Sustainable Urban Landscapes

Oak Wilt – Identification and Management

Introduction

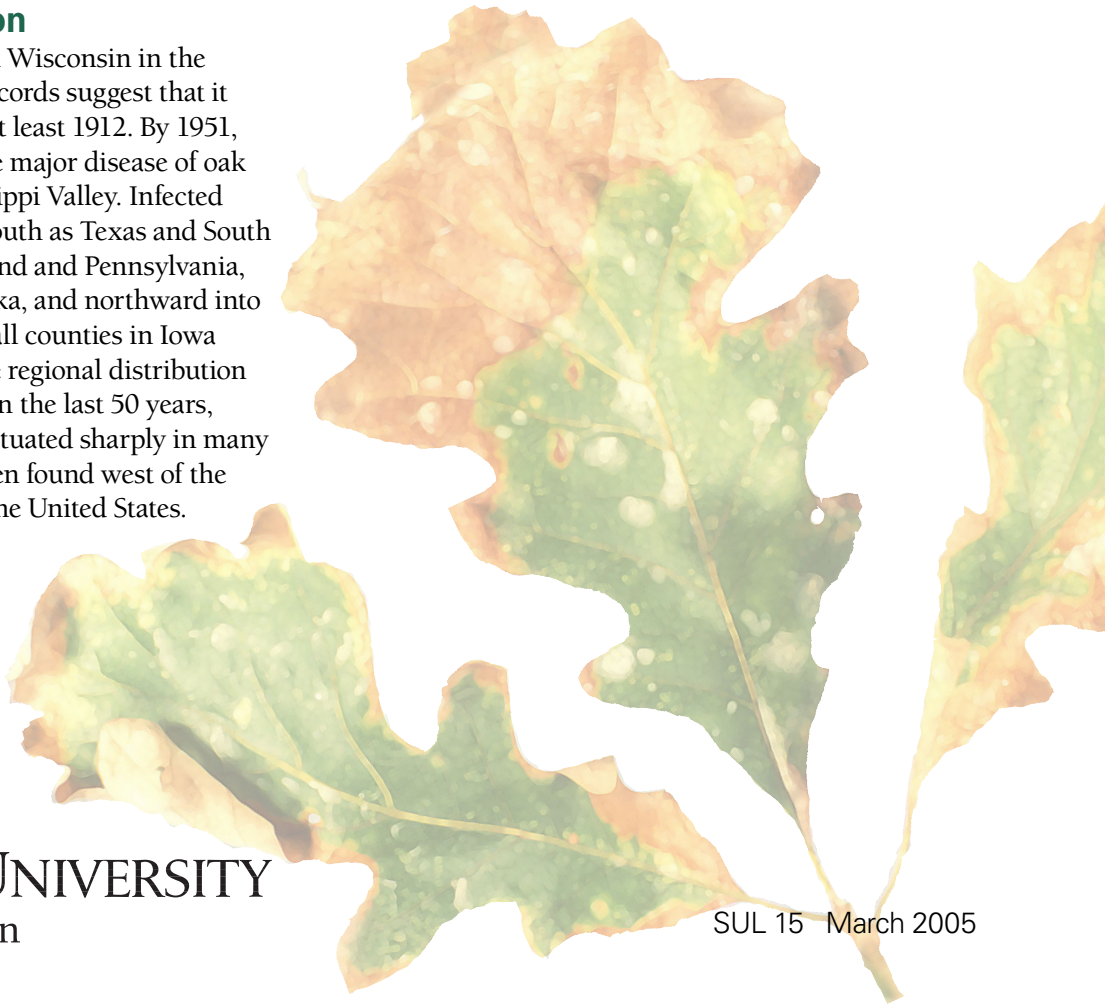
Oak wilt, the most damaging disease of oak trees in Iowa, has killed many forest and landscape oaks in the Eastern and Central United States. Oak wilt has not devastated its host species, however, mainly because its spread from diseased to healthy trees has been relatively slow and sporadic. Nevertheless, local outbreaks of oak wilt can kill or injure many trees. The management practices described in this publication can help minimize the risk of losing oaks to this disease.

History and distribution

Oak wilt was first identified in Wisconsin in the early 1940s. Disease survey records suggest that it had been present there since at least 1912. By 1951, oak wilt was recognized as the major disease of oak throughout the Upper Mississippi Valley. Infected trees have been found as far south as Texas and South Carolina, as far east as Maryland and Pennsylvania, westward into eastern Nebraska, and northward into central Minnesota. Virtually all counties in Iowa have reported the disease. The regional distribution of oak wilt has changed little in the last 50 years, although its incidence has fluctuated sharply in many localities. Oak wilt has not been found west of the Rocky Mountains or outside the United States.

Cause

The fungus that causes oak wilt, *Ceratocystis fagacearum*, invades the water-conducting tissues (xylem) of oak trees. The trees respond to this attack by plugging the xylem vessels with tyloses, which are outgrowths from cells next to the vessels. The tyloses block the normal upward flow of water through the vessels, causing the foliage to wilt and die. In this way, a tree's own defenses (tyloses) can hasten its dieback and death.



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Host range and disease severity

All oaks are susceptible to oak wilt. However, species in the red oak group (red, black, scarlet, shingle, and pin oaks) are more susceptible than species in the white oak group (white, bur, chinkapin, and swamp oaks). Trees in the red oak group often die within 1 to 4 months after infection. Trees in the white oak group typically develop symptoms more slowly. For example, bur oaks typically die after 1 to 7 years, showing progressive dieback during the process. White oaks may take up to 20 years to die, and some white oaks survive the disease.

Symptoms

Red oak group

Oak wilt symptoms first appear in late spring or early summer. Leaves discolor, wilt, and fall at the top of the tree first (Figure 1), and later at the tips of the lateral branches. Leaves turn a dull, bronzed brown at the tips and along the outer margins, with a sharp line separating discolored from normal green tissue (Figure 2). The discoloration progresses toward the leaf base and the midrib. Infected trees often wilt completely within several weeks after the first symptoms appear. The heavy defoliation that accompanies wilting includes leaves at all stages of discoloration, even completely green leaves. Oak wilt sometimes turns the outermost ring of sapwood a dark brown or black, appearing as streaks when the bark of an infected branch is peeled (Figure 3).

White oak group

Symptoms are more variable in the white oak group than in the red oak group. Although symptoms may develop in a sequence similar to that of the red oak group, they often begin in mid- to late summer and progress more slowly in the white oak group. In a given year, only a few branches of an infected tree, scattered through the crown, may show symptoms and die back (Figure 4). Leaf browning in the white oak group (Figure 5) occurs in a pattern similar to that in the red oak group (Figure 2). Trees infected for two or more years commonly develop isolated dead branches in the crown. Brown streaks often are found in the sapwood of infected branches. In white oaks, discoloration of the xylem often shows as a dark ring when the branch is cut in cross-section (Figure 6).

Figure 1. A red oak dying from oak wilt.

Figure 2. Browning of the margins of red oak leaves.

Figure 3. Brown streaks in the sapwood of a red oak branch.

Figure 4. A wilting white oak.

Figure 5. Marginal browning of white oak (bur) leaves.

Figure 6. Browning of the vascular system of a white oak.

Diagnosing oak wilt

An experienced arborist often can diagnose oak wilt reliably based on field symptoms. However, oak wilt is easy to confuse with other disorders. Among the problems that can appear similar to oak wilt is anthracnose, a fungal disease that attacks only the leaves. Anthracnose typically causes marginal browning and defoliation of leaves on the lower branches of the tree (Figure 7), but little or no lasting damage to most trees. Other

Figure 7. Symptoms of oak anthracnose, a minor oak disease that often is misidentified as oak wilt.

stresses that show symptoms similar to oak wilt include drought, insect borers (including two-lined chestnut borer), waterlogged soil, nutritional imbalances, chemical injury, and lightning. Oaks also are sensitive to disturbances accompanying construction, logging, or other nearby activities, such as soil filling, trenching, and compaction. Browning of leaves and wilt-like symptoms resulting from these disturbances resemble oak wilt.

Because there are so many similar-looking problems on oak, it is helpful to have a diagnosis of oak wilt confirmed by laboratory testing.

Samples submitted for diagnosis should consist of branch segments, 1/2 to 1 inch in diameter and 6 to 10 inches long, from several different branches that are showing symptoms. The sampled branches should have freshly wilted leaves, but must be living, because the fungus cannot be isolated from dead wood. Samples should be sealed in plastic bags and kept cool and dry prior to shipment. It also is helpful to include a few dozen partially discolored leaves. Samples can be mailed to:

Plant Disease Clinic
Iowa State University
351 Bessey Hall
Ames, Iowa 50011

(phone: 515-294-0581
email: sickplant@iastate.edu)

Include your name, address, and other pertinent information, such as the species, location, condition, and previous history of the tree. When possible, please use form PD-31, Plant Disease Identification Form, available at county extension offices. It's helpful to keep a record of the trees sampled and tag each tree with the number given to the samples taken from it. Photographs or digital images of a tree's symptoms also are very helpful to include with the branch samples. The Plant Disease Clinic charges a fee for each sample submitted.

Figure 8. Iowa State University Plant Disease Clinic.

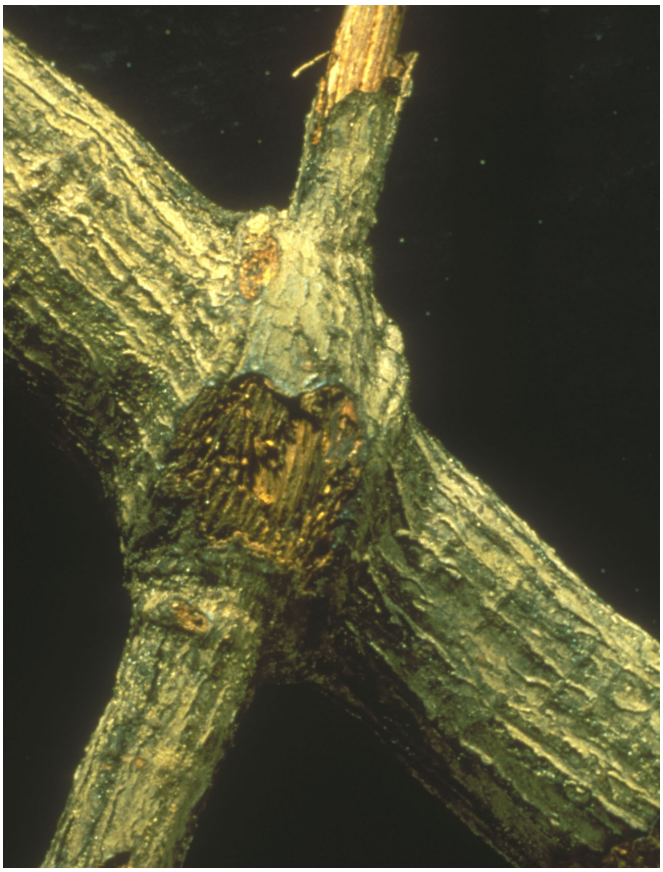

Figure 9. Root graft joining roots from adjacent oak trees of the same species.

Disease cycle and spread

Oak wilt can spread from infected trees to healthy trees in two ways: through root grafts connecting nearby oaks, and by insects that carry spores of the fungus from one locality to another.

Roots of oaks form natural grafts with roots of adjacent oaks of the same species up to 50 feet apart (Figure 9). Root grafts link together the vascular systems of the trees, forming a common network through which the oak wilt fungus can move. Root grafts rarely occur between oaks of different species. The oak wilt fungus can survive for at least three years in the root systems of red or black oaks killed by the disease and can be drawn through root grafts to nearby trees throughout that time. Root graft transmission can spread the disease outward from an initial infected tree to kill all the same-species oaks in a stand. Patches of infected trees, with dead trees at the center and dying trees on the edges, are common occurrences in woodlands affected by oak wilt (Figure 10).

Oak wilt also is spread by spores produced on infected trees. As trees of the red oak group begin to die, usually within several months after infection, the fungus begins to grow abundantly between the bark and the sapwood of the trunk or a branch. Patches of fungal filaments, called mycelial mats, push outward on the bark

Figure 10. A grove of red oaks killed by oak wilt in Minnesota.

as they grow, eventually opening longitudinal cracks in the bark (Figures 11 and 12). Mycelial mats develop primarily during spring and fall months, and less often during the summer. The mats release a fruity odor that attracts sap-feeding insects, particularly picnic beetles of the Nitidulidae family (Figure 13). Sticky spores of the fungus, which develop on the mycelial mats, become attached to the beetles. The beetles then may fly to other oak trees and feed on the sap flow from fresh wounds, transmitting spores of the oak wilt fungus. In this way, oak wilt may be spread over distances of at least several hundred feet. Oaks are particularly susceptible to wound infections in spring and summer, when sap flow from wounds is greatest.

Another group of insects, oak bark beetles, may be important in spreading oak wilt in the southern part of the disease's geographic range. These beetles breed in wilt-killed trees and feed on twigs of healthy oaks. Unlike picnic beetles, oak bark beetles do not require open wounds to transmit the fungus. However, evidence indicates that picnic beetles are the predominant insect vector of oak wilt in the Upper Midwest, including Iowa, and that oak bark beetles are relatively unimportant as vectors in this region. There is no evidence that birds, squirrels, or other animals transmit the oak wilt fungus.

Figure 11. Side view of an infection cushion of the oak wilt fungus under the bark of a red oak.

Figure 12. Another view of an infection cushion on a red oak.

Photo by USDA Forest Service

Figure 13. A picnic beetle, also called sap beetle or nitidulid beetle, can transmit the oak wilt fungus.

Control strategies

Avoid wounds during high-risk period

Oak trees wounded between April 1 and July 1 are at high risk for oak wilt infection because sap flows freely from wounds made during this period. The wounds are attractive to sap-feeding beetles that can transmit the oak wilt fungus. Sap beetles can be abundant during this period, increasing the risk of oak wilt infection. If pruning, logging, or other wounding is unavoidable during this high-risk period, wounds should be treated promptly (within several hours) with wound treatment compound or paint to avoid attracting insects. Avoid using asphalt or creosote-based paints.

The risk of insect transmission is lower from July 1 until the first hard frost, but some risk still remains. A wound dressing still can be applied to provide additional protection.

Wounds made during the dormant season, from the first hard frost until April 1, do not require wound dressing. This is the safest period for making any type of wound on oaks, whether from pruning, logging, construction activity, or other causes.

An estimated 80 percent of new outbreaks of oak wilt result from wounding during construction activity. Special care should be taken before and during site clearance and construction to protect high-value oaks from wounding and apply wound dressings where these trees have been damaged.

Prevent root graft transmission

Various mechanical methods may be used to sever all root grafts connecting wilting or suspect trees to healthy trees. The choice of method will depend on the individual situation. Time is critical to the success of this effort; the sooner the grafts are broken, the better the chances for saving nearby trees. Oaks within 50 to 60 feet of diseased trees of the same species can be at risk of infection by root graft transmission. To effectively stop spread of oak wilt within a group of oaks, two barriers are recommended: a primary barrier, separating wilting trees from adjacent, apparently healthy trees; and a secondary barrier, separating the latter from remaining trees (Figure 14). Barriers between diseased and healthy-appearing oaks of different species are usually not necessary.

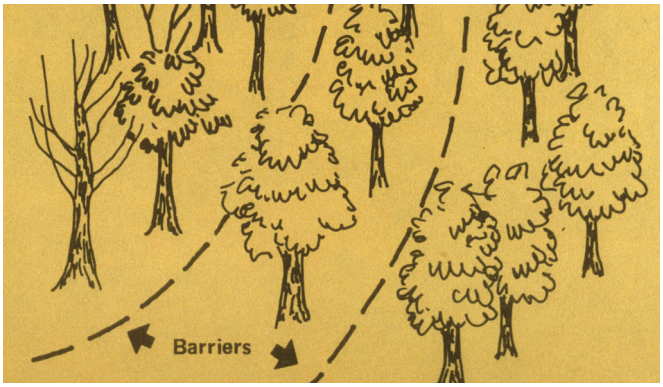

Figure 14. Recommended location of root disruption barriers to block root graft transmission of oak wilt.

It is important to break root grafts before removing oaks that are showing oak wilt symptoms, since removal of these trees before breaking the grafts can speed up movement of the fungus into neighboring oaks. In addition, cutting down healthy oaks around the perimeter of infected trees without breaking root grafts will not stop the spread of oak wilt. Roots of the felled trees remain alive, and the fungus can pass through grafts to healthy trees beyond the ring of felled trees.

A trenching machine (Figure 15) or a vibratory plow can be used to break connecting roots 4 1/2 to 5 feet deep, midway between a diseased tree and an adjacent healthy tree. This type of equipment may be available from local rental agencies, state or city foresters, or arborists. A vibratory plow may be more expensive, but it leaves much less disturbance at the ground surface and is able to reach more deeply into the ground than most trenching machines. Root disruption within 10 feet of healthy trees should be avoided, because it often causes severe root injury.

Figure 15. A trenching machine can be used to break root grafts between adjacent oaks of the same species.

In situations where root grafts cannot be broken mechanically due to the presence of barriers such as sidewalks, driveways, and buried utility lines, a soil fumigant can be used to kill the grafted roots. The fumigant is placed in the soil between adjacent diseased and healthy trees. The fumigant most commonly used for this purpose is sodium-n-methyl dithiocarbamate (sold as Vapam®). Because fumigants are highly toxic, it is advisable to consult with a professional forester, arborist, or extension specialist before proceeding.

Inject fungicide

The fungicide propiconazole (sold as Alamo®) can be injected into oaks to prevent or suppress oak wilt. Propiconazole is typically injected by a tree care professional into the root flare (base of the trunk) in late spring to early fall, and spreads throughout the tree. Fungicide injection is a viable option to protect high-value oaks adjacent to wilting trees of the same species, in situations where root disruption is not possible. Injection can be effective in suppressing oak wilt even after a small portion of the branches begin to show symptoms, but is most effective in protecting trees that are free of symptoms when injected.

Remove diseased trees and use firewood safely

Red oak group

Infected trees of the red oak group frequently develop mycelial mats as they decline and die. Removal in fall or early winter poses the least risk of spreading oak wilt. If a felled tree is cut into firewood-length pieces, it should immediately be piled and covered with a black

plastic sheet whose lower edges are covered with soil to make a tight seal. Piles that are covered in spring or early summer can be uncovered and used safely by late summer or early fall. If wood with the bark attached is chipped, the chipped material should be piled promptly to allow composting to eliminate mycelial mats. Trees intended for use as lumber should be debarked or covered quickly. If these precautions are followed, trees in the red oak group that are infected with oak wilt can be converted to lumber, veneer, pulpwood, firewood, or chips without serious risk of spreading the disease.

White oak group

Selective pruning of diseased branches may aid recovery or prolong the survival of high-value trees in the white oak group. Remove the affected branches and treat the wounds promptly. Because infected trees in the white oak group typically do not form mycelial mats, firewood or other wood products from infected white, bur, chinkapin, and swamp oaks pose no hazard of transmitting oak wilt.

Contain oak wilt in woodlands

Mechanical barriers are seldom practical or economical in most woodland situations, because individual trees are generally less valuable than in urban settings. However, trenching machines, vibratory plows, and backhoes may be used to create root transmission barriers in specialized situations. Fungicide injection is almost never cost effective in woodland situations. Another management alternative in woodlands is to let oak wilt run its course, because the disease often dies out naturally following local outbreaks. In many instances, this strategy is the most practical and cost-effective one for woodlands.

Summary

Oak wilt, a disease of Iowa woodlands and landscapes, rapidly kills red, black, and pin oaks, while white and bur oaks die back more slowly, and white oaks occasionally recover. Symptoms are often confused with other maladies, so a laboratory test should be done to confirm a tentative diagnosis of oak wilt. The disease spreads in two ways: over land, by means of insect vectors; and underground, through root grafts between adjacent oaks of the same species.

To minimize overland spread, avoid wounding oaks during the high-risk period (April 1 to July 1), and if possible during the lower risk period from July 1 to the first hard frost. When wounds are unavoidable during these periods, they should be protected by a wound treatment compound or paint. The safest period to prune oak trees is the dormant period, between the first hard frost and April 1.

To stop root graft transmission of the fungus, grafts can be broken mechanically by creating barriers between adjacent infected and healthy trees. Fungicide injection sometimes can protect high-value trees even when a small portion of the crown has begun to wilt, but is most effective in protecting healthy-appearing oaks that are at risk of becoming infected.

Integrating oak wilt management practices is usually the most effective approach to suppressing the disease. For example, it is important not only to time pruning to avoid the high-risk period, but also to remove and properly handle infected oaks in the red oak group. In communities that have experienced oak wilt outbreaks, a coordinated program involving both homeowners and government officials has been shown to be most effective.

For further information, consult the U.S. Forest Service bulletins

"How to Identify, Prevent, and Control Oak Wilt"
(http://www.na.fs.fed.us/spfo/pubs/howtos/ht_oakwilt/toc.htm)

"How to Collect Field Samples and Identify the Oak Wilt Fungus in the Laboratory"
(http://www.na.fs.fed.us/spfo/pubs/howtos/ht_oaklab/toc.htm).

To obtain a free CD, *"Oak Wilt: People and Trees,"* from the U.S. Forest Service, St. Paul, MN, telephone: 651-649-5000.

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