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PROMOTION OF WOUND CLOSURE IN SHADE TREES WITH EXOGENOUSLY-APPLIED GROWTH REGULATORS[1,2]

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Abstract. In a trial of three growth regulators in aqueous solutions at four concentrations on wounds of *Acer rubrum* 'Bowhall', 2,4-dichlorophenoxyacetic acid, (2,4-D) at 1,000 mg/l initially increased the closure rate. However, this effect was no longer significant by the end of the season. Ethephon and benzyl adenine (BA) were ineffective at lower concentrations and inhibitory to closure at 1,000 mg/l. In a follow-up study with 2,4-D, both the carrier solvent (47% ethanol) and 2,4-D at 10,000 mg/l were phytotoxic. Five auxins were applied to aqueous solutions, each at four concentrations, to wounds of *Populus* X *androscoggin* in a greenhouse. Dicamba, 2,4-D, IAA and IBA initially stimulated closure rate at 1,000 mg/l. Picloram showed a similar stimulus at 10 mg/l, but was phytotoxic at higher concentrations.

Key words. red maple, *Acer rubrum,* poplar, *Populus sp.,* wound closure, growth regulators, auxin, ethephon, 2,4-dichlorophenoxyacetic acid.

Many have tried to either speed up wound closure in shade trees or at least to protect the trees until closure is complete. Commonly employed wound dressings have no effect or even inhibit wound closure (4,9,11).

Jacobs demonstrated the essential role of indole-3-acetic acid (IAA) in callus formation at the wound site (5). McQuilkin found exogenously applied auxins inhibitory to closure in red maple at high concentrations but inconsistent results at lower concentrations (8). Davis noted some stimulation of sugar maple wound callus with o-chlorophenoxyacetic acid at 1,000 ppm in talc (2,3). Samish *et al.* observed considerable callus stimulation with 2,4-D at 2,000 to 10,000 ppm on apple tree pruning wounds (10). Crowdy's work demonstrated only an initial boost in closure rate on apple tree wounds with incorporation of 2,4-D or IBA in lanolin (1). Lagerstedt observed successful wound callus stimulation with both picloram and 2,4-D incorporated into polyvinyl acetate paint (6,7).

We tested a series of growth regulators for their ability to speed the rate of wound closure in three separate studies conducted between May and December, 1980.

Materials and Methods

Study 1. Thirty trees of *Acer rubrum* 'Bowhall' were chosen from a roadside planting on the Columbus campus of the Ohio State University. The trees were relatively uniform in age with a mean height of 6.7 m and mean diameter of 13.8 cm. Each of the thirty trees was randomly assigned to one of the following treatment groups, such that ten trees received each treatment: 2,4-D, benzyl adenine (BA), and 2-chloroethylphosphonic acid (Ethrel). Thus there were 3 individual treatment groups with 10 replications per treatment.

On May 25, 1980, each tree received four 1 cm diam. X 1 cm deep wounds at an equal height

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(approx. 1.5 m) in the four cardinal directions. A strip of black plastic tape covered all wounds. Growth regulators were applied as aqueous solutions at 0, 10, 100, and 1,000 mg/L (.75 ml/wound) by hypodermic syringe (Fig. 1). Each tree received one growth regulator at four concentrations, with the 0 mg/L level serving as the control.

Study 2. Thirty additional 'Bowhall' maples were chosen from the same roadside planting as in Study 1. This study consisted of three treatment groups, with individual trees chosen at random. Ten trees were thus assigned to each of groups A, B and C.

All treatments consisted of 2,4-D applications at four concentrations (0, 100, 1,000 and 10,000 mg/L). Since a carrier solvent of 47% ethanol was required to maintain the highest concentration in solution, two controls were used - one consisting of the carrier and the other of no treatment.

Dilutions from the 10,000 mg/L concentration were made with distilled water, so the relative percentage of ethanol was decreased with decreasing 2,4-D concentration.

On June 28, 1980, wounds 1 cm diam. X 1 cm deep were made, located in a spiral pattern around the trunk of each tree. Orientation was selected at random but the concentration was consistently graduated from 0 at the lower wound to 10,000 mg/L at the upper wound. Method of application was, however, different for each

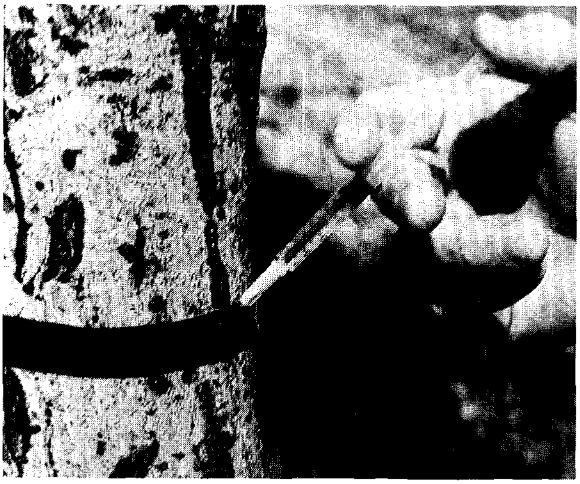

Fig. 1. Application of growth regulator solution to Bowhall red maple tree wounds by hypodermic syringe. Syringe was inserted through the tape to deliver the test material into the wound.

group:

A. Solutions were injected into taped wounds as in Study 1. Approximately 0.5 ml of solution was injected into each wound. One additional control in this group consisted of a wound which was neither taped nor treated.
B. Treatments were applied immediately following wounding by a spray bottle modified to deliver approximately 0.2 ml of solution.
C. Application was as in group B, except that treatments were reapplied at 2 week intervals for 14 weeks (for a total of 7 applications).

Study 3. One hundred and twenty one-year-old rooted cuttings of *Populus* X *androscoggin*, growing in 1-gallon containers, were maintained in an active state of growth in a heated greenhouse. Supplemental lighting was provided for long day conditions from July-December, 1980. These trees had a mean height of 90.8 cm and a mean diameter. of 8.8 mm. Supplemental lighting by 60 W incandescent bulbs placed approximately 1 m apart and 0.5 m above the plants was provided from 10 PM to 1 AM daily. Thermostats were set for a minimum night temperature of 15 degrees C (60 degrees F). Temperature was maintained as close as possible to 24 degrees C (75 degrees F).

A single 5 mm diam. wound was drilled into the stem of each plant. Black plastic tape was applied over each wound, and treatments were applied by hypodermic syringe through the tape. Six different auxin sources were used at four concentrations (0, 10, 100, and 1,000 mg/L) in aqueous solutions, with 5 replications per treatment. Auxins included:

3-Indole acetic acid (Eastman Kodak Co.)
3-Indole butyric acid (")
1-Naphthalene acetic acid (")
2,4-Dichlorophenoxyacetic acid (")
Picloram (4-amino-3,5,6-trichloro picolinic acid) (Dow Chemical)
Dicamba (2-methoxy-3,6-dichloro benzoic acid) (Velsicol Co.)

Results

Study 1. The 2,4-D seemed to offer an initial stimulus to closure rate in Study 1, but no outward effect was seen by the end of the season (Tables

1 and 2). Neither BA nor Ethephon showed any stimulatory effect. Ethephon and BA were phytotoxic at higher concentrations.

Study 2. The second study showed no beneficial effect on wound closure which had been observed in the 2,4-D treatment of Study 1. The carrier (47% ethanol) tended to delay closure (Table 3), especially when injected. The highest concentration (10,000 mg/l) of 2,4-D was obviously phytotoxic.

The highest variability occurred at the 10,000 mg/l) level and with the tape and carrier. The resulting higher variance reduced the significance of differences between treatment levels. The taped control required only about half as long to close up as the untaped control. A simple t-test of the tape versus no tape comparison shows significance at the 10% level.

Study 3. Stimulatory effects apparent in the first week following wounding had dissipated by one month (Tables 4 and 5). In the case of strong auxins, an initial localized swelling hastened closure, but eventually resulted in systemic phytotoxic symptoms. This was especially evident with the picloram and dicamba.

Table 1. Closure rate for two weeks after wounding for wounds in the Bowhall red maple trees that received 2,4-D as a wound treatment (1980).

Concentration (mg/L)	*0*	*10*	*100*	*1,000*
Mean closure rate (mm/wk)	1.9	1.9	2.25	2.8

LSD P = .05, 0.65

Table 2. Number of weeks to complete closure of a 10 mm wound in Bowhall red maple each of which received 4 concentrations of one of 3 growth regulators (1980).

	Mean Weeks to Closure		
Concentration (mg/L)	*2,3-D*	*B.A.*	*Ethrel*
0	10.7	12.0	7.9
10	10.0	9.2	12.5
100	9.4	11.6	12.1
1,000	12.0	18.8	19.8
LSD P = .05	N.S.	8.9	8.7

Table 3. Effect of 2,4-D on closure of 10mm wounds on Bowhall red maple (1980).

	Mean Number of Weeks to Close Wounds		
	Application Method		
Concentration (mg/L)	*Injection*	*Single Spray*	*Repeated Spray*
0	17.7		
0(untaped)	32.6	23.1	16.2
100	29.1	25.4	33.7
1,000	20.0	25.7	30.4
10,000	92.7	47.9	77.9
Carrier*	82.5	33.6	20.8
LDS P = .05	29.9	24.0	25.7

*Carrier = 47% Ethanol (v:v)

Table 4. Amounts of wound closure for 5 mm wounds in a *Populus* hybrid 5 days after auxin treatment (1980).

	Mean Closure (mm) After 5 Days				
	Concentration mg/L				
Auxin	*0*	*10*	*100*	*1000*	*LSD .05*
IAA	0.2	0.4	0.8	1.4	1.25
IBA	0.2	0.8	0.8	1.2	0.76
NAA	0.2	0.4	0.6	1.4	0.97
2,4-D	0.2	0.8	1.6	2.2	1.04
Picloram	0.4	1.4	1.6	1.4	0.73
Dicamba	0.4	0.6	1.0	2.2	1.12

Table 5. Number of days for closure of 5 mm wounds in a *Populus* hybrid after auxin treatments (1980).

	Mean Days to Closure (actual or estimated)				
	Concentration mg/L				
Auxin	*0*	*10*	*100*	*1000*	*LSD .05*
IAA	61	277	47	41	N.S.
IBA	70	17	21	22	N.S.
NAA	275	28	51	68	N.S.
2,4-D	35	11	33	63	44
Picloram	78	18	767	767	564
Dicamba	54	47	34	23	N.S.

Discussion

The initial wound closure stimulation of 2,4-D in Study 1 is essentially what was reported by Crowdy (1) in his work with apple trees. 2,4-D yielded better callus than the control for Lagerstedt (7) at 200 ppm and for Samish et al. (10) at 10,000 ppm. Since in past studies investigations used a variety of carriers (including lanolin, paint, talc, shellac, and wax mixture), it is often impossible to estimate the true concentrations of growth regulator to which the tissue is exposed or the time it is available. It seems clear from our second study that 10,000 mg/l 2,4-D in an aqueous solution is phytotoxic for 'Bowhall' red maple.

Closure was delayed in Study 2 as compared to Study 1 due to an decreased growth rate later in the season. We did realize an effect due to taping, but the level of significance was not as high as previously experienced.

The greenhouse study with the poplars demonstrated a similar effect for all auxins except picloram, which is obviously several times more active than the others. There was initial boost in closure rate with 1,000 mg/L of IAA, IBA, NAA, 2,4-D and of dicamba, whereas the initial boost was apparent at 10 mg/L with picloram. The higher rates of Picloram (100 and 1,000 mg/L were phytotoxic.

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ABSTRACT

NICHOLS, L.P. 1982. **Eleven excellent crabapples.** Am. Nurseryman 156(7): 90-95.

What are the best crabapples? I have looked at thousands of them for disease resistance over a 20-year period, and people keep asking that question. I submit the following list of my favorites. Of course, being a plant pathologist, I may be slightly in favor of crabapples that have disease resistance. But I am enough of a horticulturist and plant lover to concede that one might put up with a slight amount of disease, especially in the case of trees of outstanding beauty. With all crabapples, one must look further than the beauty presented at bloom time. One must consider the foliage characteristics during summer and the often neglected beauty of a show of red, orange, or yellow fruit in fall and into winter.