

DAVEY HORTICULTURAL INSTITUTE RESEARCH¹

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The Davey Horticultural Institute personnel provide to the district managers technical service regarding insects, diseases, cultural and environmental problems. It is also our responsibility to investigate, research and evaluate new chemicals, procedures and techniques. In this manner we help with decisions on which new methods and materials should be incorporated into use, to perform a better service to our clients, or to make the job safer, more effective and efficient.

One of our major efforts this season has been to investigate the uptake and distribution of Arbotect. This, as you know, is Merck's EPA-approved product used as an aid in Dutch elm disease control.

This study was undertaken because of a general lack of information in print on this subject and the desire on our part to obtain firsthand knowledge about the advantages, disadvantages and technical problems that might be associated with currently-used injection practices as well as those that might occur with reduction in injector sizes.

Two major ideas that have been voiced at either Dutch elm disease or Shade Tree meetings precipitated our tests. The first was mentioned by Dr. Dick Campana, a respected researcher on the Dutch elm disease, that there is 50% chemical distribution in the crown of an elm injected to prevent or control Dutch elm disease. This seems to be a low figure, based on the number of elms that apparently are being treated with success. The second, by Dr. Alex Shigo, a well-known researcher, indicates that the wound made by our injection sets should be as small as possible.

In order to determine the effect of the size of the injection hole on uptake time and chemical distribution in the crown, a comparison was made using the different sizes of 7/16", 5/16", 4/16" and 3/16".

Experimental design

After extensive search for a suitable test site with large numbers of elms, we were fortunate to have the enthusiastic cooperation of the service director and the city forester of Shaker Heights, Ohio.

We assumed that a gravity-fed, individual-hole injection system might produce a better distribution in the crown because of slower uptake. A sap saver, currently used in the maple sap industry, and an enema bag were found suitable for our gravity injection system.

Thirty elms were treated with Arbotect, either by gravity or by pressure feeding system, using 3/16", 4/16", 5/16" and 7/16" injectors. The chemical was pressure injected by using the Smith Combo-Spray tank at 30 psi. The elms, ranging from 16 to 30 inches in diameter at breast height (dbh), averaged 20 inches. Treatments were started on June 15, the first date the elms were readily accepting the mix, and the last treatment was made on July 8. There were three randomly selected replicates for each treatment. Holes were drilled at six-inch intervals in the root flare area and injected with Arbotect 20-S at the therapy rate of four fluid ounces Arbotect per 160 ounces water for each five inches in trunk diameter.

Phase I — Chemical uptake time studies.

In this test, chemical uptake time was evaluated for: 1) gravity vs. gang pressure injection, 2) pressure injection comparing individual hole to gang injection, 3) variations in uptake due to changes in injector size, and 4) individual tree variability using a standardized hole and gang pressure.

Gravity vs. gang pressure. The gravity-fed system was 10 to 12 times slower than the gang pressure system, and we conclude that the gravity system is too time-consuming for practical use.

¹Presented at the annual conference of the International Society of Arboriculture in Toronto, Ontario, Canada in August 1978.

Table 1. Average uptake time for injecting one quart of chemical.

Hole Size	Gravity	Gang Pressure
3/16"	3.7 hrs.	21 min.
7/16"	2.5 hrs.	12 min.

Individual hole pressure treatment vs. gang pressure. The individual hole system took 60 per cent longer than the gang system to set up and administer.

Hole size vs. uptake. As one might expect, the larger the hole, the faster the uptake. With individual hole pressure treatments, using the small 3/16" injector, uptake for one quart of chemical averaged one hour, while it averaged only seven minutes per quart when using the large 7/16" injector. Uptake with the large injector was 8.5 times faster. The fact that the area of the large hole is 5.4 times greater than the small hole, plus the 30 lbs. of pressure on the liquid, accounts for this time difference.

Tree variability. Just as there is a wide natural variability between trees in a species, there is also a wide variability in uptake time in different trees and in different holes in a tree, using the same size injector. For example, using the 7/16" injector and gang pressure, the range was from 8 to 10 minutes per quart of material injected.

Phase II — Chemical distribution in the tree crown

The objective of this phase was to determine the pattern of distribution of Arbotect in the tree crown.

Sampling. After allowing three to five weeks for chemical distribution, twig samples were collected on July 21 and 24, with the assistance of a Shaker Heights bucket truck crew.

Each tree crown was divided into three levels — top, middle and bottom — and visually quartered. Thus each tree had 12 sections. Two twigs from each section, or 24 samples per tree, were randomly selected. These twigs were five inches long and approximately a half inch in diameter. Samples, placed in plastic bags, identified as to tree, level and sector, were returned to the lab and refrigerated.

Bioassay. *Penicillium expansum* was used as the test organism; and a special thanks goes to

Dr. Jay Stipes of Virginia Polytechnic Institute for supplying the culture and for the method that he has used for detecting the presence of Arbotect in American elm wood.

P. expansum was selected for the test because of its rapid growth as well as its being inhibited by the presence of as little as one part per million of the Arbotect.

Two ¼"-length discs were cut from the middle of each of the 24 twigs, resulting in 48 discs per trees. One disc from each twig was used for top dip and the other for bottom dip into a *P. expansum* spore suspension. With bottom dip, the fungus would probably be screened by any chemical in the disc; with top dip, the fungus would be subjected to chemical on the surface only.

Bioassay Results

A. Bottom dip vs. top dip. There was a statistically significant difference in the total area of surface covered with growth of *P. expansum* between the discs given the top dip vs. those given the bottom dip. The average bottom drench disc had a smaller percentage of the disc covered with fungus (70%) than the mean top disc (77%). Thus, the more critical bottom dip bioassay method would be preferred for any future tests.

B. Twig 1 vs. twig 2. As one might expect, there was no significant difference found in chemical distribution and fungus growth when the bottom drench data were used to compare the randomly selected Twig 1 and Twig 2 from a sector in an elm.

C. Distribution of the chemical between crown levels. No significant difference was found in chemical distribution between levels — top, middle and bottom.

D. Shade vs. sunny side. An examination of *P. expansum* growth on 960 elm discs from 20 elms showed no significant difference between the samples taken from the street side, which was the shady side, vs. the residence side with more exposure to the sun.

E. Hole size and its effect on distribution. When comparing hole size (3/16" and 7/16") and its effect on distribution of Arbotect, there was no significant difference in either the percent of discs

showing inhibition in the outer annual rings or the percent of surface area of the discs showing growth inhibition regardless of the method of injection.

F. *Individual pressure vs. gang pressure systems.* Last November, at the Dutch Elm Disease Symposium at Washington, D.C., we reported differences in uptake time for a standard quantity of chemical to go into different injection holes in an elm using the one size injector. From the above study, it seemed that individual hole injections with the required amount of chemical might give better distribution in the crown.

In our present study we found that the gang-pressure system (commonly used in the field) provided a significantly higher percentage of discs with fungus inhibition and a corresponding larger area of disc protected. Significance was the .05 level.

Size (in.)	% of discs showing inhibition			% surface area of discs showing inhibition		
	Pressure			Pressure		
	Gravity	Ind.	Gang	Gravity	Ind.	Gang
3/16	56	33	60	22	9	11
7/16	57	56	72	20	15	25

G. *Chemical distribution in trees.* In an examination of 960 discs representing the 20 elms sampled, we found that 60% showed inhibition of fungus growth in the last several annual rings. Thus 60% of all branches contained sufficient chemical to inhibit *P. expansum*. There was a great variability in chemical distribution between trees, ranging from 12% to 92%.

Summary

1) The larger the hole size, the faster the uptake and the better the distribution.

2) The gang method with pressure injection is preferred to either gravity or individual hole systems because of faster uptake and better distribution.

3) In bioassay with *Penicillium expansum*, the bottom dip method was demonstrated to be more selective than top dip.

4) No differences in chemical distribution were noted between crown levels or the sunny side vs. the shady side of the tree.

5) The 4-ounce rate of Arbotect 20-S per five inches DBH was injected per tree, and chemical was detected in 60 percent of the twigs sampled.

6) The data suggest a correlation between uptake time and chemical distribution in the tree crown, with faster uptake resulting in better distribution.

7) The 7/16" injector provided better distribution and a greater portion of the twig was protected, with less variability.

8) The 3/16" injector produced a wider variability, possibly due to ease of plugging the injector opening, resulting in slower uptake and poorer distribution.

9) In our opinion, the size of the larger wound may not be as detrimental as the beneficial effects derived.

10) The injection method adopted in this study should be very valuable in treatment of the Dutch elm disease as well as the treatment of many other tree problems including insect, disease or nutrient deficiencies.

Two other investigations of an entirely different nature than Dutch elm disease were also run this summer. These were the cholinesterase (plasma and red blood cell) tests on selected spray foremen, and a sex-pheromone trap test for insects.

Cholinesterase test. For the past several years we have seen articles in trade journals and extension service publications advising those who spray with organic phosphate chemicals to have blood tests made to determine their cholinesterase level. Because of this and a desire to know whether some symptomless effect was taking place, a decision was made to conduct a study.

Ten men from those territories producing the greatest spray volume were asked to participate. The area involved spread from Illinois to New York.

Three blood sampling periods were selected — the first, to be taken before any organic phosphate sprays were applied in the spring; the second, about July, the middle of the spray season; and the third, in mid- to late August or just before the end of the normal spray season.

Blood samples were collected by Physical

Measurements, Inc., a national company. Rather than having blood checked at local laboratories and taking the chance of having different procedural tests conducted, the drawn blood was mailed to one laboratory. This permitted a better evaluation.

Most of the men tested average 200 to 300 hours of spray time between the initial and the second blood check.

The organic phosphates they used were malathion, diazinon and dimethoate.

In comparing the results of the second test with the initial observations, no abnormalities showed up in the laboratory test. The rating for each man was in the normal range, for both the plasma and the red blood cell test.

The results of this pilot test will help guide our safety department as to the future need for company-wide blood tests for all our spray foremen.

Pheromone tests. It is a well-known fact that timing of an insecticide application is very important and that insect feeding and complaints occur if the applications are made too soon or too late.

This past season you may have read about sex pheromone traps for controlling clearwing moths. Articles appeared in *American Nurserymen* and *Grounds Maintenance* magazines.

In June of this year, an evaluation of the Clearwing Borer Trap Kit from the Conrel Company in Needham Heights, Massachusetts, was started.

This year we were late in obtaining the two traps that come in the kit and did not hang them out until June 19.

Assembling the traps was a real experience, not because they are complicated to assemble, but because during the 10- to 15-minute period that pictures were being taken of the steps involved, a half dozen male lilac borer (ash borer) moths were attracted to the trap.

Traps were placed on trees approximately three miles apart in Kent. In fact, one was hung on a maple branch on my property for ease of monitoring.

The traps were generally collected every other day. The first collection turned out to be the maximum for both traps during the season. During that two-day period, one trap caught 80 lilac borers

and the other had 37.

From June 19 to August 11, a total of 522 lilac borers, 143 rhododendron borers, 19 lesser peach tree borers and 10 peach tree borers were caught in the two traps.

What will the monitoring traps do for us? They will permit us to learn the earliest spring appearance of each species attracted by the pheromone so that more accurate timing of spray applications can be made.

Discussions with Dr. Dave Nielsen, a noted researcher in this field, at the Ohio Agricultural Research and Development Center, indicates that we have a 10-day period after first catching a species to apply the proper spray. It takes this long for the eggs to hatch and the larvae to start boring into the plant.

Most borer sprays are reported to have a residual of approximately three weeks. By cleaning the moths off the traps and continuing to check the traps for new catches, you can determine whether a second spray is needed.

It is interesting to note that several of the borers mentioned as being attracted by the pheromone were not caught. One of these is the oak borer which has been reported to occur only during the odd-numbered years, so they can be expected in 1979.

The number of borers in one location was almost double the number caught in another location three miles across town. The least number was in an area which had been planted within the past 20 years where the plant materials are young and vigorous. The other site was in a wooded residential area containing mature trees which would have a greater potential for infestation.

Based on the information obtained from this monitoring, we will continue to conduct this field test in several of our sales territories to help our managers to know when to spray, where to spray, and which tree species need borer-protection sprays.

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