If you are participating in the presentations this year, please provide a written report and a copy of your final report presentation by 31 October.
If not, please provide a written report by 30 September.

Part 1 - Summary Details

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

CRDC Project Number: **SIAC1201**

Project Title: The effect of plant density on yield, profit and boll disorders in CQ Cotton

Project Commencement Date: 24/09/2011 **Project Completion Date:** 30/06/2012

CRDC Program: 2. Farming Systems

Part 2 – Contact Details

Administrator: Jamie Iker Director/agronomist
Organisation: Spackman Iker Ag Consulting
Postal Address: PO Box 1029 Emerald QLD 4720
Ph: 0418 820 958 **Fax:** (07) 49 821 348 **E-mail:** jiker@siac.com.au

Principal Researcher: Jamie Iker Director/agronomist
Organisation: Spackman Iker Ag Consulting
Postal Address: PO Box 1029 Emerald QLD 4720
Ph: 0418 820 958 **Fax:** (07) 49 821 348 **E-mail:** jiker@siac.com.au

Supervisor: (Name & position of senior scientist overseeing the project).
Organisation:
Postal Address:
Ph: **Fax:** **E-mail:**

Signature of Research Provider Representative:

Part 2 – Final Report Executive Summary

Due to the large percentage of Boll disorders and diseases that have occurred in Central Queensland Cotton production system in recent years, growers and advisers are attempting to find some answers to eliminate the risk of these occurring. The following project is a concept which is taken from the canopy management concept that a reduction of the canopy density can reduce the humidity in the crop, thus alleviating potential boll disorder conditions in wet seasons. This project looked at reduction of the plant stand within a linear metre of row to study the effect of the increase or decrease in plant densities on yield and boll disorders.

The season was an extremely wet season, at the time of boll opening and at picking, which was perfect for the results of this trial. However, due to some shortcomings of the experimental design and procedure, there was no significant difference in the trial, despite there being some areas where, with further research, may have some potential trends. In addition to the extremely wet finish to the season, a December hail storm heavily impacted on the crop which also may have affected the results negatively.

In order to completely understand this concept, the trial needs to be re-visited and conducted in such a way to alleviate any of the shortcomings of this pilot study and to ensure that the results and data are such that they can begin to provide a picture of what may be causing some of these events. Climatic conditions should be recorded within treatments in future trials, as this will assist in identifying what parameters are causing these disorder events. There is a limited amount of information available to the industry on how these disorders can be controlled or mitigated and therefore more research should be conducted in line with these ideas to assist the industry in combating these problems.

Part 3 – Final Report Guide (due 31 October)

Background

In recent years Central Queensland has had major impacts of boll disorders at harvest, which has severely impacted on the final productivity of the region. The effect of plant density on yield profit and boll disorders project was designed to attempt to identify how big an effect plant density and therefore crop canopy effected crop's performance in CQ cotton. This was a topic that had been observed in trials in previous seasons and countries more specifically high nitrogen, humidity, temperature and plant densities have an impact on boll disorders, namely hard lock (Jones et al, 2000; Marois et al, 2002; Marois and Wright, 2003; Wright et al, 2004) in the US.

Anecdotal evidence from Central Queensland suggests that all of these factors influence the boll disorders seen in the region every season. These are referred to as "Boll rot events" and are usually anecdotally linked with monsoonal or tropical weather events of high humidity, prolonged and consistent overcast weather and consistent rainfall; within a given season. As many of these factors cannot be controlled, plant density has been chosen as something that can be influenced and thus trialled to identify its benefits.

Objectives

The objective of this trial was to plant four different densities using commercial equipment to replicate what the commercial operation would be like, if and when adopted. These densities were studied throughout the season to gain some quantitative data to assist in identifying if there is a net benefit in reducing plant densities.

Methods

There were two separate planting methods for this trial, both hand-thinned and commercially planted plots. The commercially planted plots were planted with a brush-type precision planter at a seeding rate of ***5 seeds per metre***, ***9 seeds per metre***, ***14 seeds per metre*** and ***16.5 seeds per metre***. These were to form the basis of the densities 4, 8, 12 and 16 plants per metre respectively.

The second component of the experiment was to hand-thin plots to achieve the exact planting density that was required. The hand thinned areas were treated separate with segmented picking and growth habit observations being collected from these plots.

The in-crop monitoring program was composed of mainly photographic observations, one plant map and then hand picking.

Hand picking was achieved with a segmented pick (box map) and a general pick which was to simulate a machine picking operation. The general pick also involved making assessments with the type and number of boll disorders within that section. The general picking sections were 1 metre per plot and the segmented pick was also one metre per plot.

Boll disorders were identified by the way in which the bolls behaved once squeezed in the palm of the hand, if the boll disintegrated, it was deemed to be a boll rot boll but if the boll crumbled but stayed relatively intact, it was deemed to be a tight lock boll. These hand harvested packages were then weighed and tabulated for statistical analysis.

Results

The statistical analysis of the results of the trial are as follows below, there is discussion of each set of graphs after each section with more discussion in **Outcomes.**

Summary Statistics of the Data

Table 1 – Summary statistics of the data

Variable	Minimum	Mean	Maximum	St. Dev.
Actual yield (B/Ha)	3.21	5.13	8.99	1.57
Bales/Ha	4.95	5.22	5.43	0.20
Bollrot (%)	11	19	30	6
Tight lock (%)	7	16	30	6
Seed Rot (%)	8	16	24	5

Analysis

Actual Yield = Treatment + Rep + Bollrot + Seed rot + Tight lock

Table 2 – Results of the analysis of Actual Yield (Bales/Ha)

Variable	Estimate	Standard Error	Significance Level
Intercept	10.52	1.10	0.00
Bollrot	-18.39	3.97	0.00
Tight lock	-11.40	3.95	0.01
Model R^2 = 0.67			

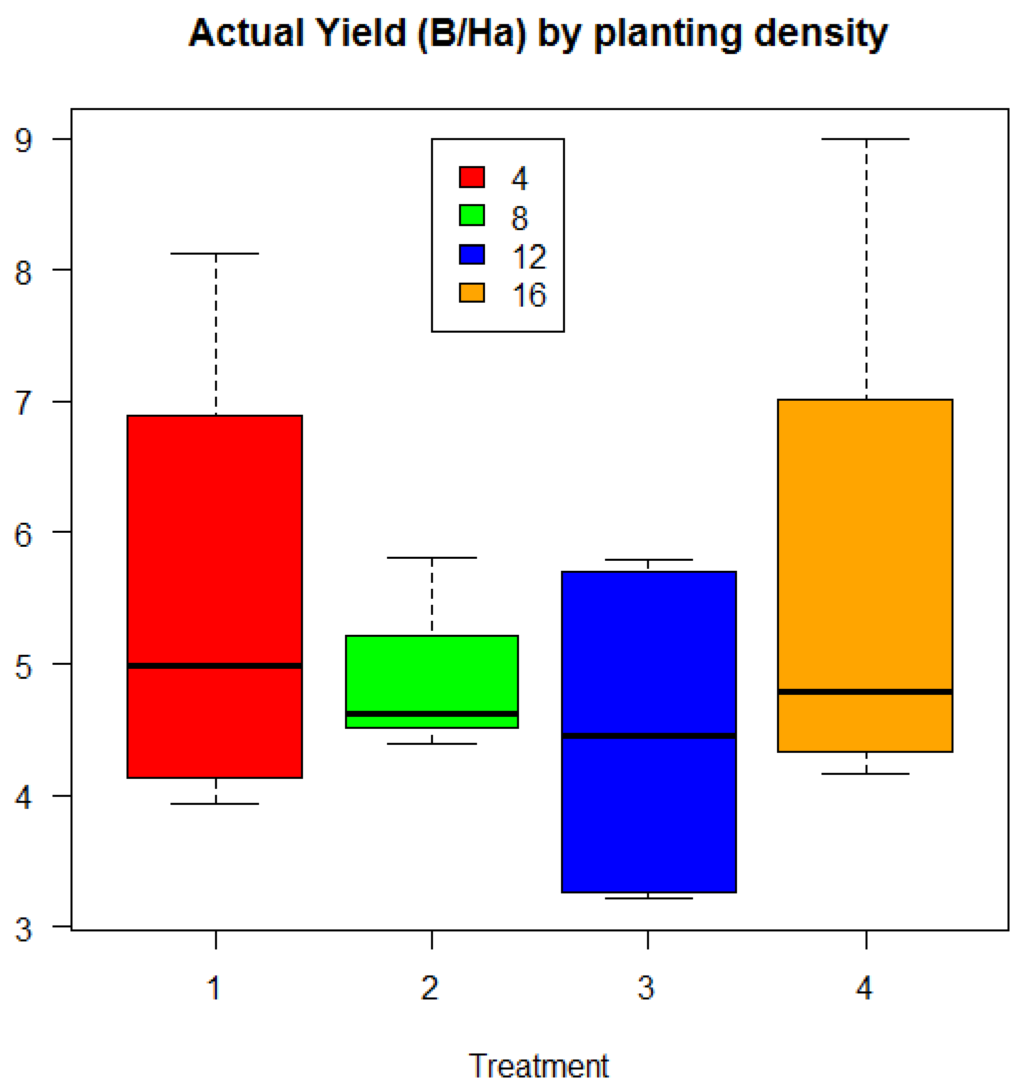

Figure 1 – Box plot of Actual Yield by planting density (treatment)

Figure 1 also shows that there is no significant difference between the effects of the planting densities on actual yield. However, the 8 plant per metre treatment shows less variation in yield across reps than the other treatments, but this effect was not significant.

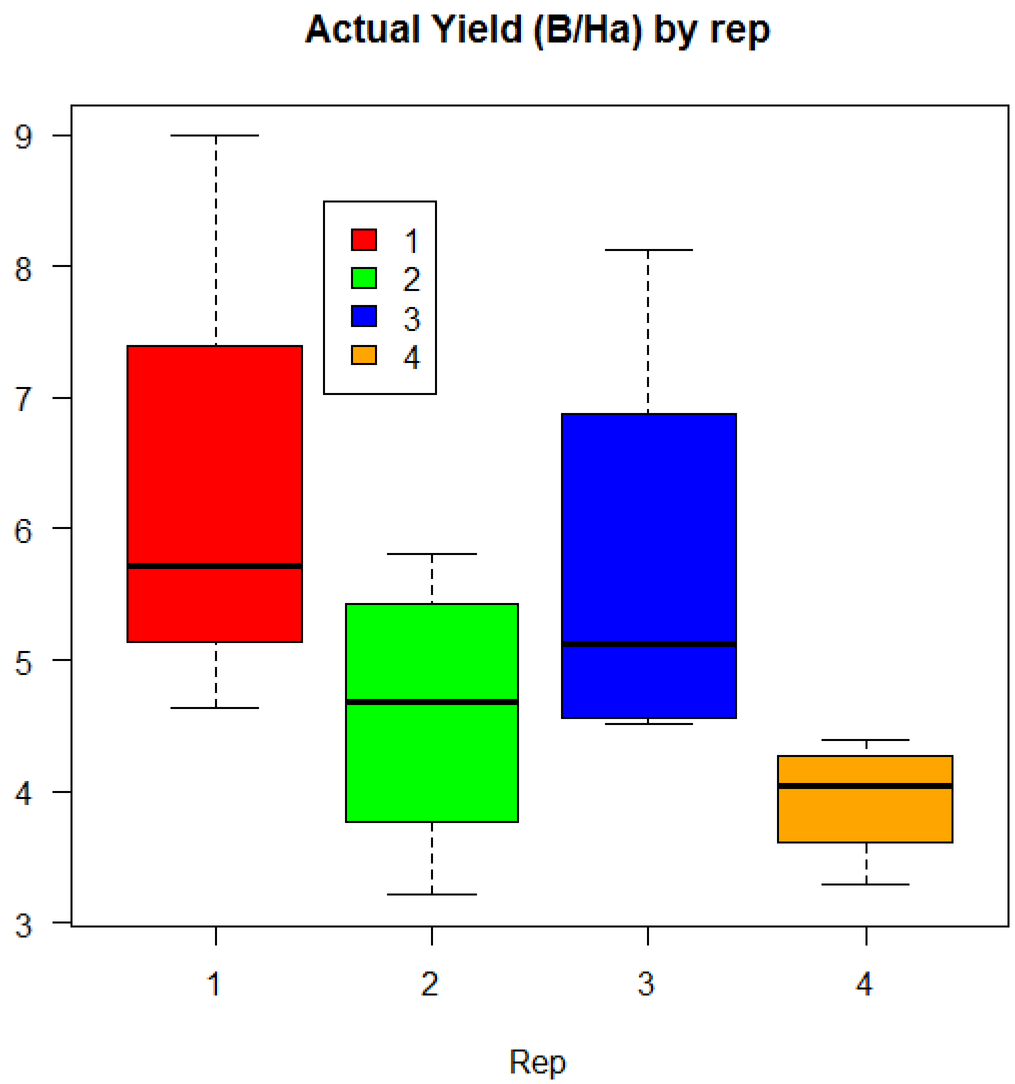

Figure 2 – Actual Yield (Bales/ha) by Rep

Figure 2 shows that there are no significant differences between reps for actual yield, which is also shown in the results in Table 2. Figure 2 shows that there are slight differences between the Actual yield in rep 4, and the yield in Reps 1 and 3. However, the Actual yield of Rep 4 is not significantly different from Rep 2. It can be seen from Figure 2 and Table 2 that the standard errors on these estimates are quite large, which can be expected from small experiments.

Summary

- Treatment was not significant in affecting the actual yield in this analysis
- Bollrot had a significant effect on actual yield and the estimate shows that as Bollrot increases the Actual yield decreases – which is what is expected.
- Tight lock also had a significant effect on Actual yield, the results show as Tight lock increases Actual Yield decreases – also which is expected
- Standard errors were large on all estimates which would have reduced the chance of detecting significant effects and this would be partially due to it being a small trial.

Commercial Bales/ha

Model
Bales/Ha = Treatment

Table 4 – Results of the analysis of Ginning yield (Bales/Ha)

Variable	Estimate	Standard Error	Significance Level
Intercept	5.64	0.03	0.00
Treatment	-0.17	0.01	0.00
Model R^2 = 0.96			

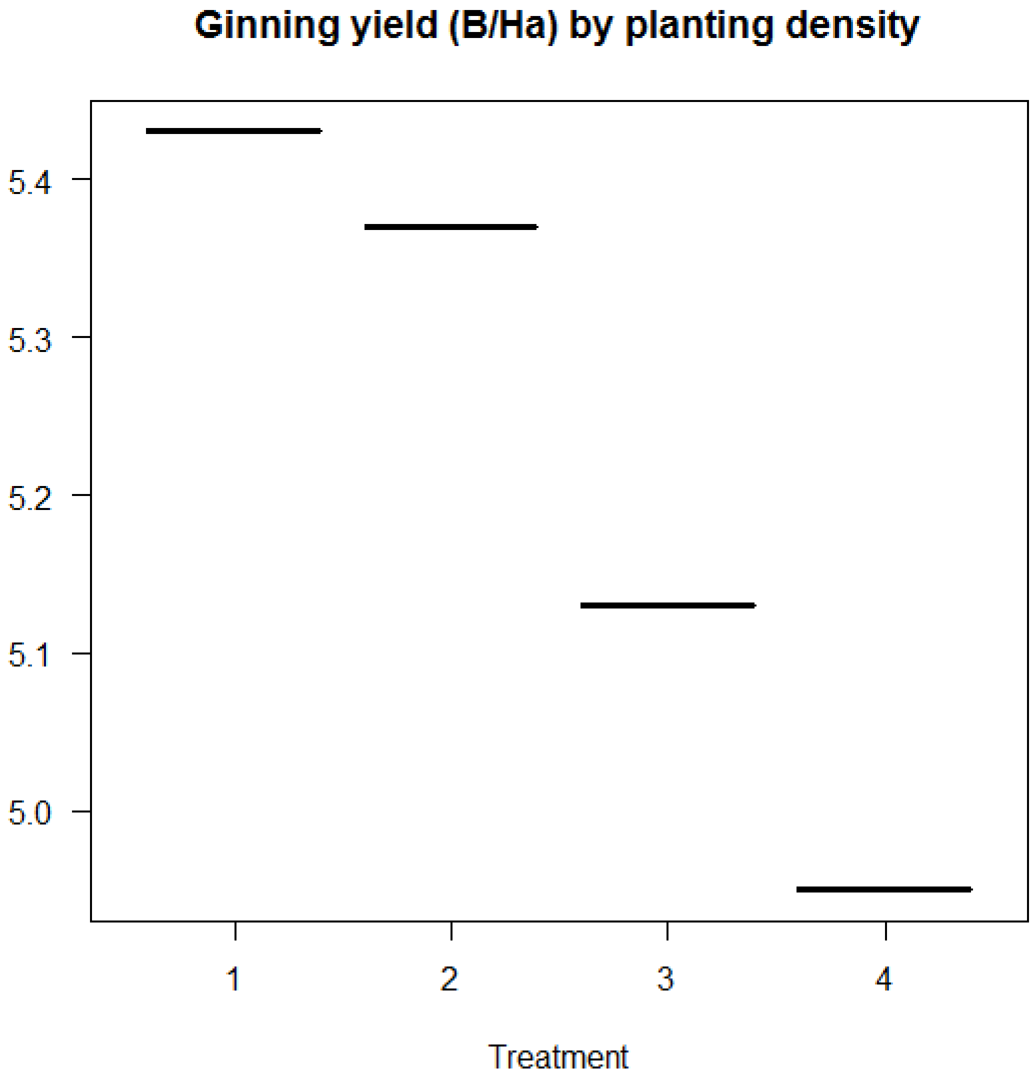

Figure 5 – Ginning results (Bales/ha) shown by plant density

Summary

- Ginning results show that as the planting density increases there is a significant decrease in Bales/Ha out of the gin
- These results are not very informative because the results were pooled across all reps within each planting treatment, therefore it is difficult to estimate statistical differences especially since it is a small data set
- However, there is a definite trend for the yield to be significantly higher for the 4 ppm and the 8 ppm groups in comparison with the 12ppm and 16ppm groups
  - It is difficult to say if there will be a significant difference between the 4ppm and 8ppm treatments from these results.

Bollrot

Model
Bollrot = Rep + Seed rot + Tight lock

Table 6 – Results of the analysis of Bollrot (%)

Variable	Estimate	Standard Error	Significance Level
Intercept	0.25	0.07	0.00
Rep	0.03	0.02	0.05
Seed rot	-0.38	0.32	0.26
Tight lock	-0.51	0.28	0.09
Model R^2 = 0.35			

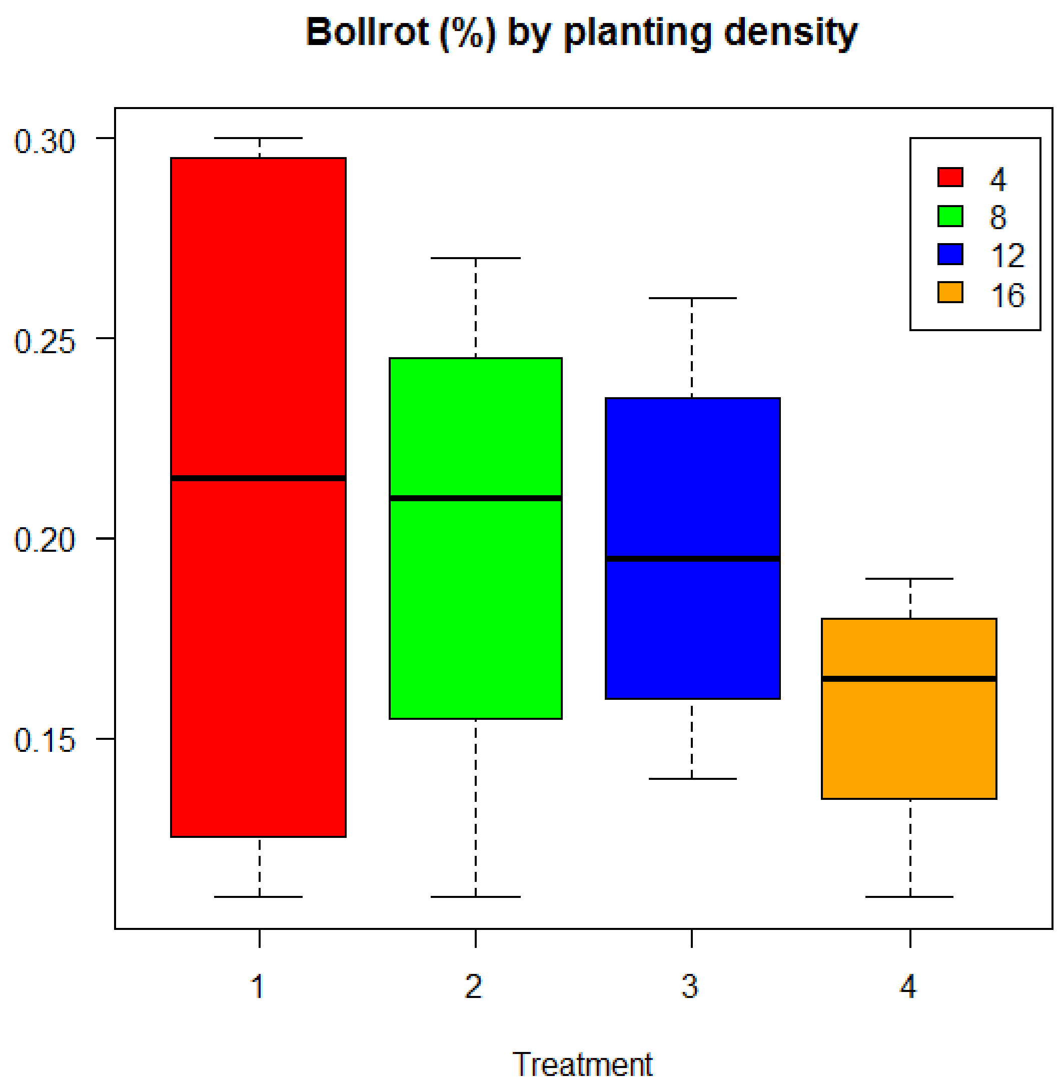

Figure 7 – Boll rot (%) by planting density

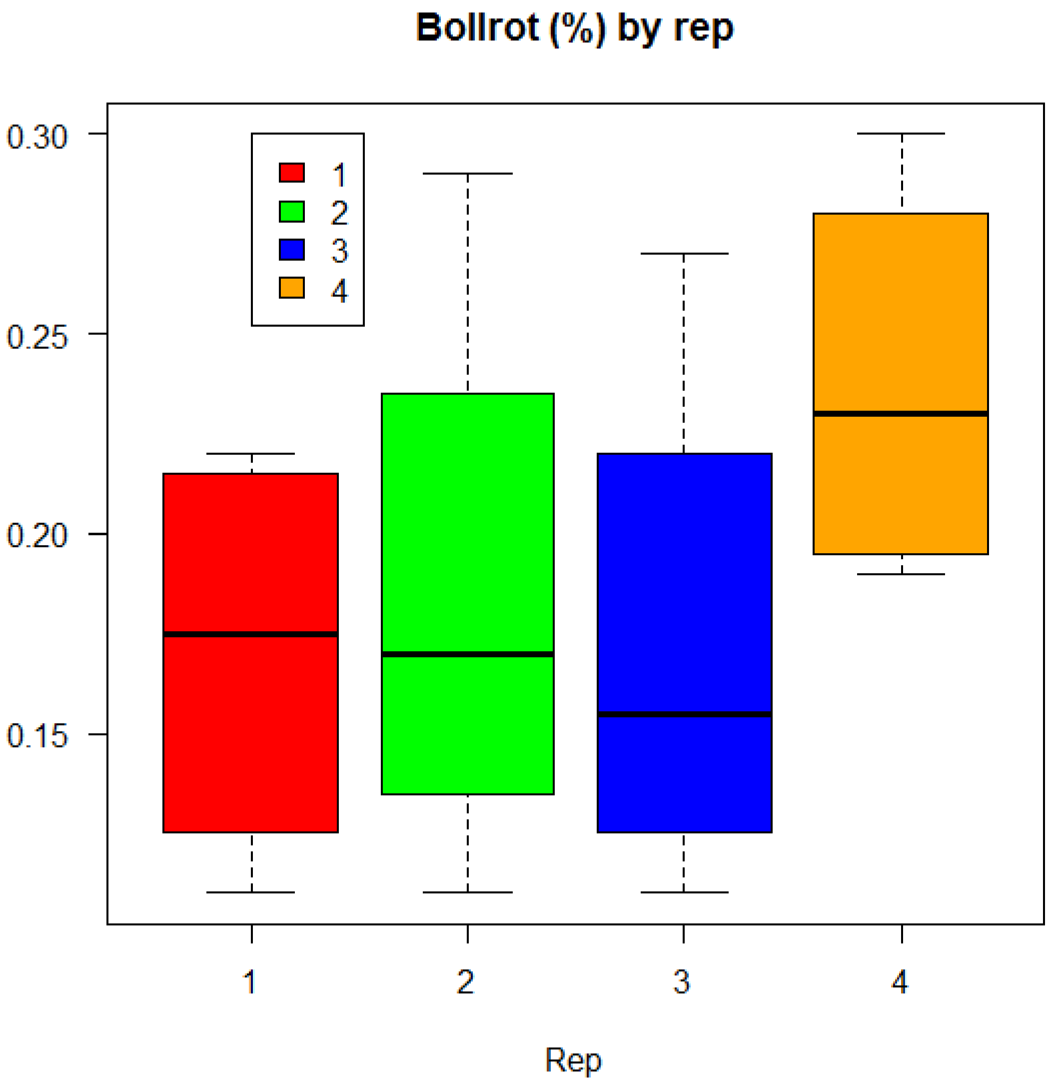

Figure 8 – Bollrot (%) by rep

Summary

- In the linear model Rep and Tight lock have significant effect on Bollrot
- The box plot of the effect of Rep on Bollrot does not really reflect a significant difference in the reps (overlapping standard errors) but this is on the raw data not the adjusted linear model data
- Rep 4 seems to have higher boll rot than the other reps – Shown in Figure 8
- Although Seed rot does not have a significant effect on Bollrot it was kept in the model because it improved model fit
- Planting density did not have a significant effect on Bollrot in this model. However, Figure 7 shows that there may be a slight trend that as planting density increases (particularly around 16ppm) then boll rot also increases.
- The model fit was very poor ($R^2 = 0.35$) which indicates that there is a large proportion of variation that we are not explaining in this model. Therefore a larger experiment on a number of farms with other variables would be in order to estimate these differences better.

Seed rot

Model
Seed rot=Treatment

Table 6 – Results of the analysis of Seed rot (%)

Variable	Estimate	Standard Error	Significance Level
Intercept	0.13	0.03	0.00
Treatment	0.02	0.01	0.32
Model R^2 = 0.07			

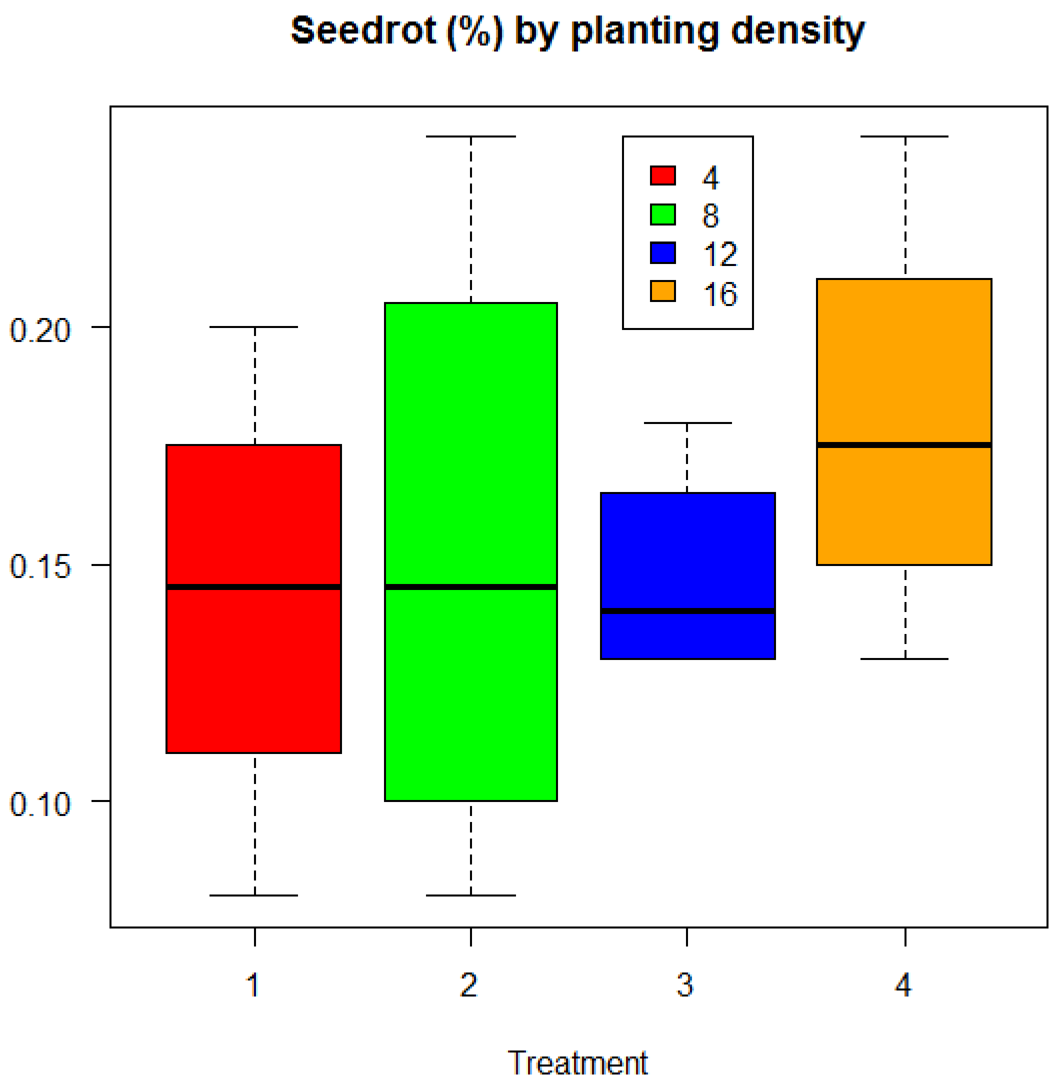

Figure 9 – Seed rot (%) by planting density

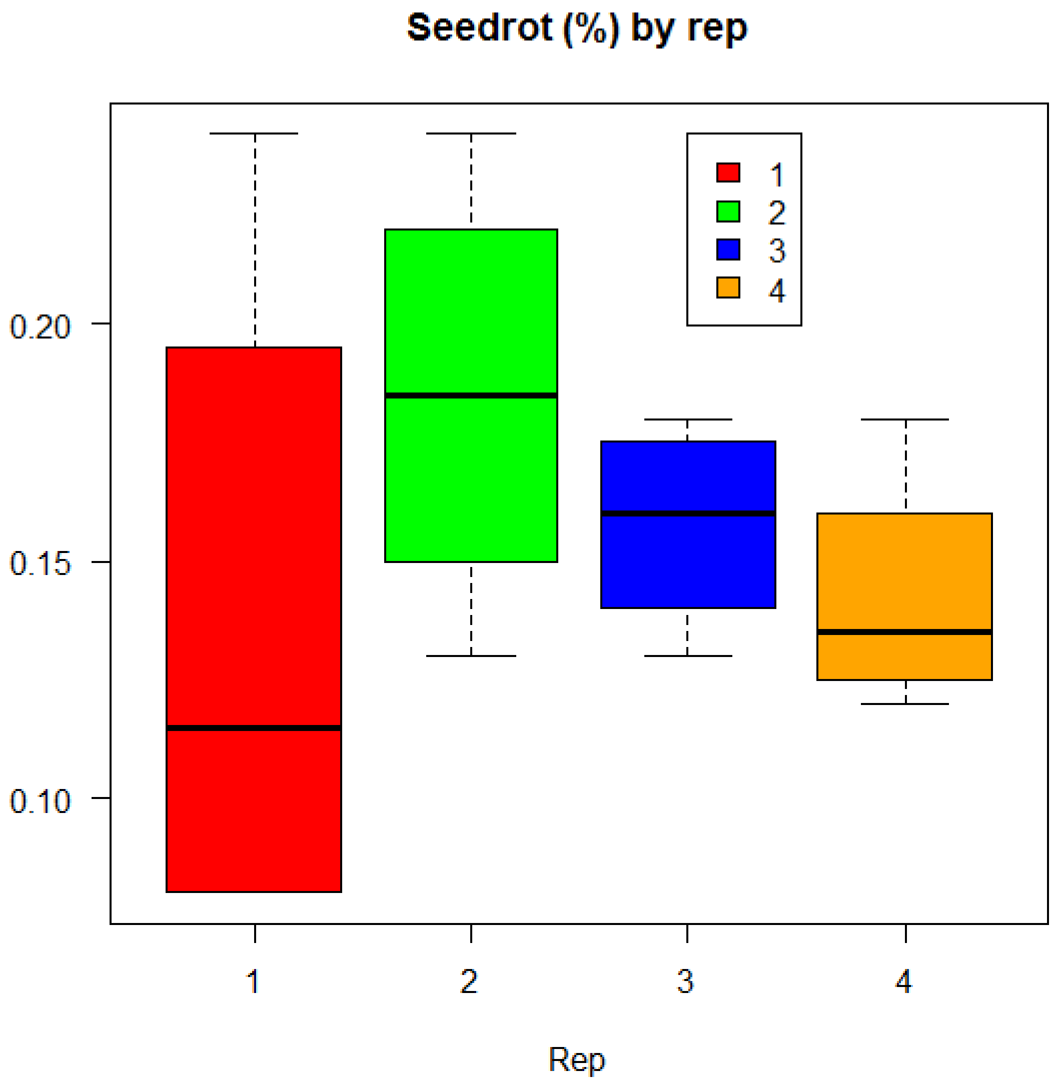

Figure 10 – Seed rot (%) by Rep

Summary

- This model is explaining essentially none of the variation in seed rot in this experiment ($R^2 = 0.07$). This means that environmental and/or other factors not tested in this experiment are largely the reason for variation in seed rot in this experiment.
- None of the variables in this experiment explained a significant amount of seed rot variation.

Tight lock

Model
Seed rot=Treatment + Rep

Table 7 – Results of the analysis of Tight lock (%)

Variable	Estimate	Standard Error	Significance Level
Intercept	0.04	0.04	0.42
Treatment	0.02	0.01	0.09
Rep	0.03	0.01	0.02
Model R^2 = 0.45			

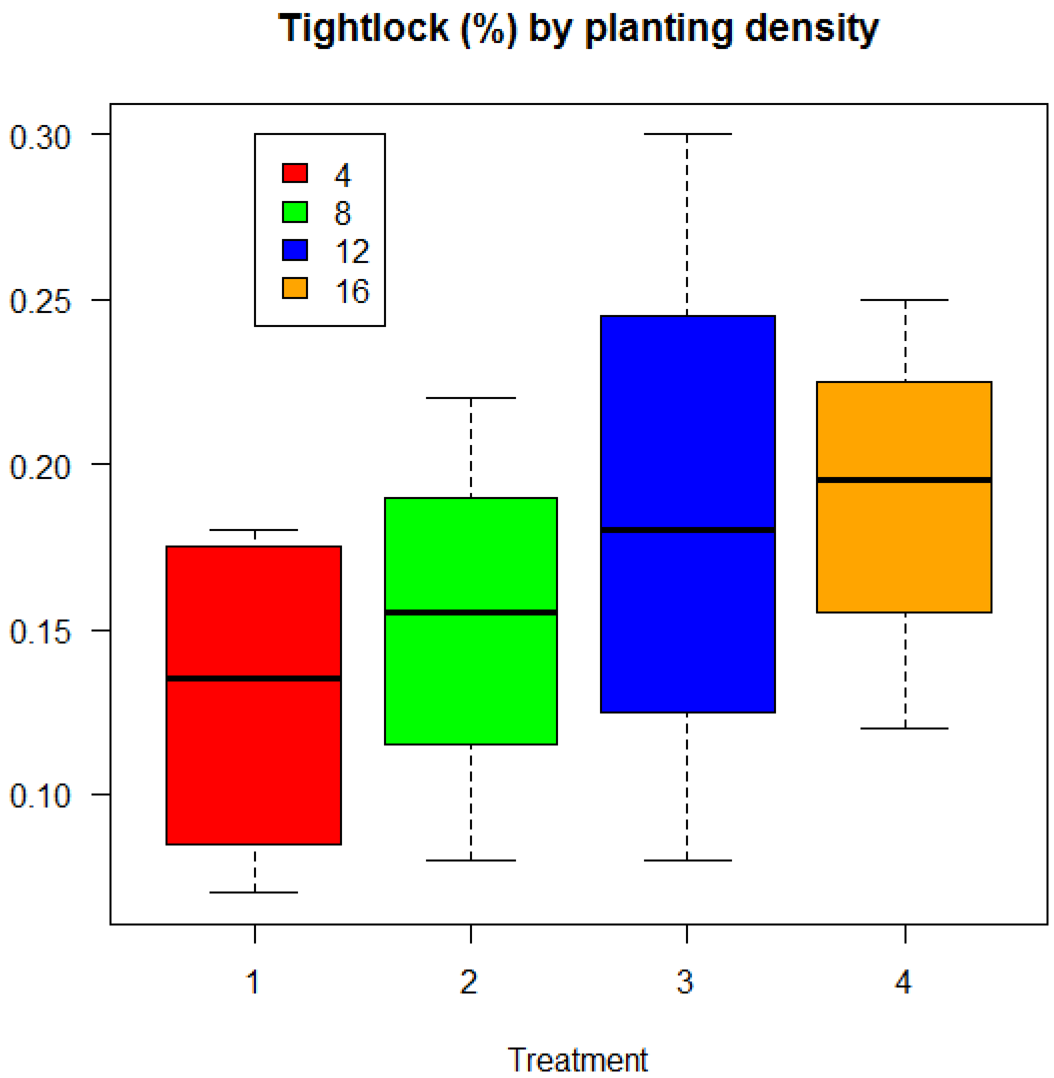

Figure 11 – Tight lock (%) by planting density

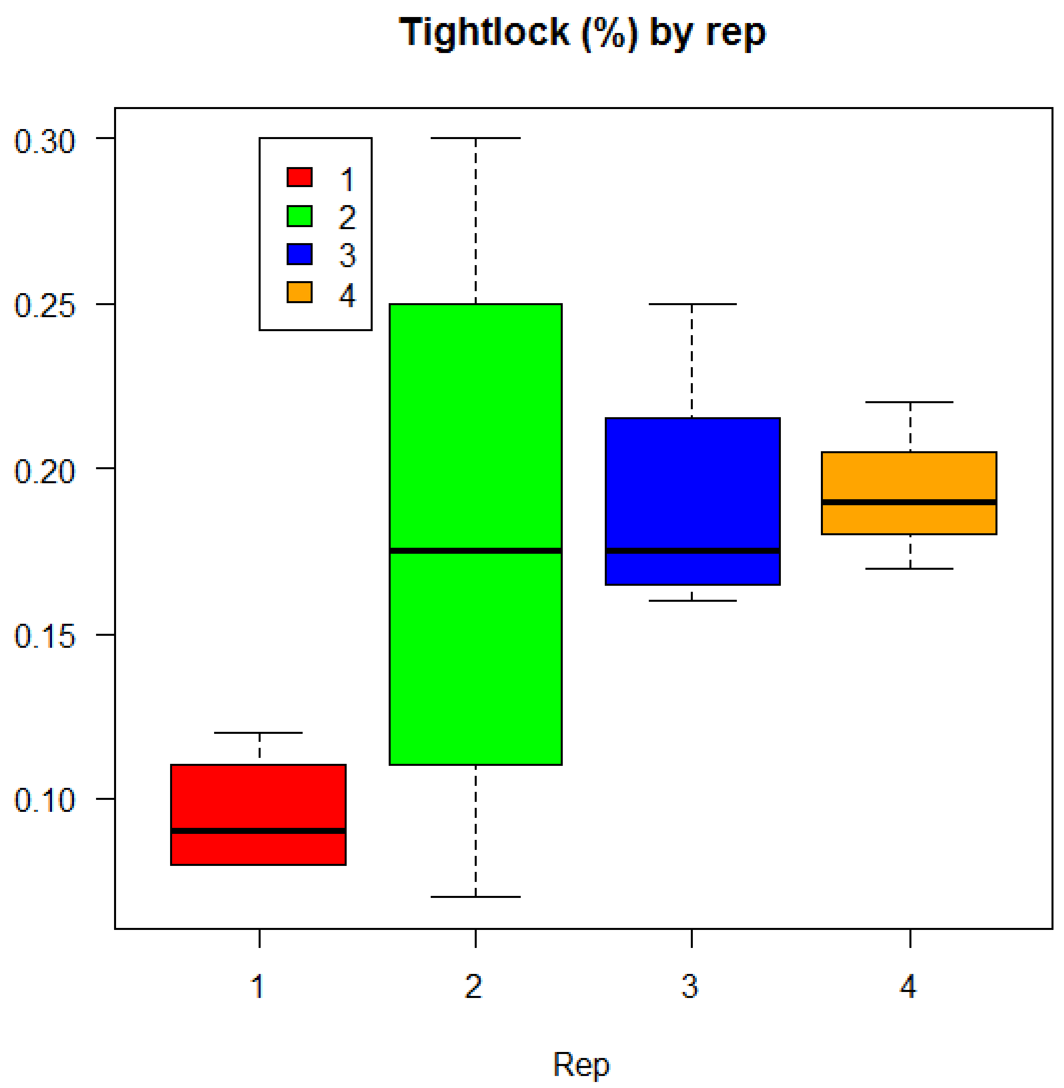

Figure 12 – Tight lock (%) by rep

Summary

- Rep was very significant in estimating differences in tight lock in this experiment. Both Table 7 and Figure 12 show that there was a significant trend that as the rep increases so does the amount of tight lock (%). This seems to be driven mostly by rep 1 which has significantly less tight lock than both reps 3 and 4. This is probably an environmental factor in the paddock
- Treatment was slightly significant in the linear model if a significance level of 0.10 was used. This also showed a trend that as the number of plants per metre increased so did the tight lock %. This difference was not as marked in the raw data, as shown in Figure 11. However, there did seem to be a trend in Figure 11 for tight lock % to increase with increasing plant densities.
- This model explained only slightly under half of the variation in tight lock % in this trial. Again this seems to indicate that environmental influences played a large part in this trial and there is definitely scope to increase the size of this experiment and to take more variables into account such as irrigation, rainfall, pests and soil type etc.

Outcomes

This experiment provided some trends of what is possible, had the trial experienced different scenarios. The experiment provided some insight into shortcomings in the experimental procedure. Had these shortcomings been avoided, the results may in fact be clearer and possibly provide data with less variability.

The collection of data was flawed due to the uncertainty of if the trial survived the moderate hail damage that occurred in December. The collection was reduced and thus caused an increase in variability. The hail event that did occur also could have influenced the trial and it's variability as plant recovery was sporadic throughout the field.

The data collection should have been increased rather than decreased in this situation as to counter the effect of the in-field variability due to the hail event. Because this was not done, this was a major shortcoming and affected the learning outcomes of the trial and will need to be rectified so as to provide sound data.

The results that were achieved however suggested that there is no significant difference between treatments and the occurrence of boll disorders. Despite the variability, if no further research was conducted, the results are therefore suggesting there is no significant benefit for planting higher or lower densities apart from cost of seed. This comes at an increased risk, that planting rates on the two "extreme" ends can have potentially significant production risks associated with them. Further research on this topic is needed to clarify some of these issues and risks.

Conclusion

The final result of this experiment is inconclusive due to the extensive variability through the trial. This was derived from sampling error and weather events, namely hail. The results did show some trends however, but these are too, inconclusive. The take home messages are that the sampling was not substantial enough to counter-act the variability of the trial and despite this there are some positive trends that need further research to explore in detail.

Extension Opportunities

Further extension of these results is somewhat limited due to the lack of a clear difference. At this stage, I believe further funding should be sought to re-conduct this trial with an improved protocol in attempt to refine some of the answers that this trial may provide. At the time of completing this report, a trial plan has been put in place for a repeat of this trial, with the amended procedure.

The results as they stand have been presented to the cotton growing community in Emerald as part of a "post-season wrap up" conducted by the QLD DAFF team.