JOURNAL OF
ARBORICULTURE

July 1985
Vol. 11, No. 7

# THE SHORT-TERM EFFECT OF SIMULATED ACIDIC RAINFALL ON THE FORMATION OF DISCOLORED WOOD IN *ACER RUBRUM*[1]

by L. Tower, A. Shigo, and E. Brennan

**Abstract.** Healthy red maple trees growing in the Massabesic Experimental Forest in Main were wounded in June 1982, with a bow saw. Dilute sulfuric acid solutions of pH 3.0, 4.0, and 5.8 were dripped into the wounds for 1 hr once a week for 7 weeks. In mid-August the trees were harvested, sectioned, and the amount of discolored wood associated with each wound was measured with a planimeter. Increased acidity did not affect the amount of discoloration that occurred.

In the Northeastern United States acidic precipitation has recently been implicated as a factor in the decline of red spruce, *Picea rubens*, (Vogelman, 1982; Siccama et al., 1982). Although no definitive evidence supports the conclusion an apparent 10 fold increase in acidity of ambient rainfall over the last 30 years correlates with the occurrence of the problem. Acidic precipitation may also have a role in the decline of other tree species in the same geographical area. Because of the potential impact of acidic rain on the health of trees, it is important to determine experimentally its effect on specific processes crucial to the well being of a tree.

During its lifetime a tree may be wounded many times by various physical and biological agents allowing adaptable microogranisms to invade, discolor and decay the woody tissue. In order to limit the amount of wood that becomes discolored and may subsequently decay, an appropriate wound response must be made by the tree to wall off the injured area. This process has been termed "compartmentalization" (Shigo and Marx, 1977). Should compartmentalization be adversely affected by acidic rain, wounds might exert a more negative effect on the health of a tree. In this paper we describe the short-term effect of acidified solutions of varying pH on the amount of discolored wood in mechanically-wounded red maple trees, *Acer rubrum*.

## Materials and Methods

During 1982 an experiment was conducted with 25- to 30-year-old red maple trees in the Massabesic Experimental Forest in Alfred, Maine. Twenty trees (6-8 cm dbh) were selected which bore no external signs of previous wounds. On 23 June, 3 kerf wounds approximately two-thirds of the tree radius were made per tree with a bow saw. One wound was made approximately 70 cm above ground level; the other two wounds were each 30 cm above the previous wound. The wounds were subdivided by hammering 1 mm triangular aluminum plates (5 X 2.5 cm) into the center of the wound (Figure 1). This method, designed by Leben, Shigo, and Hall (1982), allows each wound to accomodate a treatment and a control, thereby avoiding any effect due to position of the wound. Wounds on one group of 10 trees were exposed to sulfuric acid solution pH 3.0 and pH 5.8, ambient rain or no rain; and in a second group of 10 trees treatments were similar except that a sulfuric acid solution of pH 4.0 was substituted for pH 3.0. The solutions

1New Jersey Agricultural Experiment, Publication No. D-11353-3-84, supported by McIntire-Stennis and Northeastern Forest Experiment Station Cooperative Agreement, No. 23-615 funds.

simulated the pH range occurring in "clean" rainfall (pH 5.8), in the pollluted Northeast (pH 4.0 to 4.2), and in a drastically polluted area such as might occur near a point source of $SO_2$ (pH 3.0). The solutions were dripped into the wounds from inverted 2-liter plastic bottles fitted with rubber stoppers and cotton wicks that were attached to the tree above the wound. One liter of solution was delivered in approximately one hour once a week for 7 weeks, each time approximating the amount of stemflow a tree would receive during a 2.5 cm rainfall. Acetate collars (46 cm wide) were attached to the trees above the wounds to protect against ambient rain (Figure 2). During the experiment, records were kept of daily rainfall volume and pH.

In mid-August, 13 of the trees were harvested. In field experiments it is common to treat more trees than harvested. At the USDA Forest Science Laboratory (Durham, NH) cross sections were made at 0.5 cm and 2.5 cm above the wound. The discolored area in the cross section was traced on acetate sheets and the area of the discolored wood visible in the cross sections was determined with a polar planimeter. The amount of discolored wood was recorded.

**Results and Discussion**

The amount of discolored wood measured in the wounds of various treatments is presented in Table 1. Acidity *per se* had no effect on the amount of discolored wood; in red maple comparable areas of discoloration were measured in wounds of trees exposed to solutions of pH 3.0 and 5.8 (Figure 3) or pH 4.0 and 5.8 at points 0.5 or 2.5 cm above the wound. When rain was excluded from the wound by a plastic shield, the area of discoloration was similar to that found in the acidified wounds. In the ambient rain treatment (weighted mean, pH 3.98) the amount of

**Figure 1. The Leben, Shigo, Hall Method of subdividing a wound by a triangular aluminum plate to accomodate a treatment and a control at each site.**

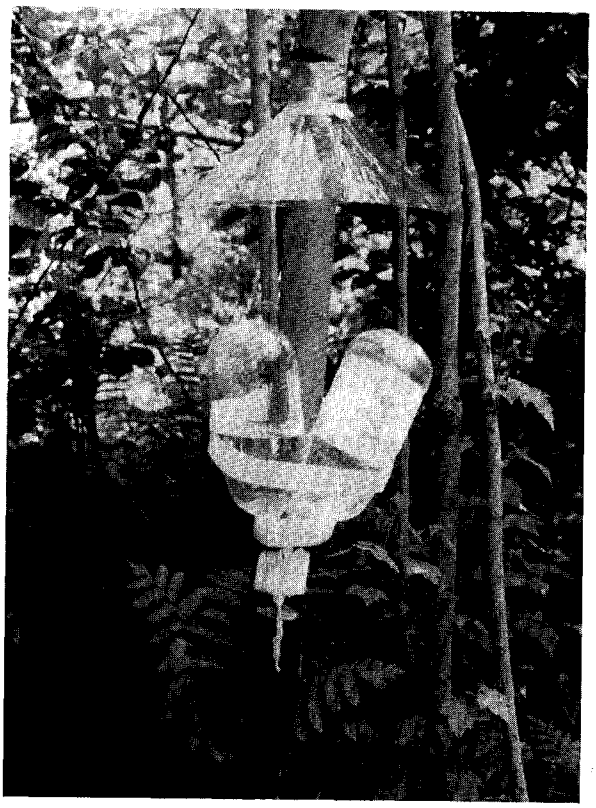

**Figure 2. Plastic bottles containing solutions mounted over a wound and protected from ambient rain by an acetate collar.**

**Table 1. Discolored area ($cm^2$) measured at 0.5 and 2.5 cms above wounds exposed to various rain treatments.**

**Group I**

| | *0.5 cm* | *2.5 cm* |
|---|---|---|
| Simulated rain pH 3.0 | 2.10[Z] a | 0.67 a |
| Simulated rain pH 5.8 | 2.20 a | 1.05 a |
| Ambient rain pH 3.98 | 2.21 a | 0.80 a |
| No rain | 2.86 a | 1.91 a |

**Group II**

| | *0.5 cm* | *2.5 cm* |
|---|---|---|
| Simulated rain pH 4.0 | 2.89 a | 0.91 ab |
| Simulated rain pH 5.8 | 3.90 a | 1.57 ab |
| Ambient rain pH 3.98 | 3.03 a | 1.86 a |
| No rain | 2.16 a | 0.41 b |

[Z]*Means in the same column followed by the same letter are* not significantly different according to Duncan's multiple range test.

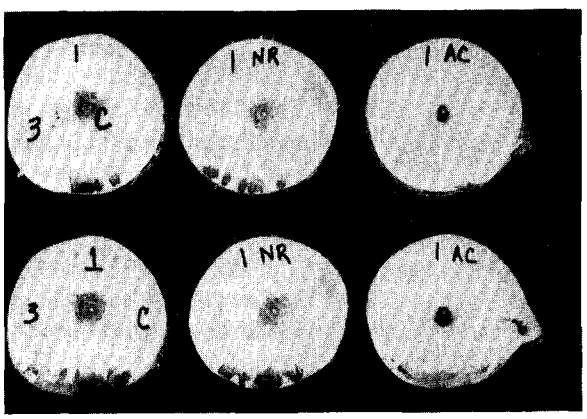


**Figure 3. Discolored wood associated with wounds on a red maple tree: C = control, pH 5.8 solution; 3 = pH 3.0 simulated acid rain; NR = no rain; and AC = ambient rain.**

discoloration 0.5 cm above the wound was similar to that found in all the other treatments, but for some unknown reason less discoloration occurred in one group of trees 2.5 cm above the wound.

From these very short-term experiments, we suggest that acidity comparable to that occurring in the rainfall of the Northeast does not adversely affect compartmentalization following wounding of healthy field-grown red maple trees. One might infer that (1) the wood is sufficiently buffered to counteract the acidity of solutions of pH 3.0 or 4.0 and/or (2) that wood-invading microorganisms are not significantly affected by solutions of pH 3.0 or 4.0 in the amounts used. There remains the possibility, however, that trees stressed by biotic or abiotic disorders might not be capable of the normal wound response in the presence of acidic precipitation.

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*Department of Plant Pathology*
*New Jersey Agricultural Experiment Station*
*Rutgers University--Cook College*
*New Brunswick, New Jersey 08903*
*and*
*United States Department of Agriculture*
*Forest Service*
*Northeastern Forest Experiment Station*
*Durham, New Hampshire 03824*