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Within-species variations in drying and preservative intake properties: a case of two progenies of plantation grown *Melia Dubia* CAV

Abstract

Two progenies of 7 years old plantation grown *Melia dubia* Cav. were taken for carrying out studies on variability in drying and preservative intake properties. Terazava[1] method of testing drying properties was used to give scores to various drying defects occurred in two progenies. The preservative intake properties like retention, penetration, treatability etc were determined using standard methods. Results indicate that the drying properties varied from progeny to progeny. Occurrence of the defects like surface checks were found to vary progeny to progeny, whereas, defects like surface deformation and honey combing didn't vary. Variation in preservative properties like retention and treatability was found to vary. The study indicates that *M. dubia* species may possess considerable intra-species variation in drying and preservative intake properties in the plantations of seed origin.

Keywords: *Melia dubia*, drying, preservation, within-species variability

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Introduction

Melia dubia Cav. is an important multipurpose, fast growing tree species. It is commonly known as Burma neem and is fairly large, deciduous and fast growing tree. It grows up to a height of 20 m with straight cylindrical bole. The species is found throughout India, Srilanka, Malaysia, Java, China and Australia. In India, tree is commonly found in Eastern Himalayas particularly in the states of Sikkim, North Bengal, Assam, Nagaland and Odisha. It is an important alternative timber species that can fulfil requirements of timber, pulp, and biomass.[2] It has some good features like- clean cylindrical bole and is a fast growing timber species that has short rotation period (6-7years). Its grains are visible and appearance is also very decorative in nature, which makes it useful for many applications.

Variability in several physical properties: density, radial and tangential shrinkage, longitudinal permeability of heartwood and sapwood were reported by Kumar et al.,[3] Studies on Variability in wood drying and preservative intake properties will give wood industries insight on the primary processing strategies to be adopted. The present study is centred on variability studies on wood drying and preservative intake properties of two progenies of plantation grown *Melia dubia.*

Materials and methods

A progeny trial consisting of 42 progenies with five replications was conducted at Mehuwala, Dehradun (30.3165° N, 78.0322° E) during 2009 to analyse a x E interaction, by Genetics and Tree Propagation Division, Forest Research Institute, Dehradun in the past. Spacing of 3 m x 3 m was maintained for proper expression of various progenies traits. The average productivity was recorded to be 34.57 m^3 ha^{-1} yr^{-1}, maximum being 55.83 m^3 ha^{-1} yr^{-1}.[3] Out of 42 progenies, 7 years old, 2 progenies (M76, M104) were selected for studies on drying and preservative intake properties based on their morphological traits and growth characteristics on ocular observation.

For drying experiments, tangential sawing was done to make 2.5 cm thick planks in both the progenies. These planks were further planed and re-converted into 20 x 100 x 200 mm^3. For preservative intake properties, heartwood part of the wood logs was taken to convert 30 x 30 mm^2 cross sections. The sticks were air-dried to about 15% MC.[4] Four sticks about three-quarter distance away from the pith measured along the radius of the heartwood were taken and re-converted into 20 x 20 457 mm^3. All samples of progenies (M76, M104) were marked and dimension of the sample, initial weight and final weight were recorded.

Determination of drying properties

Quick drying test method[1] was used to determine kiln drying. The specimens were weighed initially and were put in an oven with temperature at 103±2°C. Proper stacking of samples was done and more than 75 mm gap was maintained between each samples. Defects such as end and surface checks developed during the drying were recorded at every 2 h interval (Figure 1) and were assigned numerical values. The samples were weighed every day until they attained a constant weight (oven dried weight). In the last stages of drying, two more types of defects i.e. honey combing and deformation, were observed and noted for their extent as per methodology suggested by Terazawa.[1] For honeycombing defects, the specimens were cut into two halves in length. Defects were scaled for initial checks (1 to 8), deformation (1 to 8) and honeycomb (1 to 6). Lower values represented lesser degree of defects while higher values higher degree of defects. The defects scores were allotted for each plank on the basis of severity and occurrence.[1]

Measurement of checks

End checks extending to the surface, end splits, surface checks extending from the end and isolated surface checks were observed during the initial stages of drying. The defects were classified into eight degrees as explained Terazawa[1] methodology.

Measurement of honey combing

After the drying process was completed, five dried samples of each progenies were cross cut from middle to observe honeycombing. The honey combing defect was classified and given scores one to six as shown in Figure 2 and Table 1.[1] For measurement of collapse, the thicknesses of the samples were measured from initial point A to the maximum deformed point B, as shown in Figure 3. Based on the

difference in thickness between point A and B, this defect is classified into eight degrees as shown in Table 2.

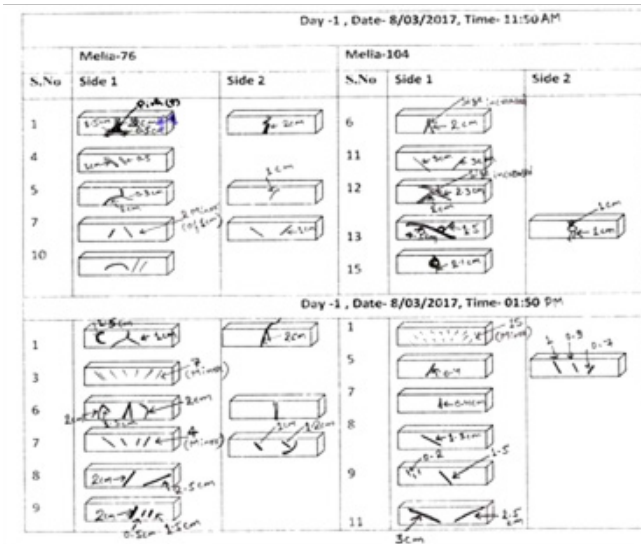

Figure 1 Size and frequency of defect during quick drying test of *Melia dubia.*

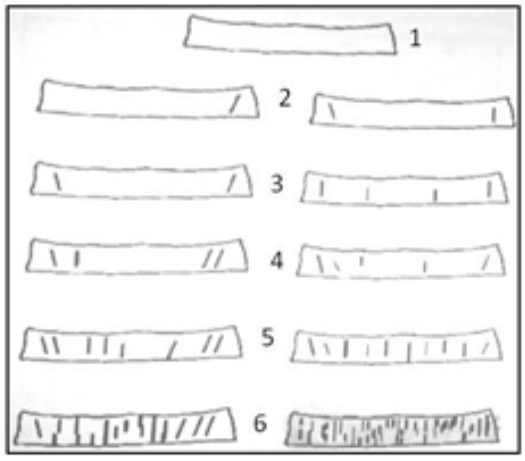

Figure 2 Defect scores for honey combing Measurement ofCollapse (Spool like deformation).

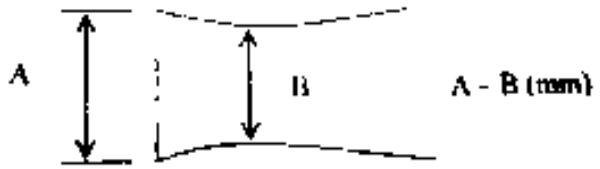

Figure 3 Defect score for collapse.

Preservative intake properties

Table 1 Classification of honeycombing[1]

Defect score	Honeycombing
1	Nil(0)
2	1 major or 2 minor
3	2 major or 4-5 minor or combination of 1 major and 3 minors
4	4 major or 7-9 minor or 1 major and 4-6 minor
5	6-8 major or 15 minor
6	15-17 major or continuous minor ones

Table 2 Measurement of degree of collapse based on difference between point A-B

Degree of deformation	1	2	3	4	5	6	7	8
Difference A – B (mm)	0–0.3	0.3–0.5	0.5-0.8	0.8–1.2	1.2–1.8	1.8–2.5	2.5–3.5	More than 3.5

Table 3 Permeability classification[5]

Treatment method

Solution of 4% CCA was used in Full Cell Process of the pressure treatment. The initial weight (W_1) of samples of M76, M104 were taken, and then the samples were placed inside the treatment cylinder and the door was tightly closed. After that a vacuum of 560 mm of Hg (gauge pressure) was created for a period of 60 min. At the end of the vacuum period, the cylinder was flooded with preservative solution. When the cylinder was filled with the preservative, vacuum pump was stopped and pressure of 7.03 kg/cm^2 (gauge pressure) was applied. A final vacuum of 560 mm of Hg for about 15 min was applied to remove the excess preservative. After the treatment, the samples were taken out from the treatment cylinder. Excess preservative was wiped out and the final weight (W_2) was taken.[4]

Retention

The amount of preservative stays in the wood measured by the following formula:

$$R = \frac{(G \times C)}{V} \times 10 kg / m^3$$

Where, R= Retention value of Preservative in kg/m^3

G= weight of treating solution absorbed by sample in grams

C = concentration of Preservative

V = volume of test sample in cm^3

Treatability

It is ability of timber to absorb preservative solution. It was calculated using following expression.[5]

$$Treatability(l / \mathrm{m}^3) = \frac{(W_2 - W_1) \times 1000}{G \times V}$$

Where, W_1= initial weight

W_2 = final weight

G= Specific gravity of wood preservative

V = volume of test sample in cm^3

The permeability class was interpreted as per classification given by Tan et al.,[5] as shown in Table 3.

Table 3 Permeability classification[5]

Permeability class	Absorption of preservative (l/m^3)
Very easy	Over 320
Easy	240-320
Average	160-240
Moderate	80-160
Difficult	Less than 80

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Determination of preservative penetration by spot tests

0.5 g Chromazurol S and 5.0 g of sodium acetate were dissolved in 100 ml of water. The test solution was sprayed over the freshly prepared end-grain of test specimens by cutting into halves. Change in colour was observed.

Measurement penetration pattern

Depth of penetration is referred to as the least perpendicular distance from the edges. The penetration pattern shall be described as fully penetrated, continuous band, scattered, patchy, confined to pores etc.

Results and discussion

Variability in drying defects

Surface checks during the timber drying are most critical type of defects, which define the drying quality. Appearance of the initial checks is known to be affected by the initial drying conditions. Severe drying conditions (high temperature and lower relative humidity) may lead to surface checks due to the stresses occurring inside wood leading to differential shrinkages as the water evaporates rapidly from upper wood surfaces. Figure 4 presents defects scores for surface checks for the two progenies under investigation. It can be seen that the two species responded differently during drying. M76 showed 29.5% higher defect score as compared with M104.

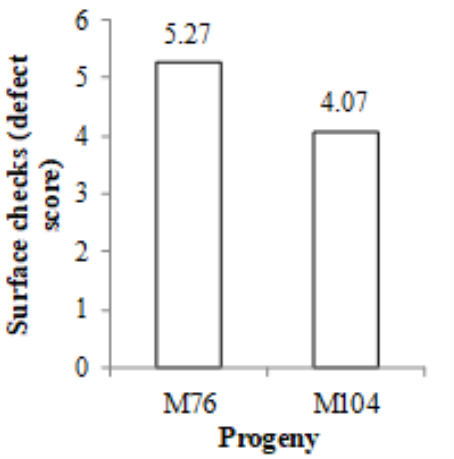

Figure 4 Defect score of progenies.

The result was also supported by air drying of tree discs of both the progenies for approximately six months. It can be seen that M76 discs showed cracks originated from the sapwood portion and advanced upto pith portion. No cracking/ checks were observed in M104. The reason behind this variability in drying charecterstics may be attributed to growth charecterstics of each progeny and the resultant growth stresses, as it can be seen that 7 years old M76 has larger mean diameter (23.65 cm) than that of M104 (19.53 cm).

From Figures 6&7 it can be seen that the drying test specimens showed variation in surface checks scores i.e. 5.27 (M76) and 4.07 (M104). M104 showed a significant lower score (29.5%) as compared with that of M76. The same is also visible in Figure 5. On other hand, the surface deformations and honey combing scores are not significantly different for the progenies. However, based on surface checks scores, it can be concluded that there is variability in the drying characteristics within the progenies of the species. In kiln drying, honeycombing is related to the initial and final temperatures and the initial relative humidity, but not to the final relative humidity. The timber having propensity for honey combing can tolerate relatively higher initial dry bulb temperatures and lower wet bulb depressions, whereas, moderate initial dry bulb temperatures and moderate initial wet bulb depressions should be employed for the timbers having propensity of surface checks.[6]

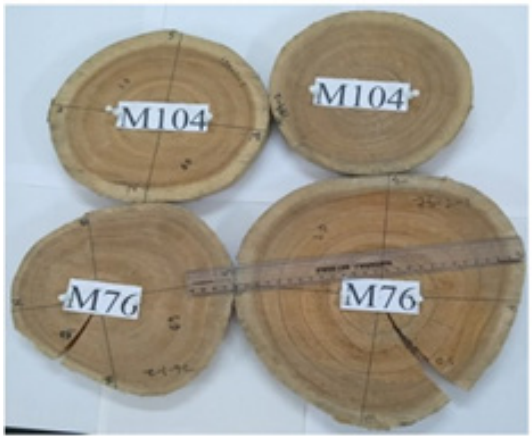

Figure 5 Discs of two progenies of M. dubia after air drying.

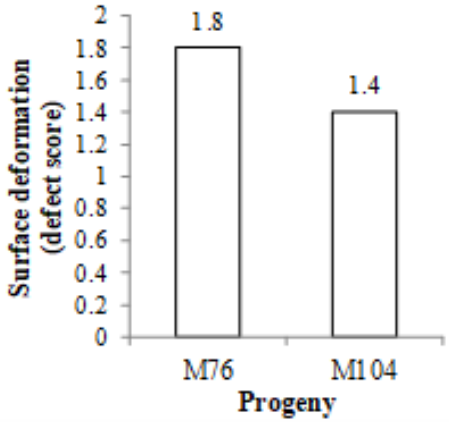

Figure 6 Surface deformation scores.

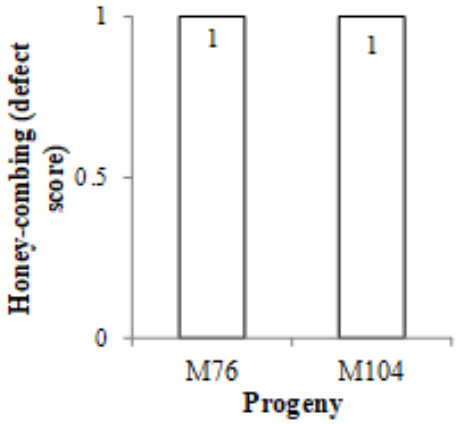

Figure 7 Honey combing scores.

Preservative intake properties

Retention

Mean, standard deviation, minimum and maximum of retention of the two progenies of *Melia dubia* are given in Table 4. Mean retention

in M76 is 107% higher as compared with that of M104. Thus, despite of variability in retention, the overall retention appears to be lower in both the species. Table 5 presents penetration pattern of the two progenies. From Table 4 & 5 it can be seen that the variability in retention and penetration patterns exist in *M. dubia* progenies. Most obvious reasons may be variation in the anatomical features especially permeability.[7]

Table 4 Descriptive statistics of retention

Spp./Progeny	Mean retention (kg/ m³)	SD	Min (kg/ m³)	Max (kg/ m³)
M76	3.99	0.64	3.06	6.02
M104	1.93	0.67	0.66	3.28

Table 5 Penetration pattern

Species/Progenies	Penetration pattern
M76	Partial
M104	Patchy and confined to pores

Treatability

Mean, standard deviation, minimum and maximum of treatability of the two progenies of *Melia dubia* are given in Table 6. Like retention, treatability also varies between the progenies. Treatability class of M76 is moderate to treat, whereas, M104 can be classified as difficult to treat class.[5] The treatability of M 76 is approximately two times higher as compared with that of M104. In earlier studies treatability of *M. dubia* (syn. *M. composita*), was evaluated and found to be falling in treatability class 'C' i.e. moderately permeable with preservative penetration of 21-42 % by Tripathi. From the Figures 8&9, it can be concluded that samples of *M. dubia* progenies show variability in preservative penetration. It appears that M76 specimens show comparatively deeper and higher penetration as compared with that of M104. Lower retention of preservative makes it less suitable for the uses where the timber is in direct contact with ground or water. However, it may be suitable for the uses like furniture etc in interior uses where the timber is not in direct contact with ground.

Table 6 Descriptive statistics of treatability

Spp./ Progeny	Mean treatability (l/m³)	SD	Min (l/m³)	Max (l/m³)	Permeability class
M76	99.85	16.07	76.6	150.4	Moderate
M104	48.27	16.89	16.41	82.06	Difficult

Figure 8 Spot test result of M76.

Figure 9 Spot test result of M104.

Conclusion

Drying defects scores of the two progenies of *M. dubia* indicate that there is considerable variability in drying properties with the progenies of the species. Defects like surface checks were found to vary in both the progenies, whereas, defects like surface deformation and honey combing didn't vary significantly. Preservative intake properties varied considerably within the progenies. Between two progenies, retention and treatability properties differed by 107%. Preservative penetration pattern varied from partial continuous band to patchy, confined to pores.

Recommendations

This study is exploratory in nature. The variability is obvious in seed originated plantations, however, the nature and magnitude of the variability in *M. dubia* indicates the need of selective screening for tree improvement programs for furniture and handicrafts. Variability studies on physical and mechanical properties may provide further insight on the subject.

Acknowledgements

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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