

Wood Anatomical Structure Of The Clones Of Eucalyptus Tereticornis Sm. (Mysore Gum)

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Abstract: Wood, being a natural material is very variable. This variability is attributed mostly to variations in the anatomical structure of the wood. The wood structure of five clones at macroscopic level and microscopic level is provided for the first time. In addition study on the general features of all the clones are also described. Thus the information provided is a starting point to understand the wood structure of the clonal material as well as identification of some of the clones on the overall structure. The growth rings were delimited by flattened fibres and parenchyma in clone 4 and clone 7. It can be seen that within tree variation of all the characteristics studied are height related and in certain cases encompass the variation within the clones and also among the clones. Development of growth rings in the present study is clone specific. The database thus generated will be useful for any species development from the point of view of wood quality.

Key words: Clones, wood, anatomical structure, growth rings and variation

Introduction:

Interest in Eucalyptus research, in India from the point of view of utilization, dates back to Tippu sultan's period when seeds of different species were planted in Nandi Hills, and then successfully introduced to the Nilgiri hills in southern India. For the subsequent large-scale plantations the seed source from Nandi Hills became the center point for wide spread distribution in the afforestation programmes (Kaikini 1961). Venkatesh and Kedharnath (1965) in their paper entitled "Genetic Improvement of Eucalyptus in India" stated that the so-called Mysore hybrid is mostly identified as Eucalyptus tereticornis quoting Nanjundappa (1957) and Kaikini (1961). Considering its wide spread adaptability, this species has been extensively planted throughout the country. According to one estimate (Tewari 1992) Eucalyptus plantations were raised to the tune of 4.28 lakh hectares primarily to meet the requirement of fuel wood and paper and pulp industries. From the review of literature it becomes evident that firstly an exhaustive work was carried out only on specific gravity and fibre length of E. tereticornis of the unimproved seed source belonging to different ages. The published data on the above aspects were mainly meant to be used for paper and pulp industry but not as a tool for improvement of the species from the point of view of improving the productivity and wood quality. Secondly the information available on the wood structure of this particular species was mainly from the published work of Dadswell (1972), Agrawal and Laxmi chauhan (1988) based on limited number of samples.

Materials and Methods:

The present study was carried out on five different clones of Eucalyptus tereticornis Sm. developed by ITC Bhadrachalam Paper Boards Ltd., Andhra Pradesh. The clones numbered 3,4,6,7, and 10 were planted at their demonstration plot, Sarapaka during 1992 – 1993 in red soil under rain fed conditions at an espacement of 1m x 1m except one clone (clone 10) where the espacement was (3m x 2m). At the time of felling i.e. four and half years, the trees had attained average heights of 15m (clone 3,6), 14m (clone 7), 18m (clone 4), and 17m (clone 10). The macroscopic and microscopic anatomical features include frequency, size and distribution of various cell types viz. vessel, parenchyma, rays and fibers. The terminology used for macroscopic features was as per Rao and Juneja (1971) and for microscopic features International Association of Wood Anatomists (IAWA) list of microscopic features for hardwood identification (Wheeler et al., 1989) which is given at the end of the thesis as Appendix was followed.

Results:

Clone-3

General features: Sapwood and heartwood slightly distinct. Sapwood is light grayish brown in colour gradually merging into light brownish coloured heartwood. Wood soft to moderately hard, light (specific gravity 0.488–0.530 oven-dry weight), lustrous, straight to interlocked grained, medium coarse textured.

Macro and Microscopic features: Wood diffuse porous. Growth rings indistinct. Vessels exclusively solitary, moderately large to small, visible to the naked eye and arranged in oblique rows, round to oval in outline, rarely filled up with tyloses, vessel lines distinct to indistinct. Parenchyma diffuse, slightly visible to the naked eye distinct under handlens. Rays fine, distinct under handlens, closely more or less evenly spaced. Growth rings indistinct in cross section. Vessels moderately large to small, vessel diameter ranges from 105µm–124µm (mean 111µm) arranged in 2-3 oblique rows, vessel frequency 16–21 per mm² (mean 19 per mm²), vessel element length, 314µm–501µm long (mean 393µm) abruptly tailed at one end. Intervascular pitting circular to elliptical, 6µm–12µm in diameter (mean 9µm), vestured. Parenchyma is diffuse and

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also vasicentric. Strands of cells with crystals. Fibres angular in cross section, fibre length ranges from 860 μm –945 μm (mean 907 μm), fibre diameter 10.98 μm –14.22 μm (mean 12.54 μm , fibre wall thickness 2.97 μm –7.38 μm (mean 4.64 μm) fibres thin to thick walled with distinctly bordered pits, non-septate. Rays are 12–16 per mm (mean 15 per mm), homocellular composed of procumbent cells, 185 μm –244 μm (mean 219 μm) in height, uniseriate 11 μm –13 μm (mean 12 μm) width, crystals absent. Percentage of vessels ranged from 27–42% (mean 34%), parenchyma 6–13% (mean 11%), rays 11–18% (mean 14%) and fibres 34–46% (mean 41%).

Clone-4

General features: Sapwood and heartwood slightly distinct. Sapwood light grayish brown slowly merging into light dark coloured heartwood. Wood moderately hard, light to moderately heavy (specific gravity 0.519–0.601 oven-dry weight) lustrous, straight to interlocked grained, medium coarse textured.

Macro and Microscopic features: Wood diffuse porous. Growth rings distinct. Vessels exclusively solitary, moderately large to small, visible to the naked eye, arranged in oblique rows, round to oval in outline, very rarely filled with tyloses, vessel line indistinct. Parenchyma diffuse, slightly visible to the naked eye, distinct under hand lens. Rays fine, distinct under hand lens, closely more or less evenly spaced. Growth rings distinct. Vessels moderately large to small, vessel diameter ranges from 116 μm –140 μm (mean 127 μm), arranged in 3–6 oblique rows, vessel frequency 13– 17 per mm² (mean 15 per mm²), vessel element length 343 μm – 458 μm (mean 392 μm) long with tail at both or one end. Intervascular pitting circular to elliptical 6 μm –9 μm (mean 8 μm) in diameter, vestured. Parenchyma diffuse and also vasicentric. Fibres circular to angular in cross section, fibre length ranges from 899 μm –999 μm (mean 948 μm), fiber diameter 11.65 μm –14.35 μm (mean 12.73 μm), fibre wall thickness 3.46 μm –7.39 μm (mean 4.98 μm) with distinct to indistinct bordered pits. Rays 12–16 per mm (t) (mean 14 per mm), homocellular, composed of procumbent cells, rays 179 μm –226 μm (mean 209 μm) height, uniseriate, 10 μm –18 μm (mean 15 μm) width, crystals absent. Percentage of vessels ranged from 27–41% (mean 34%) parenchyma 7–15% (mean 11%), rays 11–19% (mean 15%) and fibres 35–47% (mean 41%).

Clone-6

General features: Sapwood and heartwood distinct. Sapwood light grayish brown colour, gradually merging into pale brown to slightly dark brown heartwood. Wood moderately hard, light to moderately heavy (specific gravity 0.530–0.572 oven-dry weight) lustrous, straight to interlocked grained, medium coarse textured.

Macro and Microscopic features: Wood diffuse porous. Growth rings indistinct. Vessels exclusively solitary, moderately large to small, visible to naked eye, mostly scattered, rarely arranged in oblique rows, round to oval in outline , mostly filled with tyloses, vessel line indistinct.

Parenchyma diffuse, slightly distinct to naked eye, distinct under hand lens. Rays fine, distinct under hand lens, closely more or less evenly spaced. Growth rings indistinct. Vessels moderately large to small, vessel diameter ranges from 112 μm –161 μm (mean 135 μm), rarely arranged in 1-3 oblique rows, vessel frequency 13–18 per mm (mean 15 per mm), vessel element length 307 μm – 547 μm (mean 399 μm) long, with tail at one end rarely at both ends. Intervascular pitting circular 6–8 μm (mean 7 μm) in diameter, vestured. Parenchyma diffuse and also vasicentric. Stands of cells with crystals. Fibres angular in cross section, 869 μm –1006 μm (mean 925 μm) long, fiber diameter 11.94 μm –15.5 μm (mean 13.01 μm), fibre wall thickness 4.52 μm –7.42 μm (mean 5.67 μm) with indistinct bordered pits. Rays 12–16 per mm (t) (mean 14 per mm), homocellular, composed of procumbent cells, height of the ray 193 μm –249 μm (mean 220 μm), uniseriate to rarely biseriate, 17 μm –21 μm (mean 19 μm) width. Crystals present. Percentage of vessels ranged from 25-40% (mean 29%), parenchyma 9–19% (mean 13 %), rays 13–21% (mean 18%) and fibres 33–47% (mean 40%).

Clone-7

General features: Sapwood and heartwood distinct. Sapwood light grayish brown, gradually merging into pale brown to slightly brown heartwood. Wood moderately hard, light to moderately heavy (specific gravity 0.518–0.544 oven-dry weight), lustrous, straight to interlocked grained, coarse textured.

Macro and Microscopic features: Wood diffuse porous. Growth rings distinct. Vessels exclusively solitary, moderately large to small, visible to the naked eye, rarely arranged in oblique rows, round to oval in outline, mostly filled with tyloses, vessel line indistinct. Parenchyma diffuse, slightly visible to the naked eye, distinct under hand lens. Rays fine, distinct under hand lens, closely more or less evenly spaced. Growth rings distinct. Vessels moderately large to small, diameter ranges from 96 μm –127 μm (mean 115 μm), rarely arranged in 1-3 oblique rows, vessel frequency ranges from 13 – 22 per mm² (mean 17 per mm²), vessel element length 344 μm – 418 μm (mean 379 μm) long , abruptly tailed at one end or both. Intervascular pitting circular 6 μm –10 μm (mean 8 μm) diameter, vestured. Parenchyma diffuse and also vasicentric. Fibres angular in cross section, fiber length ranged from 837 μm – 927 μm (mean 886 μm), fiber diameter ranged from 12.37 μm – 14.02 μm (mean 13.08 μm), wall thickness ranged from 4.23 μm –7.6 μm (mean 5.59 μm) with bordered pits. Rays 12–16 per mm (t) (mean 14 per mm), homocellular to heterocellular, composed of mostly procumbent cells and rarely square cells, rays height ranges from 170 μm –212 μm (mean 190 μm), uniseriate to rarely biseriate, 13 μm 23 μm (mean 16 μm) in width, crystals absent. Percentage of vessels 24 – 39 % (mean 32%), parenchyma 9–15% (mean 11%), rays 12–19% (mean 15%) and fibres 36–49% (mean 42%).

Clone -10

General features: Sapwood and heartwood distinct. Sapwood light brown, gradually merging into pale brown to

slightly dark brown heartwood. Wood moderately hard, light to moderately heavy (specific gravity 0.515–0.573 Oven-dry weight), lustrous, straight to interlocked grain, coarse textured. Parenchyma diffuse, slightly distinct to the naked eye, distinct under hand lens. Rays fine, distinct under hand lens, closely more or less evenly spaced.

Macro and Microscopic features: Wood diffuse porous. Growth rings indistinct. Vessels exclusively solitary, moderately large to small, visible to the naked eye, scattered, round to oval in outline, rarely filled up with tyloses, vessel line indistinct. Parenchyma diffuse, slightly distinct to the eye, distinct under hand lens. Rays fine, distinct under hand lens, closely more or less evenly spaced. Growth rings indistinct. Vessels moderately large to small, vessel diameter ranges from 106 μm –142 μm (mean 12 μm), vessel frequency per mm^2 ranges from 11–20 per mm^2 (mean 14 per mm^2), vessel element length ranged from 336 μm –513 μm (mean 389 μm), with tail at one or both ends. Intervascular pits circular, 6 μm –9 μm (mean 7 μm) in diameter, vestured. Parenchyma diffuse and also vasicentric. Fibres angular in cross section, 908 μm –1018 μm (mean 946 μm) long, fiber diameter ranges from 12.18 μm –14.74 μm (mean 13.06 μm) fibre wall thickness 4.98 μm –7.5 μm (mean 5.72 μm) with distinct bordered pits. Rays 12–17 per mm (t) (mean 15 per mm), homocellular, rays height 226 μm –267 μm (mean 242 μm), uniseriate to rarely biseriate, ray width 18 μm –25 μm (mean 21 μm), crystals absent. Percentage of vessels ranges from 21–30% (mean 26%), parenchyma 7–18 % (mean 13 %), rays 15–25% (mean 19%) and fibres 35–48% (mean 42%). From the foregoing account it becomes evident that there are no qualitative differences among the five clones studied. The small differences in the size of intervacular pitting (IVP) between clone 3 and other clones is within the range of the size given for this species. The observation of distinct growth ring in clone 4 and clone 7 for the first time as demarcated by interrupted line of fibres needs further study as no other clones have shown this phenomenon. The list of cardkey features for the clones are as below in Table.1

Conclusions:

The occurrence of growth rings as delimited by flattened fibres and parenchyma in clone 4 and clone 7 and their absence in other clones may be a result of the locality factor. However, if these clones consistently develop growth

rings wherever they are planted then it can be concluded that it is a clone specific character. Until further studies are made on cambial behavior and their interaction with environment no definite conclusions can be drawn. Thus from the foregoing discussions it can be seen that within tree variation of all the characteristics studied are height related and in certain cases encompass the variation within the clones and also among the clones. The data generated for a limited number of clones opened a new line of understanding the clonal anatomy which is still in its infancy stage in India. It is true that more information has to be gathered for all promising clones of not only Eucalyptus but also other genera. The database thus generated will be useful for any species development from the point of view of wood quality.

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Cross sectional view of Clone 4 and Clone7

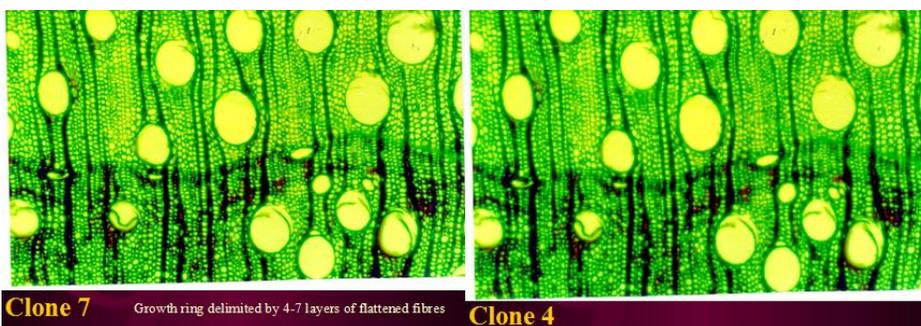


Table.1
List of Microscopic cardkey features clonewise

Clone 3	2, 5, 7, 9, 13, 22, 26, 29, 31, 42, 47, 53, 56, 58, 60, 62, 66, 69, 72, 76, 96, 104, 116, 169, 189, 192, 194, 197, 206, 211
Clone 4	1, 5, 7, 9, 13, 22, 26, 29, 30, 42, 47, 53,56, 58, 60, 62, 66, 69, 72, 76, 96, 104, 116, 169, 189, 192, 194, 197, 206, 211
Clone 6	2, 5, 7, 9, 13, 22, 26, 29, 30, 42, 47, 53, 56, 58, 60, 62, 66, 69, 72, 76, 96, 104, 116, 169, 189, 192, 194, 197, 206, 211
Clone 7	1, 5, 7, 9, 13, 22, 26, 29, 30, 42, 47, 53,56, 58, 60, 62, 66, 69, 72, 76, 96, 104, 116, 169, 189, 192, 194, 197, 206, 211
Clone 10	2, 5, 7, 9, 13, 22, 26, 29, 30, 42, 47, 53, 56, 58, 60, 62, 66, 69, 72, 76, 96, 104, 116, 169, 189, 192, 194, 197, 206, 211, 215
All the clones combined	(1), 2, 5, 7, 9, 13, 22, 26, 29, 30, 42, 47, 53, 56, 58, 60, 62, 66, 69, 72, 76, 96, 104, 116, 169, 189, 192, 194, 197, 206, 211, 215