VARIATION IN ROOT BARK CHEMISTRY OF DOUGLAS-FIR

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Abstract:-- Several studies have linked high phenolics:glucose ratios in the inner root bark tissue of Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco) to decreased susceptibility to *Armillaria* spp. and other root pathogens (Entry et al. 1991; Moore et al. 1993; Entry et al. 1994). While these studies have identified environmental factors that influence root bark chemistry, none have examined whether root bark chemistry, in particular the phenolics:glucose ratio, is genetically controlled. In the first part of this study, the effects of genetics and the environment on the root bark chemistry of 15-yr-old Douglas-fir was investigated. Significant differences in the concentrations of glucose, starch, protein-precipitable tannins and phenolics as well as in the ratio of phenolics to glucose were detected among 20 open-pollinated families and 2 progeny tests in northern Idaho. Family, site, and the family x site interaction were significant sources of variation in each of the root bark compounds and in the phenolics:glucose ratio. Single-tree narrow-sense and family heritability estimates revealed that 20-24% of the variation in the phenolics:glucose ratio can be attributed to genetic differences.

Because of its value as a timber species, the relationship between root bark chemistry and height growth was also investigated. Total height at age 12 was positively correlated with tannin and phenolics concentrations and negatively correlated with several types of damage. Height was not significantly correlated with the phenolics:glucose ratio. However, three families above the seventieth percentile in height growth had above average phenolics:glucose ratios at both sites. Heritability estimates for 12-yr height growth were 0.54 for single-tree heritability and 0.62 for family heritability. These values are slightly higher than those estimated by Walker (1995) for 8-yr height growth (0.27 for single-tree heritability and 0.54 for family heritability) in the same 20 families.

In the Inland Northwest, the ability to produce a high ratio of phenolics to glucose in the root bark tissue, especially on sites with low levels of K in the parent material, may have positive implications for forest health. Studies have shown that *Armillaria* spp. can be particularly devastating on sites with low K (Moore and Mika 1997). In the second part of this study, physical and environmental factors at the mother tree locations were examined to determine whether progeny were adapted to the conditions at those locations. A significant relationship was found between the geographic location of the mother tree and the root bark chemistry of 18 Douglas-fir families growing in 2 progeny tests in northern Idaho. The latitudes and longitudes of the mother tree locations explained significant variation in progeny starch concentrations. Elevation and longitude explained variation in progeny glucose concentrations, while elevation alone explained variation in the phenolics:glucose ratio. In addition to the geographic location of the mother tree, the habitat type series of the mother tree location had a significant effect on progeny root bark chemistry. Tannin concentrations varied significantly in progeny of mother trees growing in Douglas-fir, grand fir *(Abies grandis* (Dougl. ex D. Don) Lindl.), and western red-cedar *(Thuja plicata* (Dorm ex. D. Don)) habitat types. The effect of having a mother growing in a the western red-cedar habitat series was also significant for progeny glucose concentrations.

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Several correlations between the nutrient content of the parent rock material at 13 mother tree locations and the progeny root bark chemistry were significant. Sulfur levels in the parent rock material at the mother tree locations were positively correlated with phenolics concentrations in the progeny root bark. Phosphorus oxide levels were positively correlated with phenolics concentrations and negatively correlated with starch concentrations. Potassium oxide levels were positively correlated with progeny phenolics:glucose ratios. As a result, families with mothers growing on medium K sites tended to have below average mean phenolics:glucose ratios at the medium K progeny test site. Two of the 3 families with mothers growing on low K sites had below average mean ratios at the low K test site.

The results of this study suggest that it would be possible to select families with superior height growth and high phenolics:glucose ratios for use in a tree improvement program. However, care must be taken when collecting seed because the location and environment of the mother tree has a significant influence on progeny root bark chemistry.

Keywords: Douglas-fir, root bark chemistry, parent material, habitat type

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