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USE OF TREE GROWTH REGULATORS AT POTOMAC EDISON[1]

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Abstract. A production tree growth regulator program was initiated at Potomac Edison in July 1986. The decision to implement the program was based on information gathered in a research project. The project results show that injection time is a function of tree species and season of year. Results of injection vary with season of year and tree species.

Potomac Edison is an investor-owned electric utility based in Hagerstown, Maryland, with operations covering 7,200 square miles in parts of Maryland, West Virginia, and Virginia. Potomac Edison, Monongahela Power, and West Penn Power are companies of the Allegheny Power System. Potomac Edison maintains 15,937 miles of line, spends approximately three million dollars annually on tree trimming, and has an estimated tree population of 2.3 million to maintain. It is estimated that 1.5 million trees of this total population are candidates for injection.

History

Potomac Edison first became interested in tree growth regulators through the Electric Power Research Institute's Delaware-Ohio Project. The Company participated in the EPRI Project in the late 1970s. During that time period, small amounts of a gibberellin biosynthesis inhibitor was tried and in the early 1980s another gibberellin inhibitor, paclobutrazol, was used. Both gibberellin biosynthesis inhibitors were found to be effective and showed no phytotoxicity. Effective control without visual impacts convinced Potomac Edison that tree growth regulators (TGRs) had a place in utility tree trimming. However, it was felt that a delivery system acceptable for daily use as part of a trimming operation was not available. This prompted Potomac Edison to request research and development funds for an injection system from our Service Company, the Allegheny Power Service Corporation.

In 1983, a contract for the development of an injection system was awarded to Asplundh Tree Expert Co. The criteria established by Potomac Edison for development of the injection system were:

1. A self-contained unit (not dependent on outside power source.
2. A unit capable of easy transport by one person.
3. A unit of injection in a reasonable period of time.
4. A unit capable of soil injection and direct stem injection.
5. A unit sized to store easily on a tree trimming truck without interfering with the trimming operation.
6. A unit priced in the range of a power saw when in full production.

From the project, an injection system was developed that meets the outlined criteria. In conjunction with the development of the injection system, an extensive data base is being maintained by Environmental Consultants, Inc. It is this data base, cost considerations, and field implementation that I will discuss.

1. Presented at the annual conference of the International Society of Arboriculture in San Antonio in August 1986.

The Injection Process

A battery-powered drill is used to bore holes 3/16" in diameter on a 30-45° angle to the tree surface and 2-2½" deep just above the root flare. Injection holes are placed as close to groundline as possible so that any visual impacts are minimized. Into each hole, an injection probe is inserted to deliver material at 70 psi. The process is entirely enclosed; that is, material passes from the injection system directly into the tree.

Spacing of injection holes and volume delivered per hole is dependent upon tree species. Table 1 shows hole spacing and volume delivered per hole.

Upon completion of the injection process, each hole is sealed with a vinyl plug. This is done to prevent any material from back-flushing out of the hole and causing bark stain. It is also felt that plugging the hole provides a public relations benefit. That is, homeowners prefer to have the holes in their tree plugged. They perceive plugging the hole as necessary to maintaining tree health.

The most important consideration of the injection process is drilling the hole. If the hole is not drilled true round, there is a tendency for material to leak around the interface of the hole and the probe. If the hole is drilled at a greater angle, the material will miss the xylem tissue and uptake will be slow or not take place. If the hole is too shallow, there is a tendency to force material between the bark and xylem which results in bulging of bark and causes tissue damage in the immediate area of the hole. The person drilling the hole must also gauge bark thickness and make adjustments to the angle of entry. On thick-barked trees, the hole must be drilled in a fissure to hit the conducting xylem. Also, stem defects and other obvious injury must be avoided near or above an injection site as injection time will be increased or the material will follow the defect (example: frost cracks) and not reach conductive tissue.

Injection time. A very important aspect of field injection of TGRs is the time required to place the material into the tree. The study provided some interesting information. Injection times were slowest during the cold winter months when trees are frozen and fastest at mid-summer. Table 2 shows the average monthly injection times.

Time also varies with tree species. Generally, ring porous species are the slowest and diffuse porous, the fastest to inject. Table 3 shows a representative sample of tree species and average injection times.

Although we did not collect data on wind velocity, relative humidity, or sunlight intensity, casual

Table 1. Hole spacing and volumes.

	Hole spacing (inch)	*Amount per hole (ml)*
All Species	8	75
Except		
Maples	8	40
Oaks	4	40
Sycamore	4	150

Table 2. Average monthly injection time (All TGR and Species).

Month	*Time (Min.)*
January	30
February	45
March	10
April	12
May	15
June	22
July	7
August	4
September	4
October	9
November	9
December	10

Table 3. Average injection time.

Species	*Minutes*
Catalpa	18.16
Black walnut	9.54
Hackberry	4.91
Mulberry	17.17
Black locust	27.43
Sugar maple	4.47
American elm	9.92
Red maple	12.02
Silver maple	4.47
White ash	28.23
Box-elder	5.75
Sycamore	4.49
Kentucky coffee tree	20.56
Black cherry	4.21
Norway maple	7.32

observations suggest these factors also affect injection time. Generally, as wind velocity, relative humidity, and sunlight intensity increased, injection time decreased.

Data were maintained to determine the relationship between injection time, crown size, and diameter. Table 4 shows that there is no relationship between crown size, diameter, and injection time. Injection times remain fairly constant regardless of crown size and diameter.

The amount of time required to inject a tree versus the amount of time to trim a tree was of concern. It was hoped that the injection process could take place at the time of trimming. However, it is undesirable to have the tree trimming operation slowed by the injection procedure. To evaluate the reasonability of injection time in relation to trim time, arbitrary time intervals were assigned for injection. The classification was: 10 minutes or less—fast injection, 11 minutes to 20 minutes—medium injection, and 21 minutes and over—slow injection. Table 5 shows injection time class and percent of the trees injected. As Table 5 indicates, 83% of the trees injected took less than 20 minutes. Based on this information, the injection time for the majority of trees is well within the time interval required to trim.

Results

After one full growing season, regulated tree growth and control tree growth were measured on the 2,000+ trees for the project. Table 6 shows the percent reduction in growth of regulated trees one growing season after application. Side trimmed trees had greater reductions of sucker growth than did drop crotched trees. However, on both types of trimming, growth was cut in excess of one half normal growth in the first year after application. This is particularly significant since 60% of trimmed tree regrowth occurs in the first growing season after trimming.

The percentage of regrowth reduction varied with the month in which injection took place. For example, a different amount of growth reduction might be expected on a tree injected in February than on a similar species injected in May. Table 7 shows the amount of reduction for all tree species by month.

Table 7 does not show percentage reduction

Table 4. Crown class, diameter, and injection time.

Crown class	*dbh*	*Injection time*	*% of trees*
1 Small	6	18	1
2	8	11	17
3	14	12	64
4	23	13	16
5 Large	31	2	2

Table 5. Percent of all trees by time class.

Time class	*% of trees*
Fast (0-10 min.)	69
Medium (11-20 min.)	14
Slow (21 min.+)	17
	100%

Table 6. Overall percentage changes in growth.

All trees	−59%
Top trims	−54%
Side trims	−64%

Table 7. Percent change in growth by month injected (all species).

Month	*% Change*
January	+11%
February	−50%
March	−62%
April	−25%
May	−68%
June	−60%
July	−30%

Table 8. Percentage change by species.

Catalpa	−78%
Black walnut	−73%
Hackberry	−71%
Mulberry	−68%
Black locust	−66%
Sugar maple	−66%
Elm	−65%
Red maple	−65%
Silver maple	−64%
White ash	−63%
Box-elder	−63%
Sycamore	−60%
Kentucky coffee tree	−47%
Black cherry	−18%
Norway maple	−12%

for August through December. Trees injected after August 1st did not show a significant change in the current year's growth rate. Trees injected in January had an accelerated growth rate of 11%. We do not have an explanation for this.

The amount of growth reduction also varied with tree species. Table 8 shows a representative sample of the 72 different tree species injected.

If Table 3 and Table 8 are compared by species, there does not appear to be a correlation between the degree of control and the rate of regulator uptake. That is, a tree that is slow to take growth regulator is not any more likely to have greater or lesser control than a tree that takes regulator rapidly.

Project trees that were trimmed and had growth

Table 9. Trim cycle savings using tree growth regulators.

Year	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*Average annual cost per tree*
Two year																						
Trim 2 Yr. Cycle	X			X			X			X			X			X			X			$14.11
Trim 2 Yr. Cycle + 3 Yr. Regulate	X						X						X						X			10.43
Trim 2 Yr. Cycle + 4 Yr. Regulate	X							X							X							9.13
Trim 2 Yr. Cycle + 1-3 Yr. Regulate	X				R						X				R						X	9.17
Trim 2 Yr. Cycle + 1-4 Yr. Regulate	X						R					X						X				8.11
Three year																						
Trim 3 Yr. Cycle	X				X				X				X				X				X	11.48
Trim 3 Yrs. Growth + 3 Yrs. Regulation	X							X							X							9.13
Trim 3 Yrs. Growth + 4 Yrs. Regulation	X								X								X					8.63
Trim 3 Yrs. Growth + 1-3 Yrs. Regulation	X				R							X				R						8.38
Trim 3 Yrs. Growth + 1-4 Yrs. Regulation	X					R								X					R			7.79
Four year																						
4 Yr. Trim Cycle	X					X					X					X					X	9.73
4 Yr. Trim Cycle + 3 Yrs. Regulation	X								X								X					8.64
4 Yr. Trim Cycle + 4 Yrs. Regulation	X									X									X			8.22
4 Yr. Trim Cycle + 1-3 Yrs. Regulation	X				R								X				R					7.69
4 Yr. Trim Cycle + 1-4 Yrs. Regulation	X					R									X					R		7.29

regulator applied prior to the inception of spring growth did not respond to the regulator immediately upon initiation of the season's growth. That is, early spring growth started at the normal rate and slowed later in the growing season. Evidence of growth deceleration as the season progresses is pronounced when the distance between internodes is compared over the growing season. Initial reaction to this is negative. However, there is some benefit to having the tree start normal growth and then slow down. By putting growth on the tree in early spring, a normal appearance is achieved before growth regulation starts. That is, the thin look of a newly trimmed tree does not exist over the length of growth regulation. This is a definite benefit in gaining public acceptance of tree growth regulators in utility trimming. On a limited number of trees with three growing seasons of growth regulation, we found that the initial surge of spring growth that occurs in the first growing season does not take place in the second and third year following regulation. Thus, the project trees can be expected to have even greater reductions in the second and third year.

Cost Considerations

Preliminary work at Potomac Edison suggests that we will get a minimum of three years' control from growth regulators. Work in other parts of the country indicates that four years' control is a possibility. Using three and four years' control, 12% guiding rate of interest, and a 20-year period, various possibilities of trimming and regulation were discounted to present value on an average annual cost per tree basis. Table 9 shows the present worth values for two through four year trimming cycles under various conditions. Where an (R) is shown in the chart, it was assumed the tree would be reregulated prior to the effects of the growth regulator ending. An (X) means a tree was trimmed and regulated. As Table 9 indicates, the greatest savings under any conditions are on the two-year trim cycle. The minimum savings is $3.68 per tree and a maximum savings is $6.00 per tree, dependent on the assumption. The minimum savings is on a four-year trim cycle ($1.09 to $2.44 per tree). The average annual cost savings per tree is significant if one considers that Potomac Edison trims about 200,000 trees per year which could be regulated.

There is considerable discussion in the electric utility industry concerning the most cost effective means of injecting trees. Some feel that a specialized injection crew should be used, while others feel that the injection equipment should be put with a trimming crew and injection take place at the time of trimming. One of the criteria in the design and development of the injection equipment was that it had to be sized to fit in a tree trimming truck and in the price range of a chain saw. That objective was accomplished. Potomac Edison believes the least-cost method to inject trees is to have the equipment with the tree trimming crew and inject at the time of trimming. On Potomac Edison property, the cost per tree to regulate with a specialized crew is approximately $3.84, excluding plant growth regulator. The cost per tree to inject with a trimming crew is $.30 per tree, excluding materials. At this difference in cost, 13 tree trimming crews can be equipped with injection equipment for the cost of one specialized injection crew.

Program Implementation

The success of the growth regulator program will undoubtedly be dependent on the individual contract crew's enthusiasm and commitment to inject each tree trimmed. To start the program off successfully, each contract foreman who was expected to do tree injection was given a one-day training session. Representatives of the growth regulator company and the equipment company were present to conduct the training. Classroom discussion included characteristics of tree growth regulators, mode of action, toxicology, use precautions, public relations, equipment operation and maintenance, and injection techniques.

The field work consisted of hands-on training with emphasis on proper hole drilling, injection techniques, bole defect identification, bark thickness considerations, and hole plugging.

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