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Dutch Elm Disease in Missouri

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Dutch elm disease was discovered in Holland in 1919 and has attracted considerable attention throughout Europe and the United States. This destructive fungus disease of elms was introduced into the United States from Europe about 1930. Since then, it has spread from the east coast to the Rocky Mountains, north to Canada and southward to several southern states.

This disease has killed thousands of elms in Illinois, Indiana, Ohio, Missouri, and many eastern states. The disease is also spreading rapidly in Nebraska, Iowa, Kansas, Minnesota, and Wisconsin. In New England, the loss of elms along entire streets has changed the appearance of whole towns. Replacing the elms with other shade trees would cost hundreds of thousands of dollars.

Dutch elm disease's exact distribution in Missouri is not known, but it probably occurs in most sections of the state. The disease continues to spread and kill more elms each year.

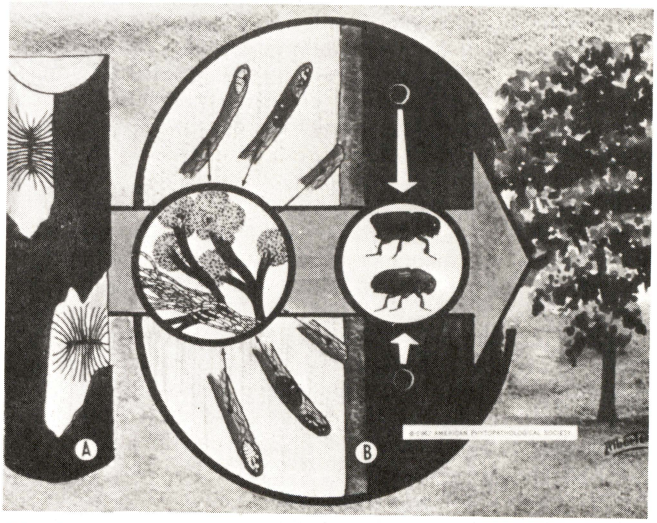
All elm species common to Missouri are susceptible to some degree; the American elm is the most susceptible. The Asiatic elms (Siberian and Chinese) are somewhat resistant. All other species of elm fall somewhere between these extremes. The Christine Buisman elm, one of the European smooth leaf elms, is highly resistant to both Dutch elm disease and elm phloem necrosis. But even this elm species has lost its resistance to new races of the fungus in Europe.

Dutch elm disease makes dead elms a common sight.

Cause

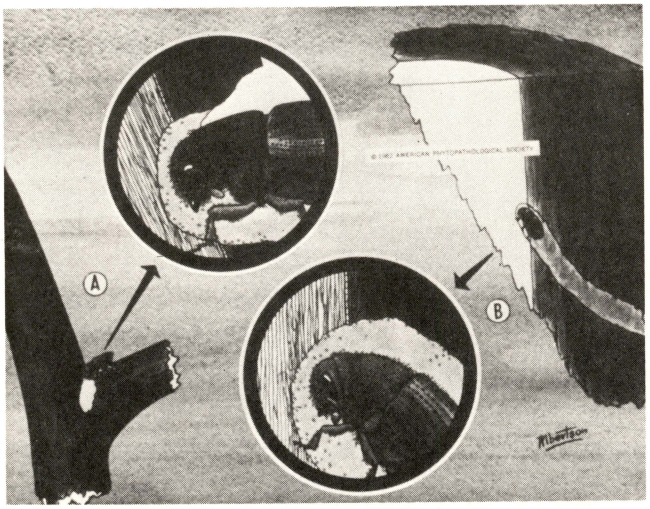
Dutch elm disease is caused by the fungus *Ceratocystis ulmi*. The European elm bark beetle, *Scolytus multistriatus* (Marsham), and the native elm bark beetle, *Hylurgopinus rufipes* (Eichhoff), usually carry the fungus from diseased to healthy trees. Because of its more aggressive habits, the smaller European elm bark beetle is the principal carrier. These beetles breed only in dead, dying, or recently cut elm wood and then winter as larvae under the bark of these trees. In the spring, adults emerge and fly a short distance, usually less than 500 feet, to feed in the crotches of twigs or small branches in the upper parts of living elm trees.

These beetles carry fungal spores on their bodies and introduce the spores into feeding wounds. (See Guide 7356, *Elm Leaf Beetle*.) Thus, through the feeding habits of adult beetles, the fungus gains entrance to the water vessels of living, healthy elm trees, where it can spread rapidly through the tree. The fungus produces a toxin, causing the tree to form gums within the water vessels. These gums plug the vessels, causing the tree to wilt and eventually to die.



Elm bark beetles carry the disease fungus from egg galleries under the bark of infected trees (A; enlarged in B) to healthy trees.

Larval galleries of small European elm bark beetles.



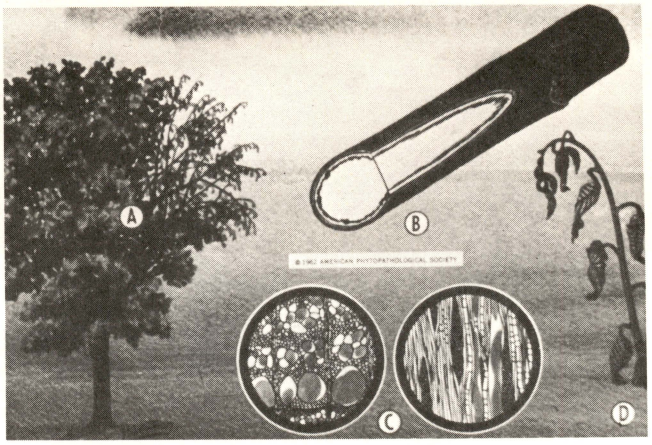
Beetles introduce fungus spores into healthy trees through feeding wounds, mainly in crotches (A) or sometimes directly through the bark (B), depending on feeding habits of beetles.

Appearance

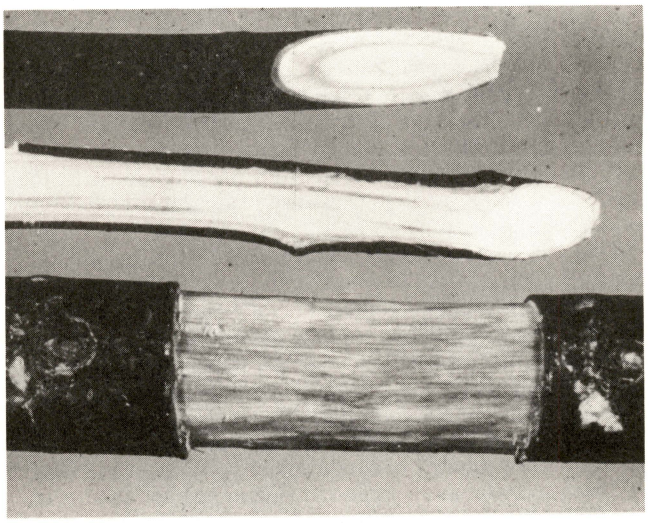
An early sign of infection is wilting and yellowing leaves on one or more branches, a condition called *flagging*. This may occur any time during the growing season and indicates that the wilting branch is infected. The wilting leaves wither and fall prematurely, and death follows. Usually, one or more branches are affected first, followed by spread of the infection to other portions of the tree's crown. Sometimes disease symptoms develop suddenly over the entire crown. Some trees die within a few weeks, while others may die slowly over one or more years.

If your elm trees show these foliage symptoms, cut off several small branches of recently wilted leaves. Look for a brown discoloration in one or more annual rings of the wood. The sapwood of these branches may be streaked with brown or may be brown throughout. If a branch is cut across with a knife, this browning may be seen as a circle of dots or as a ring in the wood beneath the bark. If this discoloration is absent, the infection is probably not Dutch elm disease.

Because several other elm diseases also show discoloration of the wood, Dutch elm disease can be diagnosed positively only in a laboratory. For such tests, specimens from actively wilting but living branches with definite brown streaking in the sapwood are needed. These sections should be ½ to ¾ inch diameter and about 8 inches long. There is no need to send leaves.



The first external symptom is called flagging, a condition of wilting and yellowing in some branches (A). The fungus invades sapwood (B), causing plugging of the water-conducting vessels (C), which in turn causes wilt (D).



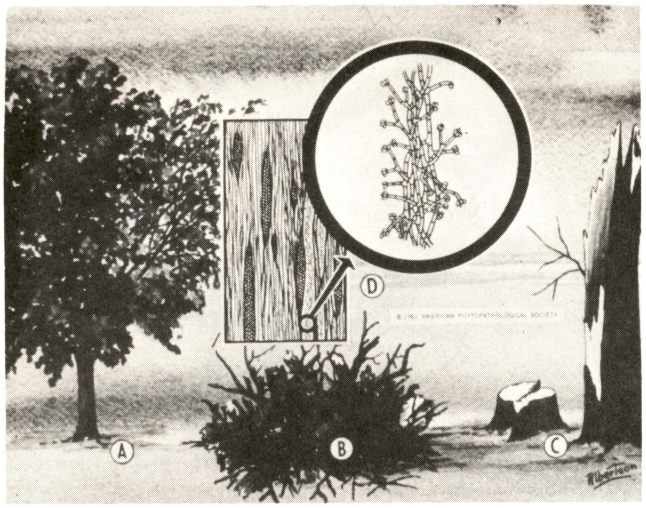
Brown discoloration in the sapwood of infected branches suggests Dutch elm disease, but only a laboratory diagnosis can confirm it.

For more instructions for preparing and mailing samples and for information on the cost of laboratory diagnosis, write or visit your local University of Missouri Extension Center or the State Extension Plant Pathology Diagnostic Laboratory, Department of Plant Pathology, 108 Waters Hall, University of Missouri, Columbia, Missouri 65211. You may also write this address for assistance with diagnosis.

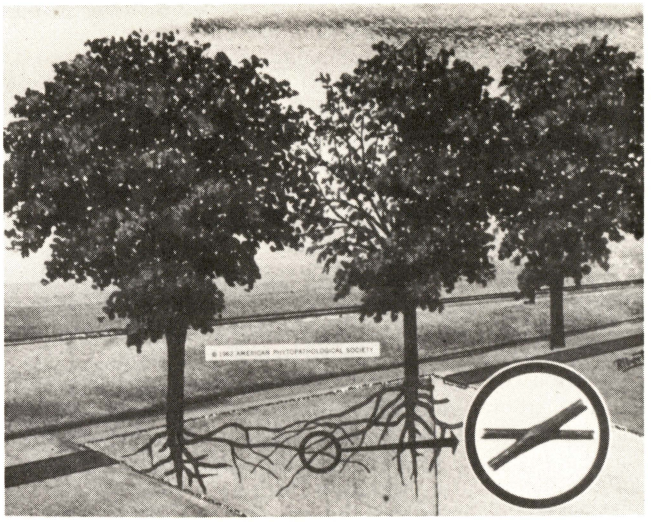
Learn the differences between Dutch elm disease and elm phloem necrosis, wetwood (or slime flux), or other silt diseases that occur in elms. Early leaf symptoms and wilts in elms may be confusing, and only laboratory analysis can reliably diagnose Dutch elm disease. The other elm diseases are also serious but must be diagnosed and treated according to the particular characteristics of the diseases. (See Guide 7254, *Elm Phloem Necrosis*.)

Prevention and Control

There is no cure for Dutch elm disease once the infection reaches the trunk and roots. Occasionally, the infection can be pruned out of the tree, if it is identified in early stages in branches before extensive spread. At present, the only ways to combat Dutch elm disease are sanitation, control of insect carriers, severing root grafts, fungicides, and planting replacement trees.



Dead and dying elm wood with tight bark harbors the fungus (A,B,C,D), and beetles breed in such wood.



Underground root grafts transmit Dutch elm disease from infected to healthy trees.

Consider several factors before starting a control program. First, estimate the value of your elms, including cost of removal should the disease kill them. Since any control program's success is related to consistent year-to-year control measures, decide whether these costs are reasonable. Options for control range from simple sanitation programs to complete programs that include insecticides and fungicides.

Place primary emphasis on preventive action. The first steps in prevention and control are early detection and accurate diagnosis of the disease in suspected trees.

Sanitation. A preventive disease program based on sanitation is most effective when used throughout the community. This option may still be acceptable in states where the disease has recently become a problem. However, the point of no return occurred in Missouri many years ago. Sanitation on a local basis is the only practical option.

Destroy reservoirs of infection and breeding places for the beetles that carry the fungus. This means you will need to remove and destroy all actual and potential sources of bark beetle breeding. The beetles prefer dying elms more than dead elms.

Prune out dead and dying branches in living elm trees. Eliminate cut, broken, or fallen elm limbs, diseased elms, and dying or dead elm trees. Remove from firewood piles all elm wood (unless de-barked) and destroy by burning before the end of March.

Beetle Control. Spraying with insecticides is of little value unless you also use sanitation practices. We recommend an application of methoxychlor *during the dormant season.* Thoroughly cover the trees from twigs to trunk base. A single late winter or early spring application should be adequate.

Spray only when there is little or no wind and the temperature is above freezing (40° F or above). Use either a hydraulic sprayer or a mist blower. Be certain the sprayer can deliver spray to the top of the tree with complete coverage. In hydraulic sprayers, use 16 pounds methoxychlor (8 gallons emulsifiable concentrate) in 92 gallons of water. Apply at a rate of 20 to 30 gallons per 50-foot tree. In mist blowers, use 100 pounds methoxychlor (50 gallons 25 percent methoxychlor emulsifiable concentrate) in 50 gallons of water and apply at a rate of 2 to 3 gallons per 50-foot tree.

An insectide spray properly formulated and applied to a healthy tree protects that tree from infection from beetles. *It will not cure a diseased tree.* Although spray protection is not perfect, spraying has kept new infections to about 2 percent, when coupled with careful sanitation.

Consult the latest *Missouri Insect Control Recommendations Handbook* for more detailed information on elm bark beetle control. Also refer to Guide 7255, *Controlling the Insect Carriers of Dutch Elm Disease and Elm Phloem Necrosis.*

Severing Root Grafts. Since Dutch elm disease can be transmitted from a diseased elm to an adjacent healthy elm through root grafts, sever such grafts before infection takes place. They can be severed mechanically or by chemical means.

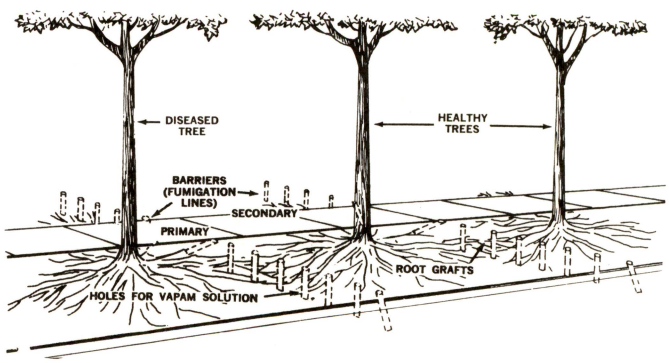
Vapam (sodium N-methyl dithiocarbamate), a soil fumigant, can sever root grafts. A small portion of the peripheral roots are killed to isolate the diseased tree. Disease-bearing sap cannot pass through dead roots.

Root grafts of large trees may extend outward 50 feet or more. With a crowbar, soil auger, power drill, or other suitable tool, drill a series of holes ¾ to 1 inch across, 15 inches deep, and 6 inches apart, just outside the drip line of the *diseased* tree crown. Mix 1 part Vapam to 3 parts water and fill each hole with the diluted solution to within 2 inches of the soil surface—*avoid overflowing.* Tamp each hole shut with your heel to reduce grass kill and dispersal into the atmosphere.

If an adjacent tree in a row or group of elm trees is already infected through root grafts from a diseased tree, we recommend a second fumigation line to break root grafts.

Two weeks *after* fumigation, remove and burn all diseased trees.

The soil fumigant should *not* be used unless you are positive a tree is diseased.



A soil fumigant can sever root grafts and isolate diseased trees.

Fungicides. Since Dutch elm disease became a serious problem, many systemic insecticides and certain anti-fungal chemicals have been tried, most with little or no success. Recently, injecting certain systemic fungicides into elm trees for prevention of Dutch elm disease has shown promise. Therapeutic results of the injected fungicides—after trees have been affected—have been variable and often disappointing. However, as preventive treatments the systemic fungicides have been more successful.

Two fungicides have been cleared by the Environmental Protection Agency for Dutch elm disease control: (1) Lignasan BLP (methyl 2-benzimidazole carbamate phosphate), a systemic fungicide closely related to benomyl (Benlate). It is now distributed under several trade names, including Correx, Elmosan, Arboral Fungicide, Elm Tree Noculate, Ulmasan, Wasco Tree Fungicide, etc. (2) Arbotect (Merck and Co.). Considerably more research has been done with Lignasan BLP through the Elm Research Institute.

These fungicides must be injected into the tree by trained arborists and others properly trained in the identification of Dutch elm disease and injection techniques. For successful prevention of disease, use injection in conjunction with sanitation and insect control programs.

Following are instructions for people trained to inject fungicides: Inject material according to label directions, using the proper amounts of fungicide and water. Determine the dosage by breast-height measurements of diameter and/or circumference of the tree. For instance, inject 2 gallons of dilute solution (for example, 1 quart of Lignasan BLP in 4 gallons of distilled water) for each 4 inches of tree diameter (or for each foot of circumference) measured at breast height. Inject the fungicide into the root flares or trunk as close to the ground level as possible. We recommend a pressurized injection harness, such as the one developed by the Elm Research Institute or other firms.

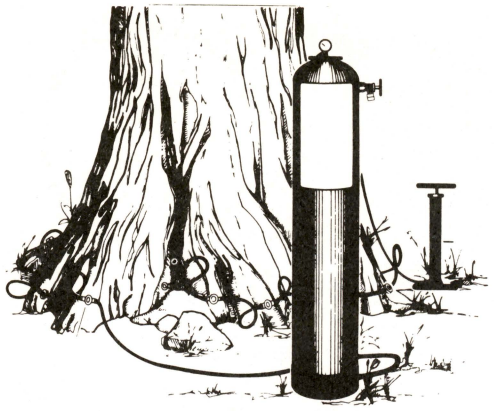
Prepare the tree by boring holes 1½ to 2 inches deep (depth of holes vary with the age of tree and depth of bark) through the bark and into the sapwood. Drill holes uniformly around the base of the trunk or in the root flares at approximately 6-inch spacings. Diameter of the holes depends on the injection equipment used. The Elm Research Institute Injection #104 uses 5/16 inch; the Hopkins elm Treater needs a 19/64 inch hole.

Attach the harness with care after drilling holes, as each fitting must be tight enough to avoid leaks. Also, permit trapped air in the tubing to escape before pumping chemical into the tree. Use low pressures, as suggested on the label (10 to 30 pounds per square inch).

Although you may treat elm trees any time during the growing season, current research shows that you obtain best protection when trees reach one-half to full leaf (usually mid-May or early June).

After the fungicide has been injected, remove injection points, fill the holes with grafting compound, and cover hole with a good tree wound dressing. Never use wooden dowels. *We recommend annual treatment for sustained prevention of infection.* Thus, each year, new holes should be drilled above and to one side of the previous year's holes.

Fungicide treatment of infected trees is less reliable. Trees showing early stages of disease development (less than 5 percent crown symptoms) represent a gamble to tree owners. Treatment can prevent infection from spreading down into the trunk, if it has not already reached the trunk. There have been some successes, but prompt treatment is essential for success.



A pressurized injection harness, which is attached to the tree, injects fungicides into trees.

Trees showing more than 5 percent crown damage may not respond to treatment. Five percent is not much symptom expression—only a few smaller branches. If the infection appears in low branches or if the fungus likely entered the tree through root grafts, chances of arresting the disease are low. Also, if early symptoms are carry-over infections from the previous year, success of treatment may be low.

Planting replacement trees. Since native elm trees are vulnerable to the Dutch elm disease, you may want to replace them with other shade tree species. See Guide 5006 for suggested shade trees.

Despite their susceptibility to Dutch elm disease, elms have many characteristics that make them valuable shade and landscape trees. They are adapted to a wide range of climatic conditions. Several elm species have attractive forms and rapid growth rates. For this reason the U.S. Department of Agriculture and state experiment stations have been conducting research to develop selections of elm that are resistant to the Dutch elm disease. Investigators in the Netherlands have found several elms with a high degree of disease resistance among commonly susceptible European elm species. Among them are the *Christine Buismen* elm and several other more promising selections that have been developed in this country and abroad. They are being tested in several parts of the United States for their adaptability and resistance to native pests. One of those is the *Urban* elm, a cross between an Asiatic and a European elm, developed by the U.S. Department of Agriculture and released to the nursery industry.

The tragic loss of elms from the Dutch elm disease should teach us not to plant extensively a single shade-tree species. In the future, a mixture of shade-tree species will provide uniform appearance and yet can keep losses from diseases and insects to a minimum.

Acknowledgments

All the photos except the one of the dead elm are used through the courtesy of the American Phytopathological Society. The drawing on the previous page is from an Iowa State University adaptation of a Stauffer Chemical Company diagram. The drawing on this page is from the Elm Research Institute booklet, *The Conscientious Injectors Handbook.*

■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914 in cooperation with the United States Department of Agriculture. Leonard C. Douglas, Acting Director, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. ■ An equal opportunity institution.