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EFFECTS OF SITE AND PLACE OF ORIGIN ON WOOD DENSITY OF TEAK (*TECTONA GRANDIS*) CLONES

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INDIRA, E.P. & BHAT, K.M. 1998. Effects of site and place of origin on wood density of teak (*Tectona grandis*) clones. Effects of site and clone origin on basic wood density of teak (*Tectona grandis*) were studied in 18 clones grown in two different locations in Kerala. Analysis of the data showed that site has a great influence on wood density while place of origin of clones has no effect. Inter-clonal variation was significant at 5% level. No evidence of any interaction between site and clones could be seen. Hence, selection of sites has to be given importance while selecting areas for teak plantations. Exploitation of tree-to-tree variation will also improve the wood density in teak.

Key words: Teak - wood density - site - clone origin

INDIRA, E.P. & BHAT, K.M. 1998. Kesan tapak dan tempat asal terhadap ketumpatan klon kayu jati (*Tectona grandis*). Kesan tapak dan tempat asal terhadap ketumpatan klon kayu jati (*Tectona grandis*) dikaji dalam 18 klon yang ditanam di dua lokasi yang berbeza di Kerala. Analisis data menunjukkan bahawa tapak tersebut mempengaruhi ketumpatan kayu manakala tempat asal klon tersebut tidak mempunyai kesan. Variasi antara-klon adalah bererti pada tahap 5%. Tiada bukti menunjukkan terdapat kaitan di antara tapak dengan klon. Oleh yang demikian, pemilihan tapak sangat penting dalam memilih kawasan untuk ladang jati. Eksploitasi kepelbagaian pokok ke pokok juga akan memperbaiki ketumpatan kayu jati.

Introduction

Tree breeders generally exploit the variation present in nature like tree-to-tree variation, variation among sites and provenances to improve or manipulate the desirable characters. In a number of studies it was noted that the geographic areas where the trees grow have a great influence on the specific gravity of wood (Howe 1974, Talbert & Jett 1981). Harris (1996) found latitude as one of the influencing factors. Ledig *et al.* (1975) noted that though there were extensive studies on the effect of environment on wood density, the results were often confusing and contradictory.

Wood density is always important since it has a major role in controlling the yield and quality of both fibre and solid wood (Barefoot *et al.* 1970). A few studies have been conducted on the effect of locality and seed origin on wood density and fibre length of teak wood (Purakayastha & Satya Murthi 1975, Kedharnath

et al. 1963). At the Kerala Forest Research Institute, experiments were conducted to study the effects of site and place of origin on the wood density of teak clones and the results after analysis are presented in this paper.

Materials and methods

Eighteen teak clones growing in the clonal teak seed orchards at Arippa (Trivandrum Division) and Palappilly (Trichur Division) in Kerala, India were subjected to this study. These clones were 14 y old. They were vegetatively propagated from 18 plus trees selected at Nilambur (Clones 1-8), Konni (9-11) and Arienkavu (12-18) of Kerala State. Hence, like seed or provenance, these clones have their clone source or place of origin at Nilambur (Nilambur Division), Konni (Konni Division) and Arienkavu (Thenmala Division). The details of the collection areas are given in Table 1.

Table 1. Climatic and edaphic factors at various sites

Factor	Arippa	Palappily	Nilambur	Konni	Arienkavu
Latitude (N)	8° 50'	10° 26'	10° - 11°	9° 3' - 9° 85'	8° 44' - 9° 14'
Longitude (E)	77° 9'	76° 24'	75° 82' - 76° 32'	76° 41' - 77° 6'	76° 59' - 77° 1'
Altitude (m)	100	40	Low alt.	Medium	Medium
Rainfall (mm)	3000	3000	2600	3300	2600
Temperature (°C)	16 - 35	18 - 41	17 - 37	12 - 35	12 - 33

Five healthy trees from each clone were selected at random from the orchards. Since destructive sampling is not allowed in the clonal seed orchards and provenance trial plots, core wood samples were used for the experiments and the study was mainly concentrated on wood density. Wood samples of 12 mm thickness were collected from the mature outermost growth increment at breast height. As soon as the samples were collected, they were wrapped in polythene bags and taken to the laboratory. Wood density was estimated on an oven dry weight to green volume basis. The latter was determined by the water displacement method. Analysis of variance was done as per standard procedures.

Results and discussion

The analysis of variance shows that there is a highly significant ($p = 0.01$) difference between sites where the clones were grown (Table 2). The difference between clones was significant ($p = 0.05$), but there was no interaction between site and clones.

Table 2. Analysis of variance for wood density

Source	D.F.	MSS
Locality	1	0.161**
Clones	17	0.003*
Locality x clones	17	0.002 ns
Error	144	0.002

*, ** Significant at 5 and 1% respectively; ns = not significant.

The results indicate that the locality where the trees are grown has a great influence on wood density in teak. The mean basic wood density of clones grown at Palappilly was 0.57 g cm^{-3}, whereas that at Arippa was 0.51 g cm^{-3}. The clones being the same and the interaction between clones and site being insignificant, the variation was due to site factors. Moreover, each clone has a higher density at Palappilly except clone No. 14 of Arienkavu origin (Table 3). Though the site x clone interaction was insignificant, there were clones which displayed great variation like clones No. 7 of Nilambur origin and No. 17 of Arienkavu origin as well as clone No. 14 which did not respond to change of site.

Table 3. Mean wood density (g cm^{-3}) of teak clones at two different sites and coefficients of variation (c.v.)

Site	1	2	3	4	5	6	7	8	9
Palappilly	0.60	0.55	0.59	0.56	0.56	0.56	0.59	0.60	0.53
c.v.	7.91	11.07	8.69	8.89	10.99	8.36	10.61	4.60	9.69
Arippa	0.53	0.52	0.54	0.51	0.50	0.50	0.49	0.52	0.47
c.v.	9.60	13.30	11.60	8.50	6.30	5.70	3.60	11.20	8.70
Site	10	11	12	13	14	15	16	17	18
Palappilly	0.60	0.59	0.56	0.56	0.54	0.55	0.58	0.63	0.58
c.v.	5.26	5.26	6.70	3.30	4.90	3.30	6.30	4.40	3.80
Arippa	0.51	0.53	0.52	0.53	0.54	0.50	0.52	0.53	0.51
c.v.	11.3	3.00	5.30	8.30	9.00	6.10	10.70	10.90	4.50

Matziris (1979) reported that the site of radiata pine strongly influenced its wood density. Zobel and Talbert (1984) noted that in species like loblolly pine, progeny from trees of high specific gravity areas produced low specific gravity wood when planted in other areas. Falkenhagen (1979) reported extreme cases in pines. When *Pinus carribaea* was introduced as an exotic to the coastal region of South Africa, it produced exceptionally low specific gravity wood, whereas *P. elliotii* produced unusually high specific gravity wood.

Analysis of the soil properties of the two orchard sites revealed that the soil at Arippa had more organic carbon (2.13%), pH (6.02) and more exchangeable bases (13.14 me 100 g^{-1}) which are some of the factors that improve the growth of teak. The values for organic carbon, pH and exchangeable bases at Palappilly were 1.1%, 5.66 and 6.1 me 100 g^{-1} respectively. But the phenotypic correlation between girth at breast height and wood density in teak was found to be 0.1, which shows a very weak relationship (Indira & Bhat 1997). In radiata pine a negative but very weak correlation between wood density and growth rate was reported by Burdon and Harris (1973) and by Matziris (1979).

Another influencing factor reported to affect wood density is the latitude of the growing sites (Harris 1996). But the difference in latitude between Arippa and Palappilly is only less than 2° (Table 1). Hence, some other factors are influencing the wood density which need a detailed study.

Effect of place of origin of clones on wood density was also analysed which shows that there is no significant difference between places of origin. The variance due to place of origin is only 21.62 % of the total variance (Table 4). An earlier study with six provenance of teak also showed that variance contributed by seed source was only 19.13 % of the total variance (Indira & Bhat 1997).

Table 4. Variation in wood density due to place of origin of clones

Source	DF	MSS	% of variance
Between origins	2	0.0008 ns	21.62
Within origins	177	0.0029	78.38

The mean basic wood density values of clones of Nilambur, Konni and Arienkavu origins were found to be 0.546, 0.538 and 0.545 g cm^{-3} respectively which do not show much variation. Matziris (1979) also could not find any variation for wood density among seed sources of radiata pine though the provenances used were from different countries like Australia, Spain and New Zealand. But tree-to-tree variation was found to be immensely large. Experiments conducted by Purakayastha and Satya Murthi (1975) have shown that seed origin contributed only 1.5% of the total variation of wood density in teak, while locality where the trees were grown contributed up to 31.4% variation, although the study was based on limited data with two provenances.

The study as a whole shows that locality or site where the trees grow has a great influence on the wood density of teak, but the place of origin of the clones has no effect. Inter-clonal variation was also found to be significant. Hence, selection of suitable areas has to be given much importance. Exploitation of tree-to-tree variation can also improve the character to a certain extent.

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