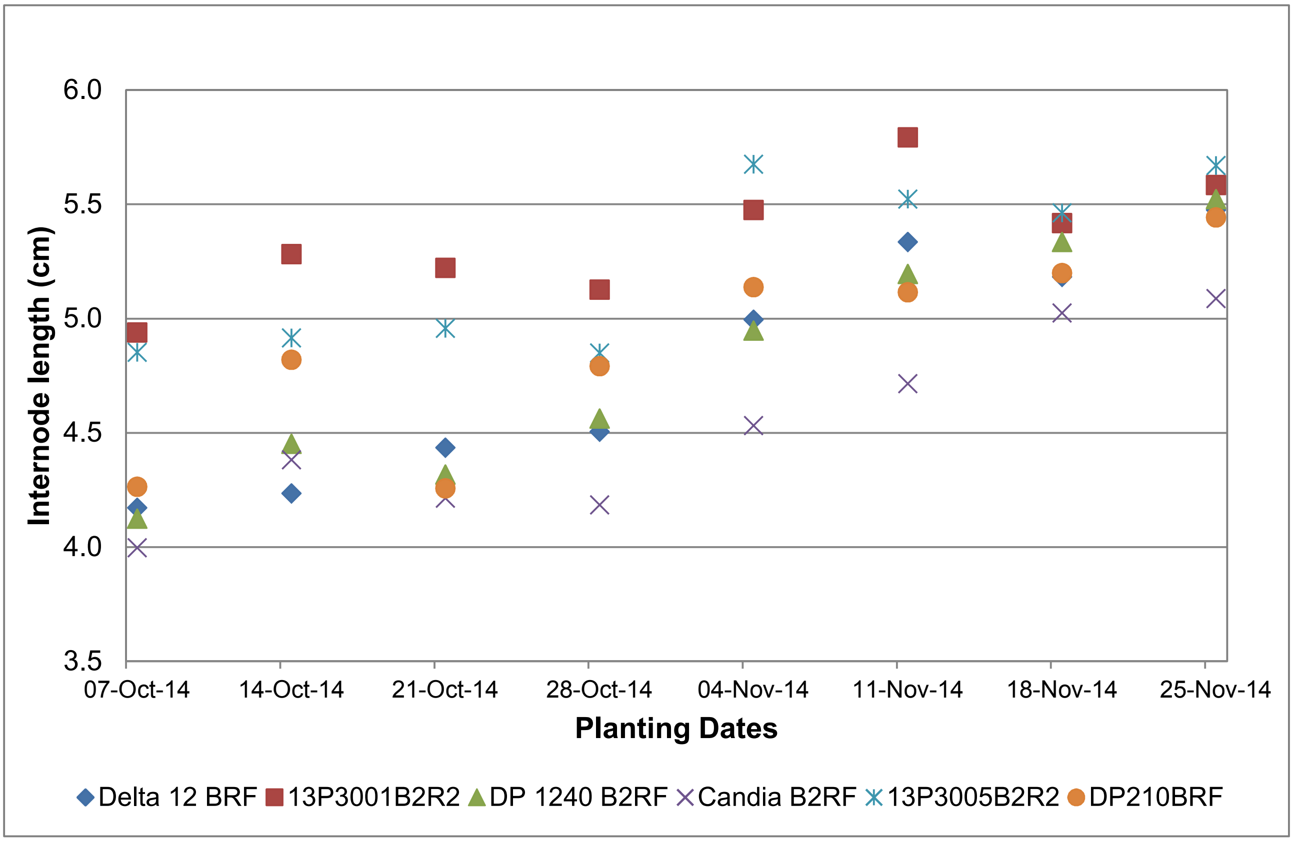

Figure 10. Height-to-node ratio of cotton cultivars planted at different dates

Table 11. Height-to-node ratio of cultivars planted at different dates

Cultivar		Planting dates								Average HNR (Calculated)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	4.17	4.24	4.43	4.50	5.00	5.34	5.18	5.48	4.79	5
2	**13P3001B2R2**	4.94	5.28	5.22	5.13	5.48	5.79	5.42	5.58	5.36	1
3	**DP 1240 B2RF**	4.13	4.45	4.32	4.56	4.95	5.20	5.34	5.52	4.81	4
4	**Candia B2RF**	4.00	4.38	4.22	4.19	4.53	4.72	5.03	5.09	4.52	6
5	**13P3005B2R2**	4.85	4.91	4.96	4.85	5.67	5.52	5.46	5.67	5.24	2
6	**DP210BRF**	4.27	4.82	4.26	4.79	5.14	5.12	5.20	5.44	4.88	3
Average		4.39	4.68	4.57	4.67	5.13	5.28	5.27	5.46		
Ranking		8	5	7	6	4	2	3	1		
CV %		6.705									
LSD_t(0.05)(PD x Cult)		0.1894									
LSD_t(0.05)(Cult x PD)		0.164									

Bolls per plant

Stress to plants reduced early leaf area, resulting in a smaller and older leaf area during boll set. Thus, the stress that occurred due to environmental conditions and the application of Mepiquat chloride in Planting Dates 2, 3 and 4 could have reach cut-out sooner and have a smaller boll load than non-stressed Planting dates 1, 5 and 7.

Cultivar DP210BRF had the highest bolls per plant at 11 November 2014 planting with 33 bolls per plant. Cultivars DP210BRF and Delta12BRF had the highest significant average number of bolls per plant, 26.4 and 26.2 respectively.

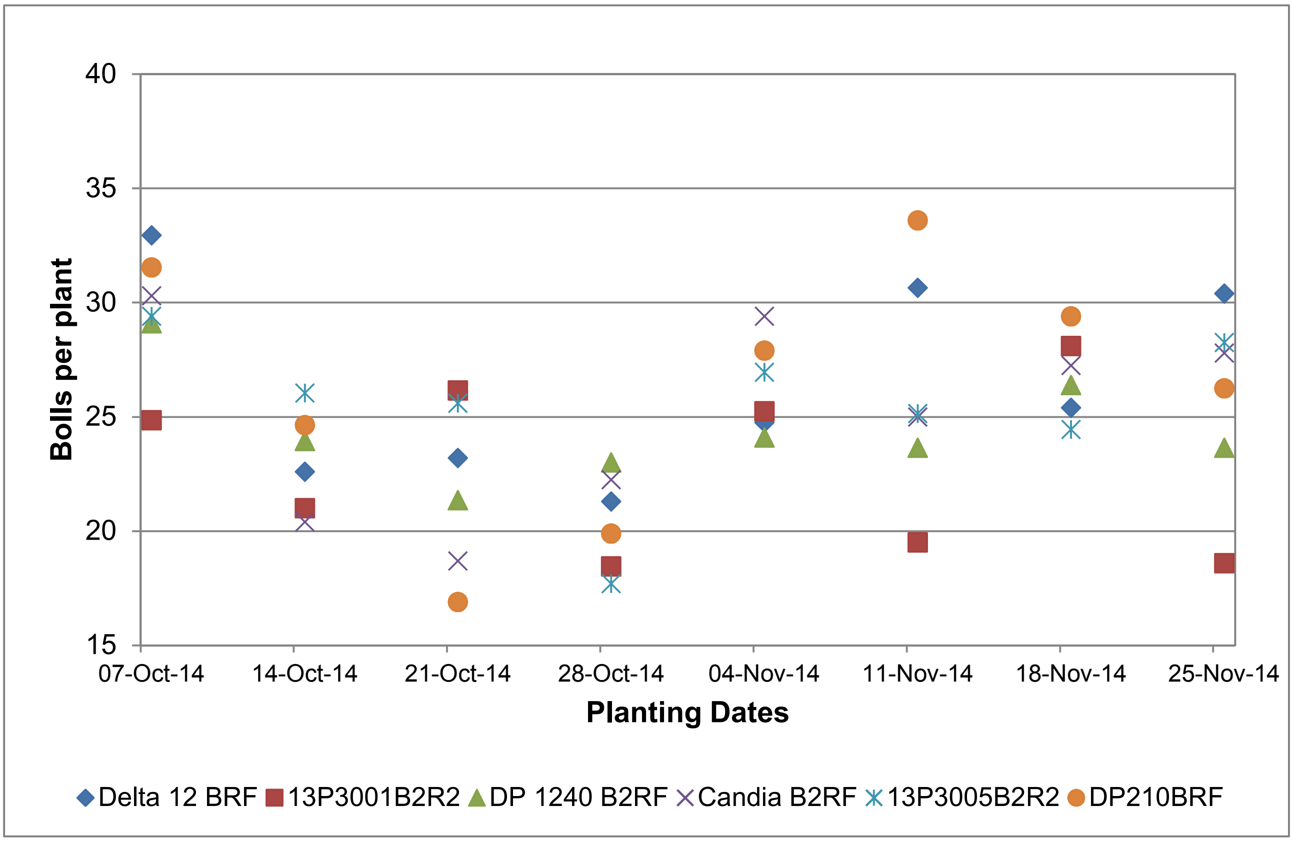

Figure 11. Number of Bolls per Plant

Table 12. Number of boll per plant

	Cultivar	PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14	Average Day Bolls per plant (count)	Ranking
		Planting dates									
1	Delta 12 BRF	33.0	22.6	23.2	21.3	24.8	30.6	25.4	30.4	26.4	1
2	13P3001B2R2	24.8	21.0	26.1	18.5	25.3	19.5	28.1	18.6	22.7	6
3	DP 1240 B2RF	29.1	23.9	21.3	23.0	24.1	23.6	26.4	23.7	24.4	5
4	Candia B2RF	30.3	20.4	18.7	22.2	29.4	25.0	27.3	27.8	25.1	4
5	13P3005B2R2	29.4	26.1	25.6	17.7	26.9	25.2	24.4	28.3	25.4	3
6	DP210BRF	31.5	24.7	16.9	19.9	27.9	33.6	29.4	26.3	26.3	2
Average		29.7	23.1	22.0	20.4	26.4	26.3	26.8	25.8		
Ranking		1	6	7	8	3	4	2	5		
CV %		19.35									
LSD_t(0.05)(PD x Cult)		2.762									
LSD_t(0.05)(Cult x PD)		2.392									

Boll retention 95% zone

Cut-out occurs when the boll load consumes all the carbohydrates produced by the leaves. This is affected by both the early boll load and the quantity of leaf area to sustain the boll load. Final plant mapping data was used to determine when cut-out occurred. Plants were considered to be cut-out when 95 percent of the harvested bolls at the first position-1 have already been set.

Planting Date 3 at 21 October 2014 significantly retained more bolls at the 95 percent zone of 83.0 %. The cultivar DP210BRF retained the highest number of bolls at the 95 percent zone of 83.288 %. The cultivar 13P3001B2R2 retained the lowest significant number of bolls at the 95% zone of 71 % at the late planting date of 25 November 2014.

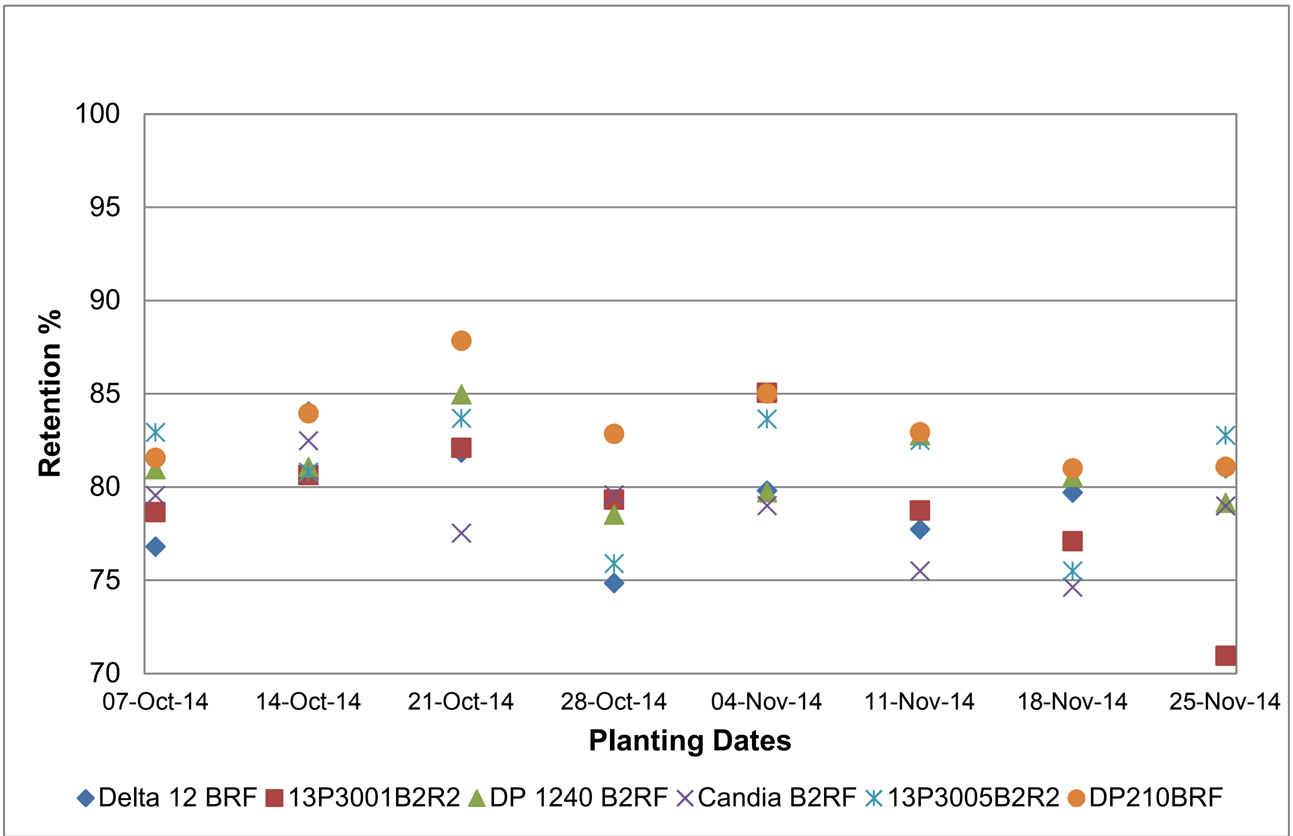

Figure 12. Boll retention 95 % zone

Table 13. Boll retention 95 % zone

Cultivar		Planting dates								Average retention 95 % bolls (calculated)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	76.8	84.0	81.9	74.8	79.8	77.7	79.7	81.0	79.5	3
2	**13P3001B2R2**	78.6	80.6	82.1	79.3	85.1	78.8	77.1	71.0	79.1	4
3	**DP 1240 B2RF**	80.9	81.1	85.0	78.5	79.7	82.8	80.5	79.1	81.0	2
4	**Candia B2RF**	79.5	82.5	77.5	79.6	79.0	75.5	74.6	79.0	78.4	5
5	**13P3005B2R2**	82.9	80.8	83.7	75.9	83.6	82.5	75.5	82.8	81.0	2
6	**DP210BRF**	81.6	83.9	87.9	82.8	85.0	83.0	81.0	81.1	83.3	1
Average		80.1	82.2	83.0	78.5	82.0	80.0	78.1	79.0		
Ranking		4	2	1	7	3	5	8	6		
CV %		6.84									
LSD_t(0.05)(PD x Cult)		3.142									
LSD_t(0.05)(Cult x PD)		2.721									

Yield kg/ha

Very high temperatures in February and early March 2015 may have cause stress to plants when they were between early square and peak flower and could have reduced yields significantly in the October plantings. Planting Date 4 had the lowest significant yield of 5193 kg/ha (Table 14).

The warm to moderate weather from middle March to end of May 2015 benefited the November 2014 plantings. Very high significant yields of 7141.3 kg/ha, 6752.5 kg/ha and 6419 kg/ha were obtained for the Planting dates 7, 5 and 6 respectively. Cultivar 13P3005B2R2 and 13P3001B2R2 had the highest significant yields of 6966.9 kg/ha and 6370.8 kg/ha respectively.

Table 14. Yield kg/ha

Cultivar		Planting dates								Average yield (kg/ha)	Ranking
		PD 1 07/10/14	**PD 2 14/10/14**	**PD 3 21/10/14**	**PD 4 28/10/14**	**PD 5 04/11/14**	**PD 6 11/11/14**	**PD 7 18/11/14**	**PD 8 25/11/14**		
1	**Delta 12 BRF**	5267.2	5770.7	5958.3	4639.9	6567.2	5964.9	6685.3	5753.7	5825.9	5
2	**13P3001B2R2**	6436.4	6625.0	6090.4	5754.8	5535.4	6800.3	7187.2	6537.0	6370.8	2
3	**DP 1240 B2RF**	6054.2	5602.9	6205.3	4971.5	6689.1	6284.1	7113.2	6249.0	6146.2	4
4	**Candia B2RF**	5512.3	4902.5	5468.4	5012.7	7165.9	5985.8	7290.2	5822.2	5895.0	6
5	**13P3005B2R2**	7447.8	6725.2	7256.1	5318.2	7656.1	7210.7	7601.5	6519.4	6966.9	1
6	**DP210BRF**	6419.8	6163.4	6277.0	5483.0	6901.1	6272.5	6970.3	5447.7	6241.9	3
Average		6189.6	5965.0	6209.3	5196.7	6752.5	6419.7	7141.3	6054.9		
Ranking		5	7	4	8	2	3	1	6		
CV %		0.016									
LSD_t(0.05)(PD x Cult)		486.62									
LSD_t(0.05)(Cult x PD)		313.59									

Fibre %

Fibre percentages were not influenced by the planting dates. Fibre percentages were also cultivar related. The cultivars 13P3001B2R2, Candia B2RF and 13P3005B2R2 had the highest significant fibre% of 44.1 and 43.9 % respectively.

Table 15. Fibre %

Cultivar		Planting dates								Average Fibre %	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	39.4	39.8	39.3	40.9	38.2	38.6	39.1	37.9	39.2	5
2	**13P3001B2R2**	44.5	43.8	44.1	43.6	43.9	44.1	44.6	43.8	44.1	1
3	**DP 1240 B2RF**	41.8	40.9	40.0	41.7	39.4	40.8	40.7	39.2	40.6	3
4	**Candia B2RF**	45.1	44.4	43.3	44.3	42.7	44.0	43.8	43.2	43.9	2
5	**13P3005B2R2**	45.7	44.1	44.9	43.5	42.4	44.2	43.5	43.1	43.9	2
6	**DP210BRF**	40.7	42.1	41.2	39.8	39.8	40.5	40.6	39.5	40.5	4
Average		42.9	42.5	42.2	42.3	41.1	42.0	42.1	41.1		
Ranking		1	2	4	3	7	6	5	7		
CV%		1.894									
LSD_t(0.05)(PD x Cult)		1.9799									
LSD_t(0.05)(Cult x PD)		0.3939									

Boll size (g)

Boll sizes for the November Planting Dates 5, 7 and 8 were significantly larger with a boll size of 6.33 g, 6.14 g and 6.11 g respectively. Planting Date 1 was also significantly larger with a boll size of 6.10 g compare to the boll sizes of Planting Dates 2, 3, 4 and 6. The cultivar DP210BRF average boll size of 6.3g over planting dates was significantly more than the other cultivars.

The smaller boll sizes of Planting Dates 2, 3 and 4 may be a directed result of the high temperatures in February and early March 2015 which caused stress to plants when plants were between early square and peak flower.

Table 16. Boll size (g)

Cultivar		Planting dates								Average Boll size (g)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	5.7	5.6	5.7	6.0	5.8	5.6	6.1	6.0	5.82	5
2	**13P3001B2R2**	6.6	6.2	5.9	6.1	6.3	6.0	6.6	6.5	6.27	2
3	**DP 1240 B2RF**	6.3	6.3	6.0	6.0	6.2	6.1	6.5	5.9	6.18	3
4	**Candia B2RF**	5.9	5.6	5.5	5.4	5.6	5.4	6.0	5.9	5.66	6
5	**13P3005B2R2**	5.8	5.9	5.8	6.0	6.2	5.9	6.3	6.2	6.02	4
6	**DP210BRF**	6.3	6.3	6.3	6.2	6.4	6.1	6.4	6.3	6.30	1
Average		6.1	6.0	5.9	5.9	6.1	5.9	6.3	6.1		
Ranking		2	3	4	4	2	4	1	2		
CV %		4.48									
LSD_t(0.05)(PD x Cult)		0.1549									
LSD_t(0.05)(Cult x PD)		0.1342									

Fibre length (mm)

Fibre length is largely controlled by variety, although weather and management can also influence the final fibre length. Water stress and extremely high or low temperatures during the elongation phase will resulted in shorter fibres.

The October planting resulted in significant shorter fibres due to weather conditions during the elongation phase. The November planting dates produced significant longer fibres.

The cultivar, DP210BRF resulted in the longest average fibre length of average 31.4 mm followed by CandiaB2RF and 13P3001 with a fibre length of 31.0 mm. From the combined analysis for planting dates over planting dates, Planting Date 8 resulted in two cultivars, 13P3001B2RF and CandiaB2RF, with significantly higher fibre lengths of 32.3 mm and 32.3 mm respectively.

Table 17. Fibre length (mm)

Cultivar		Planting dates								Average Length (mm)	Ranking
		PD 1 07/10/14	**PD 2 14/10/14**	**PD 3 21/10/14**	**PD 4 28/10/14**	**PD 5 04/11/14**	**PD 6 11/11/14**	**PD 7 18/11/14**	**PD 8 25/11/14**		
1	**Delta 12 BRF**	29.5	29.0	29.6	29.6	30.5	28.9	30.3	31.0	29.8	5
2	**13P3001B2R2**	30.3	30.9	30.3	30.9	30.0	31.3	31.6	32.3	31.0	2
3	**DP 1240 B2RF**	30.7	30.4	29.1	29.8	30.5	31.2	31.6	32.2	30.7	3
4	**Candia B2RF**	30.7	30.6	30.8	30.5	30.9	30.8	31.2	32.3	31.0	2
5	**13P3005B2R2**	30.0	29.8	30.3	29.6	30.3	30.4	31.2	32.0	30.4	4
6	**DP210BRF**	31.0	30.8	31.0	30.8	32.1	31.5	32.1	31.9	31.4	1
Average		30.4	30.2	30.2	30.2	30.7	30.7	31.3	31.9		
Ranking		4	5	5	5	3	3	2	1		
CV %		2.488									
LSD_t(0.05)(PD x Cult)		0.4365									
LSD_t(0.05)(Cult x PD)		0.378									

Uniformity index

Uniformity index is minimally affected by cotton variety. Field weathering and ginning have a more dramatic effect on uniformity.

The uniformity index values between 83 and 85 indicated a high degree of uniformity. All the Cultivars over planting dates resulted in the index values between 83 and 85.

Table 18. Uniformity index

Cultivar		Planting dates								Average Uniformity	Ranking
		PD 1 07/10/14	**PD 2 14/10/14**	**PD 3 21/10/14**	**PD 4 28/10/14**	**PD 5 04/11/14**	**PD 6 11/11/14**	**PD 7 18/11/14**	**PD 8 25/11/14**		
1	**Delta 12 BRF**	82.8	83.5	83.1	82.6	84.3	84.2	83.4	82.7	83.3	5
2	**13P3001B2R2**	83.5	84.4	83.9	84.6	85.1	84.9	86.1	85.2	84.7	2
3	**DP 1240 B2RF**	84.1	85.2	84.6	84.3	84.9	85.0	85.5	86.0	84.9	1
4	**Candia B2RF**	83.2	84.7	84.2	83.8	84.8	83.9	83.1	85.0	84.1	4
5	**13P3005B2R2**	83.6	83.6	84.7	83.7	85.1	84.2	84.4	86.1	84.4	3
6	**DP210BRF**	83.3	83.9	83.6	82.7	84.0	83.6	83.5	82.6	83.4	3
Average		83.4	84.2	84.0	83.6	84.7	84.3	84.3	84.6		
Ranking		3	5	6	7	1	8	4	2		
CV %		1.394									
LSD_t(0.05)(PD x Cult)		0.6702									
LSD_t(0.05)(Cult x PD)		0.5805									

Fibre strength (g/tex)

Variety is by far the most dominant factor in fibre strength. Environment has a small effect on fibre strength.

The cultivar Delta1240B2RF gave significantly the strongest fibres of 33.5 g/tex. From the combined analysis for planting dates over cultivars, Delta1240B2RF resulted in significantly stronger fibres of 37.0 g/tex at Planting Date 7 and 8. Planting date 8 resulted in the strongest fibres of 35.0 g/tex.

Table 19. Fibre strength (g/tex)

	Cultivar	PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14	Average Fibre Strength (g/tex)	Ranking
		Planting dates									
1	**Delta 12 BRF**	28.5	28.9	28.9	29.2	30.8	29.2	31.8	31.8	29.9	6
2	**13P3001B2R2**	30.6	30.2	30.6	30.2	31.3	31.2	34.5	35.9	31.8	2
3	**DP 1240 B2RF**	31.6	33.0	32.0	33.0	32.3	32.2	37.0	37.0	33.5	1
4	**Candia B2RF**	28.4	29.2	29.7	30.9	30.0	30.0	31.7	35.6	30.7	4
5	**13P3005B2R2**	30.5	30.7	29.9	31.4	30.0	31.1	33.2	36.3	31.6	3
7	**DP210BRF**	29.2	29.1	29.1	29.9	30.8	30.4	32.5	33.4	30.5	5
Average		29.8	30.2	30.0	30.8	30.9	30.7	33.5	35.0		
Ranking		8	6	7	4	3	5	2	1		
CV %		4.785									
LSD_t(0.05)(PD x Cult)		0.8573									
LSD_t(0.05)(Cult x PD)		0.7425									

Elongation

There was again a clear difference between the October and November planting. The October plantings had significantly higher fibre elongation of ≥ 8, while the November plantings had significantly lower fibre elongations of < 8.

The cultivar DP1240B2RF and 13P3001B2R2 resulted in the highest significant fibre elongations of 8.1 and 8.0 respectively.

Table 20. Elongation

	Cultivar	Planting dates								Average fibre elongation	Ranking
		PD 1 07/10/14	**PD 2 14/10/14**	**PD 3 21/10/14**	**PD 4 28/10/14**	**PD 5 04/11/14**	**PD 6 11/11/14**	**PD 7 18/11/14**	**PD 8 25/11/14**		
1	**Delta 12 BRF**	7.7	8.0	7.7	8.0	6.9	7.1	7.2	7.1	7.5	4
2	**13P3001B2R2**	8.9	8.8	8.7	8.5	7.4	7.1	7.7	7.1	8.0	2
3	**DP 1240 B2RF**	8.5	8.7	8.7	8.5	7.7	7.7	7.5	7.2	8.1	1
4	**Candia B2RF**	7.5	7.5	7.2	7.6	6.6	6.7	6.9	6.5	7.1	6
5	**13P3005B2R2**	8.1	8.1	8.1	8.0	7.6	6.8	7.4	7.2	7.7	3
7	**DP210BRF**	7.8	7.6	7.5	7.7	6.6	6.9	7.0	6.9	7.2	5
Average		8.1	8.1	8.0	8.0	7.1	7.1	7.3	7.0		
Ranking		1	1	2	2	4	4	3	5		
CV %		6.245									
LSD_t(0.05)(PD x Cult)		0.271									
LSD_t(0.05)(Cult x PD)		0.2347									

Micronaire (µgrams)

Planting cotton too early, resulted in very thick fibres with micronaires above 4.5µgram. Planting Date 1, 2 and 3 resulted in average micronaires of 4.6 µgram, 4.5 µgram and 4.5 µgram respectively. The cultivar Candia B2RF had the best micronaire average over the planting dates with a micronaire of 3.7µgram. Candia B2RF resulted in good micronaires over all the planting dates.

The November plantings resulted in significantly lower micronaire than the October plantings.

Table 21. Micronaire (µgrams)

Cultivar		Planting dates								Average Micronaire (µg)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	**Delta 12 BRF**	4.6	4.6	4.7	4.5	4.1	4.3	3.6	3.3	4.2	3
2	**13P3001B2R2**	4.7	4.5	4.7	4.5	4.6	4.1	4.1	4.0	4.4	4
3	**DP 1240 B2RF**	4.9	5.0	5.0	4.8	4.8	4.3	4.3	4.0	4.6	5
4	**Candia B2RF**	3.9	4.0	3.6	3.7	3.8	3.6	3.3	3.4	3.7	1
5	**13P3005B2R2**	4.8	5.1	4.8	4.5	4.4	4.4	4.2	4.1	4.6	5
6	**DP210BRF**	4.3	4.2	4.3	4.3	3.8	3.6	3.6	3.2	3.9	2
Average		4.5	4.6	4.5	4.4	4.2	4.1	3.9	3.7		
Ranking		6	7	6	5	4	3	2	1		
CV %		7.307									
LSD_t(0.05)(PD x Cult)		0.1769									
LSD_t(0.05)(Cult x PD)		0.1532									

Yellowness (+b < 9) and Degree of reflectance (RD ≥75).

Each planting date trial was hand pick when ready and cotton fibres were not exposed too long to field weathering. Thus, the degree of Reflection (Rd ≥ 75) and yellowness (+b < 9) are in the respective norms.

Table 22. Yellowness (+b < 9)

Cultivar		Planting dates								Average Yellowness (+b < 9)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	Delta 12 BRF	7.2	7.2	7.4	7.3	7.3	7.8	7.0	6.8	7.2	1
2	13P3001B2R2	7.6	7.4	7.2	7.0	7.4	7.7	7.5	6.6	7.3	2
3	DP 1240 B2RF	8.0	8.4	8.6	8.2	8.0	8.3	7.5	6.8	8.0	4
4	Candia B2RF	7.4	7.0	7.2	7.1	8.1	7.7	7.1	7.1	7.3	2
5	13P3005B2R2	7.6	7.9	8.0	7.6	7.8	7.6	6.8	7.2	7.6	3
6	DP210BRF	7.3	7.3	7.3	7.3	7.8	7.9	6.6	7.2	7.3	2
Average		7.5	7.5	7.6	7.4	7.7	7.8	7.1	7.0		
Ranking		4	4	5	3	6	7	2	1		
CV %		5.752									
LSD_t(0.05)(PD x Cult)		0.2453									
LSD_t(0.05)(Cult x PD)		0.2124									

Table 23. Degree of reflectance (RD ≥75)

Cultivar		Planting dates								Average Degree of reflectance (RD ≥ 75)	Ranking
		PD 1 07/10/14	PD 2 14/10/14	PD 3 21/10/14	PD 4 28/10/14	PD 5 04/11/14	PD 6 11/11/14	PD 7 18/11/14	PD 8 25/11/14		
1	Delta 12 BRF	80.5	81.1	79.9	79.9	80.7	81.3	82.5	83.5	81.2	3
2	13P3001B2R2	80.6	81.1	80.8	80.0	80.9	81.4	81.3	83.9	81.2	3
3	DP 1240 B2RF	78.1	78.4	77.8	77.8	80.0	80.3	82.1	82.8	79.7	5
4	Candia B2RF	81.1	82.2	81.7	80.7	80.3	81.1	82.6	82.8	81.6	1
5	13P3005B2R2	79.7	79.6	79.5	78.7	81.0	80.9	83.5	82.2	80.6	4
6	DP210BRF	80.8	81.5	80.8	80.0	80.7	80.9	83.9	82.1	81.3	2
Average		80.1	80.6	80.1	79.5	80.6	81.0	82.7	82.9		
Ranking		2	3	2	1	3	4	5	6		
CV %		1.2663									
LSD_t(0.05)(PD x Cult)		0.5857									
LSD_t(0.05)(Cult x PD)		0.5073									

CONCLUSION

Clear differences were recorded between the October and November plantings. Environmental conditions though-out the cotton growing season had influenced the growing rate of the different cultivars. It is very difficult to find a particular cultivar early in the cotton growing because environmental conditions such as hail and heavy rains had an influence on cultivar performance. The use of Mepiquat chloride on CandiaB2RF had a disadvantage on the cultivar's performance.

The new cultivars, 13P3001B2R2 and 13P3005B2R2, were recommended for shorter growing season and high yields, respectively.

PROPOSED RESEARCH FOR 2015/16

This trial was a second cotton season trial and a third season for this trial is needed because environmental conditions are unpredicted and not controllable. Also growth parameters have only been measured during one season. To do a test for cultivar stability a third year trial is needed. The trial will be planted at Groblersdal: ARC-Loskop Research Farm.