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SHOOT SIZE SIGNIFICANTLY AFFECTS ROOTING RESPONSE OF SUGAR MAPLE SOFTWOOD CUTTINGS

Abstract. Three hundred softwood cuttings were collected from each of three mature sugar maple trees to test the effect of shoot size on adventitious root formation. One of the trees was a good rooter (61 percent rooted); one was a poor rooter (19 percent rooted); and the third was a non-rooter (1 percent rooted). There was an insufficient number of rooted cuttings from the third tree to permit meaningful comparisons. For the other two trees, long cuttings rooted better than short cuttings. Also, thick cuttings tended to root better than thin ones for one study tree; for the other tree, relative shoot thickness within a particular length class had no effect on rooting.

As one step in formulating workable procedures for propagating superior sugar maple trees vegetatively, we studied the possibility of a relationship between shoot size and rooting response. Results of this study provide propagators with a criterion for selecting cuttings when they are attempting to reproduce this species vegetatively.

Materials and Methods

Approximately 300 softwood cuttings were collected from each of 3 mature sugar maple trees in mid-June 1968. The term *softwood cutting* refers to the current year's total shoot growth. The length and basal diameter of each cutting were recorded to the nearest 0.1 inch and 0.001 inch, respectively. An approximately 2-inch minimum length limit was established to insure that all cuttings would be large enough to be treated equally in the rooting bed; no maximum length nor minimum or maximum diameter limits were set.

The cuttings were lined out randomly (with regard to size) by tree source in a 20- x 60-foot plastic-covered greenhouse. Daily maximum air temperature in the greenhouse was approximately 80°F; daily minimum air temperature was approximately 60°F. The rooting medium, a 50-percent-by-volume mixture of coarse perlite and shredded sphagnum moss, was heated with electric cables; and its temperature was thermostatically maintained at 80°F. Cuttings were watered with intermitten mist; applications were regulated with a MacPenny electronic leaf. Because long days tend to stimulate rooting *(Hartman and Kester 1968)*, supplemental lighting (150-watt incandescent lamps placed approximately 4 feet above the rooting beds) provided a 20-hour day length.

A sufficient number of lower leaves were removed from the cuttings to facilitate sticking; this generally required removing one or two pairs of leaves. Before being inserted into the rooting medium, cuttings were wounded and dipped into Jiffy Grow (*Donnelly 1971*).

(Mention of a particular product is for information only and should not be considered a recommendation or endorsement by the U. S. Department of Agriculture or Forest Service.)

Cuttings were checked for the presence of roots in mid-September, approximately 3 months after they had been collected. A cutting was considered to have rooted if it had at least one recognizable root.

Results

Relationship between shoot length and shoot diameter.—As might be expected, shoot length is correlated with shoot diameter: long cuttings tend to be thicker than short cuttings. Because shoot length and diameter are positively correlated, either of these two variables could perhaps be used to test for a possible relationship between shoot size and rooting response. However, it would be expected that, when propagators select cuttings from mature trees, it would generally be easier to select them on the basis of length rather than diameter; therefore, subsequent major analyses were based on shoot length.

Effect of shoot size on rooting.—Cuttings from one tree (tree C) rooted very poorly, regardless of size. Only four cuttings from this tree, approximately 1 percent, developed adventitious roots. Cause of this almost complete failure is unknown. It appears unlikely that failure was due to improper treatment or environmental conditions within the rooting greenhouse. In mid-September the foliage of the tree from which these cuttings were collected had a rather reddish-brown cast, indicating a possible nutrient deficiency or some other physiological problem. This may have caused the almost complete lack of rooting. Because rooting was insufficient for meaningful comparisons, results from this tree were omitted from subsequent analyses of the effect shoot size has on rooting response.

Approximately 40 percent of the almost 600 cuttings from the other two trees developed adventitious roots. Of these 600 cuttings, 23 became desiccated in the rooting beds before they were checked for the presence of roots; they were omitted from subsequent calculations. In general, tree A was a relatively poor rooter (19 percent of all cuttings rooted), and tree B was a good rooter (61 percent of all cuttings rooted).

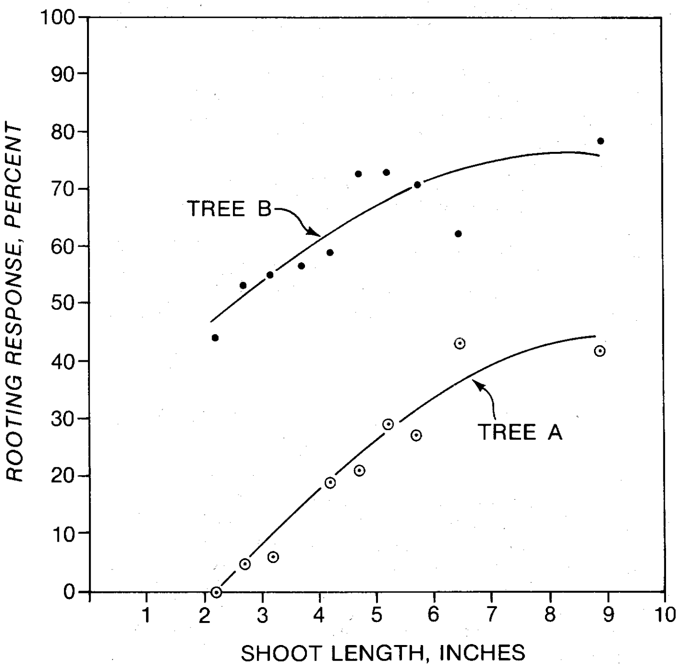
The effect of shoot size on rooting was tested by assigning all cuttings from each tree to one of 10 size classes, calculating the rooting response for each class (table 1) and determining the probability that observed differences in rooting could be due to chance. The length classes were: I.—2.0 to 2.4 inches; II.—2.5 to 2.9 inches; III.—3.0 to 3.4 inches; etc. Because there were relatively few cuttings longer than 6 inches, class IX included cuttings 6.0 to 6.9 inches; and class X included cuttings that were 7.0 inches and longer.

A general increase in rooting response with increase in shoot length was noted for both tree (fig. 1); but cuttings of a particular size class rooted much better for tree B than for tree A. The lowest rooting response obtained from tree B (44 percent for cuttings less than 2.5 inches long) was higher than the highest

Table 1.—*Rooting response of sugar maple cuttings of various length classes*

Class	Length	Tree A		Tree B		Total	
		Cuttings	Cuttings rooted	Cuttings	Cuttings rooted	Cuttings	Cuttings rooted
	Inches	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
I	2.0 - 2.4	29	0	36	44	65	25
II	2.5 - 2.9	48	4	47	53	95	28
III	3.0 - 3.4	33	6	29	55	62	29
IV	3.5 - 3.9	30	17	28	57	58	36
V	4.0 - 4.4	26	19	29	59	55	40
VI	4.5 - 4.9	23	21	22	73	50	44
VII	5.0 - 5.4	17	29	15	73	32	50
VIII	5.5 - 5.9	26	27	14	71	40	42
IX	6.0 - 6.9	21	43	26	62	47	53
X	7.0+	31	42	42	79	73	63

Figure 1.—Relationship between shoot length and rooting response for stem cuttings from two mature sugar maple trees.



response obtained from tree A (43 percent of cuttings between 6 and 7 inches long).

The probability (chi-square test) that observed size-class differences could be due to chance was less than 0.01 for tree A. For tree B, the probability was approximately 0.10. Thus cuttings from tree B rooted much better than those from tree A did, but response from tree A was more closely correlated with shoot length.

As previously stated, long cuttings tended to be thicker than short cuttings; however, considerable variation in diameter existed for shoots within any length class. Therefore we tested to see if, within each length class, relatively thick cuttings rooted better than relatively thin ones did. Tree-to-tree variations were apparent. For tree A, thick cuttings rooted better than thin ones did (30 percent vs. 9 percent rooting). The probability that this difference could be due to chance is less than 0.01 (chi-square test). For tree B, the average rooting response for relatively thick cuttings (60 percent) was approximately equal to that for relatively thin cuttings (62 percent). The probability that this difference could be due to chance was approximately 0.68.

Discussion

Several researchers have previously reported a relationship between shoot size and the potential for these shoots to be propagated vegetatively *(Snow 1941; Smith et al. 1956; Sardina 1958; Amihan 1959; Chiang 1963; Schwarz and Weide 1963; Suszka 1963; and Morsink 1971)*. Although there have been exceptions *(Snow 1941; Chiang 1963)*, researchers have generally reported that large cuttings propagate better than small ones. Morsink *(1971)* recently tested the effect that shoot size has on length and diameter of juvenile softwood sugar maple cuttings. Cuttings 35 to 55 cm long rooted better than either shorter or longer ones. Also, thick cuttings tended to root somewhat better than thin ones.

Our data support the general assumption that large cuttings root better than small ones. But we have observed tremendous tree-to-tree variability in response. Based on our results, cuttings from some trees (tree B) apparently root relatively well regardless of size (although long cuttings root somewhat better than short ones). For other trees (tree A), rooting response was very closely correlated with cutting size (none of the very short cuttings rooted); and for some trees (tree C) cuttings of all sizes rooted poorly. Tree differences were also apparent in the effect of relative shoot thickness within a particular length class. For tree A (the tree in which rooting response was closely correlated with shoot length) thick cuttings rooted significantly better than thin ones. For tree B (the tree that rooted relatively well regardless of shoot length), shoot thickness had no significant effect on rooting response.

Because of tremendous tree-to-tree variability in rooting response, we cannot meaningfully predict the response a propagator could expect by selecting cuttings of a particular size. Consideration of shoot size is certainly not a panacea for solving the problem of vegetatively propagating selected sugar maples. However, this tree-to-tree variability should not obscure the fact that a positive correlation tends to exist between cutting size and rooting response. Propagators attempting to reproduce this species vegetatively should take advantage of this relationship to increase their chances of success.

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