JUVENILE WOOD VERSUS MATURE WOOD DENSITIES IN *CEDRUS DEODARA* (ROXB.) LOUD.

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Introduction

Trees produce two different types of wood namely juvenile wood and mature wood during their development. These two types of wood differ in their properties and product qualities. The juvenile wood is formed near the pith and is also referred as pith wood or core wood or crown formed wood. Juvenile growth terminates after a specific period of time, after which mature wood is formed by physiologically mature cambium in the outer portion of the tree. Mature wood is also known as adult wood, outer wood or stem-formed wood (Panshin and deZeeuw, 1980). Juvenile wood differs from mature wood by lower wood density, lower late wood percentage, thinner cell wall, shorter tracheid length, high longitudinal shrinkage, higher microfibril angle, more reaction wood and higher degree of knots. Since the wood density is considered as an important trait to wood quality, it has been studied both in juvenile wood and mature wood of *Cedrus deodara* (Roxb.) Loud. with the objectives (i) to examine the quantitative relationship between juvenile wood and mature wood densities in order to look for the possibility of predicting mature wood density from that of juvenile wood and *vice-versa*, (ii) to find out the suitable sampling stratum for comparison of juvenile wood and mature wood densities.

Material and Methods

Cross-sectional discs of 10-13 cm (4-6") thickness were cut from eight straight and uniform crowned deodar trees of age 21, 24, 35, 65, 70, 82, 85 and 90 years at breast- height. Two opposite radial wedges from north and south direction were sawn out from pith to bark. Southern radial wedge was used for studying juvenile wood and mature wood whole-ring densities as such while northern radial wedge was further cut horizontally into two parts. Out of these, one part was used for studying juvenile wood and mature wood whole-ring densities and the second part was used for studying first-formed earlywood density. (Bala,1990, Bala and Seth, 1992). All the 944 annual rings from pith to bark on the wedges from eight trees were separated into whole-annual rings. Also, first-formed earlywood samples were separated from 472 annual rings of northern radial wedges. Wood density of each whole annual ring and first-formed earlywood sample was determined with standard procedure (Smith, 1955).

Results

In order to see the quantitative relationship between wood density of juvenile wood - Zone 1 (rings1-10) and mature wood - Zone 2 (rings 11-bark),

simple correlation and regression analyses were carried out between these two zones and between the mean wood density of mature wood and wood density of each of juvenile wood rings. The result presented in Tables 1A-2A shows that a positive and statistically highly significant correlation exists between juvenile wood and mature wood in both sampling strata namely whole ring and first-formed earlywood. The correlation between mean density of mature wood and each of juvenile wood ring is also highly significant and positive in both strata except ring 1 in case of whole-ring wood density (Tables 1B-2B).

Discussion

An examination of literature shows that several methods have been used for demarcation between juvenile wood and mature wood, but none of the method could yield consistent demarcation point that separate the two zones. This inconsistency is due to large differences in wood properties between species, within some species and even within trees (Keith and

Table 1 (A, B)

Relationship between juvenile wood and mature wood density in whole-ring in Deodar.

	Correlation coefficient r	Coefficient of determination r^2	Regression constant b_0	Regression coefficient b_1	Standard error Sb_1
(A) Between zones :					
Zone I vs. Zone II	0.9269**	0.8592	0.0258	1.0232***	0.1771
(B) Between juvenile rings and mean of mature wood :					
Ring 1 vs. Zone II	0.1467 n.s.	0.0215	0.2777	0.2448n.s.	0.6752
Ring 2 vs. Zone II	0.7784**	0.6060	-0.0831	1.0357***	0.2240
Ring 3 vs. Zone II	0.6732**	0.4533	0.4014	0.7908**	0.2355
Ring 4 vs. Zone II	0.7609**	0.5790	0.1135	0.6724***	0.1583
Ring 5 vs. Zone II	0.9258**	0.8571	-0.2905	1.5306***	0.1705
Ring 6 vs. Zone II	0.8948**	0.8006	0.4208	1.0510***	0.1272
Ring 7 vs. Zone II	0.8258**	0.6821	-0.1410	1.2500***	0.2314
Ring 8 vs. Zone II	0.8639**	0.7463	0.0097	1.0050***	0.1585
Ring 9 vs. Zone II	0.8624**	0.7438	-0.2016	1.3775***	0.2167
Ring 10 vs. Zone II	0.7666***	0.5877	0.1785	0.6122***	0.1378

Vs. = versus ; Zone I = Rings 1-10; Zone II= Rings 11-bark.
The levels of significance used are :
n.s. = non-significant
** = 1 per cent at P 0.010 level i.e. highly significant
*** = 0.1 per cent at P 0.001 level i.e. very highly significant

Table 2

Relationship between juvenile wood and mature wood density in the first-formed earlywood in Deodar.

	Correlation coefficient r	Coefficient of determination r^2	Regression constant b_0	Regression coefficient b_1	Standard error Sb_1
(A) Between zones					
Zone I vs. Zone II	0.9218**	0.8497	-0.2645	1.7400**	0.3056
(B) Between juvenile rings and mean of mature wood :					
Ring 1 vs. Zone II	0.7336*	0.5381	0.1469	0.4256*	0.1612
Ring 2 vs. Zone II	0.8001*	0.6401	0.1858	0.3986*	0.1229
Ring 3 vs. Zone II	0.8354**	0.6978	0.1912	0.4543*	0.1269
Ring 4 vs. Zone II	0.8962**	0.8032	0.1806	0.5506**	0.1818
Ring 5 vs. Zone II	0.8324**	0.6930	0.1034	0.8378**	0.2277
Ring 6 vs. Zone II	0.9056**	0.8201	0.1116	0.7027**	0.1354
Ring 7 vs. Zone II	0.9842**	0.9686	0.0935	0.6773***	0.0509
Ring 8 vs. Zone II	0.8417**	0.7086	0.0004	0.9748**	0.2604
Ring 9 vs. Zone II	0.8365**	0.7000	0.2034	0.4618*	0.1325
Ring 10 vs. Zone II	0.9843**	0.9689	0.1985	0.4932***	0.0400

Vs. = versus ; Zone I = Rings 1-10; Zone II= Rings 11-bark.
The levels of significance used are :
n. s. = non-significant
* = 5 per cent at P 0.050 level i.e. significant
** = 1 per cent at P 0.010 level i.e. highly significant
*** = 0.1 per cent at P 0.001 level i.e. very highly significant

Chauret, 1988; Loo *et al*., 1985; Bendsten and Senft, 1986). In the present study, wood is divided into two zones namely juvenile wood (rings 1-10) and mature wood (rings 11-bark) on the basis of radial pattern of wood density variation from pith to bark (Bala and Seth, 1992; Abdel-Gadir and Krahmer, 1993). The quantitative relationship between these two zones show that mean density of juvenile wood is significantly correlated with the mean density of mature wood (Tables 1A-2A). This is in confirmation with the findings of Corriveau *et al.*, 1987; Zobel and Van Buijtenen, 1989; Syzmanski and Tauer, 1991; Dvorak and Wright, 1994). Also, the mean density of mature wood is correlated separately with each of juvenile wood rings, except ring 1 for whole annual ring (Tables 1B-2B) which is in confirmation with the findings of Loo *et al.* (1985).

The present study shows that wood density of mature wood can reasonably be predicted from that of juvenile wood and *vice-versa*. For such predictions, any ring of juvenile wood (except ring 1 in case of whole annual ring) can be used in both

sampling strata namely whole annual ring and first-formed earlywood. Further, it is evident from the results that tree breeders can make the selection at an early age for the sole purpose of genetic improvement of wood density and hence wood quality.

SUMMARY

The present study aims to examine the quantitative relationship between juvenile wood and mature wood densities in order to look for the possibility of predicting mature wood density from that of juvenile wood and *vice-versa* and also to find out the suitable stratum for the comparison of juvenile wood and mature wood densities in *Cedrus deodara* (Roxb.) Loud. It is observed that a positive and statistically highly significant correlation exist between mean of juvenile wood and mean of mature wood density in both whole ring and first-formed early wood. Also, the mean mature wood density is highly significantly correlated separately with each of the juvenile wood rings in both whole ring and first-formed early wood except ring 1 in case of whole ring. Thus, the mature wood density can be predicted at an early age from the wood density of juvenile wood rings by taking either whole-ring or first-formed early wood.

सीडरस डिओडारा (राक्स०) लूड० में बाल्यकाष्ठ बनाम प्रौढ़ काष्ठ सघनताएं

एम०बी० शर्मा व सी०एल० शर्मा

सारांश

प्रस्तुत अध्ययन का लक्ष्य बाल्यकाष्ठ और प्रौढ़ काष्ठ सघनताओं में रहते मात्रात्मक सम्बन्ध को परिक्षित करना है ताकि बाल्यकाष्ठ से प्रौढकाष्ठ का पूर्वकथन करने और इसके व्युत्क्रम की संभावना खोजी जा सके और *सीडरस डिओडारा* (राक्स०) लूड० के बाल्यकाष्ठ और प्रौढकाष्ठ सघनताओं की तुलना करने का उपयुक्त स्तर भी ज्ञात किया जा सके। देखने में यह आया कि संपूर्ण वलय और प्रथमतः बने पूर्वकाष्ठ के बाल्यकाष्ठ माध्य और प्रौढकाष्ठ सघनता के माध्य में घनात्मक और सांख्यिकीय दृष्टि से अत्यधिक सार्थक सहसम्बन्ध रहता है। और, माध्य प्रौढकाष्ठ सघनता का संपूर्ण वलय के प्रथम वलय को छोड़कर संपूर्ण वलय और प्रथमतः बने पूर्वकाष्ठ दोनों के बाल्यकाष्ठ वलयों में प्रत्येक के साथ पृथक–पृथक अत्यधिक सार्थक सहसम्बन्ध रहता है। अतः प्रौढकाष्ठ के घनत्व को कम उम्र रहने पर ही संपूर्ण वलय अथवा प्रथमतः बने पूर्वकाष्ठ को विचार में लेकर वाल्यकाष्ठ के काष्ठ–घनत्व से पूर्वकथित किया जा सकता है।

References

Abdel Gadir, AY. and R.L. Krahmer (1993). Estimating the age of determination of juvenile and mature wood in Douglas fir. *Wood and Fiber Sci*., **25** (3) : 242-249.

Bala, M. (1990). Variation and correlation among some wood characteristics in *Cedrus deodara* (Roxb.) Loud. *Ph.D. Thesis*, H.P. University, Shimla. 168pp.

Bala, M. and M.K. Seth (1992). Radial pattern of wood density variation from pith to bark. *Drevársky Výskum*, **132**: 11-21.

Bendsten, B.A. and J. Senft (1986). Mechanical and anatomical properties in individual growth rings of plantation grown eastern cottonwood and loblolly pine. *Wood Fiber and Sci*., **18**: 23-28.

Corriveau, A., J. Beaulien and F. Mothe (1987). Wood density of natural white spruce populations in Quebec. *Can. J. For. Res*., **17**: 675-682.

Dvorak, W.S. and J.A. Wright (1994). Offspring- parent correlations for wood density of *Pinus tecunumanii* between native and exotic environments. *Can. J. For. Res*., **24**:1593-1596.

Keith, C.T. and G. Chauret (1988). Basic wood properties of European larch from fast growing plantations in eastern Canada. *Can. J. For. Res.,* **18** (10) 1325-31.

Loo, J.A., C.G. Tauer and R.W. McNew (1985). Genetic variation in the time of transition from juvenile to mature wood in Loblolly pine (*Pinus taeda*). *Silvae Genet*., **34**: 14-19.

Panshin, A.J. and C. deZeeuw (1980). *Textbook of wood technology*, 4th edn. Mc.Graw-Hill, New York. 643 pp.

Smith, D.M. (1955). A comparison of two methods for determining specific gravity of small samples of second growth Douglas fir. *U.S. For. Prod. Lab. Rept. No. 2033.* 13pp.

Syzmanski, M.B. and C.G. Tauer (1991). Loblolly pine provenance variation in age of transition from juvenile to mature wood specific gravity. *For. Sci*., **37**: 160-174.

Zobel, B.J. and J.P. van Buijtenen (1989). *Wood variation, its causes and control*. Springer, Berlin, Heidelberg, New York. 363pp.