Early Selection for Wound Compartmentalization Potential in Woody Plants[1]

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Abstract

Young woody plants may be successfully screened for their genetically controlled potential to compartmentalize discolored and decayed wood associated with trunk wounds to small columns. To test woody plants for their compartmentalization potential, there should be a reasonable amount of xylem tissue, about 2 years' growth, interior to the experimentally inflicted wound and at least one full growing season should occur between the time of wounding and examination.

Index words: green ash, red maple, red oak, landscape trees, sprouts

Introduction

Genetic control of wound compartmentalization in woody plants has been fairly well established (1, 2, 8). The next logical step would be to incorporate testing and selection for strong compartmentalization into breeding and evaluation programs designed to develop superior trees for planting in the urban landscape. It would be desirable to be able to make such selections on young trees so that large populations could be screened at an early age and the weak compartmentalizers could be eliminated from further testing for other characteristics. However, virtually nothing has been published on the effects of wounding young trees. Indeed, when the various studies described in this paper were initiated (1979), there was an "idea" prevalent that young trees might be too *vigorous* to exhibit "weak" compartmentalization, even though they might demonstrate this trait in later life.

In our work, we have defined weak compartmentalization as the development of wood discoloration inward from a shallow chisel or knife wound to the pith (Fig. 1). This discoloration pattern usually forms a complete wedge-shaped area. In strong compartmentalizers, there is little or no inward extension of discoloration from the original wound zone. (Fig. 1). There are numerous "compartments" and "walls" present in a tree and these have been well defined and illustrated (6, 7). As explained in an earlier paper (3), we have been most concerned with Wall 2 and the ability of a tree to "wall-off" discoloration and potential decay from the interior wood. If wounds to the tree trunk are thus compartmentalized, there is little likelihood that wound-induced decay will progress sufficiently to make the tree a "hazard" to life and property in urban plantings.

Materials and Methods

Plant materials used in this study were green ash (*Fraxinum pennsylvanica* Marsh.) seedlings from known origins, stump sprouts of red oak (*Quercus rubra* L.) of known provenance, and stump sprouts and mature trees of red maple (*Acer rubrum* L.).

A total of 100 seedlings of green ash, 5 plants each of 20 half-sib progenies, were wounded on April 21, 1979, during their second growing season. Two small wedges of wood were cut with a knife blade from opposite sides of each stem at 2 different sites about 10 cm (4 in) apart. Fifteen seedlings, 5 each of 3 progenies, were harvested on November 10, 1979, and sawn through at the wound sites. All 15 seedlings showed strong wound compartmentalization and it was concluded, perhaps improperly, that the seedlings were too young or too small to exhibit weak compartmentalization. The remaining 85 seedlings were not harvested in 1979 or 1980, but were allowed to grow on for future wounding studies. These seedlings were wounded on July 13, 1981 with 2 shallow cuts (2 mm or 0.08 in deep) made with an 8 mm (0.3 in)-wide chisel on opposite sides of the stem at 2 sites about 30 cm (12 in) apart. These stems were harvested on January 7, 1982, sawn through at the wound sites, and examined for wound discoloration.

The oak sprouts were from stumps of 25-year-old trees that had been growing at Longwood Gardens, Kennett Square, Pennsylvania, as part of a long-term

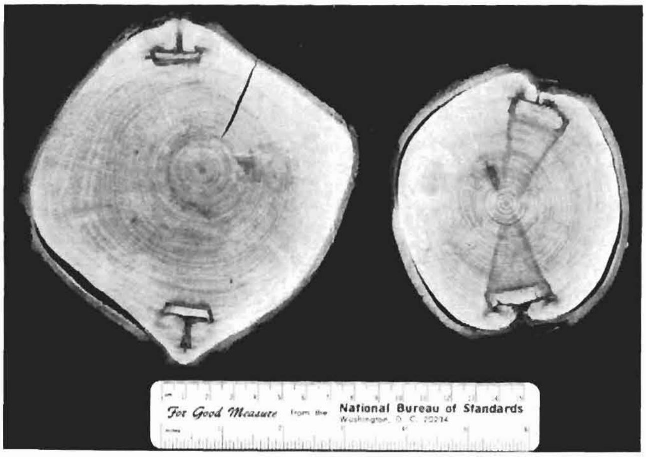

Fig. 1. Left, trunk of mature red maple showing strong wound compartmentalization of chisel wounds; right, weak compartmentalization.

[1]Received for publication March 14, 1984; in revised form June 26, 1984. Research partially supported by a grant from the Horticultural Research Institute, Inc.

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provenance test (4). The trees were felled during the winter of 1978-79 to obtain young branches for cambial isoenzyme studies (5) and to provide clonal sprout clumps for future grafting research. During the period that patch grafts were attempted (June 15-30, 1980), the largest sprout in each clump, from 5 trees of each of 13 half-sib progenies, was wounded with a knife blade in the same manner as the ash seedlings wounded in the same year. In addition, a 3 mm diameter (0.1 in) hole was drilled completely through each stem at a point roughly intermediate between the other wound sites. Thes 65 wounded sprouts were harvested in November 1980, sawn through at the wound sites, and checked for discoloration caused by wounding. Only 5 trees appeared to exhibit weak compartmentalization, but there were others that were difficult to determine. Therefore, the largest remaining sprout in each clump was chisel-wounded in November 1980 using the same technique as for the ash seedlings wounded in 1981. Similar wounds were inflicted on the largest remaining sprout of 50 stumps (5 each of 10 progenies) on July 18, 1981. All of the stems wounded on these 2 latter dates were harvested on October 22, 1982 and checked for wood discoloration resulting from wounding.

While the compartmentalization potential of the ashes and oaks used in this study was unknown at the time of wounding, that of the red maples had been determined in an earlier study (3). Stump sprouts of trees felled in December 1978 were knife-wounded June 26, 1981. Sprout production was poor and sprout growth was weak in the maple plantation and few vigorous sprouts were available for wounding. Sprouts from 8 weak compartmentalizers and 9 strong compartmentalizers were wounded in 1980. Also in June 1980, 4 large trees, 2 each of strong- and weak-compartmentalizing clones, were wounded in the upper crown.

Operating from an aerial bucket in the tops of these 40-year-old trees, knife and chisel wounds were made near the middle of each annual internode from that of 1980 back to 1970 or 1971. Plants wounded in 1980, both sprouts and tree tops, were harvested in February 1981. The maple sprouts wounded in 1981 were harvested in June 1983.

Results and Discussion

The failure to find any weak compartmentalizers in the 15 green ash seedlings knife-wounded and harvested in the same year (1979) was probably not the result of the small size or young age of the seedlings. Only 2 of the remaining 85 seedlings that were chisel-wounded at a larger stem diameter exhibited weak compartmentalization. The discolored 'wedge' in ash was quite light in color and it was only clearly visible after drying of the wood sections. It was possible that a period of time longer than part of one growing season was necessary for the full development of discoloration in weak-compartmentalizing trees.

This certainly seemed to be true in the red oaks. Only 5 of 65 sprouts exhibited weak Wall 2 compartmentalization when the time between wounding and examination was less than one full growing season. None of the sprouts showed weak Wall 3 compartmentalization resulting from the drill holes through the stems. Sprouts of 18 clonal red oak clumps, including the previous 5,

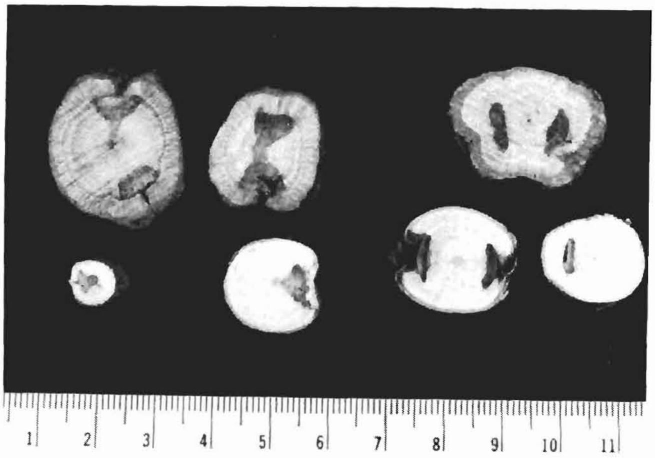

Fig. 2. Left groupings young sprouts of red oak (above) and red maple (below) showing weak compartmentalization. Right grouping, red oak (above) and red maple (below exhibiting strong compartmentalization.

showed weak compartmentalization when examined after at least one growing season following chisel-wounding (Fig. 2). The results of November and July wounding gave similar results, indicating that the date of wounding, whether during the dormant or growing phase, was not a factor. We had seen similar results in earlier (unpublished) work with birch trees wounded in December and June.

Interestingly, the 18 weak compartmentalizers represented 15 different progenies, with only 3 progenies having 2 weak trees each. Apparently the diversity of male parents of unknown compartmentalization potential as well as the small number of trees sampled in each progeny did not allow for any significant correlation of wound compartmentalization with the progeny of any particular female parent.

The need for at least one full growing season was demonstrated once again on mature red maples wounded in the upper crown. Weak-compartmentalizing clones showed clear evidence of their potential but the discolored "wedges" did not extend as far as the pith in less than one season. Wounded stump sprouts from maple trees of known compartmentalization potential gave results identical to the mature trees (Fig. 2).

Thus, it would appear that selection for Wall 2 wound compartmentalization could be effective on trees of young age or small size. The following recommendations are made for such testing:

1. That the trees be at least 1 cm (0.38 in) in diameter and at least 2 years old at the time of wounding. Slightly larger and one year older would be better.
2. That at least 2 shallow wounds, up to 4, be made with a chisel of appropriate width at various points on the stem.
3. That at least one full growing season occurs between the time of wounding and harvesting the trees for examination. It does not matter whether wounding is done during the dormant season or the growing season, but better and more reliable results might be obtained by wounding in June or July of one year and harvesting the trees in November of the following year.

Significance to the Nursery Industry

Nurserymen and scientists may now, by using the techniques and recommendations given in this paper, test large numbers of small woody plants for the ability to compartmentalize trunk wounds. These tests could be applied to large unselected populations of seedling origin or to smaller groups of plants that had already undergone some selection for other desirable landscape characteristics. At the present time, it would appear that the simplest and most accurate method of visualizing the compartmentalization response of very small plants would be by sawing off the tree stem through the wound. This procedure would indeed remove the top of the plant, but the genotype may still be preserved because of the natural tendency of most angiosperm genera to produce sprouts. For material larger than 2 in (5 cm) diameter, an increment borer might be used (3). Trees that show strong wound compartmentalization will be more likely to be landscape assets for longer periods of time and plants exhibiting this trait may be more amenable to propagation by budding and grafting (3).

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Growth Response of *Acer grandidentatum* Nutt. to Chilling Treatments[1]

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Abstract

The response of dormant canyon maple (*Acer grandidentatum* Nutt.) seedlings to chilling was investigated. The most rapid, uniform bud break occurred after the plants were chilled for 1,000 or 1,500 hours at 5 °C (41 °F). Plant height and caliper were also greater for chilled plants than unchilled controls. These results suggest that *A. grandidentatum* production can be accelerated by alternately growing the plants in a greenhouse until growth ceases and then chilling them for at least 1,000 hours to overcome rest.

Index words: Chilling requirement, bud break, rest, canyon maple, big tooth maple

Introduction

Acer grandidentatum Nutt. bigtooth or canyon maple, is a potentially useful native landscape plant in the Intermountain West (2, 3) and could be adapted to many areas of the United States. The tree is drought-tolerant, cold hardy, and has attractive fall foliage. Research on canyon maple, however, has been very limited. Canyon maple growth is slow, particularly during the first few growing seasons. Barker (3) observed seedling growth and found that an extensive root system was developed during the first growing season, but shoot growth was only about 5 cm (2 in). Hence, it would take several years to produce a saleable plant under normal growing conditions.

The present work was undertaken to determine if shoot growth of canyon maple could be accelerated using a combination of greenhouse production and induced chilling to promote growth flushes. The requirement of many woody plants to undergo chilling to break rest is well known (1, 4, 5, 6, 7), but the chilling requirement for canyon maple has not been determined.

Materials and Methods

The plants used in this study were grown from seed collected during December from canyon maple growing

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