



# Dutch Elm Disease and Its Control

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Dutch elm disease (DED) is the most destructive shade tree disease in North America, and has become one of the most widely known and destructive tree diseases in the world. All species of elms native to North America are susceptible to DED, but it is most damaging to the American elm. The American elm was one of the most widely-planted shade trees in the United States due to its unique vase-shaped growth form and its ability to grow under a wide range of conditions.

Dutch elm disease, as the name implies, was first described in the Netherlands in 1919. It spread rapidly in Europe and by 1934 was found in most European countries. DED was first found in the United States in Ohio in 1930 and around the port of New York in 1933. Oklahoma's first confirmed case of DED was found in 1961. The disease is common in the eastern half of Oklahoma and has been found as far west as Woodward County. Controlling Dutch elm disease is very difficult and is best achieved with a community-wide program.

## Cause and Symptoms

Dutch elm disease is caused by the fungus *Ophiostoma ulmi*. The fungus invades and grows in the water-conducting vessels of elms, inducing the host tree to produce material which, together with the fungus, plug the vessels and prevent water uptake. This barrier causes the tree to wilt and die.

The first evidence of DED is a wilting or "flagging" in one or more of the upper branches (Figure 1). Leaves on affected branches turn dull green to yellow and curl, then become dry, brittle and turn brown. Some trees die several weeks after becoming infected, while others wilt slowly and survive for a year or more. Peeling the bark from wilted branches reveals light to dark brown streaks or blue to gray discoloration of the wood beneath the bark. In cross section, this vascular discoloration appears as a brown ring in the outer sapwood of the wilting and dying branches (Figure 2).

**To positively identify DED, specimens from actively wilting branches with definite vascular discoloration are needed** (the fungus cannot be isolated from dead, dried branches). Branch samples from trees believed to be infected with DED should be about 1 inch in diameter and five to ten inches long. Samples should be taken to your local County Extension Office, and they will send them to the Plant Disease Diagnostic Laboratory.

## Fungal Transmission by Beetles

In the United States the fungus can be spread from diseased to healthy elms by two elm bark beetles: the European elm bark beetle (*Scolytus multistriatus*) and the native elm bark beetle (*Hylurgopinus rufipes*) (Figure 3). The European elm bark beetles are by far the more common vectors in Oklahoma because they are so highly competitive, and thus they usually displace the native elm bark beetles.

Like the DED fungus, the European elm bark beetle was introduced into the U.S. from Europe. This beetle was first reported near Boston, Massachusetts in 1909 and has spread over an even greater area than the disease itself. The European elm bark beetle was first reported in Oklahoma in 1953.

Attacks made by the beetles are for either feeding or breeding. Beetles feed primarily in one to four year old twig crotches of healthy elms. Feeding injury is most common in twig crotches of the outer portions of the tree crown. Beetles breed in dying or dead elm trees and logs with intact bark. Healthy elm trees are readily attacked for feeding, but are rarely selected for breeding purposes.

Overwintering larvae complete their development in early spring and emerge from the wood as adults in late spring. Adult elm bark beetles feed during the entire growing season of the elm.

European elm bark beetle emergence begins in April and continues through October. Two to three generations can occur in Oklahoma, with the overwintering generation emerging in late April, the first generation emerging in June, and the second generation emerging in late August to early September. The second generation is the largest in terms of numbers, but the overwintering and first generations are the most important in disease transmission because their emergence occurs when elm trees are most susceptible to the disease. Soon after adult elm bark beetles emerge, they search for feeding and breeding sites. This activity continues throughout the entire growing season of the elm. Tremendous increases in the number of elm bark beetles can occur in recently killed, cut, or damaged elm trees.

Reservoirs of the fungus develop in brood galleries established in DED-infected wood. Adult beetles that emerge from these galleries will be carrying fungus spores inside and outside their bodies, and can introduce them into healthy elms when they feed. In this way the DED fungus may be moved long distances any time during the entire active period of the adult elm bark beetle.



**Figure 1. Early symptom (flagging) of Dutch Elm Disease.**

The highest disease incidence results from beetles that emerge and feed during spring and early summer. At this time, the long vessels of the springwood, which are responsible for conducting materials inside the tree, are open and functioning. Spores of the DED fungus introduced into these springwood vessels are carried rapidly to other parts of the tree. Vessels produced later in the summer are shorter and smaller in diameter and restrict movement of the fungus. This may delay the death of the tree.

## Fungal Transmission Through Root Grafts

Root grafts (roots naturally fused together) occur between elms of the same species growing near one another (Figure 4). The prevalence of root grafts is influenced by the proximity of the trees and soil conditions. The fungus spreads from diseased to healthy trees through these grafts. The extent of spread through root grafts varies, but it is considered to be important, especially where large infected trees are within 35 to 50 feet of healthy elms.

## Control

The primary emphasis in a community-wide DED control program is preventive action. The basic elements are:

1. **DETECTION.** The systematic inspection of every elm in a control area for the early symptoms of DED.
2. **ISOLATION.** The disruption of root grafts between infected and healthy trees.
3. **REMOVAL.** The prompt elimination of all dead and dying elm material with intact bark from the control area.
4. **DISPOSAL.** The destruction (burn, bury, chip, or debark) of elm material with tight bark.

These sanitation measures are the key to successful management of the disease. Sanitation of dead and dying elm material each year can suppress the disease to minor proportions within a community. Other control techniques are



**Figure 2. European Elm Bark Beetle (top) and Native Elm Bark Beetle (bottom). Both adults are about 1/8 inch long (courtesy Dr. M.E. Ascerno).**

pruning of early infections, insecticide and fungicide applications, and planting resistant varieties of trees.

## Sanitation

Sanitation includes early detection, isolation, removal, and disposal of all weakened, dying, and dead elm trees with intact bark. This practice removes elm bark beetle breeding sites and sources of the DED fungus. Failure of sanitation will lead to higher beetle populations and more dead trees.

Dead and dying elms need to be removed because a section of an elm branch the size of a fireplace log, 22 1/2 by 3 1/2 inches, can produce up to 1,800 beetles. Left to stand, a complete tree could produce hundreds of thousands of beetles. If this tree were infected with the DED fungus, each emerging beetle carrying fungal spores could inoculate healthy trees during feeding. However, early detection and proper tree disposal prevents beetles from spreading the pathogen. Sanitation, in addition to eliminating the beetle population, eliminates a potential reservoir for the pathogen.

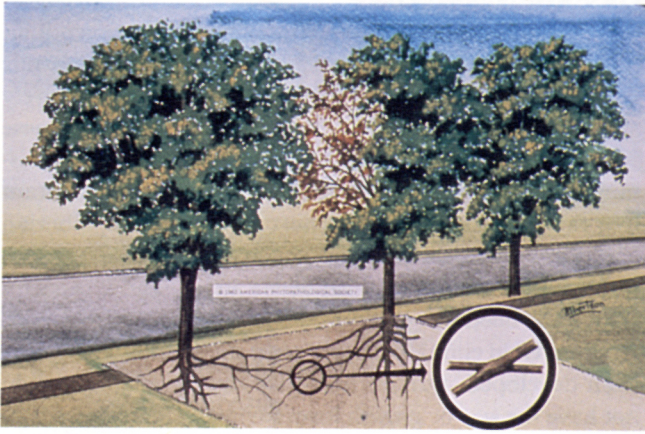
Proper disposal of elm material includes destruction of developing beetles and making the wood an unsuitable environment for the elm bark beetle. This is the final important phase in a successful sanitation program. Burning and burying are effective means of disposal, but are not productive from a wood utilization standpoint. Chipping is a good alternative to burning or burying since chipped wood cannot support beetle development. Never lose sight of the primary concern of wood disposal—the prompt elimination of beetles and beetle breeding material.

## Prevention of Root Graft Spread

The DED fungus commonly spreads from infected elms to nearby healthy elms of the same species through naturally grafted root systems. This spread can be prevented by mechanically trenching in areas where root grafts are likely to occur between infected and healthy elms. Root graft barriers or trenches should completely encircle diseased trees when elms are present on all sides.

A trench, 36-40 inches deep, between diseased and healthy trees immediately disrupts root grafts between these





**Figure 3. Variation in vascular discoloration indicative of DED, healthy twig on right (courtesy American Phytopathological Society).**

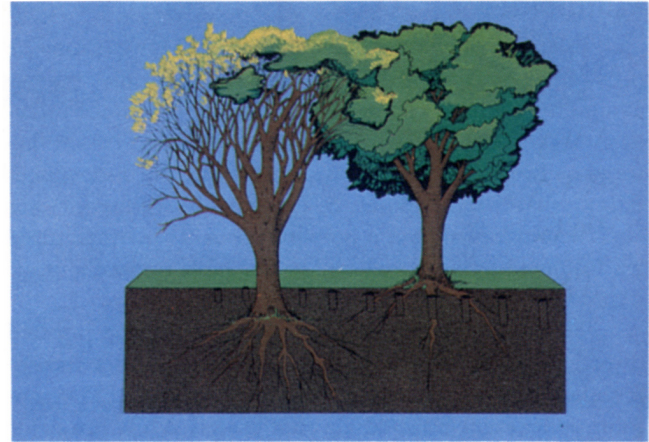
adjacent trees. A vibratory plow or mechanical trenching machine is the easiest way to trench, but its use may be limited in rocky soils or where underground utilities are present. After the trench is dug, refill it, and immediately remove the diseased elm trees.

### Pruning Diseased Trees

Early infections can be removed from elm trees by pruning. A minimum of 8-10 feet of streak-free wood (no vascular discoloration) below obviously infected branches must be removed. The entire circumference of the branch must be examined to be certain that the fungus has been removed.

### Insecticides

Another phase of the preventative program is control of the elm bark beetles by spraying with a properly labeled insecticide. A thoroughly applied spray will hopefully kill or prevent beetle feeding, and thus prevent infection by the DED fungus. A preventative spray approach to control the beetles includes treatment in late fall after the leaves have fallen. This helps control the last brood of adults that would be entering the trees to lay eggs for overwintering. Also, a treatment in early spring before bud swell, (late March to early April if possible) will help kill emerging overwintering adult brood members that would likely feed on susceptible trees. One should consider following this treatment with another spray (mid-May to early June). All bark surfaces must be completely covered with spray (especially smaller branches and twigs in the crown) to prevent bark beetle feeding or breeding. To effectively reduce bark beetle numbers, a thorough sanitation program should be followed, common root systems disrupted, and insecticide sprays utilized when needed.



**Figure 4. Root graft between diseased and healthy elms (courtesy American Phytopathological Society).**

### Fungicides

Infection of healthy elms by the DED fungus may be prevented by fungicides which are labeled for this use. To be effective, these chemicals need to be injected directly into the tree. Fungicide injections are not recommended for trees with more than five percent DED symptoms or for trees infected via root grafts. While fungicide injections have been effective in protecting valuable, healthy elms in communities with intensive DED control programs, the injection process itself can cause irreversible damage to trees. Remember, sanitation is the key to DED control.

### Resistant Varieties

Although elm species vary greatly in their susceptibility to DED, none are immune. The American elm *Ulmus americana*, our most valuable native elm tree, is one of the most severely affected. The Siberian elm (*Ulmus pumila*) and the Chinese or lacebark elm (*Ulmus parvifolia*) are the most disease resistant of the elm species. Lacebark elm is a disease-resistant tree that is well adapted to most of Oklahoma. Siberian elm is not recommended as a shade tree because it is subject to winter injury, elm leaf beetle attack, and it can support bark beetle populations. The 'Urban' and 'Sapporo Autumn Gold' elms are disease resistant hybrid trees of *Ulmus pumila* x *U. japonica* which have been developed, but do not have the size or growth form of the American elm. Two American elm cultivars, 'Valley Forge' and 'New Harmony', have shown high levels of resistance to DED, and are available through commercial nurseries. The 'American Liberty' elm is available through the Elm Research Institute in Keene, NH <http://www.libertyelm.com/index.html> but not through commercial nurseries. More than 250,000 'American Liberty' trees have been planted in the US since 1983, and only 150 have become infected with DED. The Elm Research Institute offers a warranty with the purchase of the tree.

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Extension carries out programs in the broad categories of agriculture, natural resources and environment; home economics; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

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