A COMPARISON OF THREE DIFFERENT TRUNK INJECTION SYSTEMS FOR USE WITH PLANT GROWTH REGULATORS

by A.D. Fuchs

Abstract. The development of Plant Growth Regulators and various trunk injection systems with which to introduce the chemicals into the trees has given the Utility Arborist another tool to use in their vegetation management programs. This report compares the efficiency of three different injection systems used under actual field conditions and alternate crew labor assignments. A discussion of actual test results, as well as methodology, potential problems, and specific characteristics of the injection systems will also be presented in this report.

In recent years the use of Plant Growth Regulators (PGR) has been considered by electrical utilities as a means of reducing the cost of right-of-way maintenance (1, 2, 3, 4). PGRs may extend the trimming cycle for most trees by 2 to 3 years, resulting in substantial savings (2). Research has demonstrated the effectiveness of these compounds in inhibiting tree growth, however, the cost effectiveness of these materials can only be realized if the product is delivered into the trees efficiently.

Researchers from Puget Sound Power & Light Company conducted an evaluation of trunk injection equipment comparing three different tree injector systems: 1) Stallion 75, TIS Enterprises; 2) APM Injector, Wilber-Ellis; 3) 6-point injector, Arborchem. The trial was held in order to assess the positive and negative characteristics of the injection systems under actual field conditions as well as to determine time efficiency in the field. The results of these field trials will assist managers in deciding which system is the most economical with which to equip their injection and/or tree trimming crews.

Materials

The Plant Growth Regulator used in the study was Chevron's XE-1019 (Prunit) in a 20 g/l isopropanol solution.

Three injector systems were used. The Stallion 75 system consisted of 24 portable injection tubes, which treat one hole each. These tubes are filled with the specified volume per hole of growth regulator from a pressurized bulk loader. The tubes are then pressurized to 40-50 lbs. using a small, battery operated compressor. A tree-specific number of holes were drilled (7/32 inch) using a portable drill with rechargeable battery packs.

The APM injector is a large, hand crank syringe which holds 470 ml of growth regulator. The injector is loaded through a removable hose connected to the side of the injector and leads to product container. To load the injector the handle is cranked counterclockwise. To inject, the handle is cranked clockwise. Dose is controlled by the number of cranks, and pressure can be regulated by speed of cranking. Spring-loaded "grenades" similar to the Stallion 75 tubes can be filled from the injector and used to inject holes. This system also used a portable drill with rechargeable batteries.

The Arborchem 6 point injector is a suitcase sized box with 6 injector ports, each at the end of a 5 ft hose. The box contains a large reservoir for holding the growth regulator, and six smaller chambers attached to each of the hoses. Each chamber is filled with the specified amount of growth regulator from the reservoir by opening and closing valves for each chamber. The chambers are then pressurized from a CO_2 tank which is also in the box and operated by turning valves. The injector ports at the end of each hose are then placed in the holes drilled in the trees and the valves opened. When full the Arborchem injector weighs 40 to 50 lbs. This system used a portable gasoline powered drill.

Methods

Two study areas in Eastern Washington State, Kittitas and Badger Pocket, were used in the May 5-6, 1987, injection trial. Kittitas, a small town east of Ellensburg, is characterized as having many species of ornamentals and few native trees while Badger Pocket, a rural farming area south of Kittitas, has many more native trees and windbreak species.

All of the deciduous trees in the study areas that had been recently trimmed from under power lines were located and suitable injection candidates chosen. Conifers were not treated. The diameters of the trees ranged from 4 inches for Black Locust, *(Robinia pseudoacacia)* to 60 inches for Pacific Willow (Salix lasiandra). The trees the Stallion 75 team treated averaged 19.47 inches in diameter, while the Arborchem and APM teams treated trees averaging 18.5 and 17.6 inches in diameter, respectively. All trees had fully developed leaves at the time of the trial. The various species and sizes of trees were formed into three similar groups (comparable numbers of same species and diameters). Each injector system was assigned to treat a group of 60 trees. All preparations including property owner contact were previously addressed.

The teams running the injecting equipment used stop watches to determine the total time on the job which included travel time between injection sites, equipment set-up time, and injection time. The teams were provided with a previously calculated dosage rate (milliliters/hole) and hole spacing for each species of tree (Table 1).

The relative efficiency of alternate crew labor assignments was also an important consideration. In Badger Pocket, the teams had one man working and one recording the time, while in Kittitas, the teams had two men working.

Table 1. Injector spacing and volume per hole

Species	*Injector spacing (inches)*	*Volume/ hole (ml)*
Salix lasiandra	6	75
Salix babylonica	4	75
Populus nigra	6	50
Populus alba	6	50
Populus trichocarpa	6	50
Populus tremuloides	6	50
Ulmus pumila	8	75
Acer negundo	6	50
Acer rubrum	6	50
Acer saccharinum	6	50
Acer saccharum	6	50
Acer macrophyllum	6	50
Betula papyrifera	6	50
Robinia pseudoacacia	6	50
Fraxinus sp.	6	75
Elaeagnus angustifolia	6	50
Catalpa speciosa	6	50

Results

The three groups of trees in the study were arranged in an attempt to make each group of assigned trees very nearly equal in work requirements. Consideration was given to assure similarity in proximity of trees, species that absorbed the growth regulator faster than others, trees requiring fewer holes and quantity of product, and "easy" and "hard" trees to inject. However, some major group differences were identified (Tables 2 and 3). Much of the data variance between groups was due to individual injection team problems and techniques, with the rest attributed to inherent differences between the injector systems.

The Arborchem team treated 59 trees during the trial, while the APM and Stallion 75 teams treated 58 trees each (Table 2). The five trees deleted from the trial were inaccessible during the trial.

Set-up time was very different for the three teams (Table 2). The Arborchem injector was fairly easy and quick to load, while the two other injectors took much more time to load. The Stallion 75 took much longer to set up when one man was

Table 2. Productivity of injection systems, reported in crew minutes per tree

Injector System	*# of trees*	*Time/tree*		
		Set-up[1]	*Injection*[2]	*Total*[3]
One-Man				
Arborchem	35	0.2	7.5	7.8
APM	35	0.6	7.9	8.5
Stallion 75	33	2.4	8.4	10.8
Two-man				
Arborchem	24	0.1	7.2	7.4
APM	23	0.6	13.9	14.5
Stallion 75	25	0.7	7.0	7.7

1. Includes all activities performed from arrival at site to start of injecting, e.g. loading the injector
2. Time from injecting the first tree at a site to finishing the last tree at the site
3. Set-up and injection time totaled

working (2.4 min/tree) because he had to load the injection tubes before treating the trees. Set-up time was much faster with a two-man team (0.7 min/tree), because one man was constantly filling tubes while the other injected.

The time spent injecting the trees was very similar, with the exception of the two-man APM team in Kittitas (Table 2). They had a problem with their drills losing power and also had a Northern catalpa *(Catalpa speciosa)* that did not accept the growth regulator very quickly (41 minutes, 15 holes treated). The Arborchem injector was the most efficient when operated by one man (7.5 min/tree), while the Stallion 75 was the most efficient with a two-man team (7.0 min/tree).

The total treatment time per tree for the Arborchem injector decreased slightly from 7.8 minutes per tree for a one-man team to 7.4 minutes per tree for a two-man team. The Stallion 75 injector displayed a more dramatic decrease in total treatment time per tree between one-man (10.8 min/tree) and two-man (7.7 min/tree) teams. The APM injector's two-man team had problems with their drills (14.5 min/tree), but the injector was fairly efficient when used by a one-man team (8.5 min/tree).

The average number of holes treated per tree was similar for the Arborchem and APM teams, while the Stallion 75 teams treated far fewer holes per tree (Table 3). This discrepancy came about because the Arborchem and APM teams were not directed to skip the holes that were drilled into dead and/or decaying wood. The extra holes that the Stallion 75 team drilled that they chose not to inject (especially with the one-man team in Badger Pocket) added to their injection time without getting credit for treating the holes, thereby increasing their treatment time per tree.

Table 3. Treatment data

Injector system	No. trees	Holes /tree	Time[1]/ Hole (min.)	Trees/ hour
One-Man				
Arborchem	35	9.6	0.8	7.7
APM	35	8.9	0.9	7.0
Stallion 75	33	6.9	1.6	5.6
Two-Man				
Arborchem	24	9.0	0.8	8.1
APM	23	9.7	1.5	4.1
Stallion 75	25	7.7	1.0	7.8

1. Includes set-up and injection time

The average treatment time per hole treated varied widely for the three teams. The Stallion 75 injector was much more efficient when used by a two-man team (1.0 min/hole) than with only one man working (1.6 min/hole). The two-man team had one man loading injection tubes while the other man treated the trees, consequently they could treat trees constantly without stopping to reload. The Arborchem injector was efficient with both one-man (0.8 min/hole) and two-man (0.8 min/hole) teams. The reason the one-man team was faster than the two-man team was probably due to greater work effort by the one-man team on the first day of the trial. The APM injector was efficient with a one-man team (0.9 min/hole) but was inefficient with a two-man team (1.5 min/tree), due to their previously stated problems.

The Arborchem injector treated 7.7 trees per hour with a one-man team while the APM and Stallion 75 injectors treated 7.0 and 5.6 trees per hour, respectively. Two-man teams increased the productivity of the Arborchem (8.1 trees/hour) and the Stallion 75 (7.8 trees/hour) injectors. The APM injector probably would have been more productive (4.1 trees/hour) if their drills had been working properly.

Discussion

The Kittitas and Badger Pocket injection trial provided useful data on the cost effectiveness, logistics, and problems that one might expect from a growth regulator program. During the trial the teams as a whole treated 175 trees averaging 18.5 inches in diameter and 578.2 milliliters of growth retardant per tree.

The teams worked an average of 9.1 hours each and treated an average of 6.7 trees per hour per team, excluding travel time between sites.

It is important to note that the data in the trial do not include the time needed to locate the candidate trees, acquire premission to treat from the property owner, travel time between sites during treatment, or cleaning and maintenance of equipment. Other factors not addressed that may affect treatment time are ease of access to the trees, weather and time of year, and condition of the trees.

When outfitting a crew with injecting equipment one of the most important things to consider is the type of drill to be used. A fast, dependable drill can reduce down time and increase productivity. In Kittitas, the APM team lost a significant amount of time due to problems with the battery packs to their drills, while the Arborchem team may have had an advantage over the other teams because they used a high torque gasoline powered drill. Also, the cleaner the hole that the drill bit cuts, the faster the product is delivered into the tree. Cleanly cut holes also result in fewer clogged injectors.

One source of potential bias with the data is the fact that the teams running the injection equipment were either representatives of the companies that produce the equipment or people that were accustomed to a certain type of injector. The idea was to have teams that were familiar with the different types of equipment doing the injecting. The competition between teams trying to demonstrate the advantages of their particular injector equipment may have resulted in an overstatement of the speed with which a normal crew might be expected to work. The net result was that some bias in the time of treatment categories may be present in the data. In addition, the tests were run for only 2 days so fatigue was not a factor. Overall, the data are representative of what may be expected of efficient injection crews.

Each of the three injection systems has advantages and disadvantages when used in specific situations. The Arborchem injector system was the most efficient in the time categories, treating more trees per hour. This system took less time to set up and inject the trees, and is a self-contained unit with a minimum number of moving parts. Some of the drawbacks to the Arborchem injector are its weight and bulk. Maneuvering the injector from tree to tree was fairly easy when the ground was level and there were no obstructions, but it could become difficult to use on a brushy slope or in an intensively landscaped area. Also, the fact that the hoses can only extend 5 feet from the case limits the range of the injecting, making it impossible to treat more than one tree at a time unless they are very close to each other. The injector must stay with a tree until all of the holes are treated. In general, the Arborchem injector is heavy and has a limited injecting range; however, it is fast, easy to use, and is self-contained, making it easy to store.

The APM injector needed less time to set up than the Stallion 75 system. The major advantage of the APM injector is that the worker can regulate the pressure in the injector by the speed he cranks the injector's handle. This means that the worker can maximize the rate of uptake of PGR in the hole he is treating without losing any of the PGR via "bark blow-out", which is caused by excessive pressure. Also, if a tree is absorbing the PGR rapidly, the injector can be cranked faster and the hole will be treated more quickly. This system also has spring-loaded "grenades" that can be loaded by the crank injector and will treat one hole on each refill. These grenades were useful when the tree is taking in the PGR slowly, because more than one hole could be treated at one time. This injector system is also compact and has few parts to it, however, there are disadvantages. The injector (without the use of grenades) can only treat one hole at a time. The grenades help on slow trees, but they must be filled with the crank before they are used. Also, the worker may become fatigued after a few hours of cranking, and there must be no obstructions to the handle while cranking. Aside from these drawbacks, and as long as the trees accept the PGR readily, the APM injector can treat holes quickly with no bark blow-outs and is small enough to transport easily.

The Stallion 75 injector system with a two-man team had the fastest injection time per tree. The primary advantage of the Stallion 75 is that many holes can be treated at one time, even on trees that are a considerable distance apart. The trees can be treated rapidly once the injector tubes are filled, because the tubes can be left in the holes after their valves are turned on, enabling the worker to go on to the next hole and eventually the next tree. If a certain tree is taking the PGR slowly the worker can leave the tubes in the tree and start another tree. The injector tubes can also be used to treat trees that have difficult access and/or have little working room because of their compact size. This system is limited in that each injector must be refilled after treating a single hole.

This can take a considerable amount of time and patience. Also, the system has many parts to it: a bulk loader to fill the tubes with the PGR, a small air compressor, and 24 injector tubes. These components occupy much more space than the other injector systems, however, only the injector tubes need be carried to the trees.

Certain situations may give one injection system an advantage over the others. With one man crews the APM and Arborchem injectors have an advantage over the Stallion 75, while two man crews may favor the Stallion 75 over the others. The APM injector with a one-man crew might be the system of choice when the trees are spaced far apart, while the Arborchem could be the best when the trees are close together. If access to the trees is difficult, the APM and Stallion 75 injectors may be better then the Arborchem, while the Arborchem may be best in a park or along city streets where access is very easy. In general, all three of the injector systems are effective when treating trees with Plant Growth Regulators.

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Environmental Sciences
Puget Sound Power & Light Co.
P.O. Box 97034
Bellvue, Washington 98009

Abstract

HARDER, F.K. 1987. **Can a landscaping business survive if it halts pesticide spraying?** Am. Nurseryman 166(4): 57-58, 60.

Like hard core chain smokers going cold turkey after a lifetime with the habit, we at Harder Landscape Contractors, Inc. said "no" to spraying pesticides. But we did have some anxiety and misgivings. Two years later, we have no remorse of loss—only the conviction that our company did right by our customers and our business. The decision was hardly arbitrary. For more than four decades, our family-owned company successfully applied pesticides. Without passing judgement on the safety claims made for modern pesticides, I began to share an uneasiness with a growing number of dissenters in the industry. More to the point, pesticides have become synonymous with poison in the public's opinion. The decision to spray or not to spray could affect our financial future. Since we have decided to eliminate pesticides, we reduce the opportunities for pest infestation by buying only top quality nursery stock. Before installing any vegetation, we send soil samples to agronomists for analysis. We also consider air quality when making plant selections. For maintenance operations, we program an intensive schedule of preventive tree care. Pruning, feeding and watering nuture growth. Sure, we were mildly hurt by the loss of our pesticide profit center. But, spraying only brought in about 5% of our gross volume.