

*Phenotypic Variation and Repeatability of Stem Sinuosity
in Douglas-fir*

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SINUOSITY IS one of the more conspicuous stem-form defects in young Douglas-fir. As defined here, sinuosity is any stem crookedness or displacement from the vertical that is confined within an interwhorl stem segment. It should not be confused with major stem contortions, such as sweep or corkscrew growth, whose effects are continuous throughout several interwhorls.

Sinuosity is an important cause of compression wood, since any slight dislocation of the leader from the vertical brings about formation of compression wood below the dislocation (Burns, 1920; Mergen, 1958). Minor stem crooks are covered by eccentric wood growth after a few growing seasons, leaving an outwardly normal-appearing stem with a central core containing compression wood.

Compression wood has inferior properties for lumber and pulp due to its shorter fibers, greater fibril angle, and high lignin content (Dadswell and Hawley, 1929; Wardrop and Dadswell, 1950). Pound for pound it is weaker than normal wood; it is a major cause of bowing and twisting during kiln drying; it is abnormally hard in lumber; and it is undesirable in veneer in which strength and neatness are important (Brown *et al.*, 1949). Sulfate pulps made from compression wood are somewhat inferior and sulfite pulps are greatly inferior to pulp made from normal wood (Watson and Dadswell, 1957). Curran (1936) reported that pulp from compression wood was 10 per cent lower in yield and 60 per cent lower in strength properties than pulp made from normal wood.

The quantity of compression wood in a stem is likely to be directly related to its degree of sinuosity. Zobel and Haught (1962) reported that in loblolly pine, 9-17 years old, compression wood ranged from 6 per cent of the merchantable volume in straight-stemmed trees to 16 per cent in those with considerable stem corkscrew. The stem of one excessively crooked tree contained 67 per cent compression wood.

Corkscrew stem has been demonstrated to be strongly inherited in slash pine (Mergen, 1955) and in loblolly pine (Perry, 1960), and Haught (1957) has suggested that compression wood may be decreased in future stands by breeding trees with less crook or spiral. The possibility that stem sinuosity might also be strongly inherited prompted the present study.

This paper reports results of a preliminary study of variation and inheritance of stem sinuosity in Douglas-fir, made to determine the feasibility of upgrading future stands by choosing parents from the straight trees in natural stands or in seed-production areas. Tree-to-tree variation was examined in trees 10 to 20 years old in 15 stands located in three Weyerhaeuser tree farms in southwestern Washington. Repeatability values are computed from data for 60 trees in two stands to estimate the upper limit of stem-sinuosity heritability. Correlations between sinuosity and other stem or stand characteristics are also examined.

Materials and Methods

The first problem was to develop an objective scoring method for distinguishing degree of sinuosity. A particular score should represent a given degree of crookedness, or displacement of the stem from vertical, whatever the size or condition of the tree. A score which satisfied these requirements was obtained by using the transformed secant of angle z of a right triangle (Figure 1A). The secant is obtained by computing b/a where a equals vertical length of the interwhorl and b equals length along the sinuous stem (Figure 1B); the transformation is $(\secant\ value - 1) \times 100$. This score

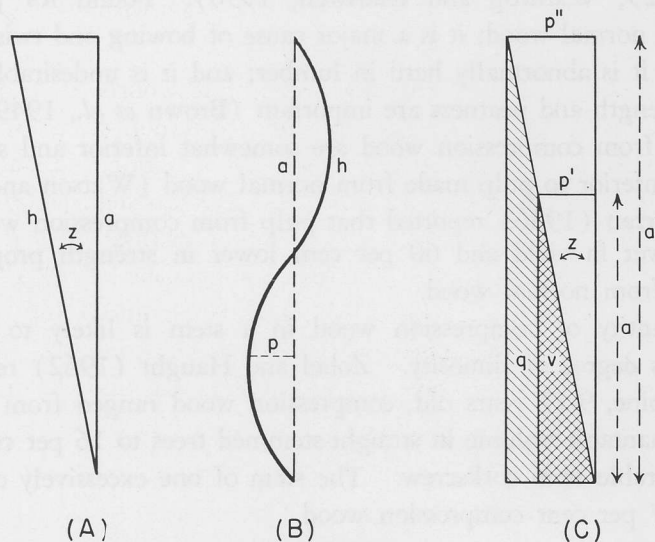


Figure 1. Diagrammatic representation of method used for scoring stem sinuosity.