COMPARISON OF NON-DESTRUCTIVE ASSESSMENT TECHNIQUES FOR SHRINKAGE AND COLLAPSE IN *EUCALYPTUS NITENS*

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INTRODUCTION

In recent years, *E. nitens* growers in southern Australia have established substantial areas of plantation to produce sawlog- and veneer-quality timber in addition to pulpwood. Drying degrade, manifested as checking (radially-oriented cracks) brought about by excessive collapse (excessive shrinkage of timber caused by the buckling or flattening of cells), has been identified as a problem that may significantly reduce recovery of appearance-grade sawn-timber from such plantations. Collapse occurs in the initial stages of timber drying as free water is removed from cell lumens. True shrinkage occurs later in the drying process as water is removed from cell walls (Raymond *et al.* in press).

This study expands on work undertaken by Kube and Raymond (2001) and Raymond *et al.* (in press) aimed at developing a suitable low-cost non-destructive technique to assess the propensity of an individual tree's timber to collapse upon drying. It investigates different methods of assessing total core shrinkage (i.e. true shrinkage plus collapse) in dried wood cores. Genetic parameters are presented for each method of total shrinkage assessment, DBH and basic density.

MATERIALS AND METHODS

Two four-year-old *E. nitens* progeny trials in Tasmania were measured and sampled in 2003. The first trial, Forest Enterprises Australia's (FEA) George's Plains trial, contained 119 open-pollinated families grown from seed collected in 1998 from a second-generation seed orchard located at Bream Creek in south-east Tasmania. The trial consisted of four replicates of twelve incomplete blocks. Each incomplete block comprised ten treatments of four trees arranged in line plots.

The second trial, Forestry Tasmania's (FT) Magazine Road trial, contained 130 open-pollinated families from the same seed collection represented at George's Plains. The trial contained 131 other treatments not planted at George's Plains but these were excluded from all analyses. It consisted of four replicates of 16 incomplete blocks. Each incomplete block comprised 15 treatments of five trees arranged in line plots.

Diameter at 1.3 m (DBH) was measured for all trees at both sites. Twelve-millimetre bark-to-bark cores were extracted at 0.9 m from the first tree in each plot with a DBH greater than 8 cm. Green volumes were measured before cores were dried to equilibrium moisture content in a controlled-temperature room at 22°C and approximately 30% humidity. Dried cores were assessed for total core shrinkage using 4 methodologies:

1) visual scoring of tangential total core shrinkage using a 1 (no observable total shrinkage) to 4 (obvious total shrinkage) scale,
2) calculation of the difference between green-core volume and dry-core volume expressed as a percentage of green core volume (Raymond *et al.* in press),
3) averaging the minimum tangential diameter on each side of the pith measured with callipers, and
4) estimation of average tangential core diameter using image analysis. Cores were scanned with the wood grain oriented vertically using a back-lit flatbed scanner and the images analysed using UTHSCSA Image Tool for Windows Version 3. Average tangential core diameter was estimated by dividing core tangential area by core length.

Once total shrinkage traits were assessed, cores were oven dried at 105°C, weighed and their basic densities calculated.

Analyses were undertaken using ASReml (Gilmour *et al.* 2002). Variance components were estimated by fitting a series of univariate models incorporating REPLICATE (fixed), *INCOMPLETE BLOCK* (random), *INDIVIDUAL TREE* (random) and *RESIDUAL* effects. In the case of DBH, *PLOT* was also fitted as a random effect. Inter-trait and inter-site correlations were estimated by fitting appropriate bivariate models. Genetic relationships between the half-sib families and their parents, grandparents and great-grandparents were defined in a pedigree file incorporating genetic groups. Estimates of individual narrow-sense heritabilities were calculated according to the following formula: $h^2_{op} = 0.625\sigma^2_{tree} / \left(\sigma^2_{tree} + \sigma^2_{plot} + \sigma^2_{error}\right)$.

RESULTS AND DISCUSSION

Heritability estimates were lower at the Magazine Road trial than the George's Plains trial for all traits (Table 1).

Table 1. Heritabilities and inter-site genetic correlations of DBH, core basic density, total core shrinkage visual score, volumetric total core shrinkage, average minimum tangential core diameter and average tangential core diameter

Trait	Heritability (std. error) George's Plains		Magazine Road		Inter-site genetic correlation (std. error)	
DBH	0.16	(0.05)	0.03	(0.04)	0.59	(0.46)
Basic Density	0.51	(0.13)	0.23	(0.11)	0.76	(0.23)
Score (1)	0.14	(0.11)	0.02	(0.10)	Did not converge	
Volumetric total shrinkage (2)	0.47	(0.13)	0.37	(0.13)	0.86	(0.20)
Average min. diameter (3)	0.38	(0.14)	0.25	(0.12)	0.56	(0.30)
Average diameter (4)	0.28	(0.12)	0.11	(0.11)	Did not converge	

The measurement of volumetric total core shrinkage appears to have the most promise as a non-destructive method for assessing total shrinkage. Estimates of heritability and inter-site genetic correlation for this trait were moderate to very high and significantly different to zero (Table 1). Inter-trait genetic correlations between volumetric total shrinkage and DBH were not significant but the estimated genetic correlations with density were -0.42 (0.20) and -0.71 (0.24) at George's Plains and Magazine Road respectively. This indicates that selection for greater density would reduce volumetric total core shrinkage in a breeding population.

The mild drying regime used in this experiment did not result in a high degree of collapse in cores and it is possible that harsher drying conditions would have produced significant heritability estimates for more of the total shrinkage measurement techniques examined. It is also important to note that the relationship between total shrinkage in cores and drying degrade in sawn boards is yet to be determined.

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