ODC 414.4:453--145.7 X 19.92 *Scolytus multistriatus* (Marsham)

DUTCH ELM DISEASE and METHOXYCHLOR

by
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DUTCH ELM DISEASE and METHOXYCHLOR

ABSTRACT

American elm trees, *Ulmus americana* L., in Milwaukee, Wisconsin, were sprayed with methoxychlor by helicopter or mist blower once each year for 3 years to control the smaller European elm bark beetle *Scolytus multistriatus* (Marsham). Twig crotches were collected from sprayed trees each year for bioassay. Methoxychlor residues persisted for at least 1 year. There were differences in beetle control between spray techniques, but these differences decreased as years of successive spraying increased, suggesting that methoxychlor residues accumulate on elms. Tree surveys were made each year to determine the incidence of Dutch elm disease. Average incidence remained stable in the areas treated by helicopter and mist blower, while it rose sharply in the control areas. Despite differences in beetle control between spray techniques, there were no differences in disease incidence between the helicopter and mist blower treatments. Later observations indicated that methoxychlor spraying can reduce disease incidence for several years after treatments have ceased, but unidentified factors also significantly affect disease incidence.

KEY WORDS: helicopter; mist blower; elm bark beetle; control; disease incidence; spray residue; elm twig; spraying.

DUTCH ELM disease (DED), caused by the fungus *Ceratocystis ulmi* (Buism.) C. Moreau, continues to spread and to destroy the American elm, *Ulmus americana* L., in the United States. DED is spread by the smaller European elm bark beetle, *Scolytus multistriatus* (Marsham), which introduces spores of the fungus into the water-conducting system of elms while feeding on twig crotches, and by transmission of the fungus through root grafts.

Before DDT was banned, chemical control recommendations were directed at preventing twig-crotch feeding by dormant-season applications of DDT or methoxychlor *(Norris 1961, Whitten and Swingle 1964)*, and at preventing the spread of fungus through roots by injecting the soil with Vapam to kill grafted roots *(Himelick et al. 1963)*.

Methoxychlor was included in the control recommendations, but most commercial and city arborists resisted using it because it increased cost and there was some question that its persistence was enough to be effective. For example, Norris *(1961)* found that methoxychlor gave 93.7 to 96.4 percent control of beetle feeding for 102 days, while DDT gave 95.1 to 99.3 percent control over the same period. Wootten *(1962)* found methoxychlor as effective as DDT for 150 days in preventing beetle feeding on twigs. But Doane *(1962)* compared methoxychlor to DDT and found methoxychlor ineffective, although the average size of the feeding scars indicated that the beetles had not fed extensively. Later laboratory tests by Cuthbert et al. *(1970)* showed that 100 times more methoxychlor than DDT was required to kill 50 percent of the beetles exposed to treated filter paper, but they did not imply that 100 times more methoxychlor would be needed to protect elms.

Wallner and Leeling *(1968)* compared helicopter and mist blower applications of methoxychlor on elms by assaying twig-crotch bark for deposits. They found larger deposits from helicopter applications. Barger et al. *(1973)* reported a similar study, but found that larger deposits were obtained by mist-blower applications.

This study began because the performance of methoxychlor had been determined mainly by beetle feeding bioassays or chemical assay. Little was known about the effect of methoxychlor on disease incidence.

Methods and Procedures

Tree selection.—American elm trees (Moline variety) were selected from one contiguous area of Milwaukee, Wisconsin. The area was divided into spray and check plots. Elm trees were rejected if they were: (1) suspected of disease; (2) adjacent to a stump, recent stump mark, or diseased tree; (3) less than 30 feet apart; (4) in poor health; or (5) if they had been sprayed with an insecticide in the last 3 years. The assumption was made that trees with latent disease were evenly distributed throughout the experimental area. For all trees, the mean dbh (diameter at breast height) was 16 inches and the mean height was 45 feet. Treatments were assigned to plots at random.

At its beginning in 1969, the study included 856 trees in the plots sprayed by helicopter, 859 in the plots sprayed by mist blower, and 1,950 in the untreated check plots. By the end of the follow-up in 1975, attrition had reduced these numbers to 245 sprayed by helicopter, 448 sprayed by mist blower, and 458 untreated controls.

Treatments.—One plot was sprayed by mist blower in the fall of 1968. Three other plots were sprayed by mist blower in the spring of 1969, and all four plots were sprayed again in the spring of 1970 and 1971. Each tree received an average of 2.5 gallons of 12.5 percent methoxychlor emulsion. A John Bean Model 300G Rotomist mist blower equipped with three number 5 nozzles was used.[1] The two outer and one center nozzle had number 45 and number 46 cores respectively.

[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U. S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

Elm trees in three other plots were sprayed in 1969 with an average of 1 gallon per tree of 12.5 percent methoxychlor emulsion, by a Bell 47G-2 helicopter equipped with a 32-foot boom and number D6 nozzles with number 45 cores. Only two of these plots were sprayed in 1970 and 1971, so only those two were used in the computations.

The same trees were sprayed each year in all spray plots, but plots or single trees that were not sprayed initially or in some other year because of inclement weather or parked cars were dropped from the study that year and all following years.

Sampling plan.—To determine how long the effects of methoxychlor persist, the plot that was sprayed in the fall of 1968 was sampled approximately every 6 weeks for a year. To compare residues from helicopter and mist blower applications, trees in all the sprayed plots were sampled in May, June, July, and September, 1969, and in June and October of 1970 and 1971. Ten twigs were collected from each of 16 sectors (4 levels and 4 quadrants) on each sample tree crown. Three trees in each plot sprayed by mist blower and six trees in each plot sprayed by helicopter were selected at random on each sampling date from among the trees that were sprayed at the same time; a total of 12 trees per treatment.

Bioassay.—The bioassay was made by confining bark beetles on twig crotches in small cages *(Barger et al. 1971)*. The mean percentage of beetles that failed to feed to the xylem of the twigs was used as a measure of the effect of the methoxychlor treatment.

Disease survey.—During August and early September, from 1969 through 1975, elm trees in the study area were inspected by two different crews for symptoms of DED. No attempt was made to determine which trees had become diseased from root grafts and which by beetle inoculation. Diseased trees were marked on the street side with a red nail, and were removed during the following winter and early spring. Trees removed for reasons other than DED were dropped from the study. The percentage of DED-infected trees each year in each plot was the incidence of the disease. The average of the incidences for all plots under each treatment is the average incidence.

Results and Discussion

Persistence of methoxychlor.—The first bioassay to measure the persistence of methoxychlor after fall application was made in January, 56 days after spraying. It showed 92.3 percent of the beetles deterred from feeding. The second bioassay, in March, 99 days after spraying, showed an 88.8 percent control. The percentage control was rather constant for the remaining bioassays and 1 year after spraying, methoxychlor residue was high enough to control 62.1 percent of the beetles (fig. 1).

These results showed that little methoxychlor disappeared from the trees during the winter, and they support a recommendation for fall application. The lower average temperature and precipitation slow the evaporation and removal of methoxychlor by water, and may account for the higher bioassay readings during the winter sampling periods.

Comparison of treatments.—To compare methods of application, bioassays were made on twig samples collected from trees in the plots sprayed in the spring by mist blower and by helicopter from 1969 through 1971. For trees sprayed by mist blower, the first and last bioassays in 1969 showed 73.5 and 45.9 percent feeding control respectively; in 1970, the percentages were 78.0 and 71.6; for 1971 they were 55.2 and 60.7 percent (fig. 2). Generally, beetle control was greater at the bottom of tree crowns than at the top.

Bioassays from the trees sprayed by helicopter always gave a lower percentage control. The lower bioassay readings were expected because these trees received less than half the spray volume delivered by the mist blower. This does not, however, suggest that one treatment is better than the other for suppressing DED. Beetle control was greatest at the tree tops and progressively lower at each lower crown level. The first and last bioassays in 1969 showed 38.0 and 11.7 percent control; in 1970, the percentages were 29.6 and 20.8; for 1971 they were 50.9 and 45.6 percent (fig. 2).

These comparative bioassays show that residues of methoxychlor may accumulate on sprayed elms from one year to the next. Bioassay readings increased every year in the

Figure 1.—Persistence of methoxychlor sprayed in the fall. Average percentage of beetles that failed to penetrate the xylem of elm twigs collected at 6-week intervals from a plot sprayed by mist blower in the fall of 1968.

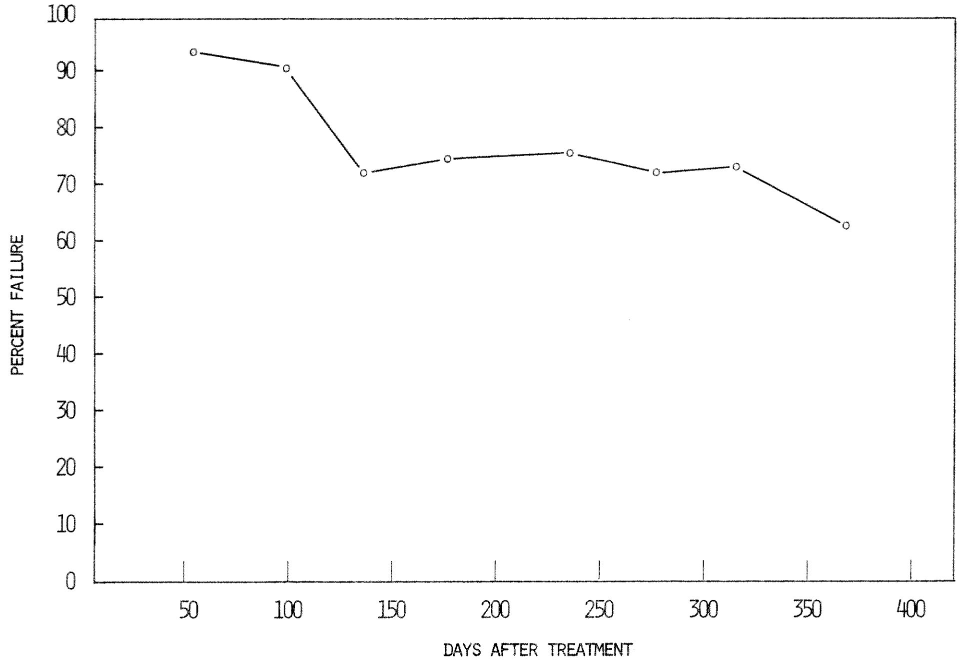
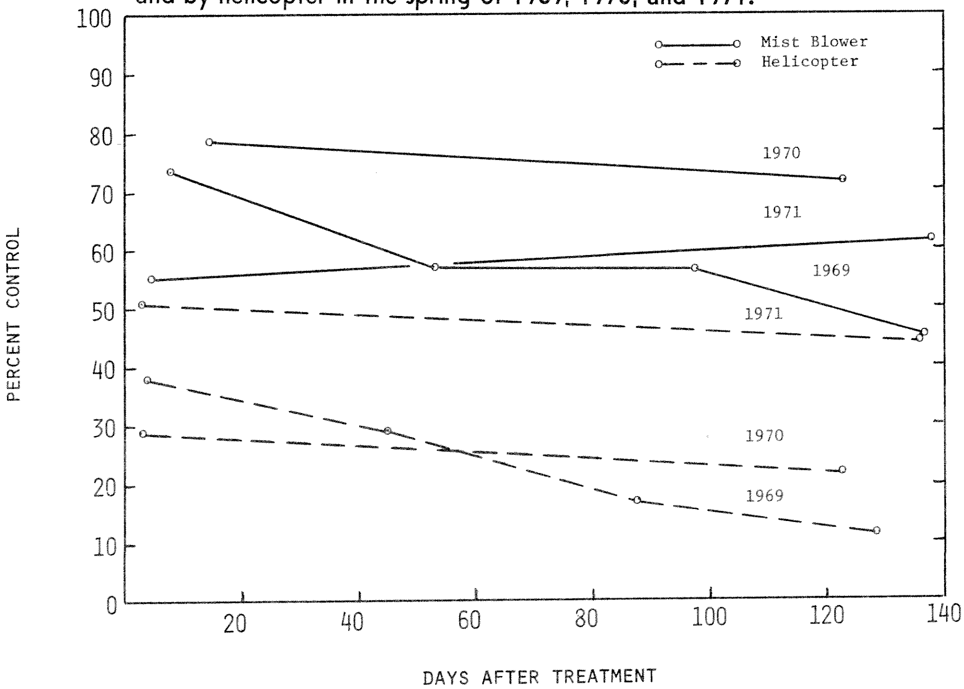


Figure 2.—Average percentage of beetles that failed to penetrate the xylem of elm twigs from plots sprayed by mist blower and by helicopter in the spring of 1969, 1970, and 1971.



plots sprayed by helicopter and increased all but 1 year in the plots sprayed by mist blower. Also, differences between the first and last readings decreased as the number of successive years of spraying increased.

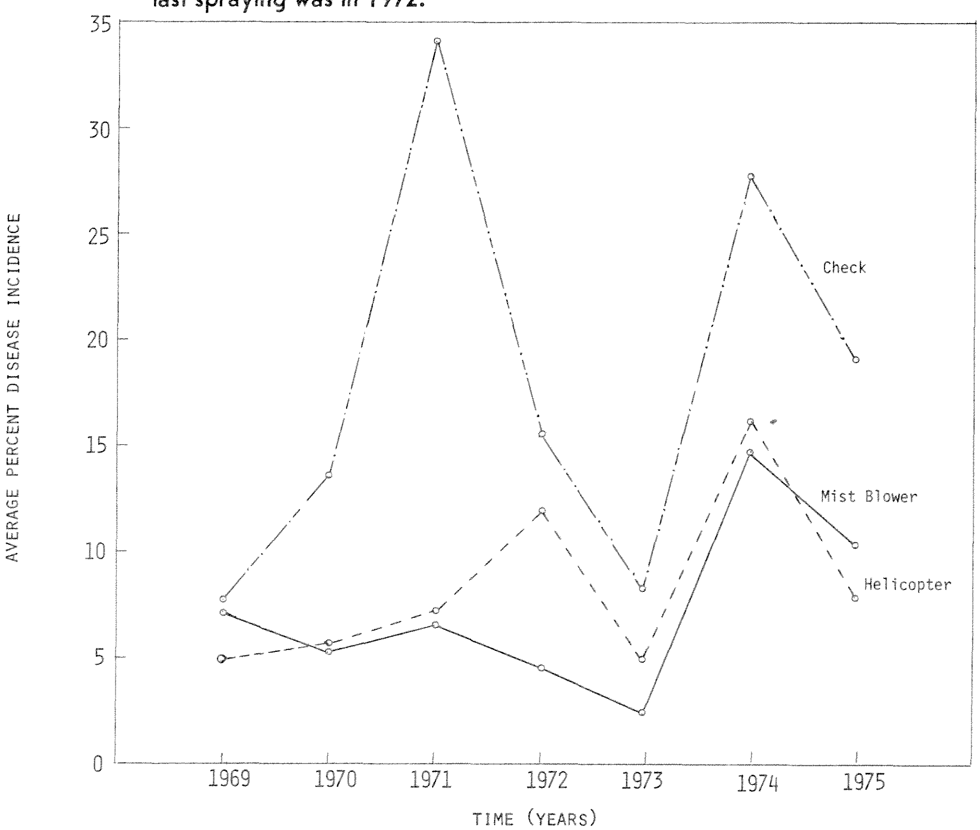
Disease incidence.—In 1969, no significant differences in disease incidence were found between plots sprayed by helicopter and those sprayed by mist blower, nor between either of these and the unsprayed check plots. Because the criteria used to select trees minimized root-graft transmissions during the first year of this study, the incidence of disease in 1969 was due mainly to new inoculations by beetles. Latent infections not detected when the trees were selected may have caused the death of some elms, but these infections were assumed to be equally distributed among the plots. In 1970 and 1971, the disease incidence fluctuated in the plots treated by helicopter and mist blower but remained near the 1969 level while the disease increased dramatically in the check plots (fig. 3).

Figure 3 shows clearly that DED was contained by spraying elms with methoxychlor by either treatment technique. Had measures been taken to reduce root-graft infections or had the incidence been computed only on beetle-vectored cases of DED, the incidence would have been lower for both treatments.

Conclusions

Although bioassays clearly showed differences in bark beetle control between trees sprayed by helicopter and those sprayed by mist blower, these differences were not reflected in the incidence of DED. And although trees treated by mist blower received an average of 2.5 times as much methoxychlor as

Figure 3.—Incidence of Dutch elm disease in plots sprayed by helicopter and mist blower and in control plots, 1968-1975. The last spraying was in 1972.



those treated by helicopter, the disease incidence was the same. Therefore, the idea that every elm tree or twig crotch must be heavily sprayed with methoxychlor to provide good protection against beetle inoculations should be reexamined. The chain of events leading to beetle feeding on elm twigs has not been determined, but there is no reason to assume that beetles in flight zero in on one twig crotch to feed. It is more likely that the beetles walk on branches after landing. Because methoxychlor is both a contact and a stomach poison, this would greatly increase the probability of the beetles' contacting methoxychlor residues before they begin feeding on twigs.

Other conclusions are that spraying elms with methoxychlor annually for 3 years, either by helicopter or mist blower, controlled the disease while its incidence increased among elms that were not sprayed. Furthermore, my data indicate that: (1) fall spraying of elms is effective; (2) residues accumulate on elms from successive yearly sprays; and (3) heavy doses of methoxychlor are not necessary to control the disease.

Observations After the Study

Although this study was not intended to continue beyond 1971, sufficient methoxychlor was on hand to spray about 800 elms in 1972. The plots treated by mist blower were sprayed, but not those that had been sprayed by helicopter. The incidence of DED increased sharply on the plots previously sprayed by helicopter, while it declined slightly on those sprayed by mist blower. However, it declined even more sharply on the check plots, although it was still higher there than on the treated plots (fig. 3).

Though no trees were sprayed in 1973 or thereafter, the disease incidence continued to decline in all the plots. It declined to levels at or below those before the study, demonstrating that unknown factors significantly affect the incidence of DED.

In 1974, the incidence of the disease rose sharply in all plots, although it was still lower in those that had been treated than in the check plots. In 1975 it declined in all plots. Thus the plots that had been treated had a continuing advantage.

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