SURVEY OF BASIC DENSITY OF PEDIGREED MARITIME PINE IN GNANGARA, PINJAR AND YANCHEP PLANTATIONS

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SUMMARY

Maritime pine (*Pinus pinaster*) growing in the Gnangara, Pinjar and Yanchep plantations north of Perth was assessed to compare the basic density of wood from pedigreed trees planted routinely from 1972 to 1987 with that of older unimproved trees. The data are essential for efficient utilisation of the resource, whether for sawlogs, MDF production or for proposed LVL production. More than five hundred trees were sampled, with the minimum sample of twenty trees (five plots x four trees) in each planting year of the pedigreed material. Smaller samples of older material were used, and thirty trees from research trials established from 1965 to 1972 were included. A bark to pith core was extracted at breast height (1.3 m) using a 'Trecor' Wood Corer, and basic density of each 35 mm section assessed commencing at the pith.

Basic density (unextracted) increased from pith to bark and decreased with decreasing age. Comparative resin content is the major factor, because the amount of resin obviously increases with age. The variation in mass at the pith (as indicated by high standard deviations) was greater than in the outer sections, and high basic density levels confirmed any high resin content. Mean basic density in the 70 to 105 mm sections of P72 to P80 plantings was about 500 kg/m^3. The results indicate that pedigreed maritime pine material has acceptable basic density, and that the density level of younger trees will increase with increasing age. Comparative data from previous assessments of Western Australian-grown maritime pine are given.

INTRODUCTION

Maritime pine (*Pinus pinaster*) is one of the major plantation species in Western Australia, with a current area of about 27 000 ha. This species has become significantly more important with planned establishment of 150 000 ha in the semi-arid areas of the Wheatbelt to reduce salinity effects while providing a commercial crop.

The current major plantations are Gnangara, Pinjar and Yanchep, with about 20 000 ha, but this area will be thinned and clear-felled progressively over the next twenty years and the area converted to a nature park. All plantings since 1972 have been improved or pedigree stock resulting from an intensive tree-breeding program initiated by the then Forests Department.

Wesfi Ltd use maritime pine industrial wood for medium density fibreboard (MDF) production in Kewdale, and there is a current proposal for Sumitomo, a Japanese company, to use part of this resource to manufacture laminated veneer lumber (LVL) for either structural or non-structural purposes. Most of the product would be exported.

Efficient utilisation requires detailed information on the wood properties of the species, particularly the pedigreed resource planted since 1972, because thinnings from these compartments are providing an increasing resource to Wesfi and would be used in LVL production. Wood density is an important predictor of strength properties, and the current survey was carried out to obtain a better understanding of the wood density profile of maritime pine. A bark to pith core was taken from each of four trees in the selected plot, and basic density of each 35 mm section assessed.

The survey was initiated following a request by the Executive Director of CALM and Mr Denis Cullity of Wesfi, and Wesfi and CALM staff were assisted by a consultant specialising in plywood production, Mr Barry McCombe. As well as assisting Sumitomo, the information is useful to Wesfi in planning production in their MDF plant.

Initially the survey was to include systematic sampling of the areas planted each year from 1972 to 1980 (P72 to P80), with comparisons made with unimproved material from P69 to P71. The number of plots sampled was proportional to the area planted, and stratification was done based on silvicultural and site variations. Plot location was nominated by a CALM forester with intensive knowledge of Gnangara, Pinjar and Yanchep plantations. The sample was subsequently expanded to include P81 to P87 (which will be thinned in the next few years), as well as a small sample of P51 and P57 because the latter was used for an earlier LVL assessment in Finland.

The second stage of the survey will assess trial plots of maritime pine established in semi-arid areas, and will involve staff from CALM's Farm Forestry Unit.

METHODS

The sampling pattern used in the pedigreed resource was based on the area established annually from 1972 to 1987 (P72 to P87). A smaller sample of unimproved resource (P51, P57, P69, P70 and P71) was included for comparative purposes. The location of each of these temporary plots (each with four trees) was nominated by Clayton Sanders, a CALM forester with intensive knowledge of the Wanneroo area. There was a requirement that the plot should be more than 50 m from any road or compartment boundary, although quickly accessible because of the scale of the survey. Suppressed and sub-dominant trees were excluded. Trees sampled from ~~research~~ trials ~~(e.g. thinning/spacing, fertiliser)~~ for the density assessment were nominated and marked by CALM treebreeder Trevor Butcher. Sampling details are given in Table 1. tree breeding

Table 1. Planting years and compartments sampled for wood density survey of maritime pine in Gnangara, Pinjar and Yanchep plantations.

Stratum	Compartment	Trial No	No of plots
P51	Gnangara 13,18,127		3
P57	Gnangara 46,49,52		3
P69	Yanchep 1,2: Pinjar 1,2: Gnangara 20,23		6
P70	Yanchep 1,2,8,9		4
P71	Pinjar 4		2
Pedigreed			
P72	Pinjar 3,6,7,8		5
P73	Yanchep 13,15,16,20		5
P74	Gnangara 28,29,30,31		5
P75	Pinjar 2,3,5,6,11,12,13,15		10
P76	Pinjar 21,28,29,30,31,33,34,35,36		10
P77	Pinjar 25,26,27,41,42,45,46,47		10
P78	Pinjar 39,40,48		5
P79	Pinjar 6,7,9,10		5
P80	Pinjar 9,20,22		5
P81	Pinjar C 12, 13,15		5
P82	Pinjar C 14,18		5
P83	Yanchep C 1,2,3		5
P84	Pinjar 4,5,10,16,17		5
P85	Pinjar H 6,9,15		5
P86	Pinjar 8,13		5
P87	Yanchep 11B,13, 14A		5
Research (tree breeding)			**No trees**
P65	Gnangara 7	YS1	2
P66	Gnangara 7, Yanchep 46A	YS3, 07	4
P67	Yanchep 37A,46A	YS12	6
P68	Gnangara 13, Yanchep 60	YS11B,12, 13B	6
P69	Yanchep 60, Gnangara 109A	YS19,20	8
P72	Pinjar 2	YS43	4

Each tree had a core sample removed, using a 'Trecor' Wood Corer with a 'Tanaka' petrol motor drill. The diameter breast height over bark was estimated, and a mark made on the corer to ensure that the core being drilled went past the pith in each tree. The corer was sharpened at the start of the survey, and proved very effective in producing a clean uniform core with good definition of the growth rings.

Each core was placed in a small plastic bag marked with plot and tree number, which was then rolled tightly to minimise moisture loss overnight.

The procedure in the laboratory was to break off the bark at the cambium, cut the core to length through the pith with a Stanley knife, and then measure and record the length from pith to cambium. The core was divided into 35 mm sections, commencing at the pith. Each 35 mm section was cut with the knife, and any residual length less than 5 mm included with the previous section because of the difficulty in obtaining an accurate density estimate when earlywood/latewood proportions are affected.

Basic density is the oven dry mass divided by the green volume. A small trial showed that moisture loss in the core overnight could be compensated for with a 20 minute soaking before cutting into sections and measuring green volume, rather than a 24-hour soak which may be required in other circumstances. The difference in volume between the two soaking times was less than 1 per cent, which was considered acceptable because the survey was comparative. Plot, tree and section number was marked on the core section with a 'Lumochrom' pencil, which provides a waterproof marking.

The volume was estimated using the displacement method. A clamp stand was placed beside a set of electronic scales with a beaker of water. The scales were tared to read zero, and a length of sharpened wire inserted at right angles into the core section, which was then submerged below the surface of the water. The reading on the scales is an accurate estimate of the displacement of water and therefore of core volume.

The cores were then dried using the oven-dried method, which requires drying at 103oC until constant weight is achieved when all moisture has been removed from the sample. As stated above, basic density is oven dry mass divided by green volume, and this measure is expressed as kg/m^3. The measurements were done on unextracted cores which contained varying amounts of resin, because extraction facilities were not available.

The mean values and standard deviations were calculated, excluding some results where resin content was unacceptably higher than average.

RESULTS AND DISCUSSION

The mean basic density and standard deviation of the 35 mm sections in each planting year are given in Table 2.

The 35 mm sections were based on the likelihood of some maritime resource being peeled and then used for LVL manufacture. The residual core after peeling on modern equipment is about 70 mm diameter, and therefore peeled veneer would be produced from the wood outside that diameter. That is, the basic density of the second and subsequent 35 mm sections indicates the likely wood density of veneers from that resource.

Table 2 shows definite trends with the mean basic density increasing with increasing distance from the pith, and decreasing from the older plantation to the younger plantation. Juvenile wood or crown-formed wood produced in the first ten years has lower density than mature wood, but the resin production associated with formation of heartwood with increasing age will reduce that difference. The standard deviation values in the first 35 mm sections tended to be higher than those in the second and subsequent sections, and reflected the variation in resin production in that first section. Inspection showed no obvious variation in ring width or earlywood to latewood proportions that would result in wood density differences. In screening candidate trees for treebreeding purposes, it would be an advantage to extract resin using either acetone or benzene to give more accurate comparisons.

As might be expected, the oldest sample trees (P51) had very high resin content. In one tree resin flowed freely from near the pith as the core was being extracted. Drilling was very difficult with the corer binding continually. The trees became progressively easier to drill with decreasing plantation age.

The Executive Director and Wesfi were advised that Sumitomo required a minimum air-dry density of 550 kg/m^3 for veneers for LVL production to ensure that stiffness of the product would meet US requirements. The basic density data from this survey indicate that air-dry density should be acceptable.

age range 30 to 138

Comparison with other Western Australian wood density data

Table 3 gives other data relating to the wood density of maritime pine grown in Western Australia. The eighty-five superior trees of maritime pine selected by Perry in Leiria, Portugal, in 1965 were the basis for the Forests Department's intensive tree breeding program. Perry and Hopkins (1967) gave basic density data for each selected tree, with a mean of 500 kg/m^3. The major traits for improvement in the program were stem straightness and vigour, with consideration also given to branch size and angle.

The CSIRO Division of Forest Products completed a major survey of density and shrinkage of native and exotic species grown in Australia (Kingston and Risdon 1963). They assessed samples of unimproved maritime pine from Western Australia, and gave mean air-dry density of 596 kg/ m^3 and basic density of 490 kg/m^3.

Table 2. Basic density of pedigreed maritime pine compared with older unimproved trees (35 mm sections).

Stratum	Plantation	No. of Plots	Core lengths (mm)	Basic Density (Mean and standard deviation)					
Unimproved				**0-35mm**	**35-70mm**	**70-105mm**	**105-140mm**	**140-175mm**	**175-210mm**
P51	Gnangara	3	160-210	502 (31)	562 (37)	564 (29)	547 (29)	565 (50)	534 (53)
P57	Gnangara	3	93-180	502 (55)	497 (40)	516 (50)	501 (48)	497 (-)	
P69	Yanchep, Pinjar, Gnangara	2 each	82-160	489 (46)	485 (37)	523 (57)	538 (50)	574 (-)	
P70	Yanchep D, E	4	82-130	482 (43)	491 (32)	527 (39)	545 (47)		
P71	Pinjar	2	92-140	508 (56)	469 (40)	514 (37)	537 (47)		
Pedigree									
P72	Pinjar	5	83-135	521 (63)	511 (36)	525 (41)	513 (29)		
P73	Yanchep C	5	105-150	471 (47)	503 (35)	540 (30)	551 (34)		
P74	Gnangara	5	100-155	461 (35)	469 (29)	502 (28)	520 (40)	515 (-)	
P75	Pinjar	10	85-140	466 (40)	478 (35)	503 (38)	491 (31)		
P76	Pinjar	10	90-140	473 (56)	461 (39)	508 (43)	496 (42)		
P77	Pinjar	10	80-140	449 (38)	464 (41)	508 (49)	504 (62)		
P78	Pinjar	5	85-130	460 (35)	468 (39)	506 (44)	498 (52)		
P79	Pinjar	5	86-135	466 (54)	459 (25)	496 (34)	487 (29)		
P80	Pinjar	5	70-125	464 (57)	466 (46)	490 (39)	488 (59)		
P81	Pinjar	5	75-110	433 (35)	440 (37)	466 (31)			
P82	Pinjar	5	80-110	445 (47)	450 (39)	479 (44)			
P83	Yanchep H	5	68-110	425 (32)	447 (43)	461 (43)			
P84	Yanchep H	5	53-105	422 (30)	465 (34)	512 (46)			
P85	Yanchep H	5	65-105	414 (29)	433 (34)	450 (46)			
P86	Yanchep H	5	60-90	393 (29)	434 (39)	459 (37)			
P87	Yanchep H	5	60-100	388 (20)	437 (29)	410 (24)			
Pedigree **~~Research~~ P65-P72**	Yanchep, Pinjar, Gnangara	(30 trees)	110-215	481 (41)	501 (41)	503 (34)	527 (35)	530 (47)	503 (34)

Table 3. Air-dry and basic density data from previous assessments of Western Australian-grown maritime pine

Resource	Sample size	Air-dry density		Basic density		References
		Mean	SD	Mean	SD	
Leirian trees selected by Perry in 1965 (Age 30 to 138)	85			500	33	Perry & Hopkins (1967)
Mature wood from the Sommerville plantation (1960s)				550		Nicholls (1966)
~~Seed orchard screening~~ Screening of breeding pop parents (Age 8–12)	336			430(Juv) 480(Mat)	30 40	Hopkins and Butcher (1994)
Wespine sawmilling trial – P71 pedigreed	36	588	37			Meachem (pers.comm)
31-year-old Yanchep plantation	10	569	53			Meachem (pers.comm)
47-year-old Gnangara plantation	10	611	54			Meachem (pers.comm)
WA resource – overall mean		559				Siemon (1983)
" -16-year-old pedigr (Agroforestry)	5	474				Siemon (1983)
Donnybrook Sunkland trial plots (13, 14 yr)		570	85			Siemon (1995)
CALM Timber Technology assessment of P73 ~~pedigreed trial~~ (Yanchep C23) – 25 years (Orchard Stock)	11 trees (x 7 discs)	557	80	458	55	CTT (1998)
Routine stock	11	550	81	454	63	
CSIRO data	10	596	36	490	28	Kingston & Risdon (1961)

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The tree-breeding program progressed with its concentration on phenotype, and wood density was given minor consideration until a seed orchard screening was done to confirm that juvenile wood (defined as the first eight rings) was of acceptable density (Hopkins and Butcher 1994). They reported mean basic density of 430 kg/m^3 for juvenile wood and 480 kg/m^3 for mature wood.

Air-dry density was measured as part of an assessment of the strength properties of Western Australian-grown maritime pine by Siemon (1983), with treatments ranging from P36 to P66. The 16-year-old pedigreed material used in the study came from the Flinn's agrofrestry trial near Mundaring, and air-dried density was low at 474 kg/m^3. The overall mean air-dry density for all samples in the study was 559 kg/m^3. A later assessment of Donnybrook Sunkland trial plots and 13 and 14-year-old maritime pine showed a mean air-dry density of 570 kg/m^3.

Wespine Industries Pty Ltd carried out a sawmilling trial of maritime pine in which graded recoveries and knot sizes from older resource was compared with pedigreed material and unimproved planted in 1971 (Meachem, pers.comm.). Air-dry density was also measured, and mean value was 588 kg/ m^3. Other data collected by Wespine were 569 kg/m^3 for 31-year-old unimproved and 611 kg/ m^3 for 47-year-old pines.

CALM Timber Technology has just completed a wood density assessment of one tree from each of eleven improved families of P73 maritime pine, which included a comparison with adjacent unimproved trees in the Yanchep trial. Although there was a significant improvement in straightness and increase in vigour (and therefore size) in the pedigreed trees, the air-dry densities and basic densities were similar in the two treatments. Air-dry densities of pedigreed and unimproved trees were 557 kg.m^3 and 550 kg/m^3 respectively, and basic densities were 458 kg/m^3 and 454 kg/m^3 respectively. The mean ring width of the pedigreed specimens was greater than that of the unimproved, but obviously the proportion of earlywood to latewood was similar in both, resulting in similar density.

Conclusion

The current survey of basic density, comparing wood of pedigreed maritime pine planted in Yanchep, Pinjar or Gnangara plantations from 1972 to 1987 with some older unimproved material (P51, P57, and P69 to P71) indicated that wood density should be acceptable when this resource is used for LVL production. There was a trend of decreasing basic density as stand age decreased, which would be explained by the higher resin contents in the older trees. Further assessments of basic density of pedigreed maritime pine will continue, with plots planted in semi-arid areas scheduled for survey in early 1999.

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