

Analysis of tree growth of clones grown in pure blocks and mixtures

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Plantation Management Cooperative

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EXECUTIVE SUMMARY

ANALYSIS OF TREE GROWTH OF CLONES GROWN IN PURE BLOCKS AND MIXTURES

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In 1988 a trial to compare the performance of clones grown in pure stands versus clones planted in mixture was planted at Tui Glen near Kawerau. The trial comprises two replications of four single clone plots, four - 4 clone mixtures and two 16 clone blocks. The clones and seedling controls were sourced from 268 control pollinated seedlings (family 268.405). The trees were planted at 4x4 metre spacing (625 stems/ha) and have not been thinned. The site is at the upper end of productivity (300 Index- 43.2, Site Index - 39.2m).

In 1999 a similar trial was planted on RCA management land at Tumbarumba in NW New South Wales. This trial tests two replicates of seven clones as pure blocks, four clone mixtures and in a 16 clone mixture. The planted stocking was once again 625 stems/ha which has not been thinned but has suffered significant mortality in some areas resulting in considerable variability in stocking. Although planted into pasture this site has much lower productivity than the Kawerau site (300 Index- 19.2, Site Index – 23.7m). Trial layout maps are included in Appendix 1 and 2.

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METHODS

The Kawerau trial was measured twice, at tree age 15 and again at 17. The Tumberumba trial was measured at age 15 only.

DBH, height, pruned height and green crown height were measured for all plot trees as well as the surround trees. This enabled the calculation of absolute stocking and in the future individual tree competition indices may be derived and used to establish the relative competitiveness of clones.

Individual tree basal area and height data have been analysed and comparisons made between the clones growing in pure blocks versus mixtures.

RESULTS

FR 450/0 – Kawerau

Mean tree basal area at age 17 (2005) of the four clones tested as pure blocks and four clone mixtures is summarised in Table 1. In pure plantings each of the four clones are significantly different from one another. Clone 31 is the largest with a mean tree basal area of 0.120m². Clone 36 is the least competitive with a mean tree basal area of 0.089m².

Table 1. Comparison of pure versus 4-clone mixed plantings of individual tree BA for each clone at tree age 15.

Clone	Pure	Mixed	Significance of pure versus mixed planting
31	0.120 ^a	0.124	n.s.
36	0.089 ^d	0.061	**
37	0.096 ^c	0.101	n.s.
43	0.107 ^b	0.114	n.s.
Combined	0.103	0.100	n.s.

Values appended with the same letter are not significantly different at p=0.05.

n.s. not significant

* significant at p=0.05

** significant at p=0.01

When grown in a four clone mixture, clone 36 was the only clone to perform more poorly than in a pure block. Grown in mixture its mean tree basal area dropped from 0.089 to 0.061 m². The other three clones each grew slightly better but not significantly different from growing in pure blocks.

The mean crop height of all four clones was not significantly different whether they were grown in pure blocks or mixture (table 2). Once again clone 36 was significantly smaller than the other three clones tested.

Table 2. Comparison of pure versus 4-clone mixed plantings of mean tree height at age 17 for each clone.

Clone	Pure	Mixed	Significance of pure versus mixed planting
31	34.0 ^a	34.5	n.s.
36	27.9 ^b	26.6	n.s.
37	32.9 ^a	32.6	n.s.
43	32.9 ^a	34.0	n.s.
Combined	31.9	31.9	n.s.

Values appended with the same letter are not significantly different at p=0.05.

n.s. not significant

* significant at p=0.05

** significant at p=0.01

Tumbarumba

At this site seven clones are tested in pure blocks and four clone mixtures. An eighth clone was substituted with another clone in the four clone mixture so cannot be used in this comparison. Individual clone mean basal area ranged from 0.0453 to 0.0752 m² in the pure block plantings (table 3). Only the largest clone (806.05) was significantly different from all other clones. As at the Kawerau site only one clone, 809.02, was significantly different in basal area when grown in mixture. Again this clone was smaller when grown in mixture with others indicating less competitiveness.

Table 3. Comparison of pure versus 4-clone mixed plantings of individual tree BA for each clone at tree age 15.

Clone	Pure	Mixed	Significance of pure versus mixed planting
108.21	0.0487 ^{bc}	0.0446	n.s.
110.03	0.0544 ^b	0.0528	n.s.
201.51	0.0454 ^c	0.0444	n.s.
802.09	0.0453 ^c	0.0447	n.s.
804.15	0.0492 ^{bc}	0.0501	n.s.
806.05	0.0752 ^a	0.0750	n.s.
809.02	0.0559 ^{bc}	0.0445	*
Combined	0.0534	0.0509	n.s.

Values appended with the same letter are not significantly different at p=0.05.

n.s. not significant

* significant at p=0.05

** significant at p=0.01

As at Kawerau, the mean crop height of all seven clones was not significantly different whether they were grown in pure blocks or mixture (table 4). The range of mean crop height was from 16.2 to 18.1 metres. The largest diameter clone (806.05) was also the tallest and whilst not different from most other clones it was significantly taller than the 2 shortest clones (809.02 and 804.15).

Table 4. Comparison of pure versus 4-clone mixed plantings of mean tree height at age 15 for each clone.

Clone	Pure	Mixed	Significance of pure versus mixed planting
108.21	16.9 ^{ab}	16.1	n.s.
110.03	17.1 ^{ab}	16.6	n.s.
201.51	17.1 ^{ab}	16.6	n.s.
802.09	16.5 ^{ab}	16.6	n.s.
804.15	16.2 ^b	16.6	n.s.
806.05	18.1 ^a	17.0	n.s.
809.02	16.2 ^b	16.2	n.s.
Combined	16.9	16.5	n.s.

Values appended with the same letter are not significantly different at p=0.05.

n.s. not significant

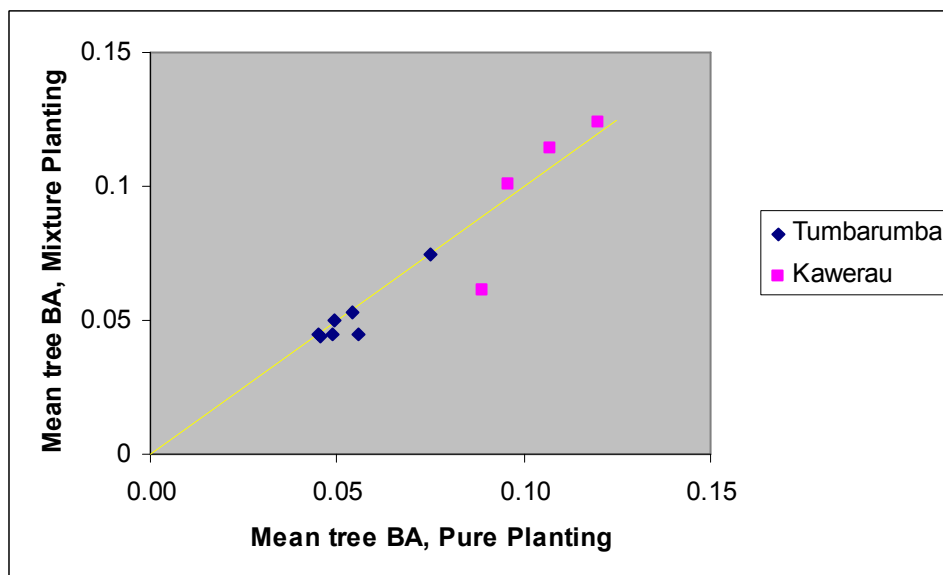
* significant at p=0.05

** significant at p=0.01

OVERALL RESULTS

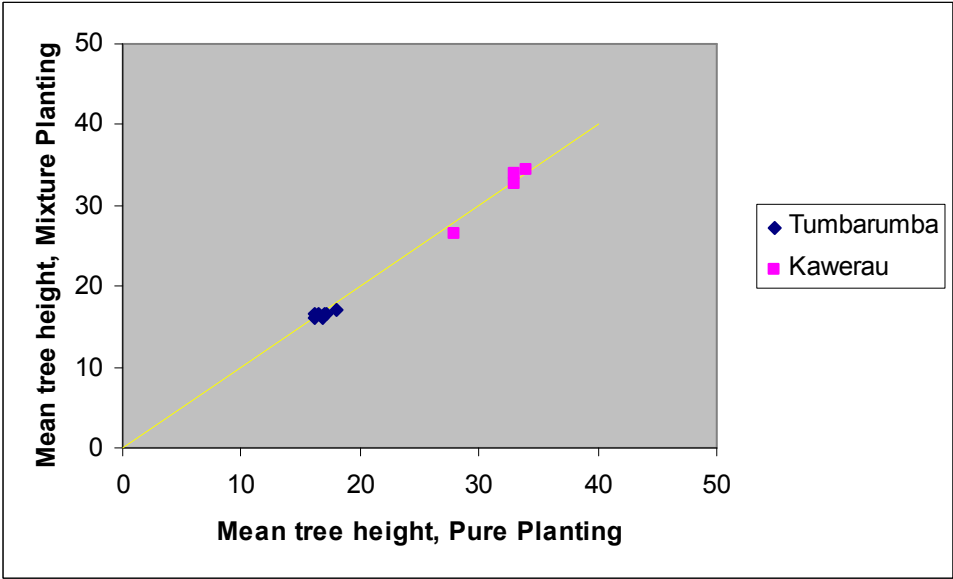
Figure 1 summarises the relationship between pure blocks versus mixtures in terms of mean tree basal area for the eleven clones tested. It can be seen that with the exception of two less competitive clones (one at Kawerau and the other at Tumbarumba) that perform poorer in mixtures than in pure blocks, most clones hold closely to the 1:1 line indicating that there is no advantage in terms of growth to planting clones in pure blocks.

Figure 1. The relationship for mean tree basal area between clones planted in pure blocks versus mixture.



Eleven clones covering a range of tree height from 16.2 to 34.5 metres show that with height growth also there is no advantage to planting clones in pure blocks over mixtures (figure 2).

Figure 2. The relationship for mean tree height between eleven clones planted in pure blocks versus mixture.



Variation between trees in mixed and pure blocks

In 2003 (tree age 15) at Kawerau trial the within-plot coefficient of variation (CV) of DBH estimated for each treatment ranged from 8.4 to 15.8. The lowest variation was found in pure clonal plots contrasting with the highest variation which was encountered with the four clone mix (table 5). Clonal mixtures did not differ significantly in terms of variability from either mixtures including more clones or control pollinated seedlings or relatively unimproved (GF 7) seedlings. Two years later, at tree age 17, the CV of all but the 16 clone mix had risen slightly to between 12.1 (pure clones) and 16.5 (four clone mix). With a site index of 39 metres and at a live stocking of 592 stems/ha full site occupancy has been achieved for many years at this site. Consequently inter-tree competition has reached levels, possibly higher than would be encountered in most current regimes. The resulting suppression of sub-dominant trees will have contributed to the increase in DBH CV.

Table 5. Comparison of within-plot CV (coefficient of variation) of DBH for different planting stock and outplanting treatments at Kawerau – tree age 15 and 17

	Kawerau, age 15		Kawerau, age 17	
	CV	se(CV)	CV	se(CV)
CP286	13.7 ^a	1.3	15.2 ^a	2.3
GF7	13.7 ^a	1.4	14.5 ^a	2.5
Mix16	14.5 ^a	1.4	14.2 ^a	2.5
Mix4	15.8 ^a	1.0	16.5 ^a	1.8
pure	8.4 ^b	1.0	12.1 ^a	1.8

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

At Tumbarumba the DBH CV ranges from 10.5 for pure clonal blocks to 19.4 for cuttings. Productivity at this site is much lower than the Kawerau site and the overall stocking is lower, and uneven, due to mortality which may contribute to increased variation within each population.

Table 6. Comparison of within-plot CV (coefficient of variation) of DBH for different planting stock and outplanting treatments at Tumberumba – tree age 15

	Tumberumba	
	CV	se(CV)
CPseedling	15.5 ^{ab}	2.6
Cuttings	19.4 ^{ac}	2.6
Mix16	11.8 ^{bc}	2.6
Mix4	13.8 ^{abc}	2.0
Pure	10.5 ^c	1.3

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

CONCLUSIONS

Depending on the genotype, selected stands planted with pure blocks of one clone can be clearly differentiated from one another in terms of tree growth. However, these trials show that there is no overall advantage, in terms of growth, to planting clones in pure blocks versus in mixtures. The one exception to this rule is that if a clone is a poor competitor relative to other clones, for whatever reason, it is likely to grow better in a pure block than in a mixture.

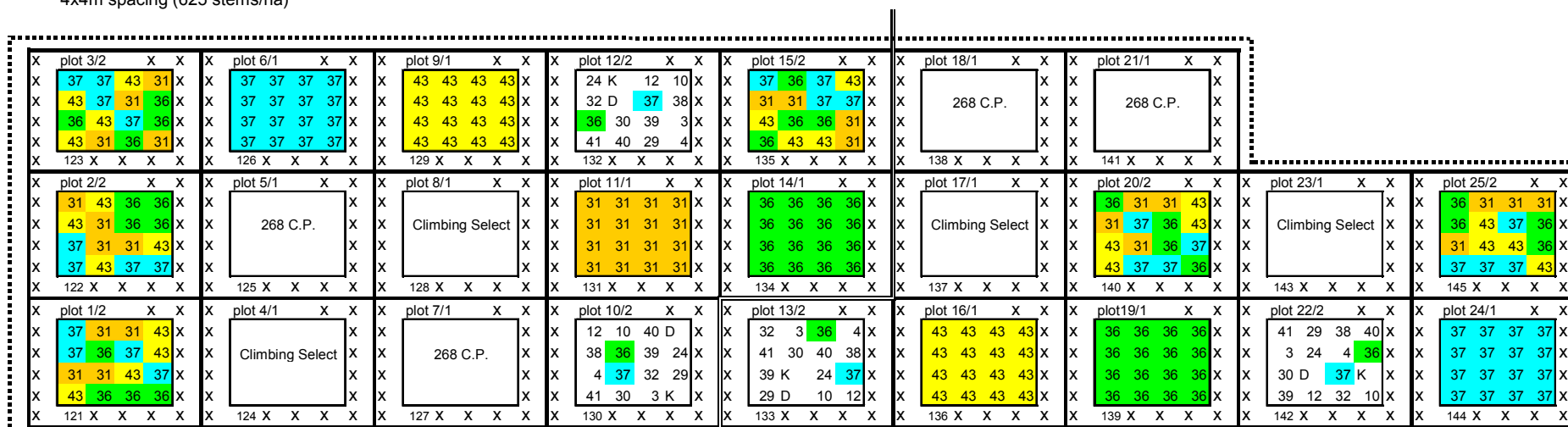
The variability in tree size of clones planted in pure blocks is less than for mixtures or control pollinated seedling stands, at least until full stand occupancy is reached and severe inter-tree competition takes effect. Further analysis of the 16 clones planted at 400 stems/ha in pure blocks and reciprocal two clone mixtures at FR 309, Tarawera valley (project 6.01), is warranted to clarify this issue.

The potential advantages of using clones to create a homogeneous resource in terms of tree morphology and wood properties has not yet been investigated in these trials. Project 6.02 is a proposal to thin the Kawerau trial in this forthcoming year. This presents an opportunity to investigate the variability of branching characteristics and internal wood properties within clones across a range of tree size.

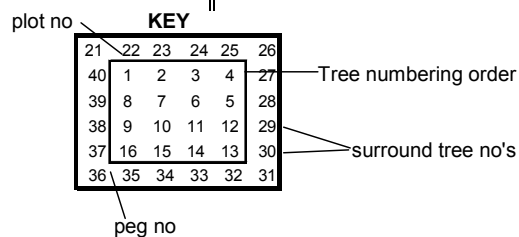
APPENDIX 1: FR450/0 – KAWERAU TRIAL LAYOUT MAP

FR 450 - Chapmans Block Clonal Trial

planted 1988
4x4m spacing (625 stems/ha)



- xxxxx plot buffer 268.405 O.P. juvenile cuttings
- trial surround 268.323 O.P. juvenile cuttings
- Clones A - K: 268.405 family cuttings
- Clones 1 - 35incl: 268.405 family juvenile cuttings
- Clones 36 - 43 incl: 26.323 family juvenile cuttings



APPENDIX 2: FR 450/1 – TUMBARUMBA TRIAL LAYOUT MAP

FR 450/1 Tumberumba clonal mixtures trial

