Dutch Elm Disease Control
Michigan State University
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COOPERATIVE EXTENSION SERVICE
Michigan State University

by W. E. Wallner and J. H. Hart[1]

DUTCH ELM DISEASE was first described by plant pathologists in the Netherlands. This disease came to the eastern United States from Europe about 1930. Since 1950 the disease has spread rapidly throughout the midwestern states and by 1966 was present in 30 states and three provinces of Canada. It occurs from the Atlantic Coast west to Nebraska and from Georgia and Oklahoma north to the northern edge of the natural range of the elm in Eastern Canada.

The first elms known to die of Dutch elm disease in Michigan were found in Detroit (Wayne County) during the summer of 1950. Since then, the disease has spread throughout the lower Peninsula and occurs in scattered areas in the eastern end of the Upper Peninsula. In 1964 approximately $9 million were spent on control measures and removal of diseased trees. The many elms removed also resulted in reduced property values and other aesthetic losses difficult to measure in terms of dollars. However, there are still approximately five million elm *shade* trees alive on public and private property in Michigan with a value of over $700 million.

No matter how you try to solve your Dutch elm disease problem, it is going to be expensive. Some Michigan towns lost nearly all of their elms to the disease in a period of 10 to 12 years. About 95 percent of the elms over four inches in diameter have been killed in some areas. This rate of loss means that, in a city which once had an elm population of 20,000 trees, 19,000 have been killed. The cost of removing the trees at $75 per tree is $1,425,000, and in many cities the average cost of removal is higher than $75 per tree.

However, this isn't the whole story; removed trees will need to be replaced if you desire shade. It will be years before new trees give suitable shade. A control program that holds the annual loss of elms to 2 percent or less of the current elm population is desirable because it avoids exorbitant tree removal costs, prevents devaluation of real estate, and insures the continued enjoyment of elms as shade trees. By doing nothing you face the high cost of removal and replacement of many trees during a short period of time.

Diseases are one of the many checks and balances operating in nature. While changes are continually occurring, the diversity of nature tends toward stability. Man is inclined to modify and reduce this diversity. The spectacular loss of street after street of elm trees by Dutch Elm Disease is a result of this lack of diversity. Planting and replacement programs should consider the interplanting of different species in order to avoid similar tree losses in the future.

Dutch elm disease control is a community problem. The wider the area over which controls are carried out, the better the results will be. To keep the disease from spreading in a community, the first infections must be found soon after they occur, and control measures must be promptly applied. Citizens must care for their own trees as well as follow the program carried out by their city or town. Under an organized program it is the law that all diseased elms (public and private) be removed and destroyed.

To control Dutch elm disease in Michigan, property owners and others interested in growing elm trees must know: (1) the cause of the disease, (2) how to recognize it, and (3) what to do about it. Necessary control measures require a program of sanitation, spraying, and destruction of grafted roots.

Cause and Symptoms of the Disease

The scientific name for the fungus that causes Dutch elm disease is *Ceratocystis ulmi*. The tiny spores ("seeds") of this fungus germinate in the water-conducting tissues of the living elm tree. As the fungus grows, it causes the tree to form gums which plug the water-conducting tissues (Figure 1). This condition causes the tree to wilt and die. Many

1 Extension Specialists in Entomology and Botany and Plant Pathology, respectively.

trees die in the same season that infection occurs — some are killed within a few weeks. Only a few live longer than the second or third season.

All elms are susceptible, with the American elm being the most susceptible. Chinese and Siberian elms are highly resistant to the disease, although individual trees have died from the disease in Michigan. Several hybrid elms, produced both in this country and in Holland, have been advertised as immune or resistant to Dutch elm disease. None of these hybrids are immune, but some of them do show resistant levels similar to the Asiatic species. The Asiatic species and many of the hybrids grow faster than our native elms. Some selections, however, are not winter-hardy in Michigan or are very susceptible to diseases other than Dutch elm disease.

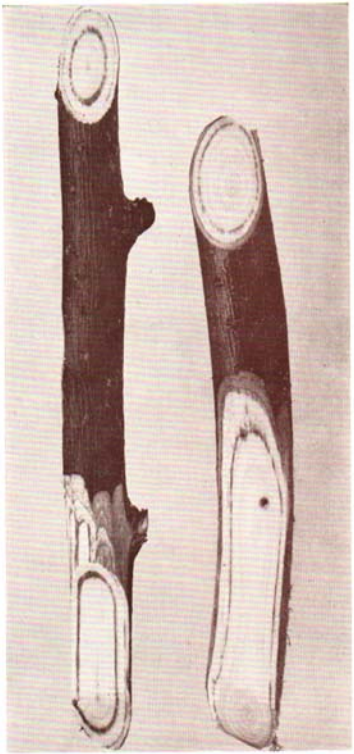

Fig. 1. Typical appearance of branch pieces from a Dutch-elm-diseased tree. The discoloration appears as a ring of BROWN DOTS in the diagonal cross sections, and as long BROWN STREAKS in the longitudinal sections. This BROWN DISCOLORATION is located in the wood just beneath the bark.

When adult bark beetles leave diseased elm trees, fungus spores are likely to cling to their bodies. These spores enter healthy trees through the feeding wounds (punctures) made by the adult bark beetles. Such wounds are usually made in the crotches of 1- and 2-year-old twigs of healthy elm trees (Figure 2).

Many Michigan communities have continued to lose elms even though the conventional control measures of sanitation and spraying are being conscientiously followed. Much of this loss can be attributed to the fungus passing through natural root grafts between diseased and nearby healthy trees. The extent of this type of transmission will vary with the spacing distance between trees. Elms over 30 feet apart are seldom united by a graft while trees less than 20 feet apart are frequently connected.

Be Suspicious of Unhealthy Elm Trees

The most noticeable sign of Dutch elm disease is the wilting of one or more branches of infected trees. The wilting leaves become yellow and, later, turn brown when dead. Branches with dead, brown leaves may hang among the green foliage of healthy branches, a further sign that the trees may have the disease.

A second way to check suspicions that elm trees may have Dutch elm disease is to examine the crotches of 1- and 2-year-old twigs for the oval, depressed feeding punctures of the beetles.

How To Be Sure About Your Trees

There is only one way you can be sure about your trees having Dutch elm disease. Diseased twigs and branches must be examined for the fungus by a plant pathologist using laboratory methods.

You go about getting this examination in the following way.

Fig. 2. Smaller European Elm Bark beetle feeding in a twig crotch. Spores of the fungus are carried from diseased to healthy trees by this feeding habit.

1. Cut six twigs or small stems about 7 inches long and ½ to 1 inch in diameter from the diseased branches of each tree. (See Fig. 1 for the appearance and description of Dutch-elm-diseased twigs and stems.)

2. Carefully mark the twigs or stems from each tree.

3. Wrap and bind securely in a suitable cardboard box for mailing. **Do not send material that has been dead for some time, or which does not show the discolored ring under the bark.**

4. Send all samples for Dutch elm disease testing to the Dutch Elm Disease Identification Laboratory, Michigan Department of Agriculture, Laboratory Division, Lansing, Michigan 48823.

If you have further questions on sending in samples for identification, check with your county agricultural agent or other responsible agencies.

NOTE: It is very important that you mail the samples immediately after collecting. Delay in getting the twigs to the laboratory only makes the problem of identification harder.

A report on the sample will be made to you in about 14 days. If the disease is found in the sample, your tree or trees should be cut down and burned immediately.

Description of the Bark Beetles

Two bark beetles are the important carriers of Dutch elm disease.

THE SMALLER EUROPEAN ELM BARK BEETLE *(Scolytus multistriatus)* first entered the United States in 1909. Since that time, it has become more and more widespread and is now the most important carrier of Dutch elm disease.

This beetle is about 1/12 to 1/8 inch long. Its color is brownish to black. (See Fig. 3 for a picture of this insect.) The female lays her eggs in niches in the side of simple, unforked egg galleries under the bark of dead or recently cut elm wood. The galleries run with the grain of the wood. The larvae (worms) bore small tunnels around the trunk or branch and away from the centrally located egg gallery. (Fig. 4 shows the egg galleries and larval tunnels of the smaller European elm bark beetle.)

Adult beetles emerge in may or early June, fly to healthy trees, and feed in the crotches of the twigs. **It is during this time — if they have emerged from the bark of diseased trees or wood — that they may introduce the fungus spores from their bodies into healthy trees. The fungus fruits abundantly on diseased wood and the sticky spores frequently adhere to the beetles.** (Fig. 5 shows the spore-producing structures of the fungus.) This habit of feeding on healthy trees, after emerging from the bark of diseased elm trees, makes this insect a major carrier of the Dutch elm disease.

This insect seems to have at least one full and a partial second generation a year in Michigan. The

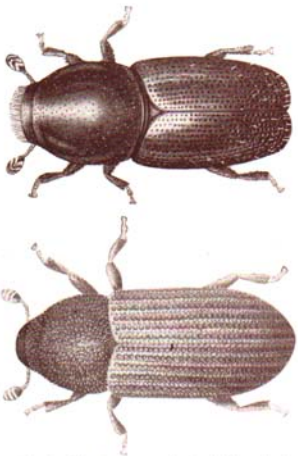

Fig. 3. The Smaller European elm bark beetle (top) is from 1/12 to 1/8 inch long. The native elm bark beetle (bottom) is about 1/16 to 1/12 inch long.

smaller European elm bark beetle usually overwinters as a grub in the bark of unhealthy elm trees or recently cut logs or firewood.

THE NATIVE ELM BARK BEETLE *(Hylurgopinus rufipes)* is small, only 1/16 to 1/12 inch long. Apparently it has one generation a year in Michigan. This beetle overwinters as an adult in the bark of

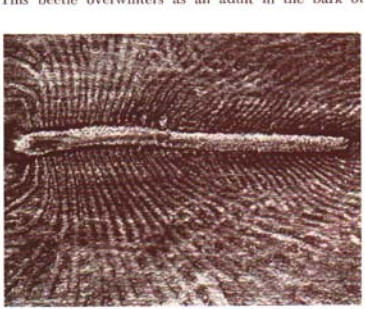

Fig. 4. Enlarged photograph of wood infested with the Smaller European elm bark beetle. Note that the egg galleries are constructed WITH the grain. This insect is the most important carrier of Dutch elm disease.

elm trees. Its color is brownish, and its body is moderately stout. The wing covers of this beetle are coarsely punctured with small depressions.

The female of the native elm bark beetle lays her eggs in galleries that run **across** (around) the grain of the wood. Remember, the smaller European elm bark beetle bores it galleries **lengthwise** of the wood. (Fig. 6 shows the egg galleries and larval tunnels of the native elm bark beetle.)

How to Control the Disease

The only known method of Dutch elm disease control is to *prevent* the fungus from moving through root grafts and to keep the bark beetles from carrying the fungus from diseased to healthy trees. There is no known cure for the disease once it is established within an elm. Three things are important: **SANITATION, destruction of root grafts,** and **chemical control with insecticides.**

SANITATION means keeping all old and dying branches pruned out of elm trees. In addition, promptly remove elm trees that are diseased, dead, or in low vigor from insect attack, flooding, soil fills, lightning, ice injury, or other causes before the beetles breed in them. Beetle-infested elm material found between May 1 and August 1 should be disposed of immediately. Such material found after August 1 should be disposed of before May 1 of the following year. Sanitation is a basic procedure in disease control, so important that spraying without a high degree of sanitation is not recommended.

Destroy beetle breeding places either by: (1) burning dead elm wood; (2) peeling tight bark from elm wood and stumps; (3) burying logs at least 6 inches deep; (4) using mechanical branch chippers; or (5) spraying bark of felled trees with 1 percent dieldrin emulsion spray or 1 percent DDT in oil. Note: Dieldrin is preferred to DDT for this purpose. (See Fig. 7 for the breeding places of the elm bark beetles.)

Spray the bark of diseased elm trunks and branches with 1 percent dieldrin emulsion spray or 1 percent DDT in oil before hauling them to the place where they will be burned. Note: It is not necessary to spray diseased material which is removed and destroyed between October and the first of May. To make an approximately 1 percent dieldrin emulsion spray, use 1 gallon of a liquid material containing 1½ pounds of actual chemical per gallon to 20 gallons of water. To make 1 percent solution of DDT in oil, mix 1 quart of a DDT emulsion with the number of quarts of kerosene or diesel oil corresponding with the stated percentage of DDT on the label. Example: Mix 1 quart of 25 percent DDT emulsion with 25 quarts of kerosene or diesel oil.

Trimming

Heavy trimming (removal of healthy branches) during July through September may increase the incidence of Dutch elm disease. This type of trimming is employed by certain communities once every 7 to 9 years, to shape trees and remove branch obstructions above streets, houses, wires, etc. As a result, trimmed trees are attractive to the smaller European elm bark beetle which invades the main trunk to lay eggs. Beetles introduce the fungus and, while the trees may appear vigorous in the fall, trees wilt and die rapidly the following spring. If trimming is necessary it should not be done during July through September.

Destruction of root grafts can be best accomplished with the soil sterilant, Vapam. This chemical has

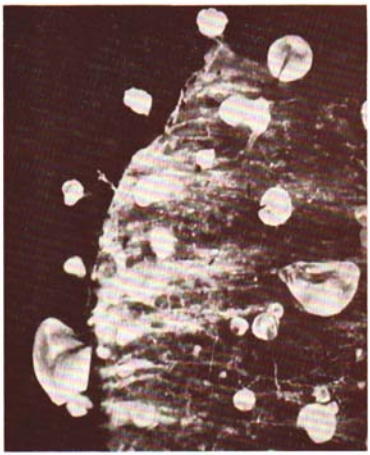

Fig. 5. Enlarged photograph of diseased elm wood on which fruiting bodies of the fungus have developed. White globular areas contain spores in a sticky matrix.

Fig. 6. Egg galleries of the native elm bark beetle (greatly enlarged) run ACROSS the grain—not lengthwise to the grain as those of the European variety.

been found to kill elm roots in a limited zone thus providing a method for chemical root pruning. Vapam should be applied immediately after a tree is diagnosed as having Dutch elm disease if it is within 30 feet of a healthy elm. If trees are less than 20 feet apart or if a diseased tree has advanced wilt symptoms, it may be necessary to treat at two sites: one between the diseased and the first healthy-appearing tree and one between the first and the second healthy-appearing tree. This is advisable because the fungus may have already passed from the diseased to the first healthy-appearing elm before Vapam was applied.

Place the line of treatment so as to kill all elm roots of the two adjacent trees that are likely to be grafted. This can best be accomplished by applying the chemical in an unbroken straight line equidistant between the diseased and adjacent healthy elm. However the line of holes should be at least 10 feet from the trunk of the healthy tree. If sidewalks, hedges,

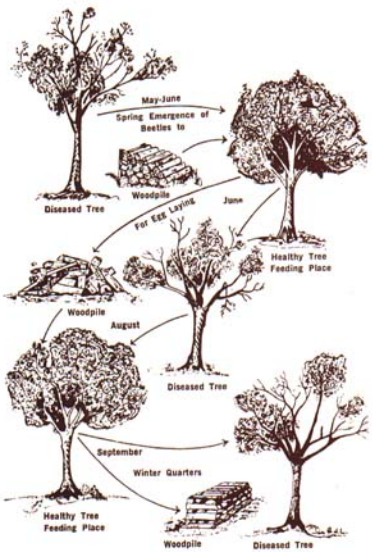

Fig. 7. This shows how bark beetles, by their feeding habits and in the normal life cycle, spread Dutch elm disease. As the beetles move from infected wood into healthy trees, they carry the fungus spores with them. DESTROY BREEDING SITES to help control Dutch elm disease!

or other plant material prevent application in a straight line, then apply the chemical in a T-shaped or L-shaped pattern.

Use Vapam diluted one part Vapam to three parts water. Fill holes drilled approximately ¾ inch in diameter, 15 to 20 inches deep, and 6 inches apart with this solution. Seal each hole carefully by tamping to prevent gas dissipation. Usually a circle of grass 3 to 6 inches in diameter is killed around the point of injection. After 4 to 6 weeks the dead spots can either be resodded or reseeded. Allow two weeks after treatment before removing the diseased tree.

CHEMICAL CONTROL means misting or spraying trees with an insecticide that will kill the beetles before they infect healthy trees. Fixed-wing aircraft application of Dutch elm disease control chemicals is not suggested in Michigan. However, recent research indicates that helicopter application can effectively be employed. Areas inaccessible to standard mist blower equipment or those with large numbers of streetside elms are necessary to justify such a method. Treating with chemicals is an aid to beetle control but not the only answer. (See "Sanitation" above.) ONLY THOROUGHLY MISTED OR SPRAYED TREES WILL BE PROTECTED FROM THE DISEASE. Partial or careless treating will only lead to disappointment and discouragement.

The Food and Drug Administration is becoming increasingly conscious of side-effect residues on pastures, crops and water supplies resulting from poor application procedures. Spray operators should take all possible precautions to prevent undue contamination of non-target areas. Failure to observe such precautions may result in a tightening of policies governing certain shade tree pesticide applications.

Suggested Spray Materials

There are two ways to apply Dutch elm disease treatments. One uses the insecticide in large quantities of water. This is called the **dilute** or **hydraulic** method of application. It takes 20 to 30 gallons of this mixture to treat a 50-foot tree.

The other method uses the insecticide in small quantities of water. It is called the ***concentrate*** or mist-blower type of application. It is preferred to **hydraulic type** applications. Two or three gallons of this material will treat a 50-foot tree.

Mist Blower Sprays†

Mist blower applications should be made under windless conditions. Winds in excess of 5 mph disrupt the column of air carrying the chemical and result in poor deposit on the trees and unwanted drift. Avoid weaving or moving the column of air rapidly. It is best to build up the column of air; in-

†DILUTE SPRAYS: If a mist-blower is not available use 8 gallons of 25 percent methoxychlor emulsion to 100 gallons of water. Apply any time before bud-swelling in the spring when the temperature is 40° F. or higher.

Note: Dilute sprays applied with hydraulic equipment are generally more poisonous to wildlife than mist-blower applications of the same material.

ject the spray into the air stream and move the column slowly through the tree.

DDT is a long residual (persistent) chemical which requires many years to degrade or break down. Research conducted in Michigan has shown that excessive amounts of DDT enter streams from municipalities via sewage and storm drains. DDT has an extremely low solubility in water, yet deposits of this chemical in silt and soil can accumulate to levels detrimental to aquatic as well as terrestrial wildlife. Methoxychlor, a chlorinated hydrocarbon similar to DDT, has shorter residual properties and does not pose problems of soil or water contamination that DDT does. **NOTE: Methoxychlor will kill fish if applied or drifted onto streams or ponds.** About 150 days of elm bark beetle control can be obtained with one application of methoxychlor. **It is recommended that methoxychlor be used in place of DDT for elm bark beetle control.** Some municipalities presently utilizing DDT may not be able to immediately discontinue the use of DDT in their control programs. **However, they should anticipate replacing DDT with methoxychlor and implement such changes as quickly as practicable.**

Apply methoxychlor anytime in the spring when the temperature is 40°F. or higher, or when the temperature at the time of application is at least 35°F. and rising. Use one part of a 25 percent methoxychlor emulsion to one part water. Most formulations consist of 25 percent methoxychlor, 73 percent xylene and 2 percent inert ingredients. By adding 50 gallons of this emulsion to 50 gallons of water a 12½ percent concentrated spray is obtained. Some xylene formulations of methoxychlor may cause pitting to certain car finishes. This problem can be alleviated by adding 5 gallons of horticultural white oil (in place of 5 gallons of water) to the above suggested spray mixture or by using a xylene or oil formulation specifically manufactured to prevent pitting. The addition of white oil in excess of 10 percent of the spray volume may decrease the residual action of the methoxychlor. Longer residual protection through the summer will be obtained by applying methoxychlor as close to bud swelling as possible. Obviously, where large numbers of trees are to be treated this cannot always be accomplished.

NOTE: 1. Use only emulsion type insecticides against Dutch elm bark beetles; wettable powders are not effective. 2. Be sure to use an emulsion specially manufactured for Dutch elm disease control. Several companies manufacture this type of product. 3. Emulsions containing acetone spot some kinds of paint. Therefore, use them carefully around buildings and cars.

Bidrin Implantation

Bidrin is a systemic insecticide which, upon injection into the trunk by the appropriate method, moves through the tree and accumulates in the leaves and bark of branches in the peripheral crown of the tree. If administered in the proper dosage, enough Bidrin will accumulate to kill beetles which feed in the twig crotches. Bidrin remains effective for a period of about 30 days.

Research results are inconclusive regarding effectiveness and phytotoxicity of Bidrin under Michigan conditions. Therefore, Bidrin is not recommended for general use in Dutch elm disease control. However, should research reveal important advances in the use of this method for elm bark beetle control, appropriate recommendations will be transmitted to all county agricultural agents.

Mite Control

If damaging mite numbers develop on the elm tree, use Kelthane (2 lbs. of 18½ percent wettable powder or 1 qt. of 18½ percent emulsion to 100 gals. of water), or 1 pound of 50 percent wettable ovex powder or 1 quart of 50 percent malathion emulsion to 100 gallons of dilute spray. When applying mist (concentrate spray) increase the amount used accordingly. Other suitable miticides are available; follow the label for instructions about their use.

Protecting Wildlife

General instructions to reduce wildlife losses are:

a. Apply the treatment during the tree's dormant period. This occurs before bud swelling in the spring. **NOTE:** Heavy migration of birds begins about the time leaves appear on the elm trees.

b. Use a mist-blower or a helicopter to apply methoxychlor insecticide. Avoid spray drift, puddling and other conditions that concentrate the methoxychlor on the surface of the soil or in it, especially when using a hydraulic sprayer.

CAUTIONS

1. When spraying for control of Dutch elm disease, use hose and gaskets of only NEOPRENE or comparable materials. Formulations containing xylene and similar solvents will rot ordinary spray hose.

2. Spray operators and others working with dieldrin, Kelthane, methoxychlor, or DDT and their formulations should protect themselves at all times from these materials. Wash skin surfaces with soap and water after exposure.

3. Dispose of excess spray material correctly by dumping into a sanitary land fill dump or a pit at least 18 inches deep to prevent contamination of water. DO NOT DUMP EXCESS SPRAY MATERIAL DOWN SEWERS OR DRAINS.

Other methods and materials for Dutch elm disease control: The suggestions given in this folder are the only reliable means of controlling the disease at this time. All other reported methods are inadequate or are in the experimental stage of development. Research is still in progress on the control of Dutch elm disease.

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