DISTRIBUTION OF NITROGEN, PHOSPHORUS, POTASSIUM, AND CALCIUM IN TEN FAMILIES OF PINUS VIRGINIANA (Mill.)

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Abstract.--Half-sib progeny from ten selected Virginia pine trees were grown on two randomized blocks and harvested at age eight. The concentration (%) and the total content (g) of N, P, K, and Ca was determined for each component of each tree. Significant family effects were observed for Ca concentration in bolewood and for Ca content in bolebark. Block effects were significant in many instances.

Virginia pine (Pinus virginiana Mill.) is a desirable source of pulpwood in several southern states (Thor, 1964). The practice of whole-tree utilization will probably be more widely applied throughout the South in the coming years (Koch, 1973), and can be applied to Virginia pine. Increased nutrient removal from the site due to whole-tree harvesting may create nutrient deficiencies, particularly on marginal sites (Weetman and Webber, 1972; Boyle et al., 1973). Since Virginia pine frequently occurs on poor sites (Snow, 1965), nutrient losses may be an important consideration for management of this species under a whole-tree harvesting system. The objectives of this study were to determine the concentrations of N, P, K, and Ca in the aboveground components of selected Virginia pine trees, to estimate the total content of these nutrients in the trees, and to determine whether or not genetic variation has a significant effect on either the concentration or the total content of nutrients in eight year-old Virginia pine.

METHODS

In September, 1963, seed was collected from twenty Virginia pine trees on the Lee Experimental Forest in Buckingham County, Virginia (Bramlett, 1965). After germination in a nursery bed, seedlings were outplanted into two adjacent randomized blocks on the Lee Forest, with one 3-tree by 5-tree plot for each family in each block. At age eight, Matthews (1974) cut every third tree in each row at ground level. This provided a sample of five trees from each family on each block, less any dead trees. Data on dry matter production and distribution was collected and analyzed by Matthews (1974).

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Due to time limitations, the sample to be analyzed for nutrient content was narrowed from twenty families to ten. Families in which more than two trees were missing were eliminated. From the remaining families, ten were chosen which represented the range of diameter and height measurements.

Each tree was separated into four components: foliage, branches, bole-bark, and bolewood. The N, P, K, and Ca concentration in each component of each tree was determined. This data was combined with the dry matter distribution data developed by Matthews (1974) to estimate the total content of each nutrient in each component of each tree. Analyses of variance were performed to determine if significant among family differences were present in the concentration or in the total content of each nutrient in each tree component.

RESULTS AND DISCUSSION

Fourteen significant differences in nutrient concentration or total content were found (Table 1). Only two of these were due to the effect of family: Ca concentration in bolewood and Ca content in bolebark. The remaining twelve differences were due to the effect of block. Thus, it can be said that genetic variation had little effect on either concentration or total content of these nutrients. Environmental variation is clearly of major importance. There is currently no detailed site information available which might offer an explanation of the environmental effect.

The results of this study indicate that attempts to influence nutrient uptake (and therefore nutrient loss due to harvesting) through selective breeding of Virginia pine would be futile. However, it must be remembered that the parents of all trees used in this study were located on the Lee Experimental Forest (Bramlett, 1965), and therefore represent only a small portion of the range-wide genetic variation existing in Virginia pine. Perhaps an experiment using seed collected over a larger area would reveal some effects of genetic variation on nutrient uptake.

It should be noted that previous studies concerning the effect of genetic variation on nutrient concentration show somewhat variable results. Giertych and Farrar (1962) tested nine provenances of jack pine and found no significant differences in foliar N concentration due to provenance; however, Mergen and Worrall (1965) tested several provenances of this species and did find significant differences in N, P, and K concentrations. Gerhold (1959) found significant differences in foliar concentrations of N and Ca between six races of 19 year-old Scots pine, but differences in P and K were not significant. Steinbeck (1966), working with the foliage of five year-old Scots pine, found significant differences between provenances for concentrations of N and P, but not for K and Ca.

Presumably most of these differences in results are due to the fact that the researchers used different sets of provenances. Within a given species, genetic variation may influence nutrient uptake, but this effect may or may not be detectable within a selected group of provenances or families. In the future, researchers who hope to detect any significant effect of genetic variation on nutrient uptake would be wise to use a sample as large and as diverse as possible

Table 1: Significant differences observed in analyses of variance for concentrations (%) and total content (g) of N, P, K, and Ca among ten families of Virginia pine.

Stand Component	Variable	Source of Variance	F Value
Foliage	P concentration	Block	6.62*
	K concentration	Block	44.22***
	K content	Block	8.84*
Branches	P concentration	Block	8.00*
Bolewood	K concentration	Block	68.00***
	Ca concentration	Family	5.25*
	Ca concentration	Block	24.00***
	P content	Block	18.30**
	K content	Block	14.98**
	Ca content	Block	7.33*
Bolebark	P concentration	Block	14.00**
	K concentration	Block	13.00**
	K content	Block	22.92***
	Ca content	Family	4.20*

* significant at P = .05
** significant at P = .01
*** significant at P = .001

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