INHERITANCE OF GROWTH POTENTIAL AND CAMBIAL ELECTRICAL RESISTANCE IN RED MAPLE[1]

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ABSTRACT:-- Diameter growth of control-pollinated progenies of red maple tended to be intermediate between that of the parent clones. Electrical resistance in the cambial zone of progeny trees likewise tended to be intermediate between parent clones throughout the growing season. Correlations between diameter growth and cambial electrical resistance were highly significant. Determinations of cambial electrical resistance are therefore probably reflections of growth rate and cannot be used to predict growth performance.

A number of studies have shown that electrical resistance (ER) in the cambial zone of trees was related to growth rate (Smith and Others, 1976; Shortle and Others 1977; Santamour, 1982). Growth rate is a heritable characteristic and, in heterozygous populations, tends to be intermediate in hybrid progenies. We determined the cambial ER of parent trees and progenies of red maple (*Acer rubrum* L.) through the 1979 growing season, then measured the trees, and attempted to determine whether ER and growth rate were "inherited" as correlated characters.

MATERIALS AND METHODS

The red maple trees used in this study were contained in plantations GP-3-46 and GP-4-46 of the Northeastern Forest Experiment Station of the USDA Forest Service. These plantations included control-pollinated intraspecific hybrids of red maple as well as trees grown from rooted cuttings of several of the parents. The crosses were made in 1940 and 1941 in New Haven, Connecticut, but because of World War II, the seedlings remained in nursery rows until outplanted in 1946. In one planting, each progeny was represented by a 36-tree block, while in the other, the progenies were merely planted in rows, according to parentage. The parent clones were included in the row plantings. Spacing between trees in both plantings was 8 feet, and there was no attempt at replication or statistical design in either planting.

The destruction of trees for a wounding study (Santamour 1979) severely limited the numbers available for determination of cambial electrical resistance. However, an average of seven trees per progeny in six control-pollinated progenies were sampled. Only a single tree each of the male parental clones G-60, G-61, and G-62 remained after felling, but we were able to sample four trees of each of the female parental clones G-64 and G-70.

Electrical resistance was measured by pushing the standard Shigometer[2] needle probes with the needles aligned one above the other, through the bark and into the sapwood of the trunk about 1 m above ground level. The resistance to the pulsed electric current was indicated on the ohmmeter. This method of testing measures the point of least electrical resistance along the path of the needle and that low point is the cambial zone (Wargo and Skutt 1975). This fact can be easily verified by inserting the Shigometer needles vertically into various areas of a freshly-cut stump cross-section.

Electrical resistance measurements were made at roughly 7-day intervals from March 19, 1979, until November 29, 1979. Because of the frequency of sampling and the large number of trees to be sampled in a given day (more than 500), only one estimate of electrical resistance was made for each tree on any day.

Tree diameter at breast height was measured 1.5 m above ground level at the end of the 1979 growing season. Correlation analyses between diameter and electrical resistance data utilized the least squares method.

RESULTS AND DISCUSSION

Cambial electrical resistance followed the seasonal path shown by Davis and Others (1979) for red maple. However, the data showed a fairly consistent intermediacy of resistance in hybrid progenies when compared to the parent clones (Tables 1 and 2). Diameter growth of the progenies also tended to be intermediate between the parents. For the two dates shown in Table 2, correlations between cambial electrical resistance and DBH (all trees) were significant at the 1 percent level: r=0.581 for July 17, 1979 and r=0.985 for November 29, 1979. Wargo and Skutt (1975) were the first to demonstrate the inverse correlation between tree diameter and electrical resistance. The data presented here and in the previous paper (Santamour 1982) amply demonstrate this relationship between electrical resistance and both diameter growth and shoot extension.

The progeny G-64 x G-61 had resistance values intermediate between those of the parent clones on 31 of the 35 sampling dates through the growing season. The difference in trunk diameter between G-64 and G-61 was 6.3 cm. The diameter difference between G-70 and G-60 was only 3.3 cm but even in the hybrid progeny G-70 x G-60, the cambial electrical resistance was consistently intermediate between the parents for 77 days (from May 22 until August 7) during the period of most active growth.

Both diameter growth and cambial electrical resistance of the hybrid progenies tended to be intermediate between the parent clones, and thus exhibited the inheritance pattern expected for characteristics whose expression is governed by quantitative genes. This intermediacy would probably have not been so apparent if the parent clones, even though represented by so few trees, had not been grown on the same site and under the same growing conditions as the progeny trees.

From a genetics viewpoint, it would be important to know if cambial electrical resistance could be used as an adjunct to other early selection criteria in selecting rapid-growing trees. Several studies have indicated that growing conditions, e.g. fertilization, release from competition, and defoliation stress may bring about changes in electrical resistance (Wargo and Skutt 1975, Smith and Others 1976). Critical studies on electrical resistance variation within clones in response to varying environmental conditions have not been reported. However, the work of Shortle and Others (1977) at least suggests that the largest and smallest members of hybrid poplar clones (as individual trees) and of sprouts in clonal red maple clumps did differ significantly in electrical resistance. Thus the magnitude of the electrical resistance may result from a genotype-environment interaction like other growth phenomena and the observed electrical resistance may be a reflection rather than a predictor of growth rate. The "inheritance" of cambial electrical resistance is therefore explained on the basis of its high degree of correlation with growth rate.

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[2] Osmose Wood Preserving Co. of America, Buffalo, N.Y. Mention of a particular product would not be taken as an endorsement by the Agricultural Research Service or the U. S. Department of Agriculture.

Table 1. Cambial electrical resistance of red maple parents and progenies at various times during the 1979 growing season (K ohms).

Date 1979	Day of Year	Parent or Progeny G-70	G-70 X G-60	G-60	G-64	G-64 X G-61	G-61
3/27	86	23.5	21.9	29.0	23.2	22.5	15.0
4/17	107	14.1	14.3	15.0	16.5	12.7	13.0
5/8	128	10.2	9.2	11.0	13.2	10.1	8.0
5/29	149	10.4	10.9	11.5	11.6	9.9	7.0
6/19	170	5.8	8.0	13.0	8.2	7.1	6.0
7/17	198	5.1	8.7	10.5	7.8	5.9	4.5
8/7	219	6.9	8.6	11.0	8.2	5.3	7.0
8/28	240	6.9	7.2	7.5	7.2	6.4	5.0
9/18	261	8.5	8.3	9.0	10.2	7.2	5.0
10/16	289	10.8	11.0	13.0	12.9	9.0	7.5
11/6	310	13.2	15.2	19.0	18.5	14.0	11.0
11/29	333	26.5	30.0	31.5	31.5	23.8	16.0

Table 2. Diameter and cambial electrical resistance of red maple parents and progenies. Values marked with an asterisk (*) are intermediate between parents.

Parent or Progeny	DBH CM.	Electrical Resistance July 17, 1979 K ohms	November 29, 1979 K ohms
G-64	13.8	7.8	31.5
G-64 X G-60	11.0*	8.7*	28.4
G-64 X G-61	17.4*	5.9*	23.8*
G-64 X G-62	10.8	7.2*	29.0*
G-60	9.1	10.5	30.0
G-61	20.1	4.5	16.0
G-62	14.7	5.0	23.0
G-70	12.4	5.1	22.7
G-70 X G-60	9.6*	8.7*	26.2*
G-70 X G-61	17.1*	7.7*	20.4*
G-70 X G-62	13.4*	8.0	25.3

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