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AIR-LAYERING SUGAR MAPLE



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AIR-LAYERING SUGAR MAPLE



A Problem of Propagation

IN RESEARCH to improve sugar maple trees, a major difficulty has been to produce clonal material for testing. Even though several workers have successfully rooted cuttings of sugar maple (Snow 1941; Dunn and Townsend 1954; Enright 1958; Gabriel, Marvin, and Taylor 1961), few of the rooted cuttings have lived beyond the first winter. The problem of severe overwinter losses of rooted cuttings remains to be solved.

Recent studies on the Hopkins Memorial Experimental Forest at Williamstown, Massachusetts, have demonstrated that branches of sugar maple can be rooted by air-layering, and that branches so rooted can be overwintered and grown with moderate success — at least with enough success to provide an adequate stock for research purposes.

The purpose of our studies with sugar maple was to develop a method by which superior sugar producers could be vegetatively propagated and grown for use in studies designed to improve

sugar yields. Because high sugar producers will ordinarily be selected from trees of tapping size, our studies were conducted on relatively large roadside sugar maples (fig. 1). Branches on a couple of young sugar maples less than 2 inches d.b.h. were also treated.



Figure 1.—Air-layering a roadside sugar maple. All the work was done on branches that could be reached either from the ground or from a temporary platform on a truck.

Procedures

Air-layering is a method of propagation whereby roots are induced to form on branches still attached to the original tree. Many workers have used this method to propagate species that are difficult to propagate on their own roots by other vegetative methods (Mergen 1955, Mergen and Cutting 1958, Zak 1956, and Bonner 1963).

The air-layer is applied to a sugar maple branch in much the same way as for other woody species. A branch selected for treatment is first wounded by girdling at the point where roots are desired; then the wound is treated with a root-inducing hormone, covered with a moist medium, and wrapped with a water-proof material. After a few weeks, when roots have formed and grown through the surrounding medium the branch is severed below the roots and planted as one would plant a seedling.

The basic steps in applying an air-layer to a sugar maple branch (fig. 2) are as follows:

1. Select the Branch and the Position on It for Treatment

At the place where roots are desired, the branch should be strong enough to support the weight of the package that will result when treatment is completed. Branches $3/16$ inch or larger in diameter at the point of treatment usually will withstand moderately high winds without breakage.

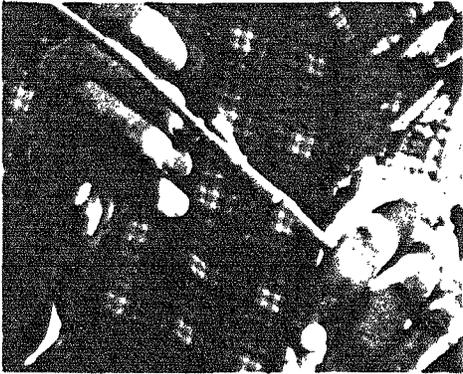
A branch should have made at least 4 inches of terminal growth the previous year to provide space for placing the package without covering newly formed leaves near the branch tip.

The treatment should be applied to a node marking the position of a previous terminal bud (fig. 2, A). Internodal positions do not respond as well.

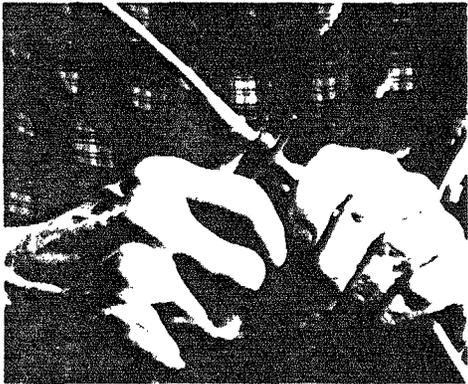
2. Girdle the Branch to Induce Rooting

Carefully remove the bark and all traces of cambium tissue from a 1-inch wide band around the branch at the point where

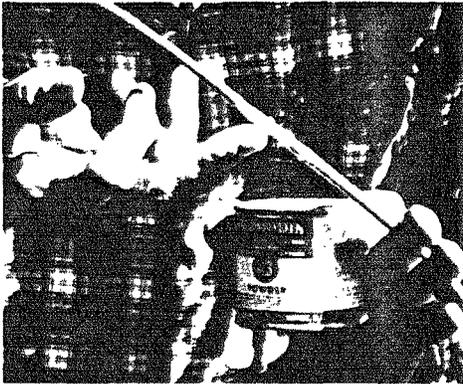
Figure 2.—Steps in air-layering a sugar maple branch.



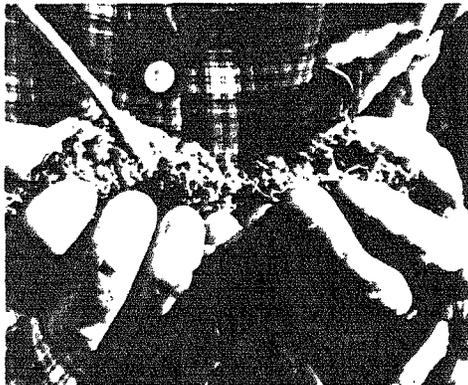
A. Select position for girdle.



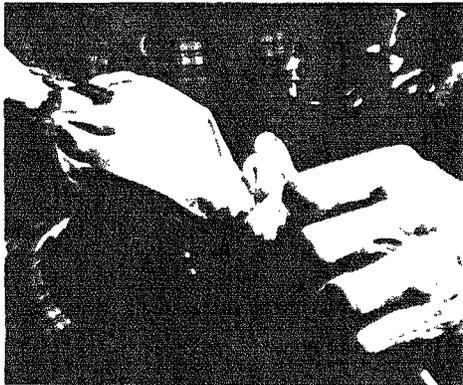
B. Make the girdle.



C. Apply rooting compound.



D. Cover with moist sphagnum.



E. Tie waterproof plastic wrapper.

roots are desired (fig. 2, B). Avoid cutting into the wood when making the girdle. Cuts in the wood weaken the stem mechanically and may result in breakage.

3. Apply Rooting Compound

To stimulate root formation, apply a root-inducing hormone to the surface of the girdled area. An 0.8-percent mixture of indolebutyric acid in talc (Hormodin No. 3) has consistently given good rooting results in our work.

Moisten the surface of the girdled area to ensure adherence of the powder. The hormone can be applied easily either by dusting or simply by dipping a finger into the powder and then rubbing it over the girdled surface (fig. 2, C).

4. Place Moist Rooting Medium around the Treated Area

Sphagnum moss, thoroughly soaked in water, makes an excellent rooting medium. It holds moisture well, can be readily shaped around a branch and, because of its fibrous nature, can easily be held in the desired shape and position until a wrapper can be tied around it.

When applying the sphagnum, scoop up a liberal handful from the container, squeeze it as dry as possible, then separate it into two equal portions and place them so as to completely cover the girdle (fig. 2, D). Avoid twisting or turning the sphagnum around the branch, as this would wipe the rooting hormone from the treated surface.

5. Place the Wrapper and Tie It in Position

To hold the rooting medium in position and to retain the moisture needed for root formation, wrap a cover of moisture-proof material around the medium and tie it securely at each end (fig. 2, E). In our work clear polyethylene plastic, in sheets 7 x 9 inches, have proved satisfactory for this purpose. Once the wrapper is in place, no further steps are necessary until roots can be seen growing out of the medium, (fig. 3).

Figure 3. — Developing roots on an air-layered sugar maple branch.



Figure 4.—Roots forming in air-layers in young sugar maple stump sprouts.

Factors That May Affect Rooting Response

So far, only the mechanics of applying an air-layer to a sugar maple branch have been considered; little has been said about factors that may affect rooting response. The Williamstown studies provided useful information about a number of these factors, the highlights of which are as follows:

Time of Treatment

Best rooting resulted when treatments were applied at about the time the first flush of terminal growth had slowed down. In the Williamstown area, this usually occurs between late May and mid-June. Few roots, if any, developed when treatments were applied much before or much after that early-summer period.

Size or Age of Tree

In our work, size or age of tree was not a factor of great importance in rooting response. Although layers on 2-inch or smaller trees (fig. 4) appeared generally to develop somewhat more numerous and more vigorous roots, up to 91 percent of our layers on trees ranging from 13 to 36 inches d.b.h. were successfully rooted. This is in marked contrast to the effect of tree age on air-layering in shortleaf and loblolly pines: in those species layers on trees more than 10 years old are reported to be difficult to root (Zak 1956).

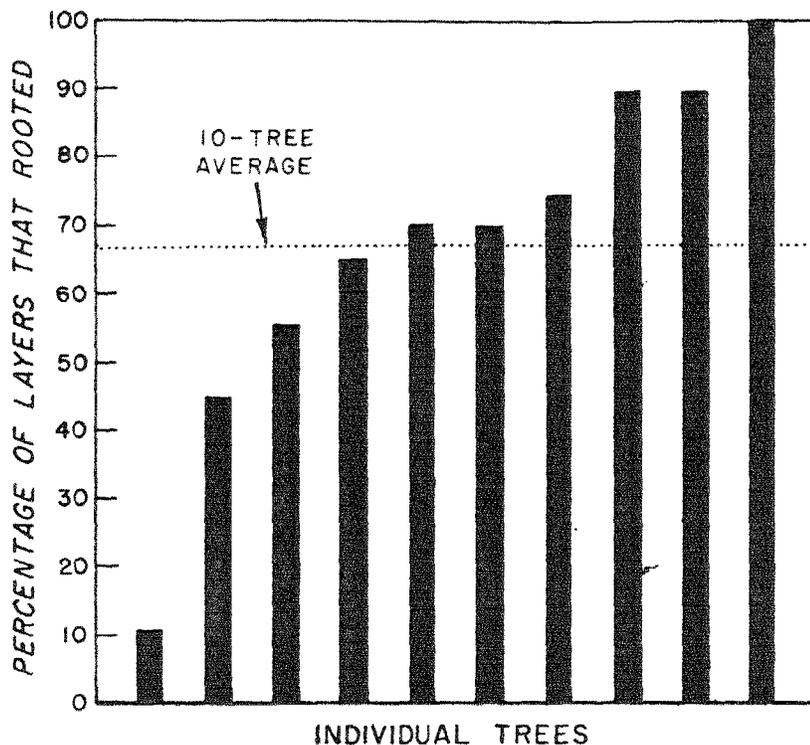
Influence of Crown Position of the Treated Branch

Within the lower third of the crown, where all our work on large trees was done, there was no evidence that crown position affected rooting response.

Variance of Individual Trees

We found that trees varied in rooting response. In 1959 an equal number of branches were treated identically on 10 roadside trees. The rooting by individual trees ranged from a low of 10

Figure 5.—Rooting responses of 10 roadside sugar maples on which equal numbers of branches were uniformly treated.



percent to a high of 100 percent. The general average for all 10 trees was 67 percent (fig. 5). The differences in rooting among trees were highly significant.

Type and Severity of Wounding

No rooting took place unless some form of complete girdle was made. Nicks, notches, and other wounds short of complete girdles resulted in calluses but no roots.

To determine whether severity of wounding influenced rooting response, girdles $\frac{1}{4}$, $\frac{1}{2}$, and 1 inch wide were made on an equal number of branches on each of two trees. As width of girdle increased, so did the percentage of branches that rooted, as shown in the tabulation that follows:

<i>Tree number</i>	<i>1/4-inch girdle</i>	<i>1/2-inch girdle</i>	<i>1-inch girdle</i>
H-662	20	13	53
H-669	7	27	33
Average	13	20	43

The differences between means were significant. Girdles wider than 1 inch did not improve rooting. A stronger tendency of the narrower girdles to bridge over with callus tissue probably accounted for their poorer rooting.

Once the importance of girdle width was recognized, we achieved increasingly higher rooting percentages as we gained experience in applying the treatment. The following tabulation shows this trend:

<i>Year</i>	<i>Trees treated (No.)</i>	<i>Branches treated (No.)</i>	<i>Branches rooted (No.) (Percent)</i>	
1959	10	200	134	67
1961	4	405	298	74
1962	6	503	453	91

Treatment Position on the Branch

As stated earlier, rooting is less successful at internodal positions than at nodal ones.

As for different nodal positions, we worked on only two: (A) the base of the 1-year-old wood, and (B) the base of the 2-year-old wood (fig. 6). In one test, rooting response at these two positions was compared for an equal number of uniformly treated branches on each of six trees. Rooting at the younger position A averaged 88 percent, and at the older position B, 94 percent (table 1). This difference was not significant.

Although the final rooting response between the two positions did not differ significantly, rooting did proceed somewhat faster at the older position (fig. 7).

Figure 7 also shows that, in this series of treatments, root formation started during the fourth week after treatment and continued into the twelfth week. However, by the ninth week more than 90 percent of the rooting had taken place. This rate

of root formation is regarded as fairly typical for sugar maples in the Williamstown area.

Figure 6. — Schematic drawing of treatment positions compared in this study.

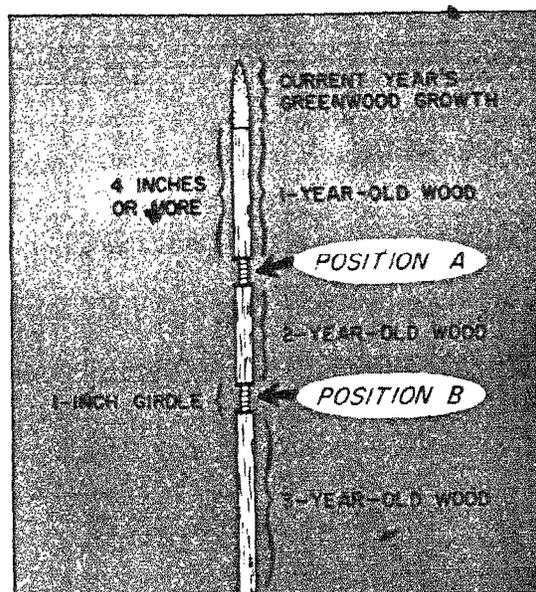


Table 1. — Cumulative record of rooting at two treatment positions¹ on the branches of six trees

Weeks after treatment	Numbers of branches			Percent of total rooting ²		
	Position A	Position B	Total	Position A	Position B	Average
4	13	14	27	5.9	6.0	6.0
5	75	110	185	34.1	47.2	40.8
6	140	165	305	63.6	70.8	67.3
7	171	189	360	77.7	81.1	79.5
8	193	210	403	87.7	90.1	89.0
9	202	213	415	91.8	91.4	91.6
10	213	232	445	96.8	99.6	98.2
11	218	233	451	99.1	100.0	99.6
12	220	233	453	100.0	100.0	100.0
Total treated	251	252	503	—	—	—
Percent rooted	87.6	93.7	90.7	—	—	—

¹Positions as shown in figure 6.

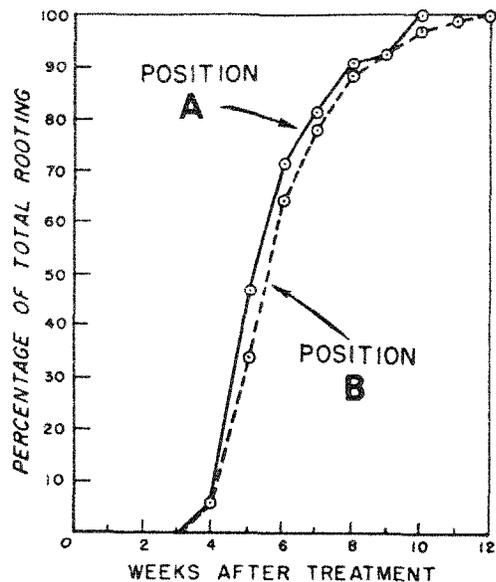


Figure 7.—Rate of root formation by treatment position.

Addition of Nutrients to the Rooting Medium

The addition of nutrients did not improve rooting response. In one test, branches treated with sphagnum moss soaked in plain tap water averaged 18 percent rooting as compared to 11 percent rooting for branches treated with sphagnum moss soaked in a dilute solution of Rapid-Gro, a liquid fertilizer.

Root-Inducing Hormones

On the basis of other research on other species, we assumed that root-inducing hormones would be effective on sugar maple, and adopted hormone treatment as standard procedure. We did not try any untreated controls and consequently do not have a direct measure of hormone efficacy on sugar maple. On slash pine, for example, Mergen (1955) reported 84.6 percent average rooting when branches were treated with 0.8-percent powdered indolebutyric acid (Hormodin No. 3), as compared with 50 percent rooting of controls. Quality and quantity of roots also were reported to be better on the treated branches.

Influence of Wrapping Material

There is evidence that some material may adversely affect rooting response. Clear polyethylene film was used recently in one experiment for wrapping air-layered branches on one tree and translucent vinyl plastic was used on branches of four other trees. For the polyethylene-wrapped branches, on-the-tree mortality was 5 percent; and for the vinyl-wrapped branches, the average mortality was 46 percent (24 to 77 percent by trees). Whether this difference in branch mortality was in fact due to the wrapping materials has not been definitely determined, but on this evidence it seems advisable not to use the vinyl plastic.

Such opaque materials as aluminum foil and black polyethylene film do not adversely affect rooting response but are inconvenient because wrappers must be opened to observe root development. Therefore clear polyethylene is recommended.

After-Rooting Procedures and Results

The earlier rooted branches are removed from the parent tree and started in soil on their own roots, the better the chances are for their over-winter survival.

Procedures

Starting around the fourth week after the air-layers have been applied, branches should be checked at weekly intervals; and those that show roots (fig. 3) should be cut from the parent tree and planted. Weekly checks should continue at least through the ninth week after treatment. By that time more than 90 percent of the root development probably will have taken place (fig. 7).

When planting an air-layer, remove the polyethylene wrapper just before planting. Planting should be deep enough to completely cover the ball of sphagnum and roots. During handling and when firming the soil around the ball, care must be taken not to damage the roots that are growing through or around the sphagnum. Water thoroughly after planting. We recommend

removing about 50 percent of the leaves at the time of planting to reduce water loss from transpiration.

In our work at Williamstown, we planted the air-layers 6 inches apart in rows 2 feet apart in nursery beds that had been prepared by plowing and harrowing. To protect the plants from excessive heat and transpiration stress during the establishment period, 50-percent shade and an intermittent fine spray of water were provided (fig. 8). The spray system was set to operate for 2 minutes every half-hour. One year we used an automatically controlled mist system instead of the spray system, and it served equally well.

Shade and spray were maintained until the end of August. Then the shade was removed and the spray was stopped to encourage hardening-off of the new growth.

To minimize compaction around the trees in our heavy soils, mulches of hardwood leaves and pine needles were liberally applied. This had the added benefit of both suppressing weeds and reducing evaporation of moisture from the soil surface.

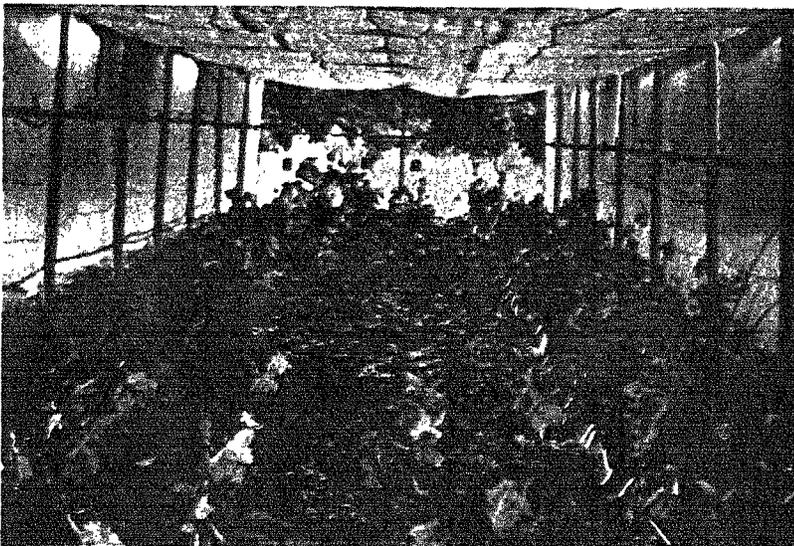


Figure 8.—Nursery bed for starting rooted sugar maple air-layers under 50-percent shade and an intermittent fine spray of water. Sprinklers are mounted along the sides of the shade frame at mid-height.

Results

Survival of the air-layers after planting in the nursery beds was low. In one bed, where air-layers from four trees were planted in 1961, survival after 4 growing seasons ranged from 20 to 44 percent, and averaged 33 percent.

In a second bed, where air-layers from 6 trees were planted in 1962, survival after 3 years ranged from 11 percent to 48 percent and averaged 28 percent (table 2).

Table 2. — Survival of branches from six roadside trees that were rooted by air-layering and planted in 1962

Tree No.	Branches planted.	Survival		
		Fall 1962	Fall 1963	Fall 1964
	<i>No.</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
501	91	84	35	24
655	82	51	24	21
656	38	100	16	13
662	49	69	43	39
669	100	86	51	48
689	65	63	15	11
All trees	426	75	33	28

Individual trees varied considerably in survival. The most critical period was during the first growing season and over the first winter. Losses averaged 25 percent during the growing period and around 40 percent more during the first winter. After that, losses were relatively low. More work is needed to improve survival over this difficult first year.

Discussion

In comparison with rooting of cuttings, air-layering has certain advantages that recommend its use for vegetative propagation of sugar maple. The principal advantages are:

1. Fewer and less-elaborate facilities are required. To propagate by cuttings, special rooting beds equipped with precision controls for light and moisture (intermittent misting) are essential. Subsequent handling of the cuttings requires greenhouse, cold-room, or cold-frame facilities. For air-layering, no special facilities are needed until the rooted branches are cut from the parent tree; and then the only facilities needed are a simple shelter, to reduce insolation and transpiration stress, and an automatic sprinkling device.

2. Through the crucial first year, new plants from air-layers are generally in better condition to survive and grow than plants that originate from cuttings. This is because the roots on air-layers are formed while the branch is still attached to the parent tree and presumably drawing some nutrients from it. Cuttings, on the other hand, develop their roots almost entirely at the expense of previously stored carbohydrates and other food substances. In the process, most or all these food reserves are used up, and before they can be adequately replenished to carry the plant through the winter and support new growth the next spring, dormancy often sets in. Consequently, rooted cuttings go into the winter in a weak condition and few of them are able to break dormancy in the spring.

The chief disadvantages of air-layers are: (1) they involve more hand work per plant and hence would be less practical than cuttings for propagating in large numbers; and (2) after root formation in air-layers gets under way, the branches must be inspected weekly and those that have reached the planting stage must be removed.

Our survival results with air-layers (table 2), although considerably better than is usually achieved with cuttings, still fell far short of complete success. Further research on establishment and over-wintering of the air-layers will have to be done if survivals are to be substantially improved. At the present levels

of success, air-layering is a feasible and useful technique of vegetative propagation for special purposes, such as tree-improvement studies, but not for mass production. And even for limited use in research operations, further studies on ways to increase survival would be well justified.

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