

## Wood density and shrinkage of five-year-old *Eucalyptus camaldulensis* × *E. globulus* hybrids: preliminary assessment

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### Summary

Trees of *Eucalyptus camaldulensis* × *E. globulus* subsp. *globulus* hybrids growing at Pinjarra, Western Australia, were harvested for assessment of wood fibre and wood properties of sawn timber. Trees were 5-y-old at the time of felling. Wood density was in the medium range: mean green density was 980 kg m<sup>-3</sup>, basic density was 507 kg m<sup>-3</sup> and air-dry density was 653 kg m<sup>-3</sup>. Green moisture content was 94%. Tangential shrinkage before reconditioning was greater than the shrinkage of mature *E. camaldulensis* or 13-y-old *E. globulus*. Radial shrinkage of the hybrid wood at 4.9% was similar to that of mature *E. camaldulensis* but less than that reported from 13-y-old *E. globulus*. The wood of *E. camaldulensis* × *E. globulus* has potential for value-added purposes; no problems were identified with sawmilling, drying and sanding.

**Keywords:** wood properties; quality; density; shrinkage; moisture content; hybrids; *Eucalyptus camaldulensis*; *Eucalyptus globulus*

### Introduction

Hybrid eucalypts are being developed for industrial plantations with the aim of producing lines that show hybrid vigour, improved tolerance to biotic and abiotic stresses, or ability to grow under conditions marginal or unsuitable for high-value species such as *Eucalyptus globulus* (Griffin *et al.* 2000). Hybrid eucalypts generally have an overall morphology intermediate between that of the parent species with few traits being dominant, but some traits may be closer to those of one parent than the other (Pryor 1954; Pilipenka 1969; Tibbits 1988; Meddings *et al.* 2003). Wood properties have moderately high heritability (Zobel and van Buitenen 1989) and have also been shown in hybrids to be generally intermediate between the parents. Wood density and radial shrinkage are traits for which most hybrids appear intermediate (Siarot 1991; Malan 1993, 2000; Verry 2000) although it is sometimes difficult to make comparisons given data from trees of different ages. There are as yet no examples of useful heterosis in wood properties where the hybrid value is better than that of the best parent. Li *et al.* (1997) reported quantitative trait loci (QTLs) in two linkage groups that affected wood density in *E. grandis*.

*Eucalyptus camaldulensis* × *E. globulus* subsp. *globulus* hybrids were made with the objective of producing trees that have commercial yields of wood or pulp when grown on saline land

(Meddings *et al.* 2001, 2003). The literature indicates that for *E. camaldulensis* and *E. globulus* up to 5.5 y old there is little difference between the wood properties of trees grown on saline and non-saline land, although there was a tendency towards greater density on saline sites (Clark *et al.* 1998; Catchpole *et al.* 2000).

There are no reports of wood properties of this hybrid, although three clones of *E. globulus* subsp. *maidenii* × *E. camaldulensis* in Morocco were reported to have a high wood density (Table 1). Those trees were considered natural hybrids and their exact parentage was unknown. As a preliminary indication of the wood properties of the *E. camaldulensis* × *E. globulus* hybrids, we report here on the harvesting and assessment of wood density and shrinkage properties of 5-y-old hybrids growing on non-saline land.

### Materials and methods

#### Plant material and field site

Hybrids were produced by fertilising flowers of *E. camaldulensis* growing in a plantation at Kwinana, Western Australia (32°15'S, 115°45'E), with pollen from *E. globulus*. The *E. camaldulensis* were clones from progenies of trees from Broken Hill, NSW (85), and Erudina, South Australia (87), respectively, and the pollen was collected from *E. globulus* subsp. *globulus* progenies from King Island, Tasmania (K). There was a high proportion of abnormal seedlings amongst the progeny and these were excluded from subsequent plantings (Meddings *et al.* 2003). Trees were planted in July 1995 on the coastal plain near Pinjarra (32°35'S, 115°50'E), 87 km S of Perth, which has an annual rainfall of about 948 mm. Many trees in a 4-y-old *E. globulus* plantation on the planting site had died during the summer of 1993/94, which was exceptionally dry. The few remaining *E. globulus* trees were removed and burned, land was ripped and mounded and herbicides applied to suppress weeds. The hybrid trees were planted 3 m apart in rows 4 m apart. Each tree was planted with two 50 g DAP fertiliser tablets (Bailey's) and no further fertiliser was applied.

#### Harvesting

The two hybrid families used in the present trial on average were 10.5 m high after 5 y. Two trees with above-average growth and form were selected from each of the families for felling and assessment of wood properties (Table 2). These were coded as 85xK and 87xK.

**Table 1.** Wood properties of some *Eucalyptus* species and their hybrids

Species and hybrids	Age (y)	Basic density (kg m <sup>-3</sup> )	Air-dry density (kg m <sup>-3</sup> )	Radial shrinkage (%)	Reference
<i>E. camaldulensis</i>	12		600–870	6.8	Van Vuuren <i>et al.</i> (1978); Dyer (1962); both cited in Malan (1993)
	14	512			Ona <i>et al.</i> (1996)
	Mature	710	913	8.9	Kingston and Risdon (1961)
	Mature?		960		Banks (1954)
	Mature		Up to 960		Poynton (1979) cited in Malan (1993)
<i>E. globulus</i>	3.5	520			Catchpole <i>et al.</i> (2000)
	13	538	737	8.5	Moore <i>et al.</i> (1996)
	14	596			Ona <i>et al.</i> (1996)
	17–23	561	790	14.4	Kingston and Risdon (1961)
	Mature	681	900	7.7	Kingston and Risdon (1961)
	Mature?		600		Banks (1954)
<i>E. maidenii</i>	Mature?		620		Banks (1954)
<i>E. maidenii</i> × <i>E. camaldulensis</i>	≥3		911		Fechtal and El Abid (1995)

**Table 2.** Details of trees harvested for wood density and shrinkage assessments

Hybrid line	Log number	Height (m)	Merchantable* height (m)	DBH (cm)	Stem form
Hybrid 85xK	2 W	10.9	6.0	24.0	Good — 1st branch at 2.6 m
Hybrid 85xK	14 O	11.1	7.0	25.3	Good — single trunk
Hybrid 87xK	6 K	12.5	6.6	20.8	Moderate — 1st fork at 2.5 m
Hybrid 87xK	13 A	13.7	9.0	28.7	Good — 1st branch at 2 m

\* merchantable height = height to trunk diameter under bark of 8 cm

Trees were felled and samples collected in October 2000. The diameter at breast height (DBH), total height and ‘merchantable’ height (i.e. to a minimum of 8 cm diameter under bark) were measured. Sample logs from the four hybrid trees (varying in length from 60 to 149 cm) were transferred to the Forest Products Commission Timber Technology mill at Harvey, Western Australia. Three of the trees produced both butt and crown logs, while the remaining tree produced only a butt log.

### Milling and assessment

The logs were sawn on a ‘Woodmizer’ portable bandsaw. Matched specimens would normally be cut from each side of the heart, but this was not possible in all cases due to some checking and internal defects. Where log quality permitted, a plank 28 mm thick was milled from bark to bark through the heart. The plank was then sawn into sections 28 mm wide to prepare specimens for assessment of wood density. The density specimens with growth rings parallel to one edge were also used to estimate tangential and radial shrinkage.

The sections were docked to lengths of 200 mm and sanded on four sides using a belt sander, to give a smooth, consistent surface, and specimen dimensions of about 25 mm × 25 mm. The properties measured were green density (green mass / green volume), basic density (oven dry mass / green volume), and air-dry density (air-dry mass / air dry volume). Lines were drawn across the tangential and radial faces in the centre of the specimens to ensure that the

dimensions were measured in the same positions each time. The specimens were then immersed in water for 24 h to reduce moisture variation prior to taking measurements.

In assessing wood density and shrinkage, measurements of mass, length, width and thickness were taken every two days and recorded while the specimens were air-drying on a wire mesh sheet. Mass was measured on a balance accurate to 0.01 g. The dimensional measurements were taken with a Vernier calipers accurate to 0.03 mm. When equilibrium moisture content of about 12% was reached, the specimens were oven-dried at 103°C to constant weight.

### Results and discussion

Despite some checking upon arrival at Timber Technology and the presence of internal defects, sawing the logs on the Woodmizer presented no problems. Growth stresses were not evident; this could be attributed to stress release caused by some checking prior to milling. The slabs from which the specimens were later prepared were quite knotty and cracked, and, as explained previously, it was not possible to prepare a complete set of defect-free specimens.

The density specimens dried at a uniform rate, although collapse was evident in some. In a commercial operation using this timber, a steam treatment at about 18% MC would be necessary to recover the wood. Values for moisture content, green density, basic density

**Table 3.** Moisture content, green density, basic density and air-dry density of *E. camaldulensis* x *E. globulus* wood

Tree	Log no.	No. of samples	Mean moisture content (%)	Mean green density (kg m <sup>-3</sup> )	Mean basic density (kg m <sup>-3</sup> )	Mean air-dry density (kg m <sup>-3</sup> )
Hybrid 87xK	6 K Crown	2	97	975	555	648
	6 K Butt	4	101	995	497	685
	13 A Crown	4	86	986	532	666
	13 A Butt	11	91 (9)	979 (33)	513 (26)	649 (49)
Hybrid 85xK	14 O Butt	5	106 (8)	996 (34)	483 (18)	622 (15)
	2 W Crown	2	85	944	509	649
	2 W Butt	2	87	952	510	677
Weighted mean			94 (10)	980 (34)	507 (28)	653 (45)

The values in brackets denote the standard deviation (given only for five or more samples).

**Table 4.** Tangential, radial and longitudinal shrinkage of *E. camaldulensis* x *E. globulus* wood

Tree	Log no.	No. of samples	Mean tangential shrinkage (%)	Mean radial shrinkage (%)	Mean longitudinal shrinkage (%)
Hybrid 87xK	6 K Crown	1	12.7	6.5	0.6
	6 K Butt	2	8.5	6.7	0.7
	13 A Crown	2	9.3	3.0	0.5 (0.3)
	13 A Butt	6	7.4 (4.4)	5.2 (2.9)	0.4 (0.3)
Hybrid 85xK	14 O Butt	5	12.3 (2.2)	4.2 (1.8)	0.3 (0.2)
	2 W Crown	2	NS	NS	0.2
	2 W Butt	2	NS	NS	0.3
Weighted mean			9.6 (3.8)	4.9 (2.3)	0.4 (0.3)

\*Values in brackets denote the standard deviation where there are five or more samples.

NS = 'not suitable'. Specimens did not have growth rings orientated parallel to the face because initial milling could not be done through the heart.

**Table 5.** Comparisons of density and shrinkage of wood of *E. camaldulensis* x *E. globulus* hybrids and parent species

Species	Green density (kg m <sup>-3</sup> )	Basic density (kg m <sup>-3</sup> )	Air-dry density (kg m <sup>-3</sup> )	Tangential shrinkage* (%)	Radial shrinkage* (%)
<i>E. camaldulensis</i> x <i>E. globulus</i> subsp. <i>globulus</i> (5 y old)	980	507	653	9.6	4.9
<i>E. globulus</i> subsp. <i>maidenii</i> x <i>E. camaldulensis</i> (≥3 y old) <sup>1</sup>				9.11	
<i>E. camaldulensis</i> (mature) <sup>2</sup>		710	913	8.9	4.4
<i>E. globulus</i> (13 y old) <sup>3</sup>	1040	538	737	8.5**	6.9**

<sup>1</sup>Fechtal and El Abid (1995); <sup>2</sup>Kingston and Risdon (1961); <sup>3</sup>Moore *et al.* (1996)

\*Before reconditioning

\*\*Based on backsawn boards and not small specimens

and air-dry density are given in Table 3, and for tangential, radial and longitudinal shrinkage in Table 4.

The wood density measurements from this assessment are compared with published data for a mature *E. camaldulensis*, plantation-grown *E. globulus* and a natural hybrid of the reciprocal cross (Table 5). The 5-y-old hybrid timber had lower basic and air-dry density than samples from either mature *E. camaldulensis* or plantation-grown *E. globulus*. The young age is most likely the

reason for this difference; density is expected to increase as the trees age, particularly as the female parent (*E. camaldulensis*) is a high-density species. It is interesting to note that in the natural hybrid in which *E. globulus* subsp. *maidenii* was used as a female parent with *E. camaldulensis* pollen, the wood of the hybrid trees was of high density, similar to that of *E. camaldulensis*.

Shrinkage measurements (Table 5) indicate that the tangential shrinkage of the hybrid was greater than of mature *E. camaldulensis*

or 13-year-old *E. globulus*, while radial shrinkage of the hybrid was slightly more than that of the *E. camaldulensis* parent, but 2% less than that of the *E. globulus* parent. It is expected that under normal growing conditions all wood properties of the hybrid will improve with age.

Overall assessment of the timber properties and processing behaviour of the hybrids indicated that there were no problems with saw milling, drying or sanding. The wood of *E. camaldulensis* x *E. globulus* has potential for value-added purposes. Further tests of wood properties of older trees will be necessary, using plantations where clonal replicates can be tested and where trees are growing in both saline and non-saline conditions.

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