Analysis of mono-clonal blocks vs mixtures trial – Tarawera Forest

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EXECUTIVE SUMMARY

ANALYSIS OF MONO-CLONAL BLOCKS VS MIXTURES TRIAL – TARAWERA FOREST

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THE PROBLEM

The ability to deploy clonal radiata pine trees holds some significant advantages to the industry such as increases in productivity and quality as well as reduction in variation. However the question on whether to deploy clones in mixed or pure blocks remains largely unanswered.

COOP INITIATIVES

In 1995 a large trial in Tarawera forest was setup by the Coop to answer the question 'do clones perform better, because of reduced competition, when planted as single clonal blocks versus clonal mixtures? The trial serves as an expansion of the two pilot trials established in 1989, located in Kawerau, New Zealand and Tumbarumba, NSW, Australia.

THIS PROJECT

This project was set up to analyse the growth data at age 10, to determine whether the way the 16 different clones were deployed has any bearing on their early growth rates.

RESULTS

The analysis showed that the different clones seem to grow at different rates. However there is no statistical difference in their growth rate between growing them in 16 clonal mixtures and pure blocks or growing them in two clonal mixtures and pure blocks. It is clear that the pure a block becomes the less variable in terms of growth the trees become.

IMPLICATIONS FOR THE COOP

There is a growing amount of evidence that the configuration that clonal forestry is deployed has little impact on the early growth of trees. As this trial is only 10 years old, the impacts of competition are probably yet to show. These results back up the results found from analysing the Kawerau trial which found similar results at age 17. A study is planned next year that repeats this study, except this time it will look at standing tree stiffness. The goal of the study is to see how wood quality characteristics such as tree stiffness vary between clones and pattern of deployment.

INTRODUCTION

The ability to deploy clonal radiata pine trees holds some significant advantages to the industry such as increases in productivity and quality as well as reduction in variation. However the question on whether to deploy clones in mixed or pure blocks remains largely unanswered. Debell and Harrington (1993) list a number of considerations that must be taken into account in the deployment of clonal material; social factors and legal requirements, biotic and abiotic hazards, operational considerations and productivity.

In 1995 a large trial in Tarawera forest was setup to answer the question 'do clones perform better, because of reduced competition, when planted as single clonal blocks versus clonal mixtures?' The trial serves as an expansion of the two pilot trials established in 1989, located in Kawerau, New Zealand and Tumbarumba, NSW, Australia. These two trials were analysed by Kimberley and Dean (2006). They showed that there was no overall advantage in terms of growth, to planting clones in pure blocks versus mixtures. This report is an overview of the analysis of growth data at age ten of the Tarawera clonal trial (FR 308).

MATERIALS AND METHODS

Site Description

The research plantings for this study were established in June 1995 next to the Tarawera River in Tarawera Forest. Tarawera Forest is located in the Bay of Plenty region of North Island, New Zealand. The elevation is about 130metres. Climate is mild with a mean annual temperature of $14^{o}C$ and an annual rainfall of 1820 mm y^{-1}. The soils at the site were classified as Typic Tephric Recent Soils using the New Soil Classification (NZSC) system of Hewitt (1998) (Smith et al., 2000).

The site is classified as highly productivity, both in terms of height and volume growth with the site index of the plots ranging between 31 – 39 and a 300 index of 28.7. The flat site was in its second rotation, before planting regenerating radiata pine had been sprayed. The site was ripped and mounded in rows approximately 5m apart. At the time of trial establishment the regeneration was yellowing but still standing.

Experimental design and treatment

The trial comprised two replications of each of the following three treatments: 8 blocks of 16 clone mixture, 10 blocks of 2 clone mixture, 10 blocks of the reciprocal of the 2 clone mix. The trial also included 16 blocks of a single-clone, these blocks were replicated three times. Figure 1 show how the different treatments are laid out in their blocks. A block is defined as the plots plus a single row of buffer trees surrounding the plot. In Figure 1 the blocks are defined by the thick black line, where as the plots are defined by the thinner line.

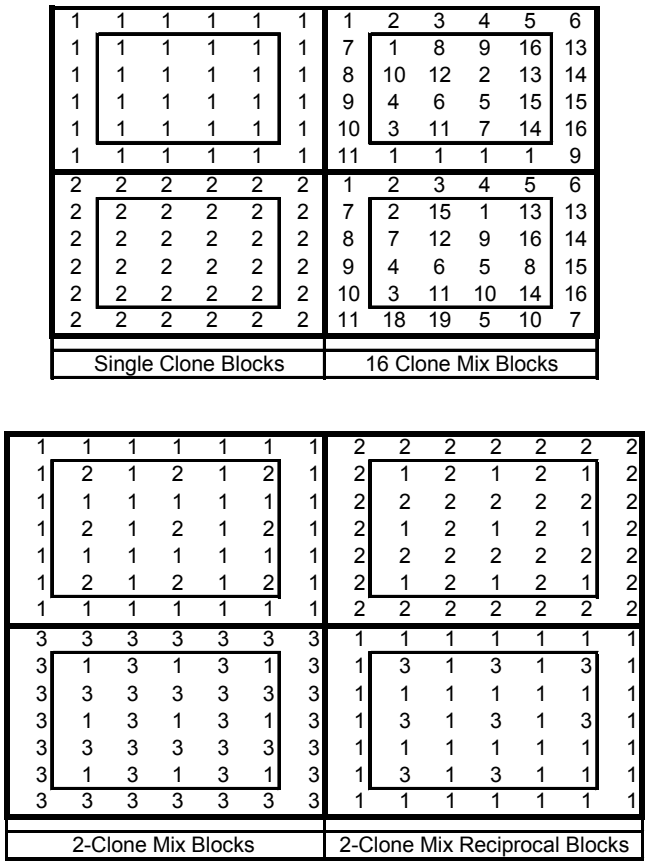

Figure 1. Examples of the layout within and between the different blocks. Each number represents a different clone.

The two-clone mixture blocks each contain 49 trees comprising 9 individuals of the surrounded clone and 40 individuals of a surrounding clone. Each clone is surrounded by eight trees of the other clone. There are two treatments in this component of the trial due to each of the two clones being planted as their reciprocal (See Figure 1).

A control, comprising GF 23 seedlings, established in four 36 tree blocks was incorporated into the trial. The control serves as genetic bench mark and will also quantify the tree growth and quality physiological maturation effects of the clonal material.

Plot Installation and Maintenance

In total the trial contains 112 plots that cover an area of 13 hectares. The two-clone mixture plots have a plot size of 0.1225 ha compared to the other treatments which have a plot size of 0.040. The larger plots size was to allow for the planting pattern of the two-clone mixtures as shown in Figure 1. The trees within the blocks/plots were planted at a target tree spacing of 5 x 5 m (400 spha). As the trees were generally planted in the rip lines which took priority over planting at 5 m spacing, the maximum variation in the between row spacing was approximately 1m.

Sixteen different clones with known parents were planted using tissue cultured plantlets. The sixteen clones were included in the single clonal block and the 16 clone mixtures, however only the first 5 clones are included in the two-clone mixtures treatments.

The trees were access pruned at age 6 to a height of 3 metres. The trial has to date remained un-thinned.

Data collection and analyses
All the plots have been measured 3 times, ages 4, 6, 8 and 10. All measurements were done in accordance with the New Zealand Permanent Sample Plot measurement standards outlined in FRI Bulletin 186 (Ellis and Hayes 1997). The diameter at breast height (1.4 m above the ground) for all the trees were measured as well as the height of a least 12 trees in each plot. The data presented in this paper was collected mid July 2007.

Analysis
For each plot in the trial the diameter and measured heights were used to generate individual diameter/height curves, these were then used to calculate the missing heights. The individual tree volumes were then calculated using volume equation 182. The individual tree diameters, heights and volumes have been used as the bases for this analysis.

The clonal effect was analysed by simply calculating the mean diameter and height for each of the 15 different clones regardless of the clonal pattern that they were planted in.

To simplify the analysis of the trial it was broken into two sub-experiments. The first experiment looked at the two clonal mixtures versus the pure clone. The mean diameter, height and volume was calculated for the two clonal mixed block and its reciprocal, which was then compared against the mean of the pure plots of the same two clones. A simple pair t-test was used to determine whether there was a statistical difference between growing clones in two clonal mixtures or pure clonal blocks.

The second of the experiments compared the 16 clone mixtures versus the pure clonal blocks. The mean diameter, height and volume was calculated for each on the 16 different clones in mix block and compared to the means of the pure blocks. Once again a pair t-test was used to determine if there was any statistically difference between pure and mixed plantings.

The amount of variation between trees in the different treatments examined using within-plot coefficient of variation (CV) of DBH and height.

RESULTS

Clonal Effect
The means DBH of the clones ranged between 24.9 and 32.5 cm, the mean height ranged from 16.8 to 20.2 metres. Figure 2 shows the mean DBH and mean height of all the trees in the trial regardless of the treatment. There is clear difference between the clones, some performing better and some worse than the GF 23 planted stock.

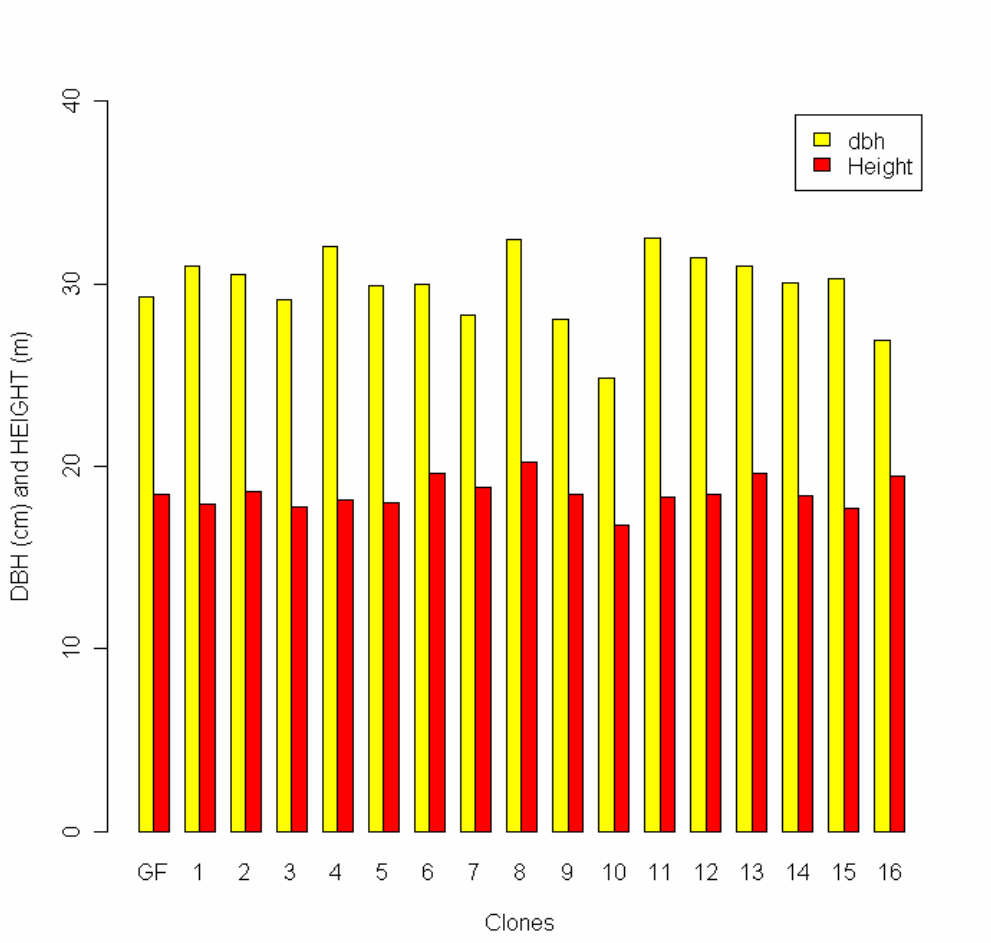

Figure 2. The mean DBH and height of the different clones.

Pure vs Clonal Mixtures

The mean DBH, height and tree volume was calculated for each clone when planted in the single clone blocks and when it was planted in a mixture blocks with the other 16 clones. Figure 3 shows no clear patterns, it could be hypothesized that a general poor performing clone would have a lower growth rate when grown in a mixture with other clones then went grown in a pure block. This does not seem to be true, for example clone 10 which is the poorest performing clone actually has better diameter growth when planted in the mixed blocks.

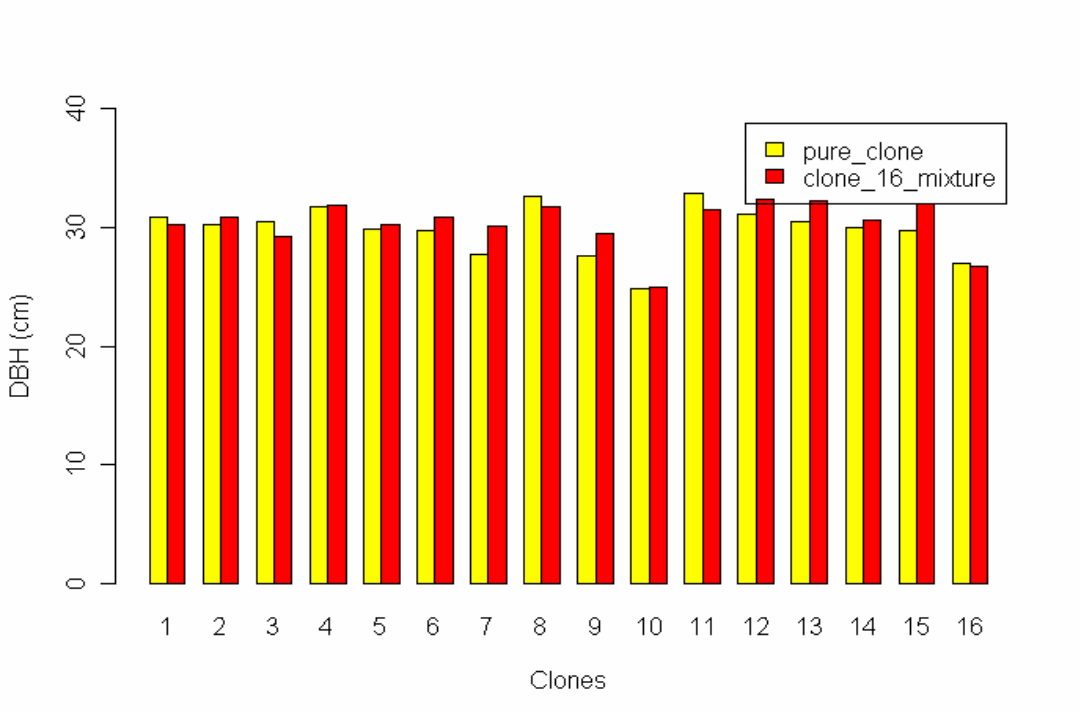

Figure 3. Mean DBH of pure clone block vs 16 clone mixture block.

Figure 4 also show no patterns in terms of pure vs mix blocks. When Figure 3 and 4 are compared it can be seen that a clone that has performed well with respect to diameter growth may not necessary excel with respect to height growth whether in mixed or pure plantings.

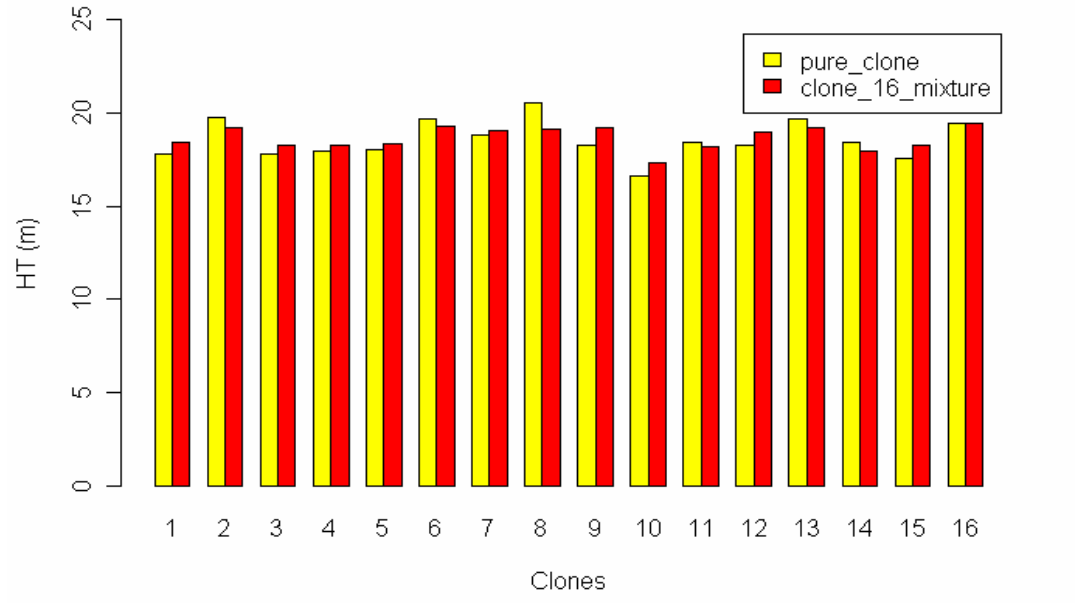

Figure 4. Mean height of pure clone block vs 16 clone mixture block.

Pair t-tests confirmed that there is no significant difference between planting in pure clone blocks and mixture blocks for DBH, height or tree volume at age 10.

Pure vs Two Clonal Mixtures

The two clone mixture blocks do not seem to differ in growth rate in comparison to the same two clones in pure blocks. Figure 5 and 6 show the impact on DBH and height growth respectively. Due to the lack of difference at this level of analysis there seems little point on trying to analysis the impact of reciprocal sub treatments of the 2 clonal mixtures treatment.

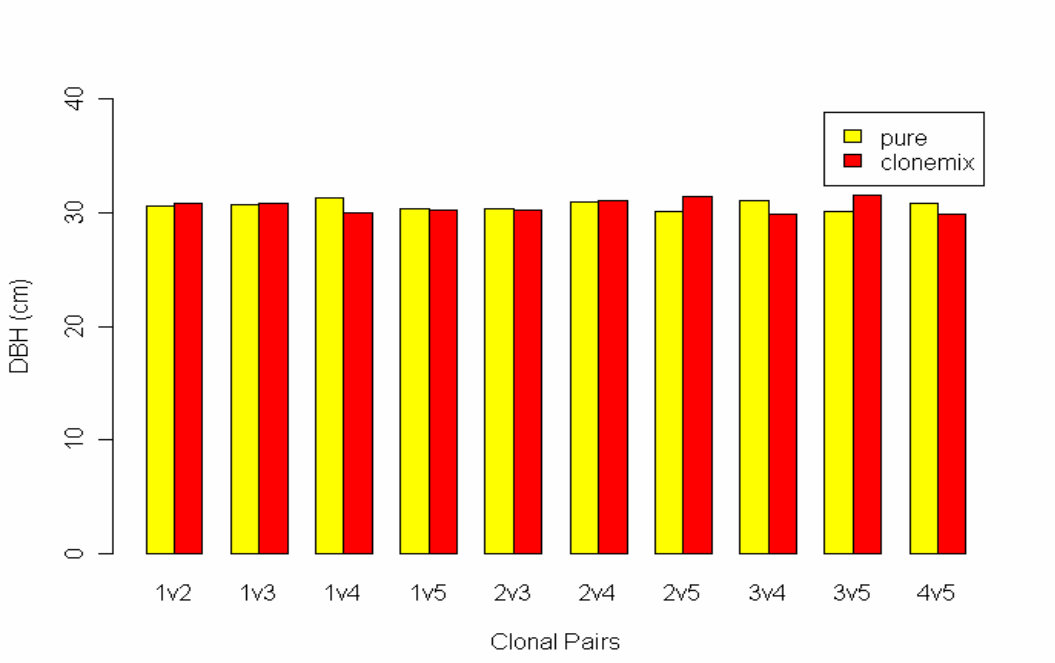

Figure 5. Mean diameter (DBH) of two clones grown either in pure block or in two clonal mixtures.

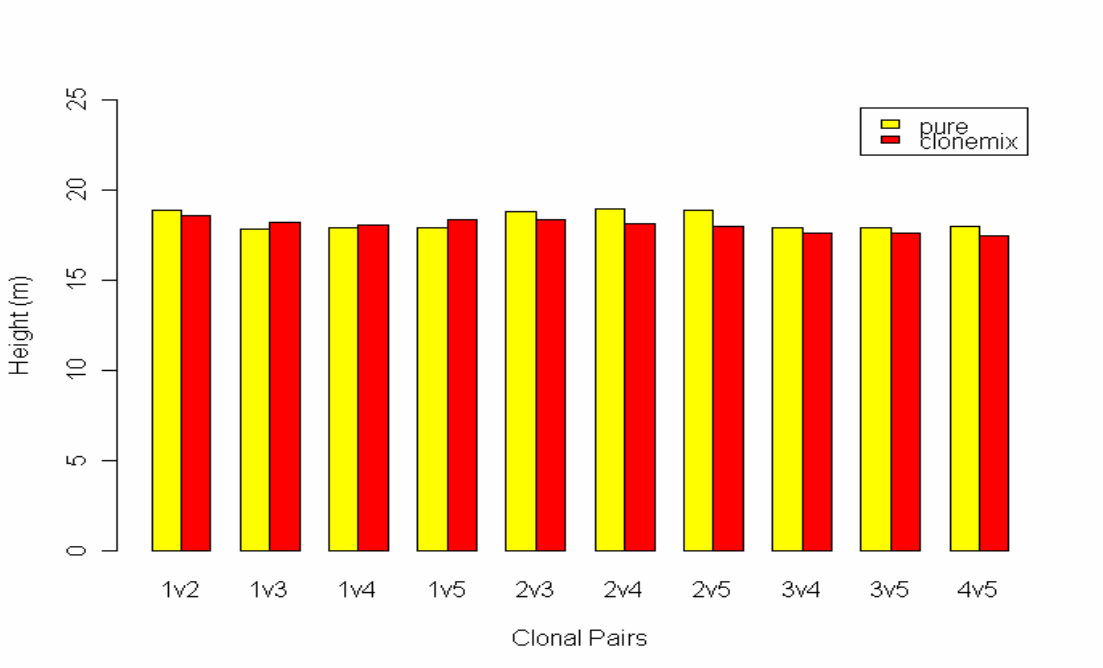

Figure 6. Mean height of two clones grown either in pure block or in two clonal mixtures.

As with the 16 clonal mixture versus the pure block, a paired t-test showed that there was no statistical difference between the two treatments in terms of DBH, height and volume growth.

Variation between trees in mixed and pure blocks

The within-plot coefficient of variation (CV) of DBH for different treatments ranged from 11.1 to 14.1 (Table 1). The CVs were significantly lower for the pure and 2 clonal mixtures than the 16 clonal mixtures and control. In this part of the analysis the two 2 Clonal Mixtures sub-treatments were considered to be a single treatment.

Table 1. Comparison of within-plot CV (coefficient of variation) of DBH for different planting stock and deployment treatments.

	CV	se(CV)
2 Clonal Mixtures	11.5[a]	0.4
16 Mixtures	13.7[b]	0.6
Pure	11.1[a]	0.6
Control (GF 23)	14.1[b]	1.7

[1]Values in a column followed by the same letter do not differ significantly (p = 0.05)

The CVs for heights (Table 2) are over half that of DBH. However there is a similar pattern between the different treatments. It is probably important to note that for some of the plots only a sub set of the trees were measured fro height.

Table 2. Comparison of within-plot CV (coefficient of variation) of HEIGHT for different planting stock and deployment treatments.

	CV	Se(CV)
2 Clonal Mixtures	5.18[a]	0.3
16 Mixtures	6.74[b]	0.3
Pure	5.00[a]	0.3
Control (GF 23)	5.66[a]	0.7

[1] Values in a column followed by the same letter do not differ significantly (p = 0.05)

CONCLUSION

There is a growing amount of evidence that the configuration that clonal forestry is deployed has little impact on the early growth of trees. As this trial is only 10 years old, the impacts of competition are yet to show. These results back up the results found from analysing the Kawerau trial which found similar results at age 17. The results are also similar to these found in studies using *Populus* clones (DeBell and Harrington 19971).

The study also showed that as with the analysis of the Kawerau trial (Kimberley and Dean 2006), variability in tree size of clones planted in pure blocks is less than mixtures or control pollinated seedling stands.

A study is planned next year that repeats this study, except this time it will look at standing tree stiffness. The goal of the study is to see how wood quality characteristics such as tree stiffness vary between clones and pattern of deployment.

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