BREAST HEIGHT BASIC DENSITY OF PHYSIOLOGICALLY-AGED CUTTINGS VS SEEDLINGS, GROWN ON A FERTILE FARM SITE

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Report No. 31 **May 1996**

FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

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A spacing trial established on a fertile farm site to compare growth and form of radiata pine cuttings from three-year-old trees, with seedlings, was assessed at age 12 years, to investigate basic wood density relationships between the two propagation types.

Thirty breast height, 'pith-to-bark' increment cores were collected from both the cuttings and seedlings treatments. In the laboratory the outer five growth rings were separated from the residual core, the length of each was measured and the basic density determined. A ring count on the residual core was included.

Analysis of the data showed a small (14kg/m^3) but significant difference (at the 95% confidence level) between basic density of the outer 5 growth rings, with the cuttings at the lower density. No other variables measured were found to be significantly different.

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INTRODUCTION

A comprehensive study (Nicholls et al.1977) showed that wood density of physiologically-aged clones of plants grown from the same genetic origin was less than wood density of seedlings.

Results from a small trial (Cown, 1982) confirmed an effect of ortet age on wood density of radiata pine cuttings. With increasing ortet age, growth and wood density in the cuttings are reduced. This 'maturity effect' was rather small in material derived from 7-year-old trees sampled at age 12 years. However, there were indications that the wood density gradient may be less than in seedlings and hence differences may become more apparent as the trees age.

A further small trial (McKinley, 1986) compared radiata pine cuttings from 7-year-old ortets with seedlings, at age 15. The results showed little difference in wood density, or for a range of other wood properties assessed.

A review of the effects of vegetative reproduction of radiata pine on wood properties, and the implications for solid wood utilisation (Cown, 1988), concludes that if cuttings are collected from trees 7 years old or less, the wood properties of the ramets will closely resemble those of the parents. Thus in order to ensure good wood quality for clonal forestry, the clones must be kept juvenile, and have their wood properties adequately tested.

A more recent study (Lausberg et al., 1995) examined wood properties of radiata pine to determine the effect of physiological ageing. Eleven-year-old seedlings were compared to 11-year-old cuttings that were physiologically aged 1,2,3,4 and 5 years. No significant effect of physiological age was found on any of the wood properties measured including density.

Results of a spacing trial established in 1984, comparing the growth and form of seedlings (GF15) and cuttings (GF16) from 3-year-old trees, were presented to the Stand Management Cooperative in 1992 (Holden et al., 1992). This trial, planted on exposed, fertile farmland located on the lower slopes of Mt Ngongotaha, showed significant differences in stem form between the cuttings and seedlings. This trial has now been selected to compare wood density between the cuttings and seedlings.

METHOD

- Collect 'pith-to-bark' increment cores at breast height from a sample of 30 cuttings and 30 seedlings (1 core / tree).
- Avoid or minimise inclusion of compression wood, and defects such as high resin content in the cores.

- In the laboratory, separate the outer 5 growth rings from each core and record the length of each core section, together with a ring count from the inner (residual) core.
- Use the maximum moisture content method (Smith, 1954) to determine basic density from the core samples.

RESULTS

The spacing trial has 14 treatments (0.2ha plots), with five replications. Excluding treatments initially established at 200s/ha, a matched treatment of cuttings and seedlings was selected from each replication, based on the 1991 trial measurement. Six trees covering the range of diameters present were selected for sampling in each of the matched treatments.

Core collection was completed in May 1996. DBH(ob) data was collected during an earlier trial measurement in April 1996, at which time the trees to be sampled were identified.

In order to minimise compression wood and resin content, a second core was frequently taken, and the best core of the two was selected. For wood density determination, high resin content near the pith on several cores (probably a consequence of stock damage reported at age two) made portions of these cores unsuitable for inclusion in the following analysis.

A summary showing sample size, mean values and variation for DBH(ob), outer 5-ring length and basic density, of the cuttings and seedlings, is given in Table 1. Similar tables for the residual core length, ring count and density, and for total core length, ring count and density, are appended.

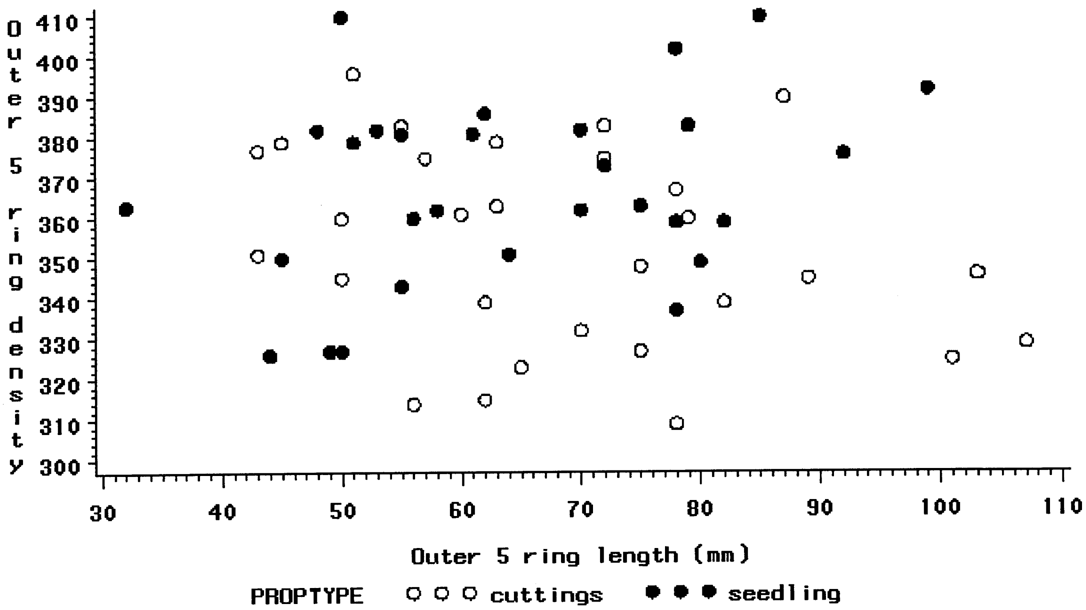
Table 1: Summary of DBH(ob), Outer 5-Ring Length and Basic Density

	CUTTINGS			SEEDLINGS		
		Outer 5-rings			Outer 5-rings	
	DBH(ob) (cm)	Length (mm)	Basic Density (kg/m³)	DBH(ob) (cm)	Length (mm)	Basic Density (kg/m³)
Sample size	30	30	29	30	30	29
Average	41.7	68	**353**	40.5	64	**367**
St Dev (±)	4.5	17	25	4.0	16	23
Minimum	35.8	43	309	31.9	32	326
Maximum	52.3	107	396	47.0	99	410

Note: Previous density assessments have shown that a sample size of 30 trees will provide a mean density value within ±3% of the true mean (M. Kimberly, statistician, pers. com.).

Analysis of the data shows there is a significant effect on the outer 5-ring density between cuttings and seedlings (P=0.0323 from the ANOVA or P=0.0246 using a t test). Specifically, the outer 5-ring density for seedlings is greater than that for cuttings at the 95% confidence level. A scatter plot of the outer 5-ring density and length data for both cuttings and seedlings is shown in Figure 1. There is no relationship between outer 5-ring density and DBH(ob) (t test, P=0.1723), nor for the DBH(ob) between cuttings and seedlings (t test, P=0.2695).

Figure 1: Scatter Plot of Outer 5-Ring Density and Length



T tests were also used to do simple means comparisons between cuttings and seedlings for outer 5-ring length, residual core length and density, and total core length and density. Total core density was significantly different at the 95% confidence level, however all other characteristics tested showed no significant difference between cuttings and seedlings.

Average residual core density (inner 5-6 rings) was 27kg/m^3 and 31kg/m^3 (8%) lower than outer 5-ring density for the cuttings and seedlings respectively.

DISCUSSION

Average outer 5-ring density for the cuttings sample at 353kg/m^3, was 14 kg/m^3 lower than for the seedlings sample. Although this difference was shown to be statistically significant at the 95% confidence level, it is not a large difference. Previous work undertaken by NZFRI has shown that seedlings consistently had a much higher proportion of compression wood than cuttings. It is understood that the presence of compression wood may well account for the difference in wood density between cuttings and seedlings. This finding is of considerable importance as the inclusion of compression wood can have a negative impact on the quality of the wood irrespective of wood density. The most notable impact of compression wood relates to increased longitudinal shrinkage and reduced stability. The trial sampled is located on an exposed site with plenty of evidence of periodic wind damage. Trial records mention wind damage such as 'toppling' being more pronounced in the seedling treatments. This will almost certainly be linked with higher levels of compression wood. However, apart from endeavouring to avoid or minimise compression wood in the sample when collecting the cores, no measure of compression wood has been included in the analysis. Cores are not an effective means of measuring compression wood, and if it were to be included in future trials, discs would need to be collected for this purpose.

(Cown, 1982) concluded that radial density gradients were somewhat steeper in seedlings than in cuttings. Data from this trial indicates support for that conclusion, as the residual core densities (inner 5-6 rings) showed a small (10kg/m^3) and not significant difference between seedlings and cuttings, while the outer 5-rings showed a larger (14kg/m^3) and significant difference. It is therefore possible that differences may become more apparent as the trees age.

CONCLUSIONS

Results support previous research findings indicating that the wood density of cuttings is lower than seedlings, however the young physiological age of the cuttings has resulted in minimal difference.

ACKNOWLEDGMENTS

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APPENDIX

Summary of Residual Core Ring Count, Length and Basic Density

	CUTTINGS			SEEDLINGS		
	Residual Core (*)			Residual Core (*)		
	Length (mm)	No. of rings	Basic Density (kg/m^3)	Length (mm)	No. of rings	Basic Density (kg/m^3)
Sample size	30	30	29	30	30	27
Average	114	5.8	**326**	117	5.9	**336**
St Dev (±)	13	0.4	21	12	0.4	26
Minimum	87	5	282	99	5	286
Maximum	135	6	361	142	6	397

* Excludes outer 5-rings

Summary of Total Core Ring Count, Length and Basic Density

	CUTTINGS			SEEDLINGS		
	Total Core			Total Core		
	Length (mm)	No. of rings	Basic Density (kg/m^3)	Length (mm)	No. of rings	Basic Density (kg/m^3)
Sample size	30	30	28	30	30	26
Average	182	10.8	**340**	182	10.9	**354**
St Dev (±)	24	0.4	20	20	0.4	25
Minimum	130	10	302	134	10	303
Maximum	234	11	373	217	11	405