EFFECT OF ATRINAL (DIKEGULAC) ON THE GROWTH OF PLANE TREE, RED MAPLE AND NORWAY MAPLE IN NEW YORK

by Daniel C. Wright, and John T. Moran

Abstract. Three hundred trees under utility electric lines were selected in 1984 in the communities of Yonkers, White Plains, and New Castle in Westchester County, New York to test the effectiveness of Atrinal (dikegulac) in controlling tree regrowth following trimming. Atrinal was applied to plane trees, red maples, and Norway maples by trunk injection after trimming. During the first growing season after Atrinal treatment, the average sprout length reduction was 48.3% for plane tree; 23.9% for red maple; and 33.3% for Norway maple. In 1984, Atrinal injection reduced the average length of longest wound sprouts for plane tree 53.6%; red maple 41.2%; and Norway maple 29.1%. The variability in tree regrowth noted among species may be due to different uptake rates of Atrinal, amount of crown removal, climatic factors, and tree health prior to treatment.

Unmanaged trees growing under utility lines can eventually disrupt electrical service to a community when weak branches break during storms. As a result, trees must be trimmed periodically which is both expensive and hazardous. Reducing the growth of trees using chemicals has been proposed as a cost effective method of maintaining trees near utility lines. Atrinal (Dikegulac Sodium or Na 2, 3:4, 6-di-o-[1-methylethylidiene]-L-xylo-2-hexulofuranosonic acid) has been used as a chemical pinching agent for ornamentals and as a growth retardant for hedge plants (9, 10, 11, 12). Atrinal also retards the growth of trees and can be applied by trunk injection (2, 3, 5, 6, 7).

The effectiveness of Atrinal, which has been tested in at least twelve states (4), has varied among species and according to location (6). The goal of the present research is to determine what factors influence the effectiveness of Atrinal trunk injections, and the long term effects of Atrinal on tree growth with particular reference to street trees in southeastern New York.

Methods and Materials

In 1984, trees under power lines in Yonkers, White Plains, and New Castle, New York were selected for inclusion in the investigation. Trees with dead wood, wounds, insect damage, or girdling roots, if present in excessive amounts, were excluded from the study.

The three hundred trees selected for the study included plane tree *(Platanus acerifolia),* red maple *(Acer rubrum),* and Norway maple *(Acer platanoides).* Trees were randomly chosen to be treated with Atrinal or to serve as controls at a ratio of approximately three to one (227 treated, 73 untreated).

The selected trees were pruned in the spring of 1984 prior to Atrinal treatment. Trimming was performed by crews in accordance with utility specifications. Tree crowns in New Castle were trimmed more extensively than in the other two areas. Roads in New Castle are often bordered by enroaching forests rather than street plantings and, consequently, many trees have less aesthetic value.

Before each tree was treated, the following data were collected: house number (for future tree identification); species; diameter at breast height, (dbh); general condition (previous growth, dead wood); girdling or exposed roots; wounding; date of trimming; percentage of crown removed during trimming; and area of crown trimmed. During Atrinal treatment, additional data were collected, including soil conditions (soluble salts, pH, moisture), and other growth data.

Atrinal was injected according to the procedure developed by the USDA-ARS (1). Holes (7/32 inches diameter, 1.5 inches deep) were drilled into trees approximately 3 feet above the ground. Trees greater than 16 inches dbh received 6 treatment holes. Those less than 16 inches dbh received 3 treatment holes.

The Atrinal formulation containing 18.5% active ingredient was diluted with water (100 ml of Atrinal per liter of water). The volume of diluted Atrinal applied to each tree was determined by one of two formulas:

Application volume (ml)(trees less than 16 inches dbh) = $(dbh)^2 \times 1.59$

Application volume (ml)(trees more than 16 inches dbh) = dbh × 25.45

Equal amounts of Atrinal were injected into each drilled hole. Injection occurred between May 16 and June 15, 1984 when most leaves were about half expanded.

Branch ends with cuts (3-5) were selected on each tree and tagged for measurement after leaf fall. Each tagged cut was located and wound sprouts were counted and measured. Growth data were collected during December of 1984, 1985, and 1986.

Using the results of an F test, statistical significance was determined by calculation of either uncorrected or corrected (based on a t-distribution) confidence intervals. Comparisons were assessed at the 95% level.

Results and Discussion

The average sprout growth of treated Norway maple was significantly inhibited by 33.3% in 1984, 17.5% in 1985, and 21.1% in 1986 (Table 1). Red maples appeared to be marginally inhibited by Atrinal only in 1984, 23.9%. Plane tree sprout growth was inhibited 48.3% in 1984; and 32.2% in 1985. The 1986 data for planes and red maples were not available due to trimming operations which occurred before the data were collected and consequently this information is absent from the results.

Not every wound sprout becomes a problem requiring trimming at a later date. Many such sprouts exhibit normal growth; growth rates equal to that of untrimmed portions of the tree. It is the supranormal growth, or long sprout, that necessitates corrective maintenance, rather than the average of all wound-related sprout growth. Comparison on a species basis revealed that the long sprouts of treated planes were 53.6% shorter than controls in 1984; and 25.8% shorter in 1985. Norway maples were significantly shorter than untreated trees from 1984 to 1986 (29.1%; 23.5%; and 22.2%), whereas the long sprouts of treated red maples were only significantly shorter in 1984, 41.2% (Table 2).

As noted in Tables 1 and 2, Atrinal is much less effective on red maples than on planes and Norway maples. Tree species may differ in their susceptibilities to particular chemicals, due to uptake, detoxification, and inherent sensitivity differences among species. Species sensitivity to Atrinal treatment may also be dependent on cultivar differences. Theoretically, trees in urban areas are cultivars that have been selected for use in a stressed environment. Hence, a planted tree species may be represented by one or only a few cultivars. In rural areas, on the other hand, roadside trees are the result of natural seeding and growth. Consequently, there may be a greater diversity of genotypes in rural areas than in urban areas.

If the average sprout growth data are compared on a species and community basis (Table 3), it is apparent that Norway maples in Yonkers and

Table 1. Comparison by species of the average sprout growth and standard errors in inches of trees trunk-injected with Atrinal in 1984 versus untreated trees.

	Previous Growth	*1984*	*1985*	*1986*
Plane tree		*		**
Treated	7.1 ±1.2	10.8 ±1.8	22.5 ±3.5	----
Control	7.7 ±2.0	20.9 ±4.8	33.2 ±6.0	----
Red maple				**
Treated	5.4 ±0.5	5.4 ±0.6	17.2 ±1.2	----
Control	4.9 ±0.6	7.1 ±1.1	18.8 ±1.5	----
Norway maple		*	*	*
Treated	6.0 ±0.2	3.6 ±0.3	19.3 ±1.2	23.6 ±2.2
Control	5.8 ±0.3	5.4 ±0.8	23.4 ±2.7	29.9 ±4.0

*significantly different (95% confidence)
**data not available

Table 2. Comparison by species of the longest sprout growth and standard errors in inches of trees trunk-injected with Atrinal in 1984 versus untreated trees.

	1984	*1985*	*1986*
Plane tree	*		**
Treated	22.2 ±4.5	57.1 ±9.0	----
Control	47.9 ±13.2	77.0 ±20.9	----
Red maple	*		**
Treated	11.7 ±1.2	44.4 ±2.2	----
Control	19.9 ±3.7	49.0 ±4.3	----
Norway maple	*	*	*
Treated	8.3 ±1.0	48.4 ±2.4	64.8 ±3.8
Control	11.7 ±1.6	63.3 ±6.0	83.3 ±9.4

*significantly different (95% confidence)
**data not available

White Plains are more resistant to Atrinal treatment than those in New Castle, a more rural area. Norway maples in Yonkers and White Plains may represent only a few cultivars, some of which may be resistant to the effects of Atrinal. Norway maples in New Castle representing a greater diversity of genotypes may be more susceptible to Atrinal's effects collectively.

However, other intercommunity factors could account for the disparity in results. Tree size, urban stress, and the percentage of crown removal were significantly different (95% level) between New Castle and the other communities (Table 4).

No correlation was evident empirically between tree dbh and growth inhibition data. Domir (3) determined that tree canopy size could influence the impact of Atrinal on sprout regrowth: less phytotoxicity, and less growth inhibition was achieved in sycamore seedlings with large versus small canopies. Crown canopy size was not measured during this investigation.

Urban stress could also influence Atrinal inhibition of tree regrowth. Girdling roots and wounding were present on a large number of the study trees in Yonkers and White Plains, while New Castle had virtually none of these urban stress problems. New Castle trees were more typical of a rural area, growing unburdened by sidewalks and set back further from the pavement. Trees with severe urban stress problems were avoided. Injured diseased trees tend to produce more adventitious buds, which sprout, than healthy non-stressed trees. Correlations based on linear regression analysis between stress and relative wound regrowth were much less than 1 suggesting that urban stress was not a determinant of Atrinal effectiveness.

The correlations between crown removal and

Table 3. Average sprout growth and standard errors in inches of Norway maples trunk-injected with Atrinal in 1984 in Yonkers, White Plains, and New Castle, New York.

	1983	*1984*	*1985*	*1986*
Yonkers				**
Treated	6.7 ±0.6	7.3 ±1.1	16.3 ±2.4	----
Control	5.3 ±0.9	6.7 ±1.9	12.8 ±1.9	----
White Plains				**
Treated	5.0 ±0.3	1.2 ±0.1	11.5 ±0.7	----
Control	5.8 ±0.5	1.5 ±0.3	11.4 ±0.9	----
New Castle		*	*	*
Treated	6.6 ±0.2	4.6 ±0.5	27.8 ±2.0	38.4 ±2.8
Control	6.0 ±0.3	8.4 ±1.2	37.5 ±4.0	43.1 ±4.3

*significantly different (95% confidence)
**data not available

Table 4. Difference in dbh, urban stress, and percentage of crown removal between trees growing in Yonkers, White Plains, and New Castle, NY.

Community	*Tree dbh (inches)*	*Urban stress rating[a]*	*Crown removed (%)*
Yonkers	*14.2*	*1.15*	*11*
White Plains	*9.43*	*0.82*	*11*
New Castle	*5.19*	*0.06*	*27*

a—Rating based on cumulative presence of wounds, root girdling, and exposed roots. A rating of 1 would indicate that on average each tree is subject to at least one major stress factor such as wounding, girdling roots, or exposed roots.

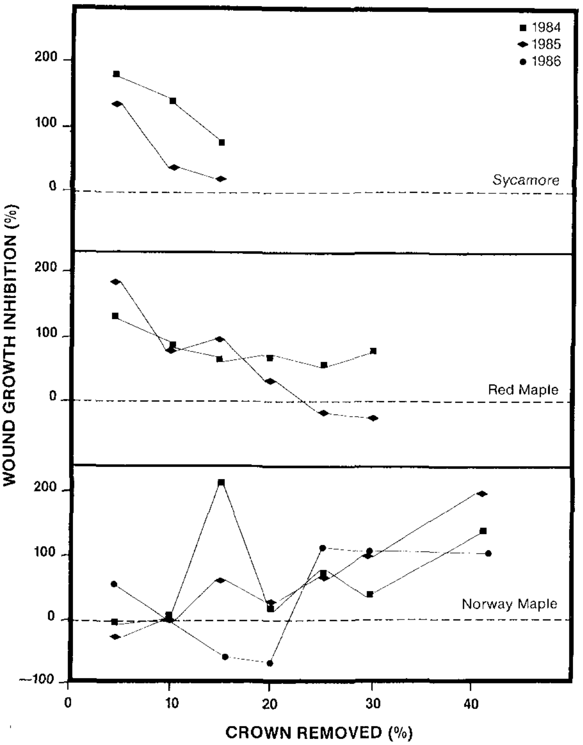

Figure 1. Comparison of percentage of crown removed versus wound growth inhibition for plane tree, red maple, and Norway maple treated with Atrinal in 1984. Wound growth inhibition equals the relative wound regrowth of untreated trees minus that of Atrinal treated trees. Relative wound regrowth was determined by comparing wound regrowth versus sprout growth prior to wounding.

relative wound sprout growth inhibition are depicted in Figure 1. Norway maple wound regrowth is positively correlated with crown removal in the presence of Atrinal, while wound growth of plane tree and red maple are negatively correlated. The negative correlations determined for plane tree and red maple could be due to less Atrinal being translocated in a tree that has been pruned heavily. Consequently, less growth inhibition by Atrinal occurs in severely pruned trees. The positive correlation of Norway maple between crown removal and Atrinal treatment could be a reflection of the greater sensitivity of this species to Atrinal, coupled with the resumption of normal uptake in succeeding years. This is by no means the only interpretation but the analysis indicates that crown removal can significantly alter the effectiveness of Atrinal treatment among different species.

Acknowledgments. We would like to thank Consolidated Edison Company of New York for supporting this investigation, and the able services of Jeanne Triol, Doug Wade, and Ron Lubin of Alpine Environmental Services for their efforts in the collection of data.

Literature Citations

1. Anonymous. 1979. Field manual for injection of chemicals to retard tree regrowth. USDA, ARS, Delaware, Ohio.
2. Domir, S.C. 1978. *Chemical control of tree height.* J.Arboric. 4:145-153.
3. Domir, S.C. 1982. *Influence of canopy size on regrowth of dikegulac-injected American sycamore seedlings* HortScience 17:204-205.
4. Domir, S.C. 1982. New methods and chemicals to control regrowth in trees. EPRI Publication EL-2569, 110p.
5. Domir, S.C. and B.R. Roberts. 1981. *Trunk injection of plant growth regulators to control tree regrowth.* J.Arboric. 7:141-144.
6. Domir, S.C. and B.R. Roberts. 1983. *Tree growth retardation by injection of chemicals.* J. Arboric. 9:217-224.
7. Hield, H., R.M. Sachs, and S. Hemstreet. 1978. *Foliar spray and bark banding with dikegulac for ornamental tree growth inhibition.* HortScience 13:440-442.
8. Roberts, B.R., D.E. Wuertz, G.K. Brown, and W.F. Kwolek. 1979. *Controlling sprout growth in shade trees by trunk injection.* J.Amer.Soc.Hort.Sci. 104:883-887.
9. Sachs, R.M., H. Hield, and J. DeBie. 1975. *Dikegulac:A promising new foliar-applied growth regulator for woody species.* HortScience 10:367-369.
10. Sanderson, K.C., W.C. Martin. 1977. *Effect of dikegulac as a post-shearing shoot-inducing agent on Azaleas, Rhododendron spp.* HortScience 12:337-338.
11. Shu, L-J, and K.C. Sanderson. 1980. *Dikegulac sodium influences shoot growth of greenhouse azaleas.* HortScience 15:813-814.
12. Shu, L-J, K.C. Sanderson, and J.C. Williams. 1981. *Comparison of several chemical pinching agents on greenhouse forcing azaleas, Rhododendron cv.* J.Amer.Soc.Hort.Sci. 106:557-561.

Brooklyn Botanic Garden Research Center
712 Kitchawan Rd.
Ossining, New York 10562
and
Alpine Environmental Services, Inc.
275 Knollwood Road
White Plains, New York 10607

Abstract

ESPOSITO, CHRISTINE. 1987. **A sampling of objectionable or misused ornamentals.** Am. Nurserymen 165(9): 167-172, 174, 176-180, 182, 184-185, 188.

The setting in which people use plants affect the attractiveness, appropriateness, usefulness, and hardiness of a species. The following article is a collection of plant professionals' suggestions of plants nurserymen should use less often, use differently, use elsewhere or avoid altogether. As many of those contributing their opinions pointed out, plant undesirability is certainly in the eye of the beholder. A common problem that results in plant unworthiness is scale incompatibility. Some landscape plants are simply too large for their surroundings. Frequently these plants are evergreens. Not understanding the habits and scales of the plants, people eventually end up needing to remove them.