# ARC-Institute for Industrial Crops

## Cotton Project Annual Progress Report

## 2015/2016

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*Excellence in Research and Development*

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| **PROJECT NUMBER** | **:** | TK 208/16 (000603) – Part A |
| **PROJECT TITLE** | **:** | Minimum input – On farm demonstrations |
| **REPORT YEAR** | **:** | 2015/2016 |
| **PROJECT MANAGER** | **:** | HJ STEYN |
| **CO-WORKERS** | **:** | MS Magwaza<br>MC Mkhwanazi<br>BF Gumede<br>C Ngwane |

## INTRODUCTION

The Makhathini Flats area of the Northern KwaZulu-Natal is very dry with an annual rainfall of 450 mm. 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 smallholder 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 diesel and seed used in planting inter row spacings of 1 meter resulting in a further reducing of Input costs. The fact that there is 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 dryland cotton production method on their own farms.

## OBJECTIVE

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

## EXPERIMENTAL PROCEDURES

The aim was to plant these three on farm demonstrations on three different soil types before 15 December 2015. Unfortunately, the rainfall was too low to successfully prepare and plant these trials before then but on 17 December 2015, the planting furrows for the sandy soil demonstration in the Bhiva area were drawn. The planting furrows on the dark clay soil in the Gugulesizwe area were drawn on 23 December 2015 and the on the red soil at the Makhathini Gin on 24 December 2015. All three demonstrations were planted in dry soil on 4 January 2016. It rained a total of only 21.6 mm in October and the biggest shower was 9.2 mm. In November it rained a total of 12 mm and the biggest shower was 9.4 mm (Table 1). From 3 December to 21 December 2016 it rained a total of 57.9 mm and the biggest shower was 13.8 mm. This rain enabled the drawing of the planting furrows.

## RESULTS AND DISCUSSION

It rained sufficiently for all three demonstration plantings to germinate successfully. Unfortunately, follow-up rains were late and the trial on the red soil died off first due to the lowest follow-up rain in the area of the trial site. The plantings on the sand- and dark clay soils performed better because of better follow up rain in those trial site areas. Due to the further low rainfall in the dark soil area this planting also died off, fortunately the follow-up rains in the sandy soil trial area was better and it survived and yielded a harvest. The full row spacing where the rows were 1 meter apart, yielded 457 kg (Table 2) of seed cotton per hectare. The double skip rows where two rows were planted one meter apart and then two rows skipped, yielded 403 kg of seed cotton per hectare. It must be kept in mind though that although the yield of the double skip row method was little lower, the inputs were also much lower (Table 3).

**Table 1.** Total rainfall in mm from November 2015 until June 2016

| Nov 2015 | Dec 2015 | Jan 2016 | Febr 2016 | March 2016 | Apr 2016 | May 2016 | June 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| 12.0 | 57.9 | 30.2 | 19.8 | 59.2 | 20.2 | 40.2 | 0.2 | **239.7** |

**Table 2.** Seed cotton yield of trial planted on sandy soil in kg/ha, 2015/2016 season

| Treatment | Yield (kg.ha) |
|---|---|
| Full Rows 1 m spacing | 457 |
| Double Skip row | 403 |
| **Average** | **430** |

**Table 3.** Comparison of Input costs and profit per hectare, 2015/2016 season

| Treatment | Cultivation /ha | Seed cost/ha | Pesticides /ha | Labour/ha | Income/ha at R5.20/kg | Input Cost/ha | Profit/ha in Rand |
|---|---|---|---|---|---|---|---|
| Full Rows 1 m spacing | R195.00 | R1 040.00 | R150.00 | R2 300.00 | R2 376.40 | R3 685.00 | --R1 308.60 |
| Double Skip row | R97.50 | R520.00 | R75.00 | R1 800.00 | R2 095.60 | R2 492.50 | --R396.90 |

The Total Input Cost per hectare for the full rows was **R3 685.00** and for the double skip row it was **R2 492.50**. The input cost for the double skip row was, therefore, **R1 192.50** less per hectare. The double skip row had an income of **R2 095.60/ha** which was **R280.80** lower than the **R2 376.40** of the full rows, but the Input costs per hectare was **R1 192.50** less than that of the full rows resulting in **R911.70** more profit per hectare for the double skip row method.

## CONCLUSION

The yield was very low this season due to the very low rainfall, yet the profit for the double skip-row rip-on-row method was R911.70 per hectare more than for the full row method. The input cost per hectare of the double skip row method was R1 192.50 less than the full row method, therefore, it is a lower risk production method.

The Makhathini Flats area is a very dry area which creates the need of a dryland cotton production method that can use every millimetre of rain effectively, has minimum input costs also lowering risk but which can still give a higher profit than more traditional dryland cotton production methods.

## NEXT SEASON

The cotton demonstration trials will be repeated on the same three different soil types on farmers' farms.

| | | |
|---|---|---|
| **PROJECT NUMBER** | **:** | TK 208/16 (000603) – Part B |
| **PROJECT TITLE** | **:** | Minimum input – Nitrogen fertilization |
| **REPORT YEAR** | **:** | 2015/2016 |
| **PROJECT MANAGER** | **:** | HJ Steyn |
| **CO-WORKERS** | **:** | MS Magwaza<br>MC Mkhwanazi<br>BF Gumede<br>C Ngwane |

**INTRODUCTION**

The Makhathini Flats area of the Northern KwaZulu-Natal is very dry with an annual rainfall of 450 mm. 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 smallholder 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 spacing of 1 meter resulting in a further reducing of input costs. The fact that there is 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 economical benefit to the farmer.

## EXPERIMENTAL PROCEDURES

It only rained 12 mm for November so on 24 November until 30 November 2015, 50 mm of irrigation was applied to enable the drawing of the plant furrows. The plant - furrows for the experiment was drawn on 09 December 2015 in the double skip row – rip on the row method. The trial was planted on the ripped furrows on 18 December 2015. Gramoxone was sprayed directly after plant to control all weeds present. No rain fell from 18 December 2015 until 07 January 2016. Thirty millimetres of irrigation was applied on 22 December until 24 December 2015 to assist uniform germination for effective trial purposes. It did not rain again until 07 January 2016 when it rained only 3.2 mm and to prevent the seedlings from dying, another 30 mm of irrigation was applied on 11 – 13 January 2016. No irrigation was applied after this.

A Youden Square Design was used with 6 treatments that was replicated 4 times. Six different Nitrogen levels were applied on 10 February 2016. 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 on 19 January 2016. The second Roundup Power Max spray was applied on the 4 March 2016.

Scouting for pests was done on 01 February 2016, 08 February 2016, 15 February 2016, 22 February 2016 and 23 March 2016 and 29 March 2016. Mospilan was sprayed for Aphids, Abamectin for Red Spider mite and Karate for leaf eater worms on 17 January 2016. A second spray of Mospilan for Aphids and Jassids and Karate for worms was done on 09 February 2016. A third spray of Mospilan and Karate was done on 01 March 2016. A 4$^{th}$ spray of Mospilan was sprayed for leaf sucking pests on 01 April 2016. The trial was badly affected by drought as it rained only 239.7 mm from November 2015 until 30 June 2016.

**Table 1.** Total rainfall in mm from November 2015 until June 2016

| Nov 2015 | Dec 2015 | Jan 2016 | Febr 2016 | March 2016 | Apr 2016 | May 2016 | June 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| 12.0 | 57.9 | 30.2 | 19.8 | 59.2 | 20.2 | 40.2 | 0.2 | **239.7** |

Adding the 50 mm of irrigation for cultivation and the two irrigations after plant, it means the trial received a total 349.7 mm of water, but after planting 299.7 mm. The first pick was harvested on 21 April 2016, the second on 05 May 2016, the 3rd on 06 June 2016 and a fourth on 04 July 2016.

## RESULTS AND DISCUSSION

The 2015/2016 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 2.** Average values for yield, plant height and petals, 2015/2016 season

| Treatment | Yield (kg.ha) | Plant height(cm) | Petals (7 plants) |
|---|---|---|---|
| 0 | 863.5 | 71 | 12 |
| 10 | 989.8 | 76 | 12 |
| 20 | 1 019.3 | 74 | 12 |
| 30 | 8 85.0 | 71 | 12 |
| 40 | 965.8 | 70 | 11 |
| 50 | 1 014.3 | 75 | 12 |
| **Average** | **956.3** | **73** | **11.7** |
| **CV** | **19.59** | **6.98** | **14.28** |

No significant differences noted between treatments but noted between treatments

### Yield

The average yield for the trial was 956.3 kg of seed cotton per hectare with the highest treatment yield average coming from 20 kg of Nitrogen applied per hectare, giving 1 019 kilograms of seed cotton per hectare. Significant differences were observed between the yield averages of the replications.

**Plant height**

The plant height was the highest with the 50 kg N/ha treatment but no significant differences. Significant differences were observed between the height averages of the replications.

**Petals**

The average petal-count per plant seemed not to have differed as the nitrogen applied increased. Significant differences were observed between the petal averages of the replications.

**FIBRE QUALITIES**

**Table 3.** Average values for fibre qualities - Pick 1, 2015/2016 season

| Treatment | Length (mm) | Strength(g/tex) | Micronaire |
|---|---|---|---|
| 0 | 27.15 | 31.70 | 4.60 |
| 10 | 26.82 | 32.42 | 4.52 |
| 20 | 27.20 | 33.10 | 4.57 |
| 30 | 27.25 | 32.27 | 4.48 |
| 40 | 28.02 | 33.15 | 4.48 |
| 50 | 27.65 | 32.37 | 4.75 |
| **Average** | **27.43** | **32.78** | **4.41** |
| **CV** | **2.19** | **4.32** | **4.57** |

No significant differences noted between treatments but noted between treatments

**Table 4.** Average values for fibre qualities - Pick 2, 2015/2016 season

| Treatment | Length (mm) | Strength(g/tex) | Micronaire |
|---|---|---|---|
| 0 | 28.42 | 34.82 | 4.23 |
| 10 | 28.75 | 35.22 | 4.30 |
| 20 | 27.92 | 35.15 | 4.23 |
| 30 | 28.67 | 34.85 | 4.22 |
| 40 | 28.85 | 34.90 | 4.13 |
| 50 | 29.07 | 34.62 | 4.32 |
| **Average** | **28.61** | **34.92** | **4.24** |
| **CV** | **1.97** | **4.67** | **5.6** |

No significant differences noted between treatments but noted between treatments

**Yield**

The average yield for the trial was 956.3 kg of seed cotton per hectare with the highest treatment yield average coming from 20 kg of Nitrogen applied per hectare, giving 1 019 kilograms of seed cotton per hectare. Significant differences were observed between the yield averages of the replications.

**Plant height**

The plant height was the highest with the 50 kg N/ha treatment but no significant differences. Significant differences were observed between the height averages of the replications.

**Petals**

The average petal-count per plant seemed not to have differed as the nitrogen applied increased. Significant differences were observed between the petal averages of the replications.

## Length

### Pick 1 (Table 3)

The average length was 27.43 mm which is on the low side with the longest fibre coming from the treatment of 40 kg N/ha that measured 28.02 mm.

### Pick 2 (Table 4)

The average length was 28.61 mm with the lowest at 27.92 coming from the 20 kg N/ha treatment and the longest at 29.07 mm coming from the 50 kg N/ha treatment. Significant differences were noted in fibre length between treatments 0-, 10 - and 30 kg N/ha.

## Strength

### Pick 1 (Table 3)

The average strength measured was 32.78 g/tex with the treatment of 20 kg N/ha as the highest at 33.10g/tex. The lowest strength value came from the 0 kg N/ha and was 31,7 g/tex.

### Pick 2 (Table 4)

The average strength measured was 34.92 g/tex which was higher than for the first pick with the lowest at 34,62 g/tex coming from the 50 kg N/ha treatment. No significant differences were noted.

## Micronaire

### Pick 1 (Table 3)

The average micronaire measured was 4.41. The treatment of 50 kg N/ha gave the highest micronaire value of all the treatments at 4.75 and the lowest micronaire value was 4.48 given by both the 30- and 40 kg N/ha treatments.

**Pick 2 (Table 4)**

The average micronaire measured for Pick 2 was 4.24. The treatment of 50 kg N/ha again gave the highest micronaire value of all the treatments at 4.32 and the lowest micronaire value was 4.13 given by the 40 kg N/ha treatment.

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 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 (001007)

**PROJECT TITLE** : High temperature tolerance in cotton

**REPORT YEAR** : 2015/2016

**PROJECT MANAGER** : MM Pretorius

**CO-WORKERS (Internal)** : P Maja
N Schwan

**CO-WORKERS (External)** : Prof DM Oosterhuis *
Dr Fred Bourland *
Dr D Loka *
Dr TR FitzSimons *

* Department of Crop, Soil and Environmental Sciences, University of Arkansas. Fayetteville.

**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.

**EXPERIMENTAL PROCEDURES**

**Heat tolerant**

Heat tolerant trials has been planted from the 2013/2014 up to the 2015/2016 seasons at Rustenburg, and during 2015 at Marianna, Arkansas, USA. For the current 2015/2016 season, cotton trials were planted at the Agricultural Research Council-Institute for Industrial Crops (ARC-IIC), Rustenburg, on 6 and 19 November 2015. 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 rain of 287.4 as well as 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 from

November 2015 to March 2016 are presented in Figure 1. Measurements were done to obtain two temperatures regimes namely 35 °C and 32 °C day/night. The experimental design was a fully randomized block design 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 and seed cotton yield and fibre qualities. Data were analysed using JUMP.

**Biostimulant**

Cotton was planted at the Agricultural Research Council-Institute for Industrial Crops (ARC-IIC), Rustenburg, on 23 October 2015. Four different cotton (*Gossypium hirsutum* L.) cultivars were planted namely VH260 and Arkot 9704 (two cultivars with heat tolerance), DP393 (a heat sensitive cultivar) and DP210 BRF, (a cultivar of unknown tolerance). Plant growth hormones included - Salicylic acid, Putrescine, 1MCP, Pix, and a control spayed with water. Three rows of 3 m in length at an inter-row spacing of 1 m and an intra-row spacing of 20 cm were planted. The middle row was used to sample leaves for analysis. Measurements were made of boll counts, boll weights and seed cotton yield. Data were analysed using JUMP.

**Measurements**

**a. Yield**

Total seed cotton yield (kg/ha)
Boll count and boll weight (Biostimulant only)

**b. Physiological measurements (leaf)**

Membrane leakage (ML)
Chlorophyll fluorescence (CF)

**c. Climatical data**

Daily minimum and maximum temperatures and rainfall

## RESULTS

### Membrane leakage (ML)

At Rustenburg in 2015/16 (p=0.0001) ML differed significantly between the two temperature regimes (Fig 2). The high temperature regime of 35 °C gave the highest percentage ML 89.4 % compared to the 49.5 % for the low temperature regime (32 °C). In Figure 3, Arkot 9704 (30.6%) gave significantly lower leakages in the low temperature regime than the other three cultivars, VH260 (70.4 %), DP393 (59.7 %) and DP210 (44.1 %). In the high temperature regime variable results in ML were obtained for cultivars. No significant differences existed between cultivars in the high temperature regime and percentage change in ML between temperature regimes for VH260 (16.1 %) was significantly lower than Arkot 9704 (58.9 %) and DP210 (46.8 %) but not than DP393 (31.0 %) (Table 1).

**Table 1.** Percentage change in membrane leakage from the low temperature regime to the high temperature regime at Rustenburg 2015/2016

| Cultivars | 2015/16 |
|---|---|
| VH260 | 16.1 c |
| Arkot 9704 | 58.9 a |
| DP393 | 31.0 bc |
| DP210 | 46.8 ab |

1. Columns with the same letter are not significantly different at p=0.05.

### Chlorophyll fluorescence (CF)

Chlorophyll fluorescence differed significantly (p=0.0001) at temperature regimes (Fig 4). At Rustenburg in 2015/2016 the low temperature regime of 32 °C gave higher CF (0.698 $F_v/F_m$) than the high temperature regime of 35 °C (0.665 $F_v/F_m$). Chlorophyll Fluorescence of cultivars in the low regime differed significantly (Fig. 5). Arkot 9704 gave the highest CF of 0.717 ($F_v/F_m$) in the low temperature regime. This differed significantly from VH260 (0.684 $F_v/F_m$) and DP393 (0.680 $F_v/F_m$) but not from DP210 (0.709 $F_v/F_m$). Cultivars did not differ significantly for the high temperature regime in Rustenburg in 2015/16 (Fig. 5).

Percentage change in chlorophyll fluorescence differed significantly, with the lowest % change in CF between the low and high temperature being with VH260 (1.8 %), compared to the 2.3, 2.9 and 5.8 % of DP393, DP210 and Arkot 9704, respectively (Table 2).

**Table 2.** Percentage change in chlorophyll fluorescence from the low temperature regime to the high temperature regime at three locations.

| Cultivars | 2015/16 |
|---|---|
| VH260 | 1.9 b |
| Arkot 9704 | 5.8 a |
| DP393 | 2.3 ab |
| DP210 | 2.9 ab |

[1] Columns with the same letter are not significantly different at p=0.05

**Seed cotton yield**

The mean seed cotton yield for planting 1 was 2215 kg/ha. Planting 2 had a mean seed cotton yield of 2786 kg/ha. Although seed cotton yield did not differ significantly during planting 1, VH260 resulted in the highest yield of 2463 kg/ha compared to Arkot 9704 (2152 kg/ha), DP210 (2020 kg/ha), and DP393 (2227 kg/ha). Although not significantly different, DP393 gave the highest seed cotton yield during planting 2 (2900 kg/ha), compared to Arkot 9704 (2680 kg/ha), DP210 (2744 kg/ha), and VH260 (2818 kg/ha) (Fig. 6).

**Biostimulant applications**

**Boll count**

Although not significant, VH260 tended to give the highest boll count of 23.7 bolls. Again not significant, 1MCP gave the highest boll counts of 23.8. At the interaction between cultivars and biostimulants, significant differences were not found but 1MCP tended to give the highest boll count for cultivar DP393 (24.7) followed by VH260, while Salicylic acid resulted in the highest boll count of 24.1 (Table 3).

**Boll weight**

Although significant differences were not found, boll weights of 10 bolls per plot showed that salicylic acid had increased boll weights for two of the cultivars planted namely Arkot 9704 (50.8 g) and DP393 (54,3 g) (Table 2). Pix resulted in increased boll weights with cultivar VH260 (53.7 g), and Putrescine gave the highest boll mass with the local cultivar (DP210) (52.2 g). In one case a difference of 12.2 gram were observed in boll weights between VH260 that received Pix (53.7) and VH260 sprayed with salicylic acid (42.5 g) (Table 4).

### Seed cotton yield

Although significant differences were not found (Fig 2), the lowest yield of 1766 kg/ha was recorded for cultivar DP393 sprayed with Pix. Double that yield was recorded with cultivar VH260 that was treated with Putrescine namely 3539 kg/ha (Table 5).

## DISCUSSION

Heat tolerant trials has been planted from the 2013/2014 up to the 2015/2016 seasons at Rustenburg, and during 2015 at Marianna, Arkansas, USA. In all the trials, higher membrane leakages occurred at the warmer temperature regimes. VH260 showed the least damage in membrane leakages, which is in line with the fact that VH260 is a heat tolerant cultivar. At all the localities in South Africa and the US, when chlorophyll fluorescence was measured, it decreased when plants received a heat stress. This is in accordance with chlorophyll fluorescent research reported in literature on a variety of crops. In 2015/2016 the cultivars Arkot 9704 and VH260 had the highest chlorophyll fluorescence, showing that these two cultivars have higher photosynthetic efficiency. Again VH260 showed the lowest decrease in chlorophyll fluorescence (Table 2), re-affirming the fact that it is a heat tolerant cultivar.

No significant main effects or interactions were found at any of the measured parameters at the biostimulant part but the cultivar that yielded the highest was VH260 with 2679 kg/ha. The biostimulant or growth hormone treatment that did the best was the Putrescine treatment (2676 kg/ha). The interaction VH260 that was sprayed with Putricine did the best overall with 3539 kg/ha.

## CONCLUSION

Choosing a heat tolerant cultivar can lead to successful yield increases in the current warmer climatical conditions in cotton production areas of South Africa. VH260 planted at the correct planting date has the potential to give the highest seed cotton yields. Near double seed cotton yields can be expected when producers plant the correct cultivar with application of the growth hormone Putrescine. This was the first year of the biostimulant study, and although not significant, it does show potential for higher yields. Future of the trial: The dosages of the growth hormones, bigger plots, and the inclusion of an organic Bioflavonoid Compound named OR-51 from the company ORO AGRI. A literature study on the sensitive time of the crop when application of growth hormones will have the best effect, and different dosages is necessary.

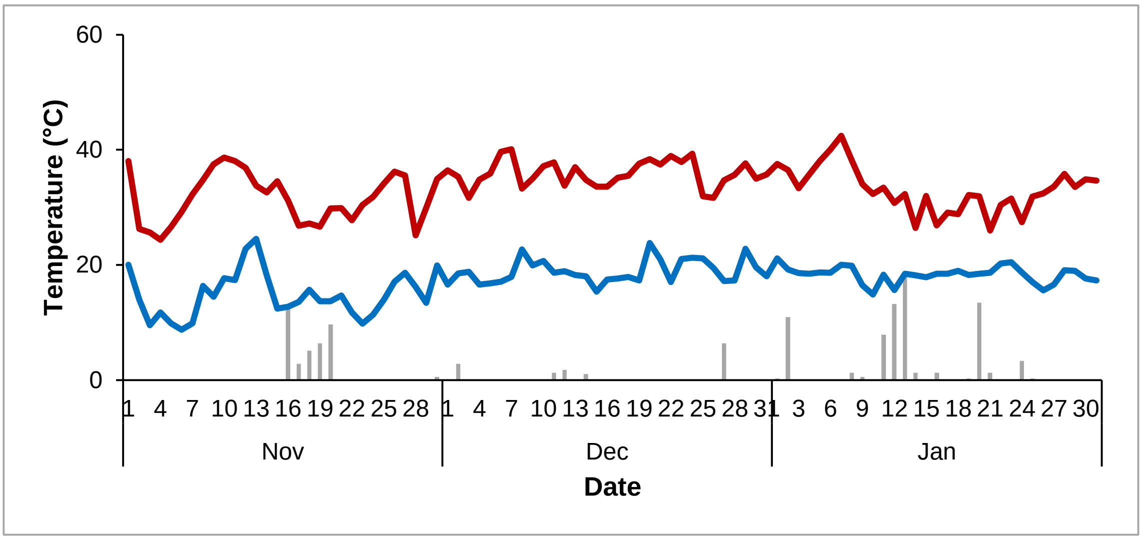


**Figure 1.** Maximum and minimum temperatures, and rainfall data, of the field studies in Rustenburg, South Africa in 2015/2016

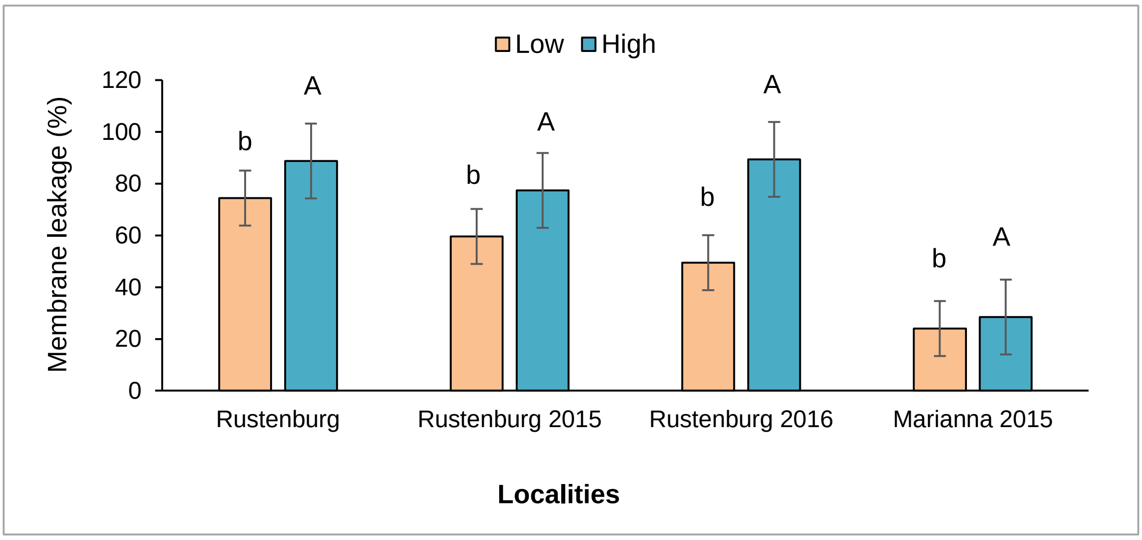


**Figure 2.** Membrane leakage (%) of two temperature regimes meaned over four cultivars measured during early flowering at (A) Rustenburg 2013/14, 31.0 °C control, 35 °C heat stress (HS), (B) Rustenburg 2014/15, control 27 °C, HS 32 °C (C) Rustenburg 2015/16, control 32 °C, HS 35 °C, and (D) Marianna (2015) control 32 °C and HS 34 °C as an indication of the effect of heat stress on cell integrity. Columns with the same lowercase letters are not significantly different (p=0.05). Error bars indicate the confidence interval for data of each point at α=0.05 level

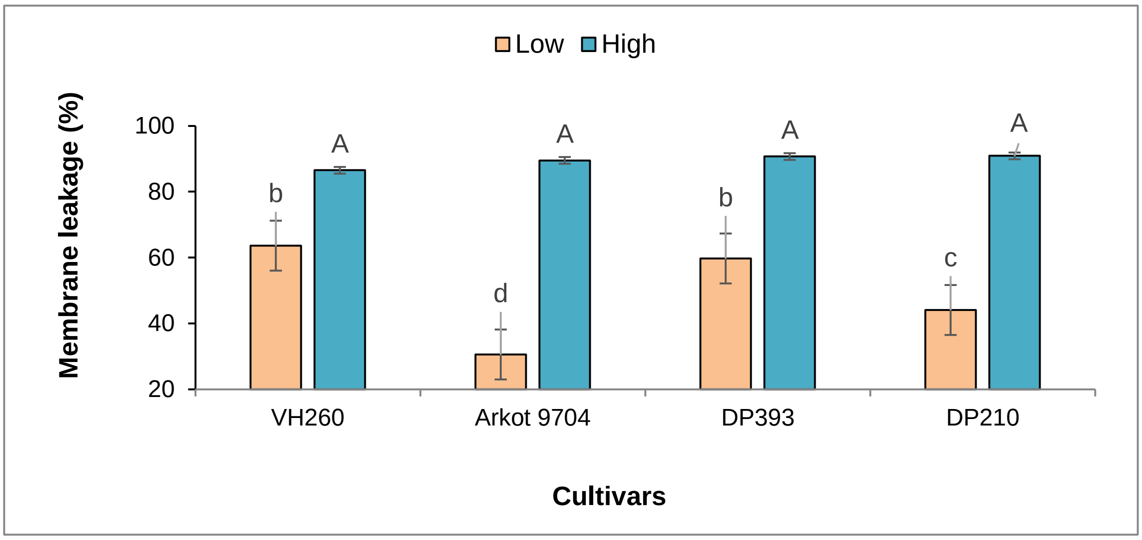


**Figure 3.** Membrane leakage (%) of four cultivars at two temperature regimes, high and low at Rustenburg in 2015/2016. Light columns (low temperature) with the same lowercase letters are not significantly different (p=0.05). Dark columns (high temperature) with the same capital letters are not significantly different (p=0.05). Error bars indicate the confidence interval for data of each point at α=0.05 level

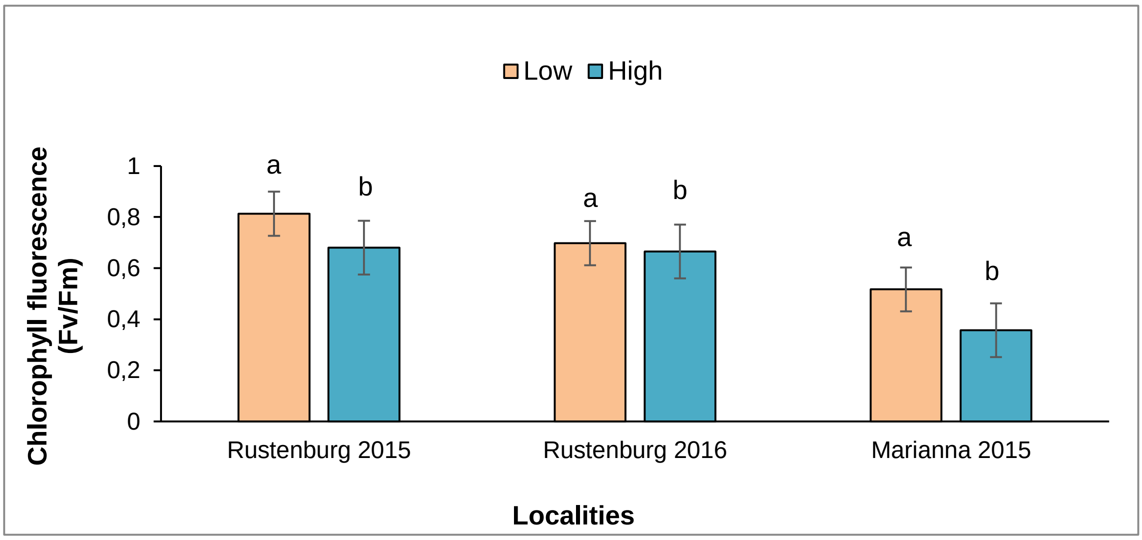


**Figure 4.** Chlorophyll fluorescence ($F_v/F_m$) of two temperature regimes meaned over cultivars measured at 32 °C and at 35 °C, at Rustenburg in 2015/16 as an indication of the effect of heat stress on the efficiency of photosystem II. Light (low temperature) and dark (high temperature) columns with the same lowercase letters are not significantly different (p=0.05). Error bars indicate the confidence interval for data of each point at α=0.05 level.

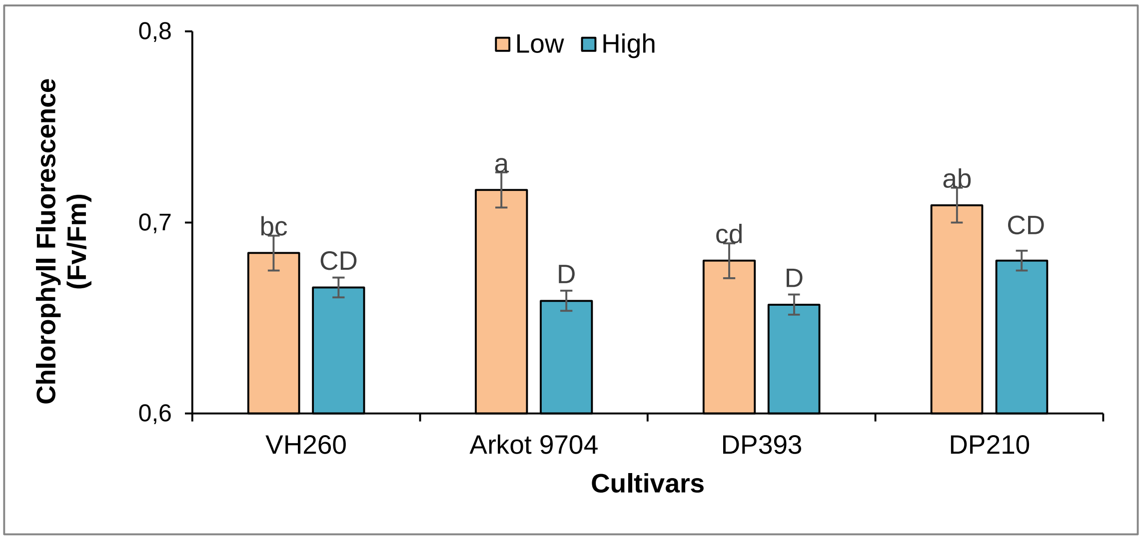


**Figure 5.** Chlorophyll fluorescence ($F_v/F_m$) of the interaction between temperature regime and cultivars at Rustenburg in 2015/2016 as an indication of the effect of heat stress on the efficiency of photosystem II. Light columns (low temperature) with the same lowercase letters are not significantly different (p=0.05). Dark columns (high temperature) with the same uppercase letters are not significant (p=0.05). Error bars indicate the confidence interval for data of each point at α=0.05 level.

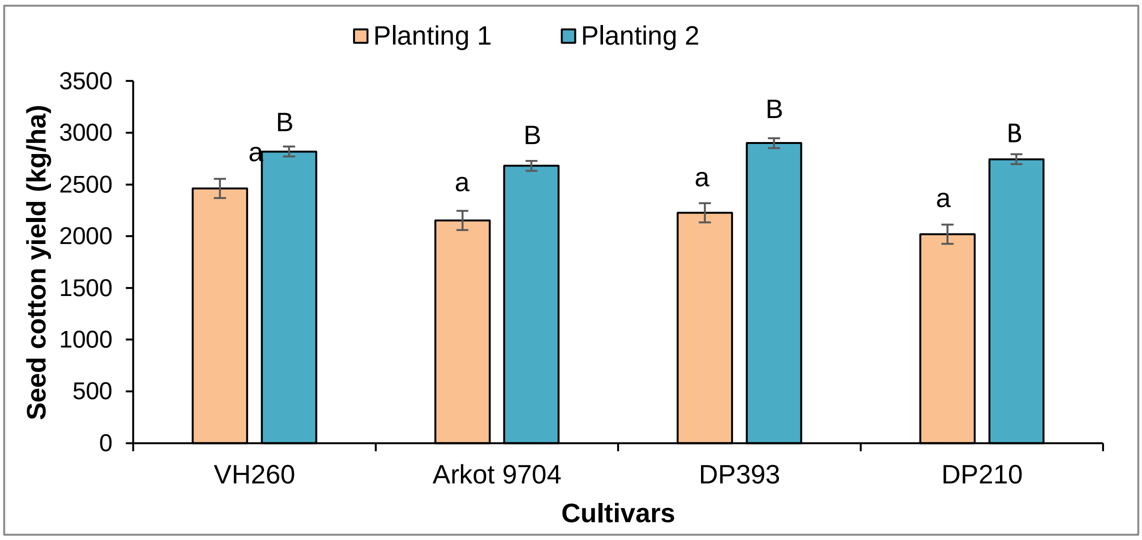


**Figure 6.** Seed cotton yield (kg/ha) at Rustenburg in 2015/2016. Dark columns (planting 1) with the same uppercase letters are not significant (p=0.05). Light columns (Planting 2) with the same lowercase letters are not significantly different (p=0.05). Error bars indicate the confidence interval for data of each point at α=0.05 level.

**Table 3.** Boll count of the biostimulant application, Rustenburg, 2015/2016

| | | | | | |
|---|---|---|---|---|---|
| **Cultivar** | **Arkot 9704** | **DP210** | **VH260** | **DP393** | |
| | 21.7 | 22.9 | **23.7** | 22.7 | |
| | | | | | |
| **Treatment** | **Pix** | **Salicylic acid** | **1MCP** | **Putrescine** | **Control** |
| | 22.2 | 22.6 | **23.8** | 22.2 | 23.1 |
| | | | | | |
| **Interaction** | **Pix** | **Salicylic acid** | **1MCP** | **Putrescine** | **Control** |
| **Arkot 9704** | 21.7 | 20.7 | 23.3 | 20.1 | 22.4 |
| **DP210** | 21.9 | 22.8 | 23.1 | 21.9 | 24.9 |
| **VH260** | 23.5 | 24.1 | 23.9 | 23.7 | 23.3 |
| **DP393** | 21.5 | 22.7 | **24.7** | 22.8 | 21.9 |
| | | | | | |
| **Tukey's LSD (p=0.05)** | | | | | |
| **Cultivars** | 1.1 | | | | |
| **Treatments** | 0.8 | | | | |
| **Interaction** | 1.9 | | | | |
| **CV** | 12.6 | | | | |

**Table 4.** Boll weight (g) of 10 bolls of the biostimulant application, Rustenburg, 2015/2016

| **Cultivar** | **Arkot 9704** | **DP210** | **VH260** | **DP393** | |
|---|---|---|---|---|---|
| | 49.5 | 47.5 | **50.3** | **50.3** | |
| | | | | | |
| **Treatment** | **Pix** | **Salicylic acid** | **1MCP** | **Putrescine** | **Control** |
| | 47.9 | 48.3 | 49.3 | 28.3 | 53.1 |
| | | | | | |
| **Interaction** | **Pix** | **Salicylic acid** | **1MCP** | **Putrescine** | **Control** |
| **Arkot 9704** | 50.0 | 50.8 | 48.3 | 45.9 | 52.3 |
| **DP210** | 42.3 | 46.7 | 46.5 | 52.2 | 49.6 |
| **VH260** | 53.7 | 41.5 | 51.5 | 49.5 | **55.3** |
| **DP393** | 45.4 | 54.3 | 51.0 | 45.6 | 55.0 |

| **Tukey's LSD (p=0.05)** | |
|---|---|
| **Cultivars** | 2.1 |
| **Treatments** | 1.7 |
| **Interaction** | 3.7 |
| **CV** | 11.9 |

**Table 5.** Seed cotton yield of the biostimulant application, Rustenburg, 2015/2016

| | | | | | |
|---|---|---|---|---|---|
| **Cultivar** | **Arkot 9704** | **DP210** | **VH260** | **DP393** | |
| | 2380 | 2432 | **2679** | 2176 | |
| | | | | | |
| **Treatment** | **Pix** | **Salicyslic acid** | **1MCP** | **Putrescine** | **Control** |
| | 2149 | 2219 | 2332 | **2676** | 2707 |
| | | | | | |
| **Interaction** | **Pix** | **Salicylic acid** | **1MCP** | **Putrescine** | **Control** |
| **Arkot 9704** | 2027 | 2288 | 2580 | 2548 | 2455 |
| **DP210** | 2478 | 2237 | 2568 | 2445 | 2432 |
| **VH260** | 2327 | 2093 | 2306 | **3539** | 3131 |
| **DP393** | 1766 | 2258 | 1874 | 2171 | 2810 |

| | |
|---|---|
| **Tukey's LSD (p=0.05)** | |
| **Cultivars** | 164.3 |
| **Treatments** | 165.7 |
| **Interaction** | 324.4 |
| **CV** | 21.7 |

| | | |
|---|---|---|
| **PROJECT NUMBER** | **:** | TK 208/21 (001009) |
| **PROJECT TITLE** | **:** | Evaluation of planting date on production of cotton cultivars in SA |
| **REPORT YEAR** | **:** | 2015/2016 |
| **PROJECT LEADER** | **:** | CE Fourie |
| **CO-WORKERS** | **:** | KC Phalane<br>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.

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. Too high soil temperatures have also a negative influence on seed germination.

The results of the 2015/16 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.

## EXPERIMENTAL PROCEDURE

### 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. 7 October 2015 (PD 1)
2. 14 October 2015 (PD 2)
3. 21 October 2015 (PD 3)
4. 28 October 2015 (PD 4)
5. 4 November 2015 (PD 5)
6. 11 November 2015 (PD 6)
7. 18 November 2015 (PD 7)
8. 25 November 2015 (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)

### 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 5 m lengths, at an inter-row spacing of 90 cm and intra-row spacing of 15 cm.

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 through-out the growing was very warm and dry with little rain. Mepiquat chloride (Pix) was not applied on any of the trials

**Statistical analysis**

All the data was statistical analysed by using Genstat - Levene's Test for Homogeneity.

## RESULTS

### 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 2015 to January 2016) weather conditions were very dry with hot temperatures and little rain and this continued through February 2016 to end March 2016. Warm to moderate temperatures were then experience till end of May.

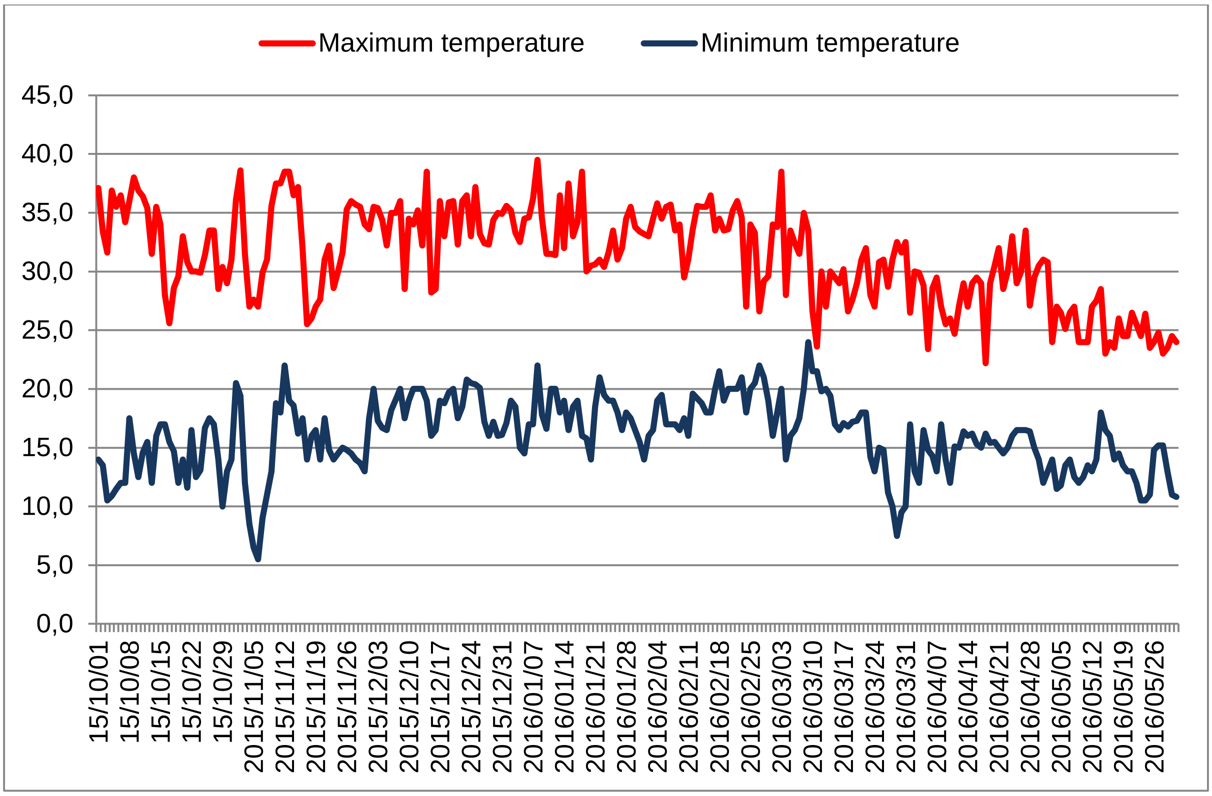


**Figure 1.** Seasonal minimum and maximum air temperatures (°C) at Groblersdal 2015-16

**October 2015 Air temperatures**

The minimum and maximum temperature data collected from the weather station at ARC-Loskop Research farm indicated that the maximum temperatures for October were much higher than the long-term values. The minimum temperatures varied through-out the month of October below the recommended 15 – 18°C.

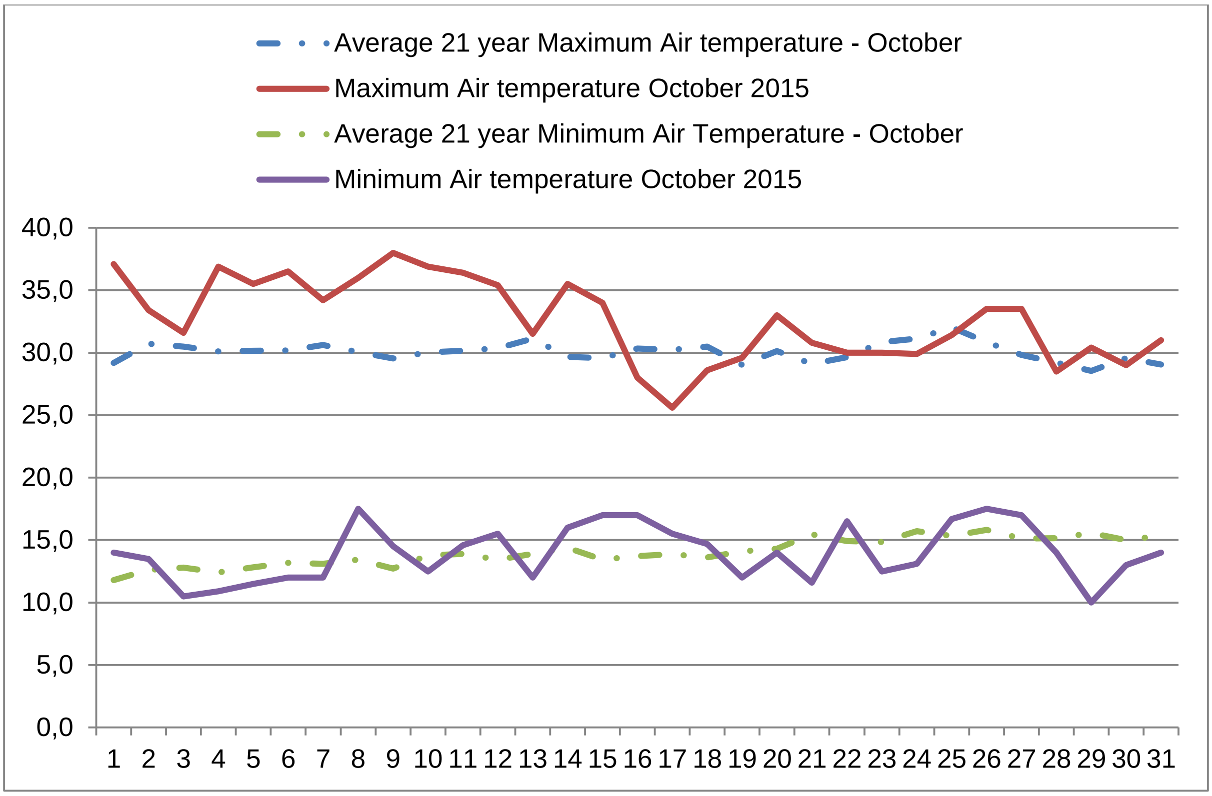


**Figure 2.** October 2015 Air temperatures (°C)

**November 2015 Air temperatures (°C)**

The minimum and maximum temperature data collected at the weather station for November 2015 indicated a variation in temperatures. Very warm maximum temperatures were experienced in the first half of November with cool night temperatures through-out the month.

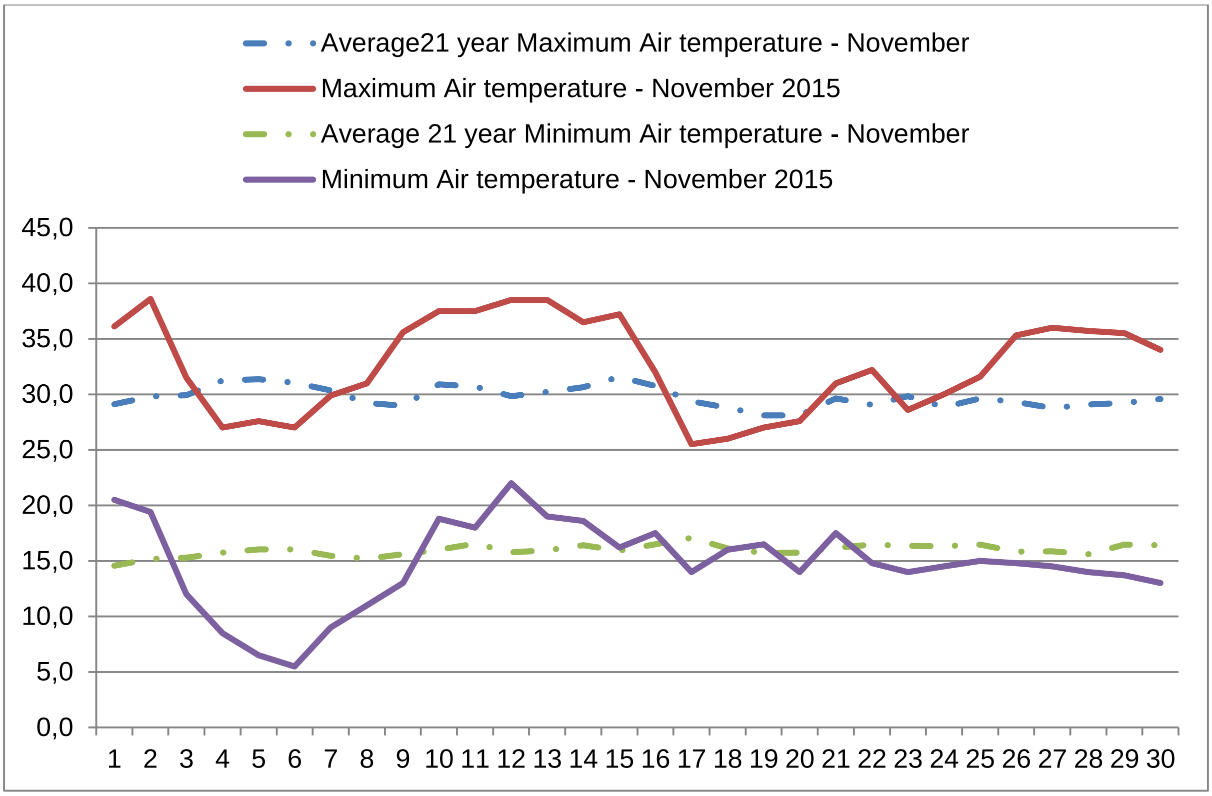


**Figure 3.** November 2015 Air temperatures (°C)

**Soil temperature**

A soil temperature meter was installed on the 30th of September 2015 to record soil temperatures during sowing season of the eight planting dates. A graph for the soil temperature is given in Figure 4 and 5 below.

**October 2015 – Soil temperatures**

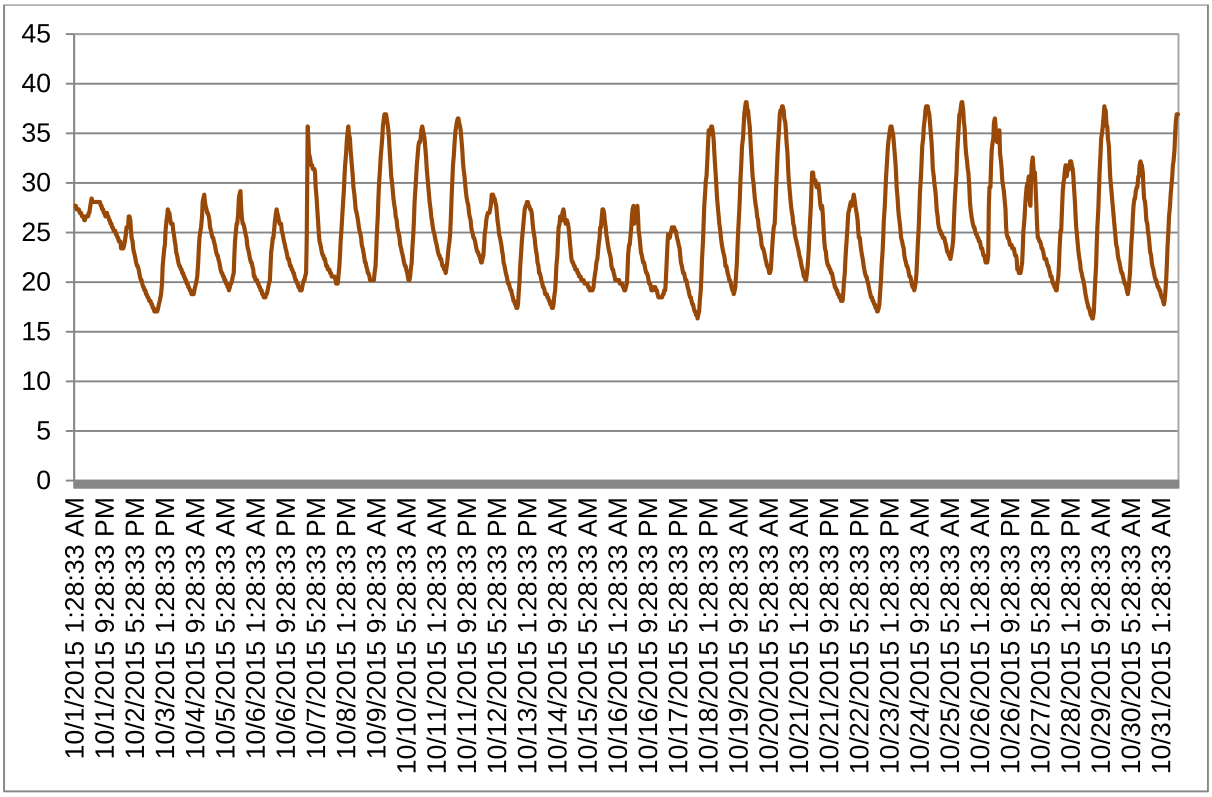


**Figure 4.** October 2015 – Soil temperatures (°C)

**November 2015 – Soil temperatures**

Soil temperatures for November 2014 were abnormally high for sowing of cotton. Soil temperatures in the 10 day were recorded above 40°C.

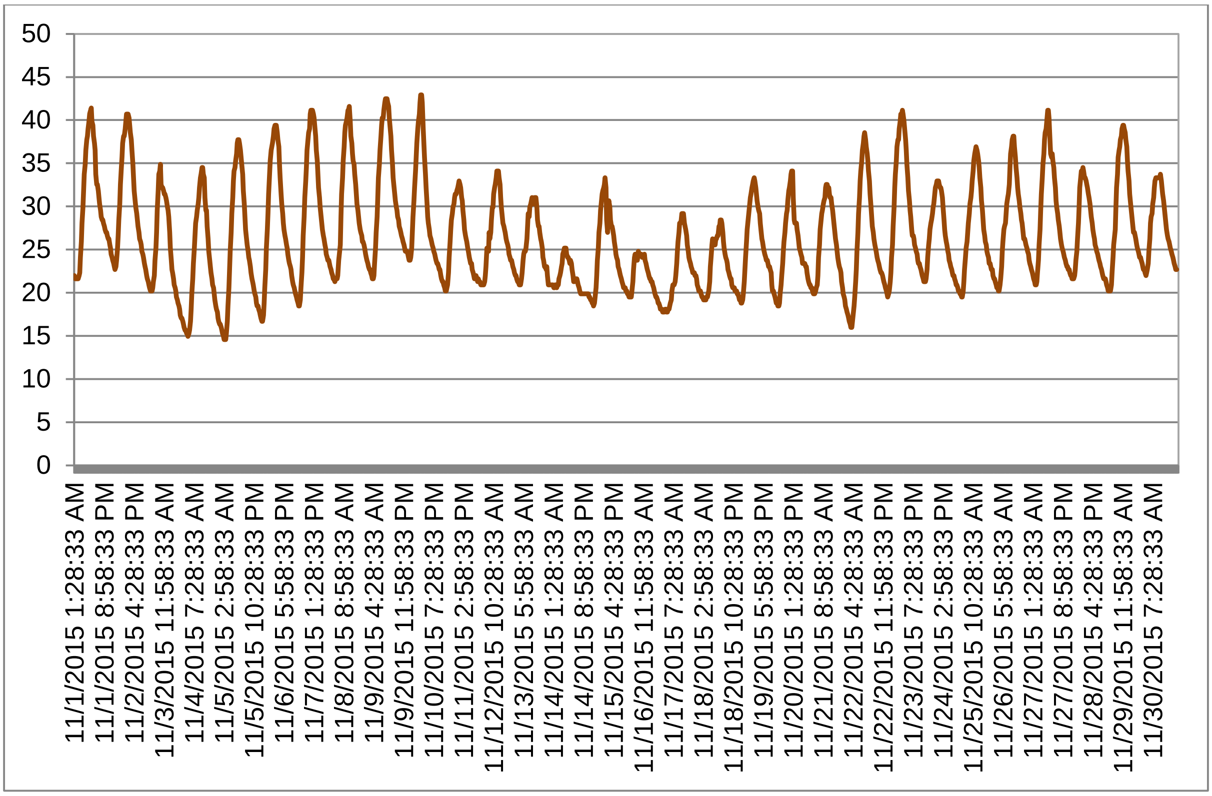


**Figure 5.** November 2015 Soil temperatures (°C)

**Rainfall (mm)**

A total of 387 mm rain was recorded during the growing season of the Plant Date Trials. Figure 6 indicates the rainfall for the 2015/16 cotton growing season with the highest rainfall for February 2016 (169 mm) and November 2015 (60 mm). Very dry and hot conditions were experienced through-out the growing season.

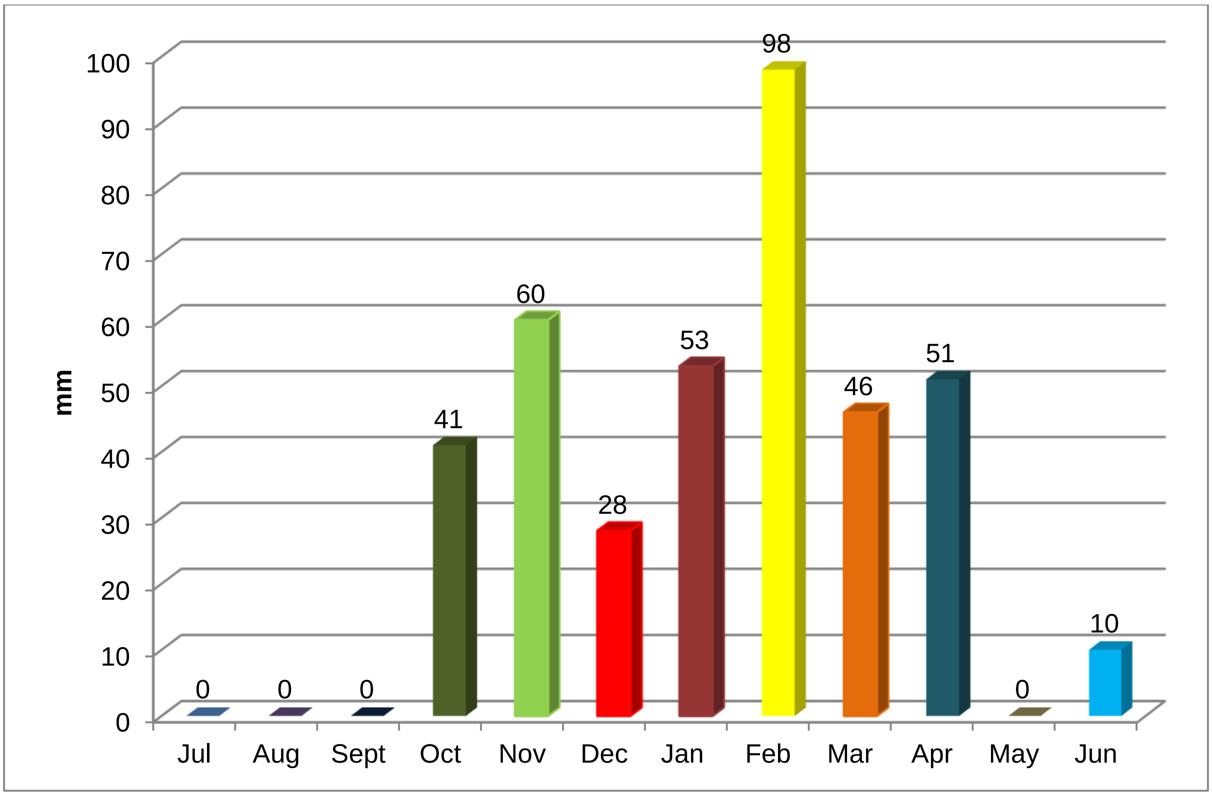


**Figure 6.** Monthly rainfall measured at ARC-Loskop Research Farm, Groblersdal (mm)

**Germination %**

Soil temperatures indicated that the soil was warm enough from the beginning of October. Other environmental conditions played a part in plant stand. Very high daily temperatures dry out the soil topsoil and this played a role in germination counts on Planting Date 3 and Planting Date 4.

**Table 1.** Germination percentage 7 days after planting

| Cultivar | | Planting dates | | | | | | | | Ave Germination % - 7 Days after plant | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>07/10/15 | PD 2<br>14/10/15 | PD 3<br>21/10/15 | PD 4<br>28/10/15 | PD 5<br>04/11/15 | PD 6<br>11/11/15 | PD 7<br>18/11/15 | PD 8<br>25/11/15 | | |
| 1 | Delta 12 BRF | 82.5 | 80.4 | 75.0 | 40.7 | 80.4 | 91.1 | 84.5 | 84.1 | 77.3 | 6 |
| 2 | 13P3001B2R2 | 79.6 | 81.4 | 71.4 | 64.3 | 84.3 | 95.0 | 85.4 | 82.3 | 80.5 | 2 |
| 3 | DP 1240 B2RF | 92.5 | 86.8 | 71.1 | 47.5 | 75.4 | 95.7 | 83.9 | 83.2 | 79.5 | 4 |
| 4 | Candia B2RF | 78.9 | 85.0 | 73.6 | 67.1 | 84.6 | 92.5 | 85.0 | 76.4 | 80.4 | 3 |
| 5 | 13P3005B2R2 | 75.4 | 93.6 | 76.1 | 64.3 | 85.7 | 95.0 | 87.7 | 83.0 | 82.6 | 1 |
| 6 | DP210BRF | 91.4 | 74.3 | 75.4 | 41.4 | 78.2 | 90.4 | 84.8 | 85.0 | 77.6 | 5 |
| Average | | 83.4 | 83.6 | 73.8 | 54.2 | 81.4 | 93.3 | 85.2 | 82.4 | | |
| Ranking | | 4 | 3 | 7 | 8 | 6 | 1 | 2 | 5 | | |
| CV % | | 1.16859 | | | | | | | | | |

**Table 2.** Germination percentage 14 days after planting

| Cultivar | | Planting dates | | | | | | | | Ave Germination % - 10 Days after plant | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>07/10/15 | PD 2<br>14/10/15 | PD 3<br>21/10/15 | PD 4<br>28/10/15 | PD 5<br>04/11/15 | PD 6<br>11/11/15 | PD 7<br>18/11/15 | PD 8<br>25/11/15 | | |
| 1 | Delta 12 BRF | 89.3 | 52.1 | 8.6 | 40.7 | 83.2 | 93.2 | 86.1 | 88.0 | 67.7 | 5 |
| 2 | 13P3001B2R2 | 91.8 | 45.4 | 56.8 | 76.4 | 86.8 | 96.1 | 88.2 | 84.5 | 78.2 | 2 |
| 3 | DP 1240 B2RF | 95.4 | 42.5 | 18.2 | 79.3 | 76.8 | 96.1 | 87.3 | 84.1 | 72.5 | 4 |
| 4 | Candia B2RF | 94.6 | 36.4 | 26.8 | 79.6 | 84.6 | 95.7 | 87.7 | 78.6 | 73.0 | 3 |
| 5 | 13P3005B2R2 | 94.6 | 68.6 | 58.9 | 78.6 | 88.2 | 97.5 | 89.6 | 86.3 | 82.8 | 1 |
| 6 | DP210BRF | 95.0 | 27.5 | 5.7 | 56.4 | 78.6 | 92.1 | 87.9 | 85.9 | 66.1 | 6 |
| Average | | 93.5 | 45.4 | 29.2 | 68.5 | 83.0 | 95.1 | 87.8 | 84.6 | | |
| Ranking | | 1 | 7 | 8 | 6 | 5 | 2 | 3 | 4 | | |
| CV % | | 1.13516 | | | | | | | | | |

**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

**Plant height at Final Plant Mapping**

Figure 7 indicates that the November plantings resulted in significant taller plants. This result 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 13P3001B2R2 and 13P3005B2R2 resulted in significantly taller plants at the 5$^{th}$ Planting Date with heights of 138.2 cm and 137.5 cm respectively. The cultivar Candia B2RF resulted in significant shorter plants over all the planting dates with an average plant height of 99.6 cm (Table 6). The shorter plants of Candia B2RF could be cultivar related.

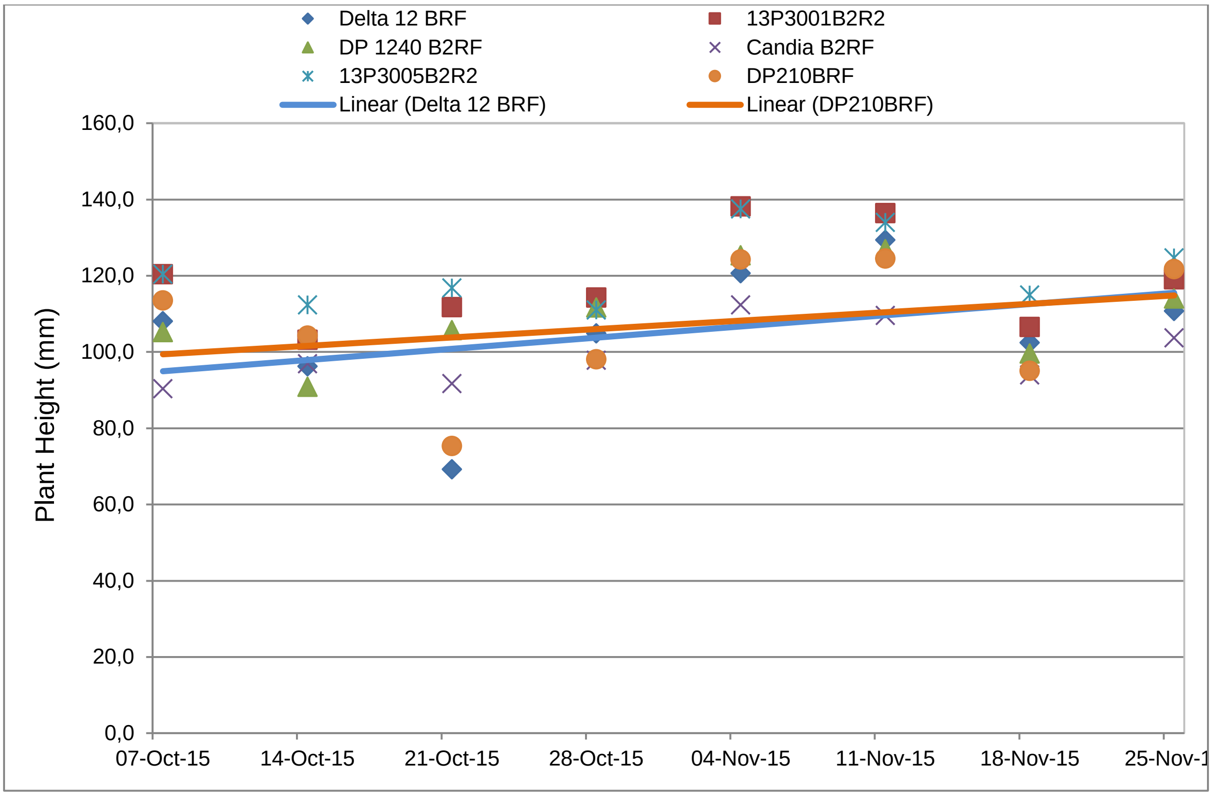


**Figure 7.** Plant Height at Final Plant Mapping

**Table 3.** Plant height at Final Plant Mapping (cm)

| Cultivar | | Planting dates | | | | | | | | Ave Plant height (cm) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1 07/10/15 | PD 2 14/10/15 | PD 3 21/10/15 | PD 4 28/10/15 | PD 5 04/11/15 | PD 6 11/11/15 | PD 7 18/11/15 | PD 8 25/11/15 | | |
| 1 | Delta 12 BRF | 108.1 | 96.3 | 69.2 | 104.9 | 120.7 | 129.4 | 102.5 | 110.8 | 105.2 | 5 |
| 2 | 13P3001B2R2 | 120.5 | 103.3 | 111.8 | 114.3 | 138.2 | 136.4 | 106.6 | 119.1 | 118.8 | 2 |
| 3 | DP 1240 B2RF | 105.3 | 90.9 | 105.8 | 111.7 | 125.3 | 126.9 | 99.7 | 114.1 | 110.0 | 3 |
| 4 | Candia B2RF | 90.3 | 96.9 | 91.7 | 97.8 | 112.3 | 109.6 | 94.0 | 103.8 | 99.6 | 6 |
| 5 | 13P3005B2R2 | 120.4 | 112.3 | 116.8 | 111.0 | 137.5 | 134.0 | 115.0 | 124.7 | 121.5 | 1 |
| 6 | DP210BRF | 113.5 | 104.3 | 75.3 | 98.1 | 124.3 | 124.5 | 95.1 | 121.8 | 107.1 | 4 |
| Average | | 109.7 | 100.7 | 95.1 | 106.3 | 126.4 | 126.8 | 102.1 | 115.7 | | |
| Ranking | | 4 | 7 | 8 | 5 | 2 | 1 | 6 | 3 | | |
| CV % | | 5.55678 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 3.5623 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 3.0841 | | | | | | | | | |

## Number of vegetative nodes

The number of vegetative nodes produced before the first fruiting branches are formed depends on the variety and the environment.

13P3005B2R2 resulted in significantly more average vegetative nodes. Planting Date 1 significantly had the highest number of vegetative nodes.

**Table 4.** Number of vegetative nodes

| Cultivar | | Planting dates | | | | | | | | Ave Number of Vegetative nodes above cotyledons (count) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1 07/10/15 | PD 2 14/10/15 | PD 3 21/10/15 | PD 4 28/10/15 | PD 5 04/11/15 | PD 6 11/11/15 | PD 7 18/11/15 | PD 8 25/11/15 | | |
| 1 | Delta 12 BRF | 4.85 | 4.85 | 3.20 | 4.50 | 4.25 | 4.28 | 4.13 | 4.03 | 4.26 | 3 |
| 2 | 13P3001B2R2 | 4.85 | 4.33 | 4.08 | 4.67 | 4.45 | 4.50 | 4.75 | 4.65 | 4.53 | 2 |
| 3 | DP 1240 B2RF | 4.20 | 4.15 | 4.33 | 4.50 | 4.18 | 4.00 | 3.93 | 3.98 | 4.16 | 5 |
| 4 | Candia B2RF | 4.35 | 5.05 | 4.08 | 4.00 | 4.05 | 4.00 | 4.05 | 4.13 | 4.21 | 4 |
| 5 | 13P3005B2R2 | 5.00 | 4.85 | 5.00 | 4.77 | 4.50 | 4.75 | 5.05 | 4.00 | 4.74 | 1 |
| 6 | DP210BRF | 4.33 | 4.40 | 3.17 | 5.00 | 3.88 | 4.35 | 4.03 | 4.05 | 4.15 | 6 |
| Average | | 4.60 | 4.60 | 3.98 | 4.57 | 4.22 | 4.31 | 4.32 | 4.14 | | |
| Ranking | | 1 | 2 | 8 | 3 | 6 | 5 | 4 | 7 | | |
| CV % | | 7.15 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.1808 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.1565 | | | | | | | | | |

## Fruit Branches

The number of fruit branches decreased significantly in the end of the November plantings (Table 5). This may be related to the fact that later plantings develop during warmer weather, resulting in faster vegetative growth.

The cultivar, CandiaB2RF, resulted in significantly lower fruiting branches over all the planting dates.

**Table 5.** Number of fruit branches

| Cultivar | | Planting dates | | | | | | | | Ave Number of fruit nodes (count) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>07/10/15 | PD 2<br>14/10/15 | PD 3<br>21/10/15 | PD 4<br>28/10/15 | PD 5<br>04/11/15 | PD 6<br>11/11/15 | PD 7<br>18/11/15 | PD 8<br>25/11/15 | |
| 1 | Delta 12 BRF | 22 | 17 | 12 | 16 | 18 | 19 | 16 | 17 | 17 |
| 2 | 13P3001B2R2 | 24 | 18 | 18 | 16 | 18 | 18 | 15 | 15 | 18 |
| 3 | DP 1240 B2RF | 19 | 16 | 15 | 19 | 17 | 19 | 15 | 15 | 17 |
| 4 | Candia B2RF | 18 | 17 | 16 | 16 | 17 | 16 | 15 | 15 | 16 |
| 5 | 13P3005B2R2 | 21 | 18 | 18 | 17 | 18 | 18 | 17 | 17 | 18 |
| 6 | DP210BRF | 22 | 16 | 12 | 15 | 17 | 17 | 14 | 17 | 16 |
| Average | | 21 | 17 | 15 | 17 | 17 | 18 | 16 | 16 | |
| CV % | | 5.8943 | | | | | | | | |

**Height-to-node ratio (HNR)**

The height-to-node ratio is a simple determination of the plant's vigour 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 2016 to mid-March 2016 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 mid-March and April benefitted the November 2015 plantings. Plants were growing more vigorously and the internode lengths (cm) were significantly longer.

Cultivar 13P3001B2R2 and 13P3005B2R2 had the longest internode lengths of 5.37 cm and 5.37 cm respectively. The two cultivars are both strong growers and improved management of the cultivar is needed. CandiaB2RF had the shortest internode length of 4.76 cm.

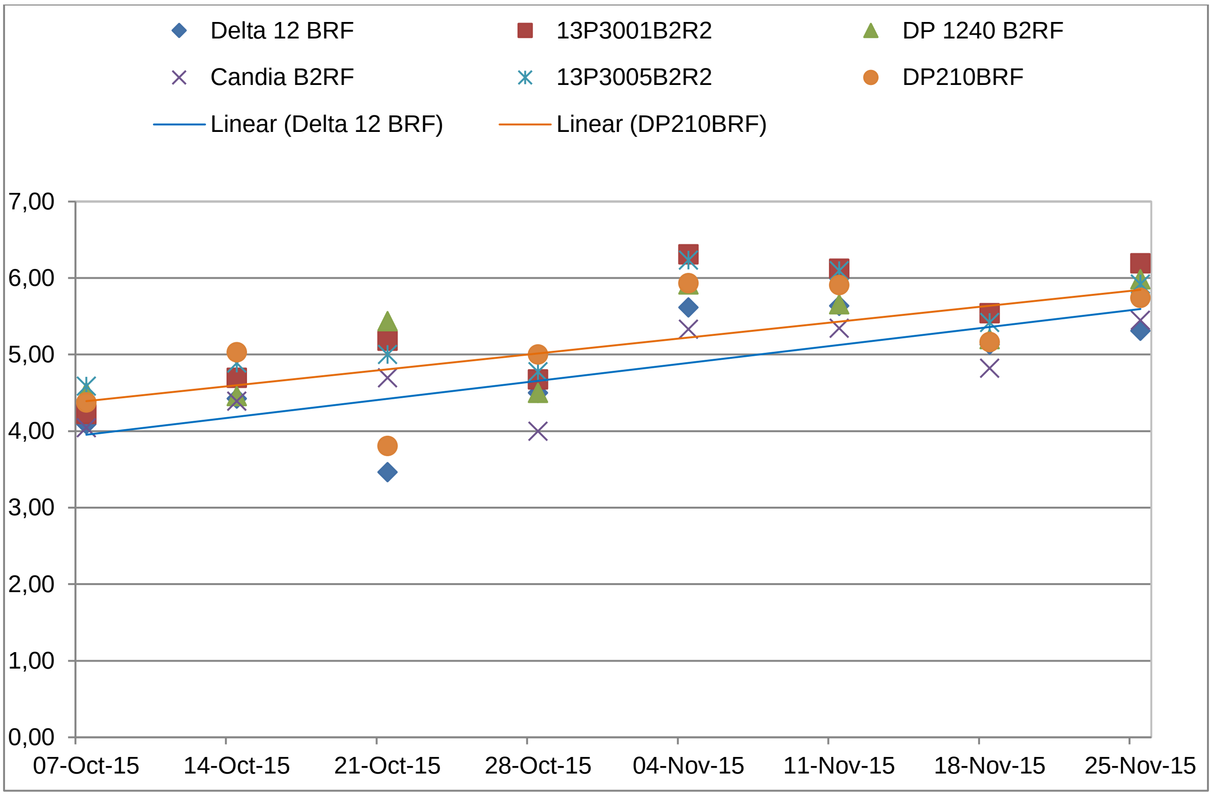


**Figure 8.** Height-to-node ratio of cotton cultivars planted at different dates

**Table 6.** Height-to-node ratio of cotton cultivars planted at different dates

| | | Planting dates | | | | | | | | Ave HNR (Calculated) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1 07/10/15 | PD 2 14/10/15 | PD 3 21/10/15 | PD 4 28/10/15 | PD 5 04/11/15 | PD 6 11/11/15 | PD 7 18/11/15 | PD 8 25/11/15 | | |
| 1 | Delta 12 BRF | 4.09 | 4.42 | 3.46 | 4.50 | 5.62 | 5.64 | 5.13 | 5.31 | 4.77 | 5 |
| 2 | 13P3001B2R2 | 4.22 | 4.70 | 5.18 | 4.67 | 6.31 | 6.12 | 5.54 | 6.19 | 5.37 | 1 |
| 3 | DP 1240 B2RF | 4.51 | 4.46 | 5.44 | 4.50 | 5.92 | 5.66 | 5.20 | 5.99 | 5.21 | 4 |
| 4 | Candia B2RF | 4.04 | 4.39 | 4.70 | 4.00 | 5.33 | 5.35 | 4.82 | 5.45 | 4.76 | 6 |
| 5 | 13P3005B2R2 | 4.59 | 4.89 | 5.00 | 4.77 | 6.24 | 6.10 | 5.42 | 5.92 | 5.37 | 2 |
| 6 | DP210BRF | 4.38 | 5.03 | 3.81 | 5.00 | 5.94 | 5.91 | 5.16 | 5.74 | 5.12 | 3 |
| Average | | 4.30 | 4.65 | 4.60 | 4.57 | 5.89 | 5.79 | 5.21 | 5.77 | | |
| Ranking | | 8 | 5 | 6 | 7 | 1 | 2 | 5 | 4 | | |
| CV % | | 6.878 | | | | | | | | | |
| $LSD_t(0.05)$(PD x Cult) | | 0.2016 | | | | | | | | | |
| $LSD_t(0.05)$(Cult x PD) | | 0.1784 | | | | | | | | | |

**Bolls per plant**

Stress to plants reduces early leaf area, resulting in a smaller and older leaf area during boll set. Although the trial was an irrigation trial, drought conditions with high temperatures and little rainfall contribute to plant stress. As the growth continue under the drought conditions the plants under stress could have reached cut-out sooner for Plant Date 7 and Plant Date 8 resulting in a smaller boll load than the early Planting dates.

Cultivar DP210BRF had the highest average bolls per plant with 25 bolls per plant.

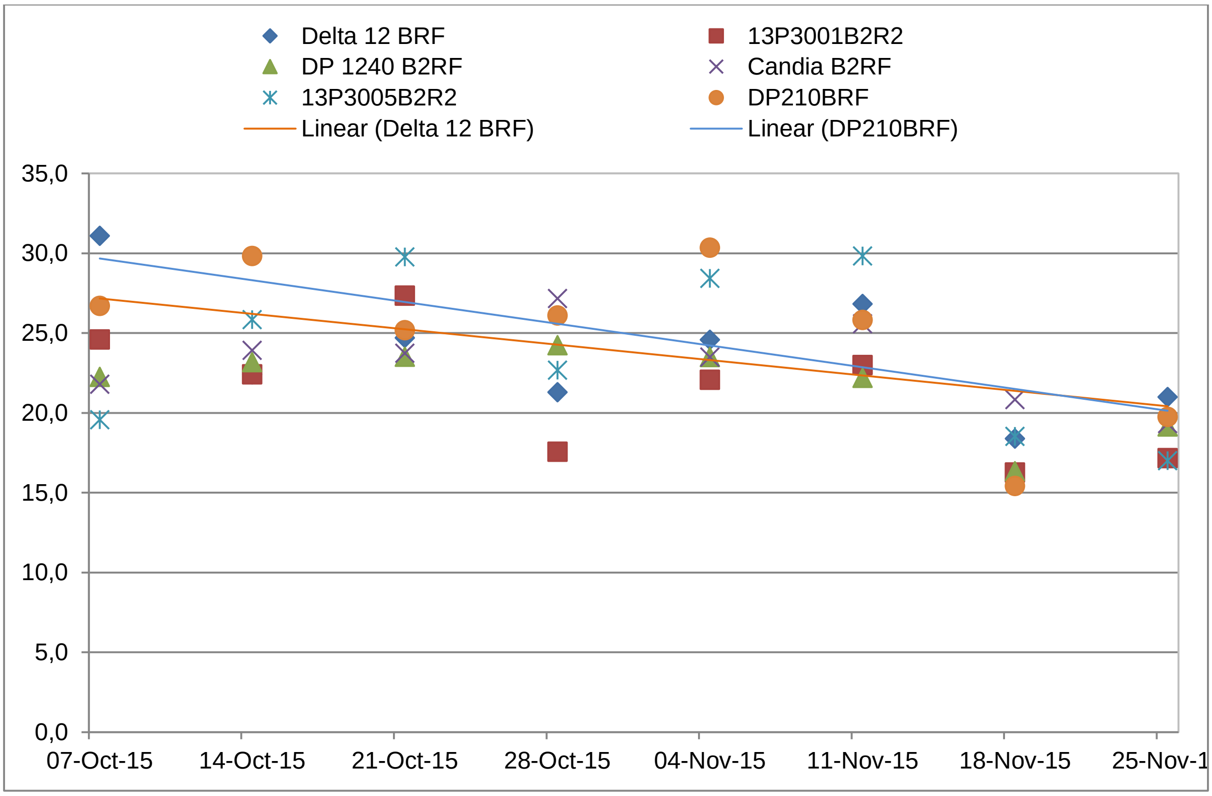


**Figure 9.** Number of Bolls per Plant

**Table 7.** Number of boll per plant

| Cultivar | | Planting dates PD 1 07/10/15 | PD 2 14/10/15 | PD 3 21/10/15 | PD 4 28/10/15 | PD 5 04/11/15 | PD 6 11/11/15 | PD 7 18/11/15 | PD 8 25/11/15 | Ave Day Bolls per plant (count) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Delta 12 BRF | 31.1 | 22.4 | 24.7 | 21.3 | 24.6 | 26.8 | 18.4 | 21.0 | 23.8 | 3 |
| 2 | 13P3001B2R2 | 24.6 | 22.4 | 27.4 | 17.6 | 22.1 | 23.0 | 16.3 | 17.2 | 21.3 | 6 |
| 3 | DP 1240 B2RF | 22.2 | 23.2 | 23.5 | 24.3 | 23.5 | 22.2 | 16.4 | 19.1 | 21.8 | 5 |
| 4 | Candia B2RF | 21.8 | 23.9 | 23.8 | 27.2 | 23.5 | 25.6 | 20.8 | 19.3 | 23.2 | 4 |
| 5 | 13P3005B2R2 | 19.6 | 25.9 | 29.8 | 22.7 | 28.4 | 29.8 | 18.5 | 17.0 | 24.0 | 2 |
| 6 | DP210BRF | 26.7 | 29.8 | 25.2 | 26.1 | 30.4 | 25.8 | 15.4 | 19.7 | 24.9 | 1 |
| Average | | 24.3 | 24.6 | 25.7 | 23.2 | 25.4 | 25.5 | 17.6 | 18.9 | | |
| Ranking | | 5 | 4 | 1 | 6 | 3 | 2 | 8 | 7 | | |
| CV % | | | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | | | | | | | | | | |

**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 reach cut-out when 95 percent of the harvested bolls at the first position have already been set.

Planting Date 5 on 4 November 2015 significantly retained more bolls at the 95 percent zone of 81.7 %. The cultivar Candia B2RF retained the highest number of bolls at the 95 percent zone of 78.9 %. The cultivar 13P3001B2R2 significantly retained the lowest number of bolls at the 95% zone of 74.4 %.

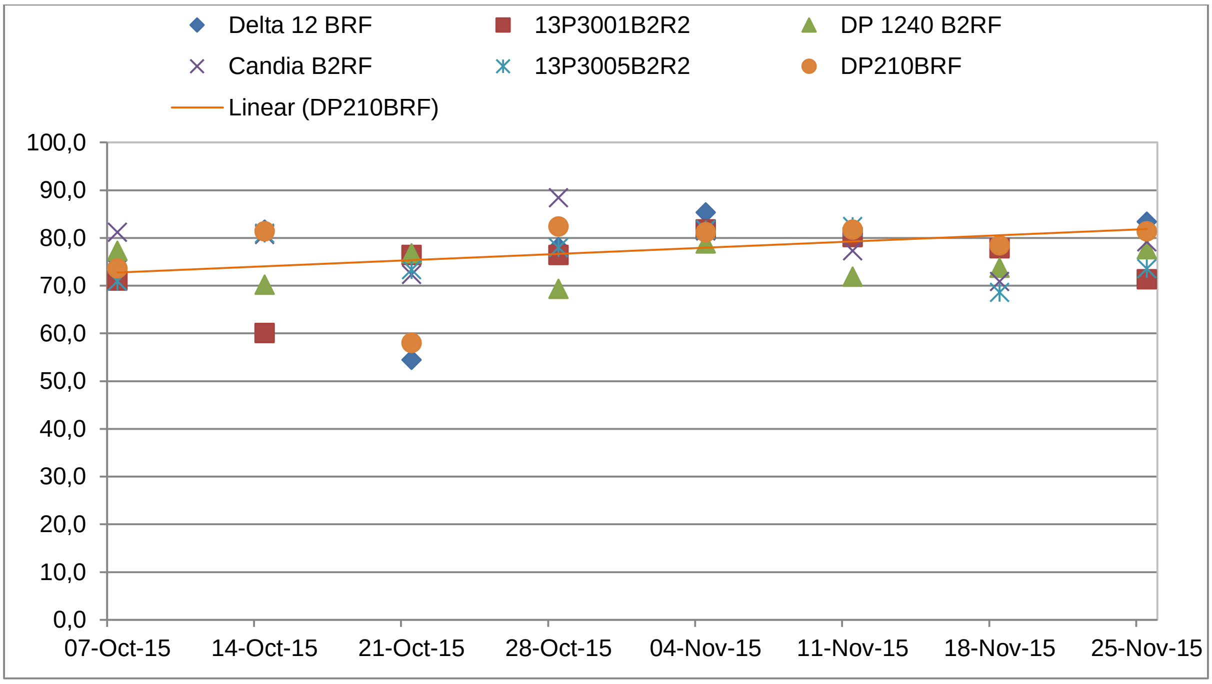


**Figure 10.** Boll retention 95 % zone

**Table 8.** Boll retention 95 % zone

| Cultivar | | Planting dates | | | | | | | | Ave retention 95 % bolls (calculated) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1 07/10/15 | PD 2 14/10/15 | PD 3 21/10/15 | PD 4 28/10/15 | PD 5 04/11/15 | PD 6 11/11/15 | PD 7 18/11/15 | PD 8 25/11/15 | | |
| 1 | Delta 12 BRF | 75.3 | 81.8 | 54.5 | 78.1 | 85.3 | 80.8 | 77.8 | 83.4 | 77.1 | 3 |
| 2 | 13P3001B2R2 | 71.0 | 60.1 | 76.4 | 76.5 | 81.8 | 80.2 | 77.9 | 71.3 | 74.4 | 6 |
| 3 | DP 1240 B2RF | 77.3 | 70.2 | 76.8 | 69.3 | 78.8 | 71.9 | 73.8 | 77.6 | 74.5 | 5 |
| 4 | Candia B2RF | 81.2 | 80.7 | 72.3 | 88.4 | 81.5 | 77.3 | 70.9 | 79.2 | 78.9 | 1 |
| 5 | 13P3005B2R2 | 71.0 | 81.0 | 73.4 | 77.9 | 81.7 | 82.4 | 68.6 | 73.6 | 76.2 | 4 |
| 6 | DP210BRF | 73.6 | 81.4 | 58.0 | 82.4 | 81.2 | 81.7 | 78.5 | 81.4 | 77.3 | 2 |
| Average | | 74.9 | 75.9 | 68.6 | 78.8 | 81.7 | 79.0 | 74.6 | 77.7 | | |
| Ranking | | 6 | 5 | 8 | 4 | 1 | 2 | 7 | 3 | | |
| CV % | | 1.284358 | | | | | | | | | |

**Seed Cotton Yield**

Very high temperatures and low rainfall through-out the growing season resulted in low yields (kg/ha). Planting Date 2 and 3 had the lowest significant yields of 3563.4 and 2817.9 kg/ha respectively (Table 14).

Significantly higher yields of 5420.2 and 5743.7 kg/ha were obtained for the Planting dates 5 and 6 respectively. Cultivar 13P3005B2R2 and 13P3001B2R2 had the highest significant yields of 5315.2 kg/ha and 5238.8 kg/ha respectively.

**Table 9.** Yield kg/ha

| Cultivar | | Planting dates | | | | | | | | Ave yield (kg/ha) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>7/10/2015 | PD 2<br>14/10/2015 | PD 3<br>21/10/2015 | PD 4<br>28/10/2015 | PD 5<br>4/11/2015 | PD 6<br>11/11/2015 | PD 7<br>18/11/2015 | PD 8<br>25/11/2015 | | |
| 1 | Delta 12 BRF | 3988.4 | 3427.7 | 662.8 | 2760.4 | 4636.7 | 4948.1 | 3435.2 | 3404.0 | 3407.9 | 6 |
| 2 | 13P3001B2R2 | 5743.9 | 3877.5 | 5291.0 | 5237.1 | 6677.6 | 6433.7 | 4402.1 | 4247.6 | 5238.8 | 2 |
| 3 | DP 1240 B2RF | 3340.5 | 2298.3 | 1977.0 | 3286.8 | 4770.3 | 5201.4 | 3588.4 | 3641.9 | 3513.1 | 5 |
| 4 | Candia B2RF | 3675.7 | 3439.4 | 2434.1 | 3543.3 | 4544.2 | 4397.2 | 4104.4 | 2927.8 | 3633.3 | 4 |
| 5 | 13P3005B2R2 | 5348.9 | 5425.1 | 5459.9 | 5338.6 | 6714.9 | 6962.5 | 3755.6 | 3516.0 | 5315.2 | 1 |
| 6 | DP210BRF | 4988.7 | 2912.5 | 1082.6 | 3949.7 | 5177.7 | 6519.5 | 3698.5 | 3260.5 | 3948.7 | 3 |
| Average | | 4514.3 | 3563.4 | 2817.9 | 4019.3 | 5420.2 | 5743.7 | 3830.7 | 3499.6 | | |
| Ranking | | 3 | 6 | 8 | 4 | 2 | 1 | 5 | 7 | | |
| CV % | | 0.0218 | | | | | | | | | |
| $LSD_t$(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 13P3005B2R2 and 13P3005B2R2 had the highest significant fibre% of 44.5 and 44.2 % respectively.

**Table 10.** Fibre %

| Cultivar | | Planting dates | | | | | | | | Ave Fibre % | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>7/10/2015 | PD 2<br>14/10/2015 | PD 3<br>21/10/2015 | PD 4<br>28/10/2015 | PD 5<br>4/11/2015 | PD 6<br>11/11/2015 | PD 7<br>18/11/2015 | PD 8<br>25/11/2015 | | |
| 1 | Delta 12 BRF | 37.9 | 39.9 | 37.2 | 40.1 | 37.9 | 39.4 | 41.8 | 39.2 | 39.2 | 6 |
| 2 | 13P3001B2R2 | 42.8 | 42.9 | 44.7 | 45.4 | 43.5 | 45.0 | 45.4 | 44.0 | 44.2 | 2 |
| 3 | DP 1240 B2RF | 40.7 | 39.8 | 41.0 | 42.5 | 40.8 | 41.9 | 42.6 | 41.4 | 41.3 | 5 |
| 4 | Candia B2RF | 42.8 | 43.9 | 44.5 | 42.5 | 44.4 | 45.0 | 45.4 | 44.5 | 44.1 | 3 |
| 5 | 13P3005B2R2 | 43.8 | 44.3 | 45.0 | 45.3 | 42.7 | 45.8 | 45.4 | 43.5 | 44.5 | 1 |
| 6 | DP210BRF | 39.9 | 41.0 | 42.3 | 47.1 | 45.3 | 41.7 | 42.2 | 41.6 | 42.6 | 4 |
| Average | | 41.3 | 42.0 | 42.4 | 43.8 | 42.4 | 43.2 | 43.8 | 42.4 | | |
| Ranking | | 6 | 5 | 4 | 1 | 4 | 2 | 1 | 3 | | |
| CV% | | 2.19 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.5377 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.3939 | | | | | | | | | |

**Boll size**

Boll sizes for Planting Dating 6 was significantly larger with a boll size of 5.8 g. The cultivar 13P3001B2R2 average boll size of 5.84 g over planting dates was significantly more than the other cultivars.

**Table 11.** Boll size (g)

| Cultivar | | Planting dates | | | | | | | | Ave Boll size (g) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>7/10/2015 | PD 2<br>14/10/2015 | PD 3<br>21/10/2015 | PD 4<br>28/10/2015 | PD 5<br>4/11/2015 | PD 6<br>11/11/2015 | PD 7<br>18/11/2015 | PD 8<br>25/11/2015 | | |
| 1 | Delta 12 BRF | 5.1 | 4.9 | 4.7 | 4.9 | 5.3 | 5.2 | 5.1 | 5.0 | 5.02 | 5 |
| 2 | 13P3001B2R2 | 5.5 | 5.7 | 5.9 | 5.8 | 6.1 | 6.2 | 5.7 | 5.8 | 5.84 | 1 |
| 3 | DP 1240 B2RF | 5.4 | 5.7 | 6.0 | 5.3 | 5.8 | 5.9 | 5.2 | 5.0 | 5.54 | 4 |
| 4 | Candia B2RF | 5.0 | 5.1 | 5.3 | 4.7 | 5.1 | 5.1 | 5.0 | 4.6 | 5.00 | 6 |
| 5 | 13P3005B2R2 | 6.1 | 5.9 | 5.8 | 5.8 | 5.8 | 5.9 | 5.8 | 5.4 | 5.80 | 2 |
| 6 | DP210BRF | 5.4 | 5.8 | 5.9 | 5.3 | 6.0 | 6.2 | 5.3 | 5.5 | 5.67 | 3 |
| Average | | 5.4 | 5.5 | 5.6 | 5.3 | 5.7 | 5.8 | 5.3 | 5.2 | | |
| Ranking | | 5 | 4 | 3 | 6 | 2 | 1 | 6 | 7 | | |
| CV % | | 6.234 | | | | | | | | | |
| $LSD_t(0.05)$(PD x Cult) | | 0.1959 | | | | | | | | | |
| $LSD_t(0.05)$(Cult x PD) | | 0.1697 | | | | | | | | | |

**Fibre length**

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

The cultivar, DP210BRF resulted in the longest average fibre length of average 31.2 mm followed by 13P3001B2R2 with a fibre length of 30.6 mm. From the combined analysis for planting dates over planting dates, in Planting Date 5 the cultivar DP210BRF resulted in a significantly higher fibre length of 32.0 mm.

**Table 12.** Fibre length (mm)

| Cultivar | | Planting dates | | | | | | | | Ave Length (mm) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1 7/10/2015 | PD 2 14/10/2015 | PD 3 21/10/2015 | PD 4 28/10/2015 | PD 5 4/11/2015 | PD 6 11/11/2015 | PD 7 18/11/2015 | PD 8 25/11/2015 | | |
| 1 | Delta 12 BRF | 28.7 | 29.1 | 29.7 | 30.4 | 30.2 | 29.6 | 29.3 | 30.0 | 29.6 | 5 |
| 2 | 13P3001B2R2 | 29.5 | 29.8 | 31.0 | 31.3 | 30.8 | 31.0 | 30.7 | 30.4 | 30.6 | 2 |
| 3 | DP 1240 B2RF | 29.5 | 29.4 | 30.0 | 30.4 | 31.5 | 30.7 | 29.9 | 30.8 | 30.3 | 3 |
| 4 | Candia B2RF | 29.8 | 22.8 | 22.8 | 23.1 | 31.2 | 31.0 | 30.7 | 31.1 | 27.8 | 6 |
| 5 | 13P3005B2R2 | 28.8 | 29.4 | 30.4 | 30.3 | 30.4 | 30.6 | 29.6 | 30.2 | 30.0 | 4 |
| 6 | DP210BRF | 30.3 | 30.1 | 31.3 | 31.6 | 32.0 | 31.5 | 31.7 | 31.2 | 31.2 | 1 |
| Average | | 29.4 | 28.4 | 29.2 | 29.5 | 31.0 | 30.7 | 30.3 | 30.6 | | |
| Ranking | | 6 | 8 | 7 | 5 | 1 | 3 | 4 | 2 | | |
| CV % | | 2.734 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.4763 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.4124 | | | | | | | | | |

**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 13.** Uniformity index

| Cultivar | | Planting dates | | | | | | | | Ave Unifor-mity | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>7/10/2015 | PD 2<br>14/10/2015 | PD 3<br>21/10/2015 | PD 4<br>28/10/2015 | PD 5<br>4/11/2015 | PD 6<br>11/11/2015 | PD 7<br>18/11/2015 | PD 8<br>25/11/2015 | | |
| 1 | Delta 12 BRF | 82.77 | 83.2 | 83.4 | 83.0 | 82.7 | 81.5 | 82.2 | 84.7 | 82.9 | 6 |
| 2 | 13P3001B2R2 | 84.17 | 85.1 | 85.3 | 85.6 | 84.5 | 84.7 | 84.9 | 86.5 | 85.1 | 1 |
| 3 | DP 1240 B2RF | 84.81 | 84.3 | 84.2 | 84.9 | 84.4 | 83.9 | 83.8 | 83.9 | 84.3 | 3 |
| 4 | Candia B2RF | 84.49 | 83.6 | 84.7 | 83.7 | 83.0 | 82.9 | 82.3 | 83.8 | 83.6 | 5 |
| 5 | 13P3005B2R2 | 83.52 | 84.2 | 84.7 | 84.5 | 84.5 | 83.9 | 85.8 | 83.8 | 84.4 | 2 |
| 6 | DP210BRF | 82.96 | 83.9 | 84.1 | 84.3 | 84.1 | 83.2 | 83.3 | 84.4 | 83.8 | 4 |
| Average | | 83.8 | 84.1 | 84.4 | 84.3 | 83.9 | 83.4 | 83.7 | 84.5 | | |
| Ranking | | 6 | 4 | 2 | 3 | 5 | 8 | 7 | 1 | | |
| CV % | | 1.0054 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.489 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.4232 | | | | | | | | | |

**Fibre strength**

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

The cultivar Delta1240B2RF significantly gave the strongest fibres of 30.8 g/tex. From the combined analysis for planting dates over cultivars, Delta1240B2RF resulted in significantly stronger fibres of 32.1 g/tex at Planting Date 2. Planting Date 2 resulted in the strongest fibres of 29.9 g/tex.

**Table 14.** Fibre strength (g/tex)

| Cultivar | | Planting dates | | | | | | | | Ave Fibre Strength (g/tex) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>7/10/2015 | PD 2<br>14/10/2015 | PD 3<br>21/10/2015 | PD 4<br>28/10/2015 | PD 5<br>4/11/2015 | PD 6<br>11/11/2015 | PD 7<br>18/11/2015 | PD 8<br>25/11/2015 | | |
| 1 | Delta 12 BRF | 27.77 | 28.0 | 28.5 | 27.3 | 28.1 | 27.8 | 27.5 | 26.5 | 27.7 | 6 |
| 2 | 13P3001B2R2 | 28.31 | 29.7 | 30.6 | 29.0 | 29.2 | 29.3 | 29.0 | 28.6 | 29.2 | 4 |
| 3 | DP 1240 B2RF | 31.25 | 32.1 | 30.5 | 30.1 | 31.8 | 29.7 | 30.2 | 30.9 | 30.8 | 1 |
| 4 | Candia B2RF | 26.68 | 29.3 | 29.5 | 28.3 | 28.1 | 27.7 | 27.9 | 28.9 | 28.3 | 5 |
| 5 | 13P3005B2R2 | 28.62 | 30.4 | 29.7 | 29.8 | 30.2 | 29.2 | 27.0 | 29.6 | 29.3 | 3 |
| 6 | DP210BRF | 28.78 | 29.8 | 30.0 | 30.3 | 30.7 | 28.9 | 29.3 | 27.5 | 29.4 | 2 |
| Average | | 28.6 | 29.9 | 29.8 | 29.1 | 29.7 | 28.8 | 28.5 | 28.7 | | |
| Ranking | | 7 | 1 | 2 | 4 | 3 | 5 | 8 | 6 | | |
| CV % | | 4.374 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.7377 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.6388 | | | | | | | | | |

## Elongation

The Planting Date 8 significantly resulted in the higher fibre elongation of 8.5. The cultivar 13P3005B2R2 resulted in the highest fibre elongation of 8.5.

**Table 15.** Elongation

| Cultivar | | Planting dates | | | | | | | | Ave fibre elonga-tion | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>7/10/2015 | PD 2<br>14/10/2015 | PD 3<br>21/10/2015 | PD 4<br>28/10/2015 | PD 5<br>4/11/2015 | PD 6<br>11/11/2015 | PD 7<br>18/11/2015 | PD 8<br>25/11/2015 | | |
| 1 | Delta 12 BRF | 7.96 | 7.5 | 7.9 | 7.4 | 7.8 | 7.8 | 8.1 | 9.2 | 8.0 | 3 |
| 2 | 13P3001B2R2 | 8.63 | 8.5 | 8.0 | 8.3 | 8.2 | 8.4 | 8.8 | 9.3 | 8.5 | 1 |
| 3 | DP 1240 B2RF | 8.49 | 8.4 | 8.0 | 8.4 | 7.7 | 7.9 | 8.6 | 8.2 | 8.2 | 2 |
| 4 | Candia B2RF | 8.05 | 7.5 | 7.3 | 7.6 | 7.1 | 7.4 | 7.4 | 7.9 | 7.5 | 5 |
| 5 | 13P3005B2R2 | 8.17 | 8.3 | 7.6 | 8.0 | 7.8 | 7.9 | 9.1 | 8.5 | 8.2 | 2 |
| 6 | DP210BRF | 7.61 | 7.8 | 7.1 | 7.4 | 7.5 | 7.6 | 7.9 | 7.7 | 7.6 | 4 |
| Average | | 8.2 | 8.0 | 7.7 | 7.9 | 7.7 | 7.8 | 8.3 | 8.5 | | |
| Ranking | | 3 | 4 | 7 | 5 | 7 | 6 | 2 | 1 | | |
| CV % | | 6.906 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.2776 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.2404 | | | | | | | | | |

**Micronaire**

Planting cotton too early, resulted in very thick fibres with micronaires above 4.4µgram. Planting Date 1, 2, 3 and 4 resulted in average micronaires of 4.5 µgram, 4.5 µgram, 4.5 µgram and 4.3 µgram respectively. The cultivar Candia B2RF had the best micronaire average over the planting dates with a micronaire of 3.5 µgram. Candia B2RF resulted in good micronaires over all the planting dates.

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

**Table 16.** Micronaire (μgrams)

| Cultivar | | Planting dates | | | | | | | | Ave Micro-naire (μg) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1 7/10/2015 | PD 2 14/10/2015 | PD 3 21/10/2015 | PD 4 28/10/2015 | PD 5 4/11/2015 | PD 6 11/11/2015 | PD 7 18/11/2015 | PD 8 25/11/2015 | | |
| 1 | Delta 12 BRF | 4.3 | 4.2 | 4.3 | 4.0 | 3.8 | 3.7 | 3.9 | 3.6 | 4.0 | 5 |
| 2 | 13P3001B2R2 | 4.9 | 4.7 | 4.9 | 4.8 | 4.5 | 4.4 | 4.6 | 4.5 | 4.7 | 2 |
| 3 | DP 1240 B2RF | 4.6 | 4.6 | 4.1 | 4.5 | 4.2 | 4.1 | 4.3 | 4.0 | 4.3 | 3 |
| 4 | Candia B2RF | 3.8 | 4.1 | 3.9 | 3.7 | 3.2 | 3.0 | 3.7 | 3.6 | 3.6 | 6 |
| 5 | 13P3005B2R2 | 5.0 | 4.9 | 5.0 | 4.8 | 4.6 | 4.5 | 4.7 | 4.6 | 4.8 | 1 |
| 6 | DP210BRF | 4.5 | 4.5 | 4.3 | 4.3 | 3.4 | 4.1 | 4.0 | 3.5 | 4.1 | 4 |
| Average | | 4.5 | 4.5 | 4.4 | 4.4 | 3.9 | 4.0 | 4.2 | 3.9 | | |
| Ranking | | 1 | 1 | 2 | 2 | 5 | 4 | 3 | 5 | | |
| CV % | | 7.158 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.1729 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.1497 | | | | | | | | | |

**Yellowness and Degree of reflectance**

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 17.** Yellowness (+b < 9)

| Cultivar | | Planting dates | | | | | | | | Ave Yellow-ness (+b < 9) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1<br>7/10/2015 | PD 2<br>14/10/2015 | PD 3<br>21/10/2015 | PD 4<br>28/10/2015 | PD 5<br>4/11/2015 | PD 6<br>11/11/2015 | PD 7<br>18/11/2015 | PD 8<br>25/11/2015 | | |
| 1 | Delta 12 BRF | 6.9 | 6.9 | 6.9 | 6.5 | 6.8 | 6.5 | 6.3 | 6.0 | 6.6 | 4 |
| 2 | 13P3001B2R2 | 7.2 | 7.1 | 7.2 | 6.7 | 7.2 | 6.8 | 6.1 | 6.2 | 6.8 | 3 |
| 3 | DP 1240 B2RF | 8.2 | 8.3 | 7.9 | 7.8 | 7.8 | 7.2 | 7.0 | 7.1 | 7.6 | 1 |
| 4 | Candia B2RF | 7.1 | 7.5 | 7.0 | 6.9 | 7.0 | 6.5 | 6.3 | 6.4 | 6.8 | 3 |
| 5 | 13P3005B2R2 | 7.8 | 7.5 | 7.7 | 7.6 | 7.8 | 6.8 | 6.8 | 7.0 | 7.4 | 2 |
| 6 | DP210BRF | 7.5 | 7.1 | 6.7 | 6.8 | 6.9 | 6.6 | 6.5 | 6.3 | 6.8 | 3 |
| Average | | 7.4 | 7.4 | 7.2 | 7.1 | 7.3 | 6.8 | 6.5 | 6.5 | | |
| Ranking | | 1 | 1 | 3 | 4 | 2 | 5 | 6 | 6 | | |
| CV % | | 5.08 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.2043 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.1669 | | | | | | | | | |

**Table 18.** Degree of reflectance (RD ≥75)

| Cultivar | | Planting dates | | | | | | | | Ave Degree of reflectance (RD ≥ 75) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PD 1 7/10/2015 | PD 2 14/10/2015 | PD 3 21/10/2015 | PD 4 28/10/2015 | PD 5 4/11/2015 | PD 6 11/11/2015 | PD 7 18/11/2015 | PD 8 25/11/2015 | | |
| 1 | Delta 12 BRF | 79.4 | 82.18 | 82.8 | 85.1 | 81.1 | 80.3 | 79.4 | 80.3 | 81.3 | 3 |
| 2 | 13P3001B2R2 | 79.5 | 80.76 | 82.7 | 84.3 | 81.0 | 80.0 | 81.1 | 81.6 | 81.4 | 2 |
| 3 | DP 1240 B2RF | 77.8 | 79.10 | 82.1 | 82.2 | 79.4 | 78.4 | 77.1 | 78.6 | 79.3 | 6 |
| 4 | Candia B2RF | 79.9 | 82.27 | 84.5 | 84.1 | 81.6 | 80.8 | 80.7 | 80.7 | 81.8 | 1 |
| 5 | 13P3005B2R2 | 78.7 | 80.55 | 82.9 | 82.9 | 79.3 | 79.1 | 79.3 | 79.6 | 80.3 | 5 |
| 6 | DP210BRF | 80.8 | 81.01 | 81.9 | 84.5 | 80.3 | 79.5 | 79.5 | 80.9 | 81.1 | 4 |
| Average | | 79.3 | 81.0 | 82.8 | 83.9 | 80.4 | 79.7 | 79.5 | 80.3 | | |
| Ranking | | 8 | 3 | 2 | 1 | 4 | 6 | 7 | 5 | | |
| CV % | | 0.906 | | | | | | | | | |
| $LSD_t$(0.05)(PD x Cult) | | 0.4587 | | | | | | | | | |
| $LSD_t$(0.05)(Cult x PD) | | 0.397 | | | | | | | | | |

## CONCLUSION

Clear differences were recorded between the October and November plantings. Environmental conditions throughout the cotton growing season had influenced the growing rate of the different cultivars. It is very difficult to find a particular cultivar suited for planting early in the cotton growing season because unstable environmental conditions occurred continuously.

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

## PROPOSED RESEARCH FOR 2016/17

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

| | | |
|---|---|---|
| **PROJECT NUMBER** | **:** | 101795 |
| **PROJECT TITLE** | **:** | Biological control of nematodes on cotton |
| **PROJECT MANAGER** | **:** | SC Khuzwayo |
| **CO-WORKER(S)** | **:** | LN Malinga<br>I Beyleveld<br>S Magapong |
| **DURATION** | **:** | 15/11/2015 – 30/11/2016 |
| **PROVINCES** | **:** | Northern Cape, North West |
| **LOCALITIES** | **:** | Field trial: Vaalharts,<br>Pot trial: ARC-IIC, Rustenburg |

**DESCRIPTION OF THE PROBLEM**

Cotton (*Gossypium* spp.) is the world's leading fibre crop, and an important source of edible oil. Root-knot nematodes (RKN), in particular *Meloidogyne incognita* race 4 is the predominant nematode species and race that adversely affects the production of cotton in South Africa and thus result in substantial yield losses (De Beer, 2010). *Meloidogyne* species has partly rendered various pest management programs already in place ineffective therefore putting food security of the continent at risk (Onkendi *et al*., 2014). Results have indicated that the damage to cotton done by *M. incognita* race 4 can be quite severe and that yield losses in sandy soils with a heavy *M. incognita* race 4 infestation can be as much as 40% (Van Biljon, 2007). With this in mind, it is essential that the full spectrum of crop production limitations is considered appropriately, including the often overlooked nematode constraints (Nicol *et al*., 2011). Chemical nematicides remain the most reliable means of controlling root-knot nematodes globally. However, due to their toxicity to humans and the growing pressure from environmentalist groups, chemical nematicides are increasingly being withdrawn from the market both internationally and locally here in South Africa. For many years Temik® has been the most commonly used nematicide. Its sudden withdrawal from the market early in 2011 left growers with much to think about (The Link, 2012).

## IMPACT OF THE PLANNED RESULT

The planned result should assist farmers choose the most effective chemical and biological control agents against root-knot nematode on cotton, to increase yields to such an extent that it comes economically viable.

## MOTIVATION FOR THE PROJECT

Cotton creates thousands of jobs in South Africa as it moves from field to fabric. It is of vital importance to reduce the occurrence of damaging nematode species especially *Meloidogyne incognita* race 4 on cotton. Since Temik® has been removed from the market, which was the main nematicide used on cotton in South Africa, producers have been left with limited options. There are no commercial cotton varieties resistant to root-knot nematodes and the limited availability of nematicides needs to be carefully evaluated for farmers to use products that will produce better yield and good quality. It is therefore imperative to evaluate some of the available nematicides and biological agents.

## OBJECTIVES

To evaluate the effect of nematicides and biological agents for the management of nematodes in a cotton farming system under field and greenhouse conditions.

## POSSIBILITY OF TECHNOLOGY TRANSFER

To commercial and small-scale cotton farmers through field days and articles.

## EXPERIMENTAL PROCEDURES

### Field trial

A field experiment was conducted at Vaalharts irrigation scheme in the Northern Cape Province of South Africa.  Various products were evaluated viz:

i. Untreated control,
ii. Vydate CLV,
iii. Seed Treatment,
iv. OR_079 + Vydate CLV,
v. OR_079,

vi. OR_079 + Or 151.

The experiment comprised of a randomized block design with 6 treatments, replicated 6 times and consist of six rows of 5m. Four center rows were used as the data rows to eliminate any side effects. Nematodes was extracted according to the procedure of Jenkins (1964) from one 250-ml sub-sample taken from the composite sample from each plot for identification and quantification of all plant parasitic nematodes (PPN) present. Then nematode samples (for soil and roots) counting was done before planting, 6 weeks after planting and 12 weeks after planting. Rating index was established for root-knot nematode and plant parameters for yield. To determine nematode root infestation, four randomly selected plants from the four center rows of each plot was sampled 12 weeks after planting each crop. Nematodes was extracted from the excised roots by maceration and sugar-centrifugal flotation (Coolen and D'Herde, 1972) for identification and quantification of all PPN present. The nematode data will be $\log_e$ (no. + 1) transformed for analysis (Van Ark, 1981). Data will be analysed using Genstat and subjected to an analysis of variance. Means was compared by Tukey's multiple range test ($P \leq 0.05$).

**Pot trial**

Pot trial is being conducted in Rustenburg (North West Province) at ARC-IIC. Three cotton seeds were sown directly in the pots. For the evaluation, 80 pots containing 3 kg pasteurised soil, were used. The experiments were devised in a randomized block design with 10 replications per treatment. The necessary contact insecticides and fungicides were applied and normal maintenance practises followed by application of fertilizer per pot before planting. LAN was added after emergence and repeated 10 days later. Contamination with extraneous nematodes was prevented. The plants were irrigated twice a day using an automatic micro-irrigation system. The DP 1518 B2XF Deltapine bollguard 2 by Monsanto was used in the trial. The following nematicides/bio-nematicides and environmental-friendly products are being evaluated:

i. Untreated control,
ii. Vydate CLV,
iii. Seed Treatment,
iv. OR_079 + Vydate CLV,
v. OR_079,
vi. OR_079 + Or 151.

Nematode sampling was done before planting (soil) and at 6 weeks and 12 weeks after planting. Final sampling (soil and roots) will be done at 50% boll opening. The following plant parameters will also be determined: plant height, fresh and dry aerial mass, fresh root mass and root galls rated according to an index of 0 – 5. The nematode data was $\log_e$ (no. + 1) transformed for analysis (Van Ark 1981). Data will be analysed using Genstat and subjected to an analysis of variance. Means will be compared by Tukey's multiple range test ($P \leq 0.05$).

## RESULTS AND DISCUSSION

Analysis of data for the field trial is currently in process and the results will be available before the end of August 2016.

| | | |
|---|---|---|
| **PROJECT NUMBER** | **:** | TK 205/29 (000629) |
| **PROJECT TITLE** | **:** | Survey of current status of disease and pests on cotton in South Africa |
| **PROJECT MANAGER** | **:** | LN Malinga |
| **CO-WORKER(S)** | **:** | Dr HB Tesfagiorgis<br>P Mphuthi<br>S Khuzwayo<br>I Beyleveld<br>I Kolobe |

## DESCRIPTION OF THE PROBLEM

Cotton has been an important crop in the socio-economic development of South Africa. However, cotton production is of an intensive cost and any yield less than optimal has a direct impact on the profitability of the farming. Cotton is susceptible to a wide range of plant pathogens and insect pests that have significant impact on the yield and quality of the fibre. The damage by these organisms is more severe on farmers from developing countries who lack the knowledge of these pests and are limited with their control inputs and availability of options compared to the ones from first world.

## MOTIVATION FOR THE PROJECT

Although incidences of pests and diseases is not new in South African cotton farmers, there is no recent information that reflects the current status on cotton. The last survey conducted to deal with these issues was performed more than 13 years ago. With the introduction of new cultivars by some of the leading seed companies in South Africa, the relevance of pests and diseases and the damage associated with them might have changed. Hence, it is imperative that such a survey is conducted to assess the status of the most important diseases and pests of cotton in selected areas to get an updated information. This survey would also give relevant information especially on the agronomic and other activities of the farmers on the dynamics of the pests and diseases and their management.

## OBJECTIVES

To determine the relevance or current status of pests on cotton in South Africa

## EXPERIMENTAL PROCEDURES

The survey will consist of two components. The first will involve an electronic survey of all cotton producers, both commercial and smallholder, to determine the current status and knowledge on pests and diseases, as well as production practices being used which could influence these. This survey will be done through the auspices of Cotton SA. The second part will involve field surveys that will be conducted to assess the incidence and relate the results with the farmers' perception. The outcome of these surveys is expected to provide critical information for further research to establish threshold levels of the most economically important pests and diseases and develop sustainable control options that would meet the farmers' needs.

The questionnaire for the survey has been developed in collaboration with Cotton SA. The electronic survey will be conducted before the end of2016 and the field surveys during the 2016/17 season.

# COTTON SURVEY QUESTIONNAIRE

1) How many hectares do you plant under irrigation, _____and how many hectares under dryland conditions _______?

2) Typical environmental conditions and soil type of your field/region

| Average rainfall | Minimum temperature | Maximum temperature | Soil type |
|---|---|---|---|
| | | | |

3) Do you practice conservation agriculture?

| Yes | No |
|---|---|
| | |

4) Do you make use of soil analysis?

| Yes | No |
|---|---|
| | |

5) How do you harvest your produce?

| Hand pick | Machine | Both |
|---|---|---|
| | | |

6) What was your average yield per hectare for the past 5 seasons? ______________

7) Variety information

a. Names of varies usually planted

_____________________________________

_____________________________________

_____________________________________

b. Type of your favourite variety

| GM | Non-GM |
|---|---|
| | |

c. Resistance of the variety to diseases and insects

| | Yes | No | I don't know |
|---|---|---|---|
| Resistance to diseases | | | |
| Resistance to insects | | | |

If resistant to diseases, please mention the names______________________________

If resistant to insects, please mention the names_______________________________

8) Has a researcher (agronomist/plant pathologist/entomologist) visited your field?

| Yes | No |
|---|---|
| | |

If yes, when was the last time they visited your field: _________________________

9) Awareness, incidence and economic importance of diseases and pests

a. Diseases

| | Do you know it | | Occurrence | | Ranking on damage they cause (1-5) |
|---|---|---|---|---|---|
| | Yes | No | Common | rare | |
| a. Seedling disease | | | | | |
| b. Bacterial blight | | | | | |
| c. Verticillium wilt | | | | | |
| d. Fusarium wilt | | | | | |
| e. Nematodes | | | | | |
| f. Alternaria leaf spot | | | | | |
| g. Wet-weather blight | | | | | |
| h. False mildew | | | | | |
| i. Boll rot | | | | | |
| j. Virus diseases | | | | | |
| k. other | | | | | |

Ranking: 1= causes severe yield loss, 2 = causes significant yield loss; 3=causes moderate loss; 3= low yield loss; 5= causes no yield loss (not important)

b. Insect pests

| | Do you know it? | | Occurrence | | Ranking on the damage they cause |
|---|---|---|---|---|---|
| | Yes | No | Common | rare | |
| a. Bollworms | | | | | |
| b. Aphids | | | | | |
| c. Cotton stainers | | | | | |
| d. Jassids/leafhoppers | | | | | |
| e. Whiteflies | | | | | |
| f. Ants/termites | | | | | |
| g. Spider mites | | | | | |
| h. Spiders | | | | | |
| i. Parasitic wasps | | | | | |
| j. Ladybirds | | | | | |
| k. Other | | | | | |

Ranking: 1= causes severe yield loss, 2 = causes significant yield loss; 3=causes moderate loss; 3= low yield loss; 5= causes no yield loss (not important)

10) Which management strategies do you use to protect your cotton from damages by diseases and pests (please indicate with **X** in the table below)

| | No control | Farming practices | Chemical application | Use of resistance cultivars | Biological control | Others |
|---|---|---|---|---|---|---|
| Disease | | | | | | |
| Insect pests | | | | | | |

11) Which factor was the most limiting to your cotton yields?

| Irrigation | fertilizer | labour | climate | disease | insects | weeds |
|---|---|---|---|---|---|---|
| | | | | | | |

12) If you could choose, in which area of cotton production would you like to see research?

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