objective of the study reported here was to demonstrate a technique of application and an amount of properly diluted chemical (dosage rate) which together will have the following attributes: (1) Maximum distribution of the chemical to all susceptible parts of the tree; (2) Optimal migration of the chemical into new apical and radial wood; (3) Effectiveness as a curve for mature American elms which are in an early state of infection by the Dutch elm disease fungus, **Ceratocystis ulmi**.

The overall objective is to provide the users of these systemic fungicides with dependable information on how to best use them.

EXPERIMENTATION Three injection techniques, trunk, ground level and exposed root flare, and a range of dosage rates were tested in various combinations on groups of healthy, mature, even-aged American elms. Label rates as well as rates exceeding those suggested on the label were evaluated. Most of the trees injected are located on the Minnesota State Fairgrounds and have an average DBH (diameter at 4.5 feet above the ground) of 22.3 inches.

To assess the distribution and relative strength of the treatments being tested, a sampling bioassay technique was used to detect and determine the percent distribution of the chemical in the crowns of the treated trees. There were five trees in each group and 16 samples from each tree for a total of 80 samples for each treatment.

The bioassay technique consisted of placing small sections of the branch samples on agar plates which had been covered with spores of **Ceratocystis ulmi** (Smalley, 1973.) The development of the fungus on the branch sections was a relative measure of the amount of chemical present in that part of the tree.

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Between June and September, 1976, 11 naturally infected American elms were treated with TBZ at the triple therapy rate. Percent foliar symptoms of Dutch elm disease in the crowns of these trees at the time of injection varied between 5 and 15 percent. Six of the trees were injected at ground level and five were infected through exposed root flares. In most cases, the branches with symptoms of the disease were removed about two weeks after injection, but no effort was made to remove all of the infected branches if they were not wilting.

RESULTS. The bioassays indicated that three high dose, exposed root flare injection treatments, one MBC-P treatment and two TBZ treatments, provided detectable quantities of the fungicide to practically all parts of the treated trees

Some data not reported here, as well as work by others, indicate that MBC-P does not remain in the tree very long, regardless of the dosage used. It will not protect the tree the year following treatment. Bioassays in 1978 of trees injected in 1977 will undoubtedly confirm this conclusion.

The two highest TBZ dosages rates (2 x Th. and 3 x Th.) can provide detectable fungicide activity to the most recent annual ring at least into a second growing season. The double therapy rate (2 x Th.) will result in detectable amounts of chemical more than a year after treatment, but the fungicide will not be as well distributed or at levels as high as with the triple therapy rate. Repeated bioassays during the 1977 growing season indicated that the general quality of the triple therapy rate (3 x Th.), measured in terms of percent distribution and relative levels of activity, will remain relatively high throughout the second growing season. If the apparent trend continues, appreciable chemical activity may extend into a third growing season after injection. Bioassays in 1978 will determine whether or not these trends are confirmed.

During the 1977 growing season, 2 of 11 diseased elms treated therapeutically with TBZ in 1976 died, and one developed symptoms in one additional branch. Symptoms of Dutch elm disease did not reappear in any of the other eight trees. The only trees which wilted completely or developed new symptoms of Dutch elm disease had been injected at ground level and all five of the trees that were injected through exposed root flares survived through the 1977 growing season without retreatment or recurrence of symptoms. On the basis of bioassay and cultural examinations of the trees that died, **incomplete** and **uneven** chemical distribution was the most probable reason for the failure of the fungicide to save them. Even these elms may have survived if the exposed root flare injection technique had been used.

SUMMARY: Most effective injection technique: **EXPOSED ROOT FLARE.** Most promising chemical: **"Arbotect" 20-S.** Most promising dosage rate: **3 x MAXIMUM THERAPY LABEL RATE.** Chemical concentration: **3000 PPM** (1.92 fluid oz. Arbotect/gallon of solution). Rate of application: **1.25 gallons of solution/inch DBH.**

Although our research results are incomplete and some important questions remain unanswered, we can draw some preliminary conclusions on the basis of what we do know. The data from those treatments avaluated all seem to indicate that exposed root flare injection of "Arbotect" 20-S at the triple Therapy rate will provide the most fungicide for the longest time and will probably yield the most satisfactory results. Interpretation of the data is tentative because the exact relationship between bioassay results and actual resistance to infection in the tree has not been established. Specific conclusions about the significance of bioassay results will be possible only after artificial inoculation-bioassay experiments have been completed.

To consistently effect a cure for established Dutch elm disease infections in mature elms, **all parts** of the diseased tree must receive **enough chemical** to both suppress and inactivate the fungus and subsequently proyide the tree with the opportunity it needs to compartmentalize the infection and leave it buried harmlessly in new wood. Exposed root flare injection appears to be the only practical method of attaining satisfactory chemical distribution. There is also some evidence to indicate that the resulting injury to the tree will be less severe and the wounds will close more quickly than wound in the main stem.

Our research results are corroborating some reports from the University of Wisconsin which indicate that TBZ, the active ingredient in "Arbotect" 20-S, has some physical and chemical properties that are highly desirable in a systemic fungicide. The chemical will move into the crown of the tree where it is needed to combat the Dutch elm disease fungus but it will not move into the leaves in appreciable quantities (Nishijima, 1977). In addition, the chemical is quite stable and will move into new radial wood, provided the concentrations present initially are high enough. The research results indicate that the ability of this fungicide to move into new wood as the trees grow is a function of the total dose initially injected. The more fungicide injected initially, the longer the chemical activity will continue to exist in the newest formed wood. Of the dosage rates tested so far, the triple therapy rates appears to maximize this attribute of TBZ.

The most important advantages of a long-lasting treatment relate to cost and the need to minimize the injury to trees from wounds made in the injection process. Shigo has clearly established that the

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multiple injuries which result from tree injection are serious wound from which the tree can never completely recover and that yearly injections to prevent Dutch elm disease are unacceptable to the well-being of the tree (Shigo, 1977). Accordingly, although the initial expense of the triple therapy rate will be the most costly (two 27'' elms can be treated with 1 gallon of ''Arbotect'' 20-S), both the cost and the additional injury caused by subsequent injections will be avoided.

In contrast to the above research results it is necessary to indicate to all concerned that the label is the law and that the data presented here do not change the law. They do indicate, however, that the label rates which have been approved may not provide adequate levels of fungicide to the treated tree.

REFERENCES: Nishijima, W.T. 1977. Systemic fungicides for Dutch elm disease control. Ph.D Thesis. University of Wisconsin. Shigo, A.L. and Richard Campana. 1977. Discolored and decayed wood associated with injection wounds in American elm. J. Arbor. 3: 230-235. Smalley, E.B., C.J. Meyers, R.N. Johnson, B.C. Fluke and R. Vieau. 1973. Benomyl for practical control of Dutch elm disease. Phytopathology 63: 1239-1252.

DOSAGE SCHEDULE FOR

''Arbotect'' 20-S,*

Chemical concentration: 3000 PPM = 1.92 fluid oz. Arbotect/gallon

Rate of Application: 1.25 gallons (5 qts.)/inch DBH

Circumference (Inches)	DBH (Inches)	Gallons of Solution	Fluid Ounces ''Arbotect'' 20-S
31.4	10	12.5	24.0
34.6	11	13.75	26.4
37.7	12	15.0	28.8
40.8	13	16.25	31.2
44.0	14	17.5	33.6
47.1	15	18.75	36.0
50.3	16	20.0	38.4
53.4	17	21.25	40.8
56.6	18	22.5	43.2
59.7	19	23.75	45.6
62.8	20	25.0	48.0
66.0	21	26.25	50.4
69.1	22	27.5	52.8
72.3	23	28.75	55.2
75.4	24	30.0	57.6
78.5	25	31.25	60.0
81.7	26	32.5	62.4
84.8	27	33.75	64.8
88.0	28	35.0	67.2
91.1	29	36.25	69.6
94.3	30	37.5	72.0
97.4	31	38.75	74.4
100.5	32	40.0	76.8
103.7	33	41.25	79.2
106.8	34	42.5	81.6
110.0	35	43.75	84.0
113.1	36	45.0	86.4
116.2	37	46.25	88.8
119.4	38	47.5	91.2
122.5	39	48.75	93.6
125.7	40	50.0	96.0
128.8	41	51.25	98.4
132.0	42	52.5	100.8

*Equivalent to three times the maximum therapy label rate.

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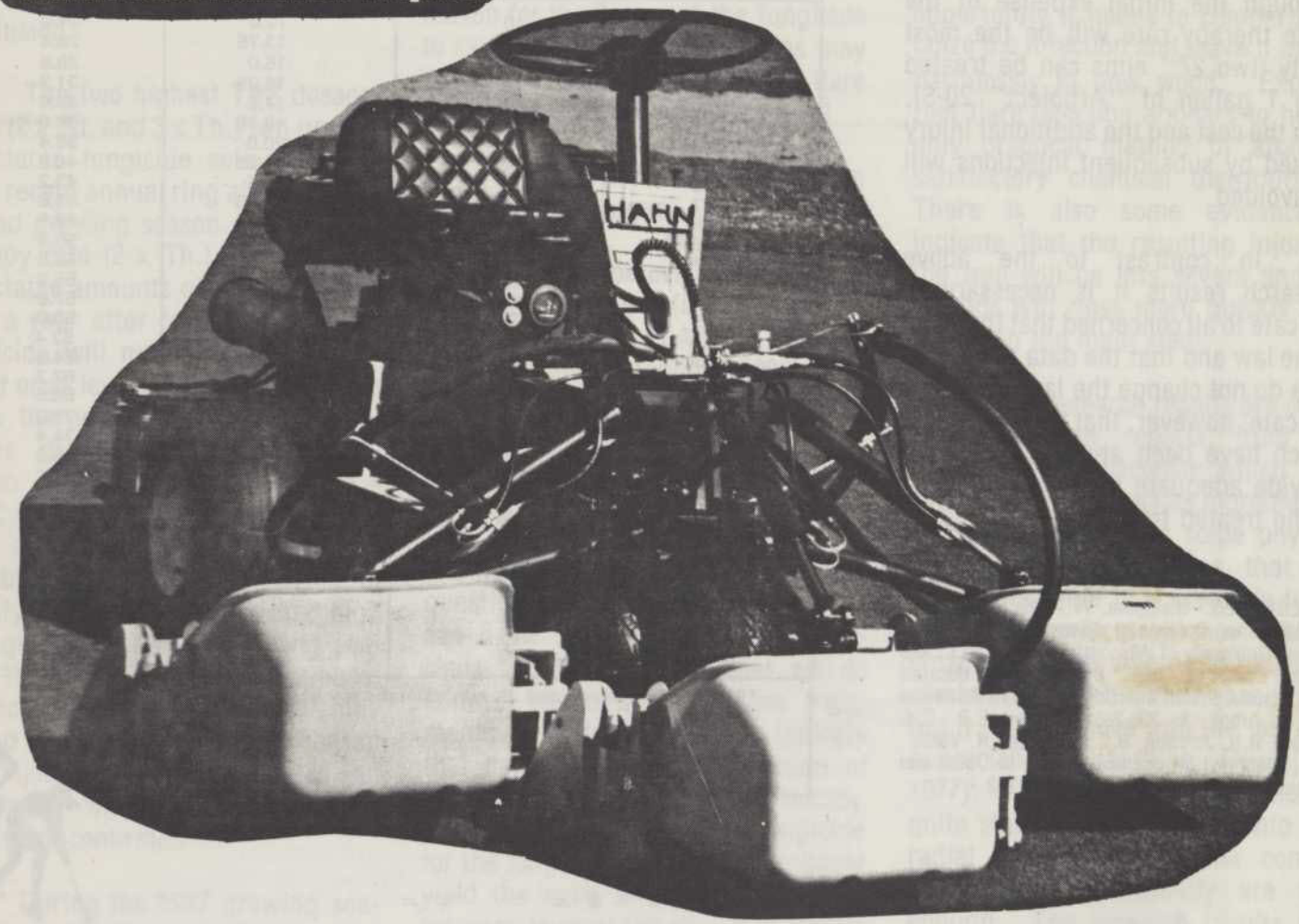

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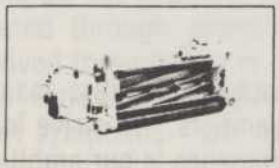

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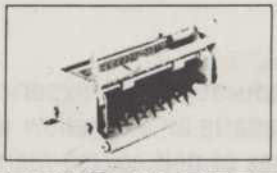

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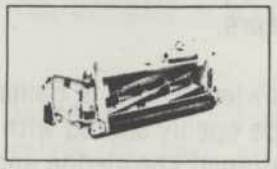

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