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Air-drying of eucalypts logs: Genetic variations along time and stem profile

Rafael T. Resende[a,*], Angélica de Cássia O. Carneiro[b,*], Ricardo Augusto D.C. Ferreira[c], Kacilda N. Kuki[d], Ramon U. Teixeira[c], Úrsula R. Zaidan[d], Raul Duarte Santos[e], Helio G. Leite[b], Marcos Deon V. Resende[b,f,1]

[a] Universidade Federal de Goiás (UFG), School of Agronomy/Forestry Sector, 74.690-900, Goiânia, GO, Brazil
[b] Universidade Federal de Viçosa (UFV), Department of Forestry, 36.570-900, Viçosa, MG, Brazil
[c] Souza Cruz S.A., Av. General Plínio Tourinho, 83880-000, Bom Jesus, Rio Negro, PR, Brazil
[d] Universidade Federal de Viçosa (UFV), Department of Plant Science, 36.570-900, Viçosa, MG, Brazil
[e] Celulose Nipo Brasileira (CENIBRA S.A.), Harvest and Transport Sector, 35.196-000, Belo Oriente, MG, Brazil
[f] Empresa Brasileira de Pesquisa Agropecuária, Embrapa Florestas, 83.411-000, Colombo, PR, Brazil

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ABSTRACT

Knowledge of wood drying potential is relevant in forestry and biomaterials technology field, being directly related with timber transport, lumber properties, charcoal yield and pulping process. Using mixed models approach by REML-BLUP procedure, we aimed to evaluate the moisture content loss potential among different eucalypt genotypes, by means of genetic correlations, heritabilities, coefficients of variation and determination of wood air-drying over 154 drying days and in five tree stem heights. Moreover, we tested three possible auxiliary traits (Heartwood/Sapwood ratio, Log Circumference, and Basic Wood Density) for indirect selection on wood air-drying rate. The highest air-drying heritabilities occurred at the two most basal stem heights and only after the 98th day. However, genetic correlations across the drying measurements were considerably high from day 42. The three auxiliary traits demonstrated potential for indirect selection, suggesting the possibility of integrating wood air-drying to future *Eucalyptus* sp. breeding programs. There is no need to wait for industrial moisture content to carry out genetic evaluation. Besides, perform selection at trees basal region is the safest way to improve the air-drying rate of genotypes.

1. Introduction

The *Eucalyptus* genus account trees and, less commonly, shrubs from the *Myrtaceae* family (Flores et al., 2016). Some tree species present very commercially valued parts, such as wood, bark, branches and leaf oils. Both hardwoods and conifers wood have a prominent place among materials historically used by mankind for specific purposes. Eucalypts wood is typically used as source of short fiber cellulose for the pulp industry; but it is also employed in the production of medium density coal, in rural and civil construction, and in the manufacture of panels and furniture. For all these purposes, eucalypt plantations are done on large forest stands and after the harvest, the logs are piled up for a while on open field to allow dehydration (Fig. 1a and b). An additional drying of the wood is necessary and can be done by either stocking the logs on timber yards, and let them air dry naturally, or keep them in kiln for a certain period of time (Kong et al., 2018). In the present study the log dehydration was purely carried by natural air-drying system.

According to technological development, techniques involving wood industrialization and usage have constantly improved, with drying being a procedure that undoubtedly must be incorporated into solid wood processing (Miller, 1999). Drying consists in removing water from wood until an adequate moisture content be reached (Rezende et al., 2010). As stated by Vermaas (1995), drying is the intermediary process that contributes most to aggregate value for solid wood products, and one of the most costly. Drying process reduces its water moisture rate, decreasing transportation costs and pathogen attacks, aggregating quality to sawn timber treatment (Plumb et al., 1985). From energy perspective, wood drying contributes to a greater charcoal gravimetric yield and heating power (Zanuncio et al., 2015). For multiple purposes, it has been desirable that the wood reaches moisture content below 30% for industrial processes (Lenz et al., 2015).

On felled eucalypts logs, as other hardwoods, the air-drying begins with free water (liquid or vapor) leaving the cell's lumen, followed by the bound water, held among the hygroscopic microfibrils of the cell

* Corresponding authors.
E-mail addresses: rafael.tassinari@gmail.com (R.T. Resende), cassiacarneiro1@gmail.com (A.d.C.O. Carneiro).
[1] Current address: UFV, Department of Forestry.

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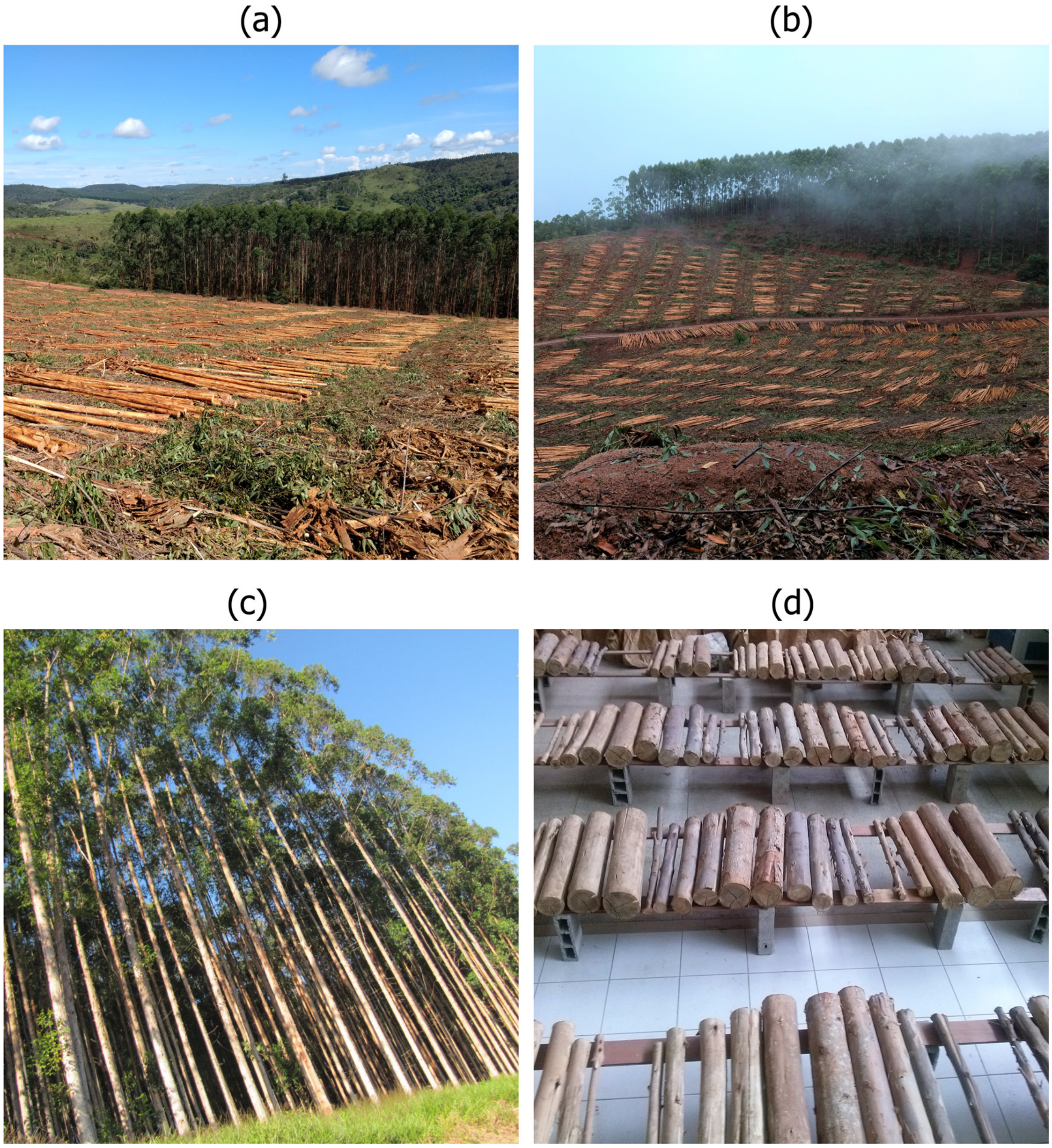

Fig. 1. Illustrative images of the conventional wood air-drying process in a pulpwood eucalypts company and the presented field and lab experiments. Part 'a': Queued log piles after rotation harvest. Part 'b': stacked wood at stand. Part 'c': Experimental clonal test. Part 'd': Partial wood air-drying experiment.

wall. However, the drying time and energy expenditure is not a straight forward, because both will be affected by inherent and non-inherent factors of the wood (Redman et al., 2016).

At a general perspective, log circumference size, with or without bark, has been observed to highly affect moisture loss, requiring longer drying time at a greater cost (Byrne and Nagle, 1991). A higher percentage of heartwood to sapwood can also difficult the drying, in terms of the heartwood be more impermeable, especially due to vessel blockage by tyloses and extractive deposition, hindering water flux from inner to outer layers of the wood (Jianmin and Liping, 1996). Also, it is reported that basic wood density (BWD) is positively related with wood drying, i.e., the higher the density, the greater the drying potential of the material. For charcoal, the higher the BWD, the greater is the resistance as well as the kiln mass amount correspond to production costs reductions, which contributes to elevate the blast furnace productivity (Byrne and Nagle, 1991). Thus, besides wood drying, the log circumference, H/S ratio and basic density traits must also be considered while choosing species and genotypes for wood energy use.

Forest breeding program requires information on genetic nature of traits and individuals to be selected. Thus, knowledge of genetic parameters, such as heritability and correlations, is essential to determine the best breeding program strategies (Castro et al., 2016). The genetic correlations are important to quantify the genotypic relation between traits, helping breeders to obtain a better understanding of the selected trait effect on another. For instance, when the trait to be improved presents low heritability and/or is difficult to be measured, breeder may be able to use other traits with high genetic correlation to perform indirect selection. In conifers species, variation of moisture content loss by air-drying is observed (Lee and Choi, 2016). Redman et al. (2016) showed that specific wood properties of four commercial hardwood species (*Eucalyptus pilularis*, *E. marginata*, *E. obliqua* and *Corymbia citriodora*) also represent different drying patterns for each of them. Barbosa et al. (2005) elaborated a drying plan for different eucalypts clones and observed a genetic tendency toward post-drying defects. Some studies have been published providing information on genetic parameters of some factors affecting wood drying potential, such as