RADIAL VARIATION OF WOOD DENSITY AND FIBRE LENGTH IN TREMBLING ASPEN

by

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Summary

Fifteen genetically distinct clones of trembling aspen (Populus tremuloides Michx.) from natural stands in central Alberta, Canada, were sampled to examine radial variation of wood density and libriform fibre length. Six clones were chosen to graphically display the large amount of variation that occurs, among clones and among trees within clones for both traits. Variation in change of wood density across the radii among clones was substantial. The most obvious clonal patterns of change were 1) for trees to have a very high wood density near the pith, then wood density decreases and stabilises, and 2) wood density increases steadily across the radius. Fibre length patterns of change across the radius were all very similar. The results indicate that early assessments of wood density in aspen may not be an accurate reflection of what the long-term average wood density may be for a particular aspen clone.

Key words: Populus tremuloides, juvenile wood, radial variation, fibre length, density.

Introduction

Variation of anatomical properties of wood within the main stem of a tree is often quite large, and has been shown to be strongly related to proximity of the crown during wood formation (Larson 1960, 1962, 1964; Isebrands 1972). It is well known that both environmental and genetic factors are involved in this process of wood formation and that the anatomical properties can be influenced to different degrees by each of the factors.

Density and fibre length are two wood properties that are important in determining the quality of wood for commercial use. Previous studies have examined genetic variation among trees for basic density and fibre length in trembling aspen (Populus tremuloides) (e.g., Brown 1961; Einsphar et al. 1967; Yanchuk et al. 1984). Little is known, however, about detailed patterns of variation within trees for these two traits in relation to genetically different groups of trees. The objectives of this paper are to present examples of variation for wood density and libriform fibre length in trembling aspen within trees, and among trees within clones. Examining radial variation among clones will provide an appropriate comparison for observing natural variability within trees and also show how genetic differences can affect these wood properties. Also, if critical values of wood density or fibre length are necessary for some aspen end-product use, the importance of clonal variation (and the different patterns of radial variation among clones) may have practical applications.

Materials and Methods

The trembling aspen clones used here have been previously described in detail by Yanchuk et al. (1984). Fifteen clones were sampled in the original study, but only six have been chosen for detailed study here. The six clones were selected on the basis of the type of variation pattern they exhibited and the extremes of high and low values of wood density and fibre length.

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Fig. 1. Radial variation in basic density of wood among trees in trembling aspen clones.
Sample trees were at least 36 years of age (the oldest tree in the study was 47 years) and were selected for their straightness (to avoid the possible inclusion of reaction wood) and the absence of obvious decay. Due to the high incidence of heart rot, the number of acceptable trees in each clone varied from five to nine. One 11 mm diameter increment core was removed at breast height from the southern radius of each tree. The increment cores were segmented into sections containing growth rings 1–4, 5–8, 9–12, 13–16, 17–20, 21–24, 25–28, 29–32 and 33–36. Distance from the pith was measured at the midpoint of each of the 4-year sections. Wood density determinations were made by the maximum moisture content method (Smith 1954). Measurements of fibre length were made on cells from macerations from each alternate 4-year section from the pith outwards. Therefore, each tree was represented by five fibre length values (i.e., rings 1–4, 9–12, 17–20, and 33–36). To insure an unbiased estimate of fibre length, fibre preparations and measurements were made as outlined by Taylor (1975). Fifty unbroken fibres in each sample were measured using a microcomputer digitizer apparatus (Micko et al. 1982).

Results and Discussion

For most of the clones, wood density was relatively high near the pith, decreased around growth rings 12–20, then increased (Fig. 1a). The best example of this typical reduction of wood density within the juvenile stage of wood formation (i.e., rings 5–12) was clone 4 (Fig. 1a). The only exceptions to this pattern were clone 7 and clone 11 (Fig. 1b & c) which showed relatively constant wood densities across the radii. Although clones 11 and 7 were both relatively high wood density clones, they exhibited quite different wood density variation patterns. The lack of variability among density values across the radii for all trees in clone 11 is contrasted by a substantial amount of variation among all trees in clone 7. This variation in clone 7 may be due to an unusual variety of environmental factors (biotic or abiotic), or some genetic predisposition in clone 7 may have caused wood development to adjust more easily to environmental conditions. It is unlikely that macroclimatic differences could have caused this large within clone variability since all clones used in this study were growing in a relatively close vicinity (all within 100 m of each other).

Clone 1 (Fig. 1b) showed an interesting pattern in that all trees had near the pith wood densities between 315 and 357 kg/m$^3$. Wood density then dropped slightly in most trees and increased again gradually till all trees had relative density values between 342 and 380 kg/m$^3$. To contrast this, trees in clone 4 (Fig. 1a) had densities between 332 and 426 kg/m$^3$ near the pith, and densities at the outermost wood, ranged between 331 and 370 kg/m$^3$. Although a more rigorous statistical presentation indicated that clonal differences were statistically significant (Yanchuk et al. 1984), it did not elucidate on the apparent inherent patterns of wood density variation across the radius.

The patterns of variation described above for these six aspen clones lead to two implications. First, assessment of wood density in young trembling aspen stands may lead to incorrect clone assessments. Density values can be relatively high in the first eight years or so, then true clone density patterns are expressed (i.e., clones 14 and 11). Secondly, if a ‘critical’ or ‘threshold’ wood density value is required for a particular end-product use typically suited to aspen, clonal differences, as well as the patterns of transition of wood density across the radius, could have a large impact. For example, if a ‘threshold’ value of 370 kg/m$^3$ for wood density was required, clones 11 and 7 consistently produce adequate wood in this regard, whereas clone 1 starts out low but attains an average of approximately 370 kg/m$^3$ in the outer wood. For short rotation use, any aspen improvement program which considers density, should concentrate on clones exhibiting patterns similar to that of clones 11 and 7.

The most obvious difference, when comparing fibre length variation to wood density variation, is the general lack of variability in the pattern of radial change among clones for fibre length (Fig. 2a–c). Clonal differences in fibre length, based on analysis of variance were significant (Yanchuk et al. 1983, 1984).
Fig. 2. Radial variation in fibre length of wood among trees in trembling aspen clones.
In almost all cases fibre length steadily increases across the pith with very little fluctuation.

Wood samples obtained from bolts or cross-sectional discs from the main bole can only provide a very crude estimate of a particular wood characteristic. Variation with height in individual stems also can cause substantial variability (Yanchuk et al. 1983). As shown, both wood properties exhibit substantial variability within and among trees, and it is therefore difficult to develop accurate statements about 'average' values for trees (or clones), particularly if effects of age (or distance from the pith) and clone are not considered. Fibre length apparently does not vary as much as wood density in the patterns of variation across the radius.

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References


