

# INTERCLONAL, INTRACLONAL, AND WITHIN-TREE VARIATION IN FIBER LENGTH OF POPLAR HYBRID CLONES

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## ABSTRACT

Variation in fiber length pattern within the stem, within clones, and between clones of the hybrid *Populus x euramericana* was investigated. Samples were taken from a total of twenty-seven nine-year-old trees representing ten clones from one site in south-central Quebec. Sample disks from each tree were taken from four heights. Each even-numbered ring from the pith was also sampled at each height to determine the radial variation pattern in fiber length. Clones, heights, and the position of annual rings from pith had significant effects on average fiber length. Individual tree broad-sense heritability was 0.41. The main source of variation was the position of annual rings from pith, which accounted for about 80% of total variance. Fiber length increased from pith to bark for all sampled heights. For a given annual ring, fiber length was low at the bottom of the tree and tended to reach a maximum at mid-height. Weighted average fiber length at breast height was significantly correlated to weighted average fiber length of the merchantable stem. Finally, the correlation between fiber length and growth rate varied over the age of the tree. At early ages, correlation between ring width and fiber length was not significant; at older ages, slight negative but significant correlation was found between these two traits.

*Keywords:* Fiber length, *Populus x euramericana*, intraclonal variation, interclonal variation, hybrid variation.

## INTRODUCTION

Increasing demand for wood and fiber and declining availability of wood supplies have prompted investigations into the potential of fast-growing species as raw material for the various wood industries. The poplars (*Populus spp.*) are among the fastest growing trees in the temperate regions and produce wood that is widely used by the forest industry. Many hybrids have been selected, planted, and test-

ed. In the northeastern regions of North America, *euramericana* clones have been the most widely planted hybrids. They have shown excellent performance under several different site conditions and have generally shown commercial potential as raw material or breeding stock. However, little attention has been paid to the wood quality of these clones. In a previous paper, Beaudoin et al. (1992) reported on interclonal, intraclonal, and within-tree varia-

tion of poplar wood density. Except for wood density, the fiber length, often considered to be a limiting factor in wood use, has been the most studied wood property in hardwoods (Zobel and Jett 1995). Fiber length is particularly important for the pulp and paper industry since it determines to a large extent the physical and mechanical properties of paper and paperboard (Van Buijtenen et al. 1962; Einspahr et al. 1963; Keays et al. 1974; Zobel and Van Buijtenen 1989). Few studies have examined interclonal, intraclonal, and within-tree variation of fiber length in poplars and their hybrids (Yanchuk et al. 1984). Hence, the purpose of this study was to provide information on patterns of fiber length variation within tree, within clones, and between clones of *Populus x euramericana* hybrid trees coming from one site in south-central Quebec.

#### MATERIALS AND METHODS

The sampling site was approximately 50 kilometers south of Sorel in south-central Quebec (45°50' north latitude, 73°13' west longitude). The site is part of the Champlain marine deposit with rich silty-clay soil (40% clay). A total of twenty-seven trees from ten adjacent clones of *P. x euramericana* (*P. deltoides* x *P. nigra*) were chosen from a clonal plantation on the site. All trees were nine years old and were randomly selected after taking into account stem straightness and absence of obvious decay. The number of acceptable trees per clone was between two and four. Four 8-cm-thick disks were taken at progressive heights of 0.5, 1.5, 3.0, and 4.5 m above the ground. Cardinal direction does not affect the fiber length of poplars (Kaeiser 1956; Zenker 1968), and we removed one wedge at a random cardinal direction from each disk. Wedges were kept frozen until sample preparation. Small parallelepiped samples (3 mm × 3 mm × 5 mm) were extracted from the outer part of the initial wood from each even ring (2, 4, 6, and 8). These samples were macerated with Jeffrey's solution (15%) for 24 h then washed with distilled water until complete removal of

TABLE 1. Average values of fiber length for ten *Populus x euramericana* clones.

Clone code	Number of trees	Fiber length (mm)	Standard deviation (mm)
37	2	1.028	0.028
131	2	0.956	0.025
136	2	0.900	0.027
205	3	1.050	0.031
1102	4	1.026	0.024
1132	2	1.047	0.026
3005	3	1.021	0.031
3301	2	0.987	0.031
3307	3	1.013	0.032
3308	4	1.054	0.034
Average		1.015	0.033

the Jeffrey's solution. The defibrillated samples were stained in a Safranin solution for 24 h, then spread and glued onto microscope slides. The fiber images were projected onto a numeric surface of a Micro-Plan II planimeter, an apparatus for analyzing images in two dimensions. Forty random unbroken fibers were measured to the nearest 0.001 mm from each sampled ring. The inner bark diameter of each disk, the ring width, and its distance from the pith were recorded to estimate the weighted average fiber length. The weighted average fiber length at each sampled height was estimated based on the areas of the rings. The weighted average fiber length of the merchantable stem was estimated from the weighted averages at each height and on the inner bark disc diameter. Data were evaluated using analyses of variance at 95% and 99% probability levels.

#### RESULTS AND DISCUSSION

The overall average fiber length of the ten *euramericana* clones was 1.015 mm with a coefficient of variation of 3.2% (Table 1). The average fiber length for the rings 2, 4, 6 and 8 from the pith at breast height along with previously reported data are shown (Table 2). The average for the sixth annual ring (1.06 mm) agreed with the reported average for the same hybrid (*P. x euramericana*) by Smith and Rumma (1971) at the same annual ring











