Oak Wilt in Minnesota

Jennifer Juzwik - Research Plant Pathologist, US Forest Service

Brian Schwingle - Forest Health Specialist, MN Department of Natural Resources

Matthew Russell - Extension Specialist-Forestry

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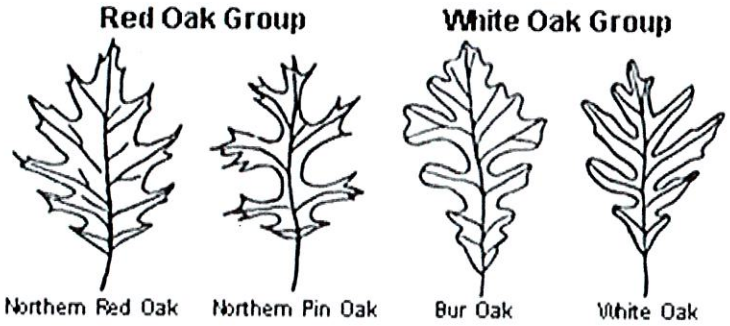
Introduction

Oak wilt, caused by the non-native fungus *Ceratocystis fagacearum*, is responsible for killing large numbers of oaks annually in Minnesota. Oaks are a valuable and abundant shade and forest tree in the state. Oak wilt is most severe in red oak group species such as northern red oak and northern pin oak (Fig. 1). Fortunately, this valuable resource can be protected by utilizing effective management techniques.

Oak wilt occurs in 24 states in the eastern United States and is not known to occur elsewhere. In Minnesota, the disease is currently found in an area bounded on the north by Pine County, on the west by Stearns and Nicollet counties, and south to the Iowa border (Fig. 2). The greatest concentrations of oak wilt are found in Sherburne, Anoka, Isanti and northwestern Dakota counties.



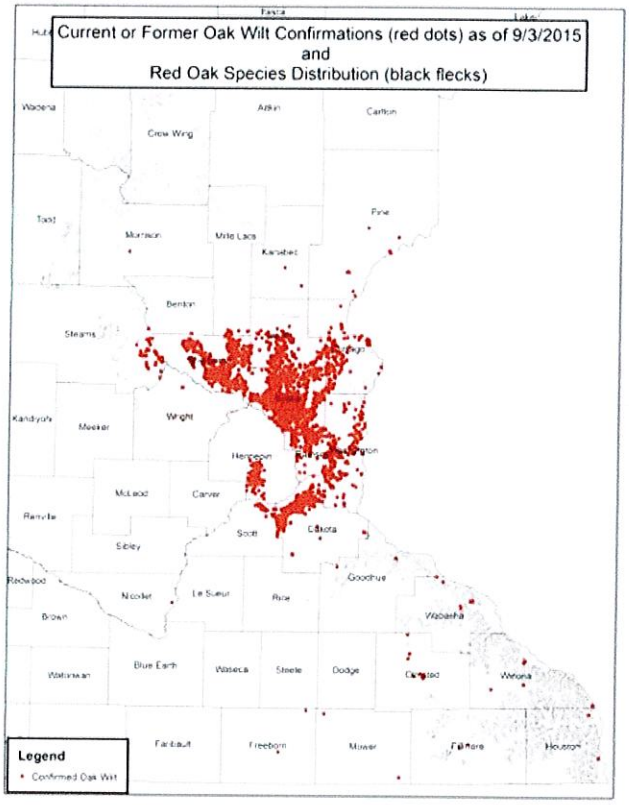


Figure 1. (left) The four most common species of oaks in Minnesota.

Figure 2. (above) Former or current oak wilt locations in Minnesota are shown as red dots.

Symptoms

Red oak group

Following infection, the fungus is quickly transported through the water-conducting system of red oaks and leads to rapid wilting. Wilting usually starts at the top or outer portions of the tree crown and quickly progresses downward.

Leaves take on a bronze to reddish brown discoloration beginning with the tip and margins, progressing toward the midrib and base of the leaf (Fig. 3A). A water-soaked appearance may develop on dark green leaves. Affected leaves are quickly cast and can be found on the ground around the dying tree.

Complete wilting and leaf loss can occur in as little as 4 weeks in branch infections or shortly after leaf-out the spring following root graft infection.

A dark bluish-gray discoloration may be observed on the wood surface when bark is peeled back from a branch with wilted leaves.

White oak group

Affected branches of bur oaks are scattered through the crown (Fig. 3B). Progressive development of the disease may occur year to year with tree death occurring between two and five years or longer after first symptoms develop. Bronzing and browning of leaves generally occurs from the tip and a portion of the leaf margin toward the midrib or base of the leaf, but symptoms may be irregular.

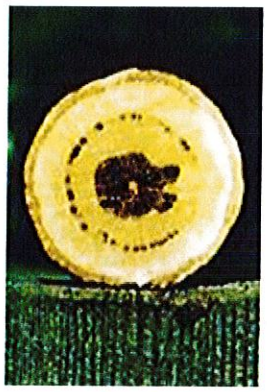


Figure 4. Cross-section of white oak branches show discoloration often seen as small dark dots in the wood just under the bark.

In white oaks, a single main branch or fork of the crown may exhibit wilting leaves during summer but no further symptom development may occur until the next year or following years (Fig. 3C). White oaks in Minnesota have been observed with very slowly progressing symptoms. A dark brown to black discoloration on the wood surface may be found when the bark is peeled back from a branch with wilting leaves. Walled-off fungal infections may also be observed in the cross section of an infected branch (Fig.

Oak wilt lookalikes

Bur oak blight, another common and significant disease of bur oak in Minnesota, can be readily confused with oak wilt. Injury caused by **two-lined chestnut borer** can also be confused with oak wilt. **Anthracnose** may mimic some leaf symptoms of oak wilt, but usually occurs only in the lower crowns of trees.

Oak Wilt Fungus Spread

The oak wilt fungus spreads from diseased to healthy trees either below-ground via connected roots or above-ground by insects. Most new infections are the result of fungus transmission through roots of adjacent trees that have grafted together. Frequency of root grafting depends on the oak species involved, the size of the trees, soil type and terrain. For example, root grafting is very common among northern pin oaks on sandy soils in flat terrain. The maximum distance over which root grafting may occur is also dependent on these same factors.

As a general rule, the probability of root graft spread decreases with distance from the diseased trees. For example, the majority of such spread in a Minneapolis-St. Paul urban study was found to occur within 30 feet, but wilt did occur in some trees up to 50 feet from the nearest infected tree. Root grafts may occasionally occur between different species of oak, including species from different oak groups.

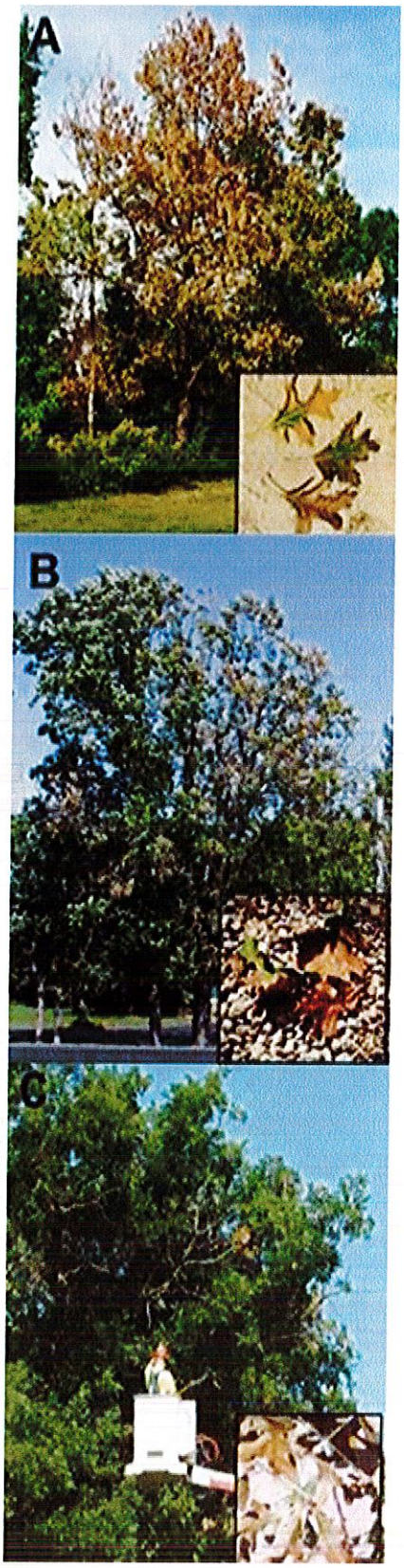


Figure 3. Oak wilt symptoms on red (A), bur (B) and white oaks (C).

Two species of sap beetles (Family *Nitidulidae*) (Fig. 5) are the primary insect transmitters of *C. fagacearum* overland from diseased trees to healthy trees in Minnesota. Insect transmission is important as it is the means by which new oak wilt centers are starter.

Sap beetles are attracted to the volatiles produced by the sporulating fungal mats in the bark-wood interface (cambium) of oak wilt-killed trees (Fig. 6). Although mats are commonly produced during the spring and fall, the mats that are produced April through mid-July on red oaks that wilted the previous year are most important in disease spread. This is the same time period during which red oaks produce large diameter springwood vessels that are particularly susceptible to infection by *C. fagacearum*. In addition, the primary sap beetle vector species are strongly attracted to tree volatiles associated with fresh, wood-penetrating wounds. Thus, wounded oak trees visited by fungus-contaminated beetles can result in oak wilt spread, particularly during the spring months. Oak bark beetles (*Pseudopityophthorus* species) are important oak wilt vectors in some parts of the U.S., but are not considered important vectors in Minnesota.

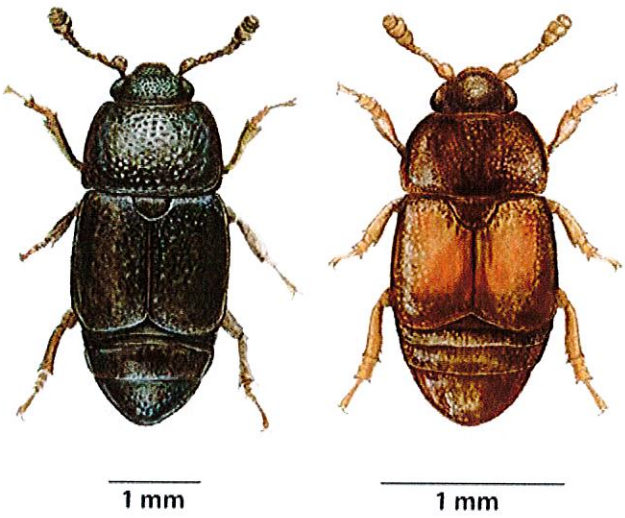


Figure 5. *Carpophilus sayi* (left) and *Colopterus truncates* (right).

Management Strategies

Individual control actions can be taken to stop the spread of the oak wilt fungus, but the coordinated use of several actions is the best strategy.

Accurate diagnosis of the disease is highly recommended before any control action is undertaken. Diagnosis can be done by an experienced tree care professional or by consulting the University of Minnesota's Plant Disease Clinic (http://pdc.umn.edu/).

Stopping belowground spread

Root grafts are most common between closely-related oak species (e.g., red oaks). Healthy trees of a different species can be found in oak wilt infection centers (e.g., bur oaks in a red oak infection center; Fig. 7). Cutting root connections between diseased and healthy oaks is the best way to prevent expansion of existing oak wilt centers. A vibratory plow with a 5-foot long blade is commonly used in Minnesota to cut the roots. Other equipment, such as a trenching machine, backhoe and mini-excavators can be used but are more disruptive to the site, require back-filling with soil, and often do not reach a 5-foot depth.

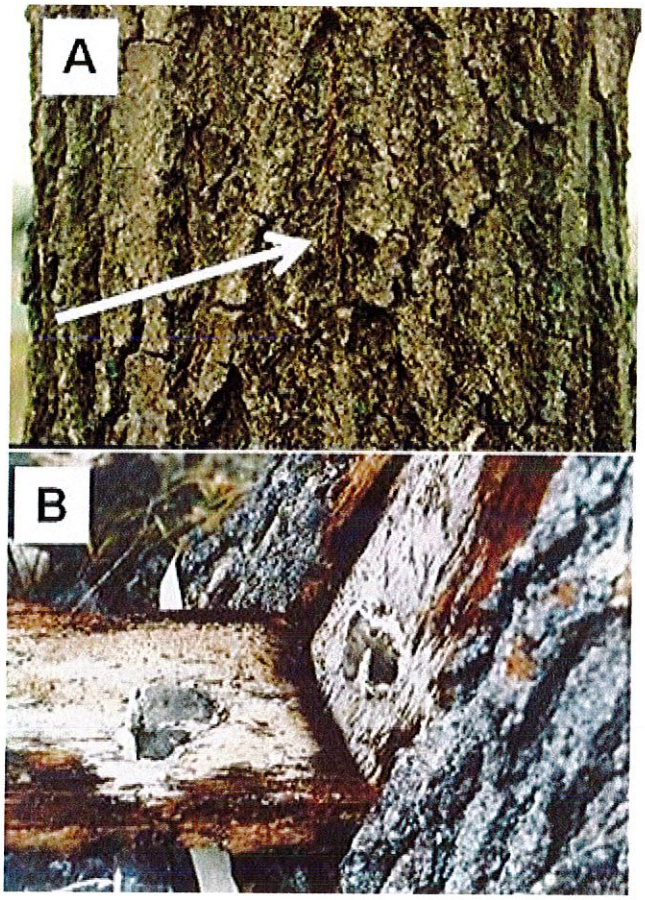


Figure 6. Diagnostics of oak wilt damage showing bark crack (A) and mirror image of sporulating mats (B).

In situations where oaks are near houses, retaining walls, or other structures, carefully digging with shovels has been done but is labor intensive.

Root cutting is done along pre-marked lines that are best placed by experienced tree care professionals. The primary control line is generally placed between the first and second ring (or tier) of healthy oaks out from the diseased trees (Fig. 8). This is because the healthy-appearing trees closest to the diseased trees may already have the fungus in their roots, even if they appear non-symptomatic. When only using a primary control line, the healthy oaks within that line can be removed after root cutting is finished. Alternatively, they may be monitored for several years and removed if they wilt.

A secondary control line may be placed between the diseased and healthy trees to preserve additional trees. This secondary control line often fails though and complicates management efforts.

After establishment of control lines, wilting and recently wilted red oaks should be felled and eliminated by debarking, burning, burying, or wrapping and sealing in four to six mil plastic until the end of September the year following tree wilt.

If not destroyed, the spores the may form on these oaks the following spring could be carried by sap beetles to wounded oaks and start new infection centers.

Figure 7. A healthy bur oak in the middle of an oak wilt infection center impacting northern red oaks, Wabasha County.

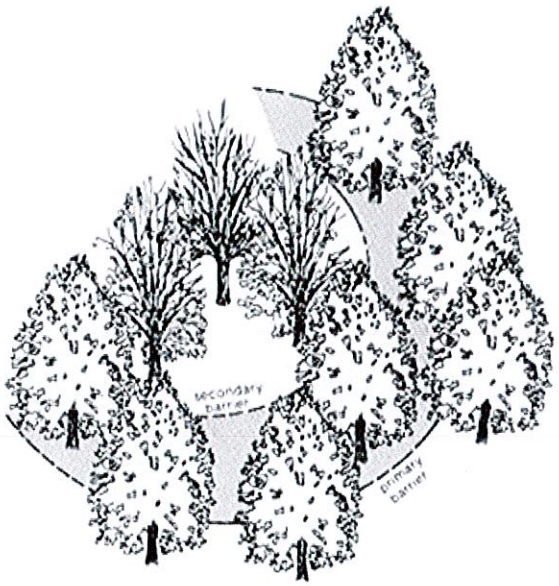


Figure 8. Diagram of root graft barriers around infected trees.

Preventing spread by insects

Avoiding wounding or cutting healthy oaks, particularly during spring and early summer, is important in preventing fungus spread by the sap beetles (Table 1). If branch pruning or tree felling must occur, immediate treatment of the cut surface with water-based paint, a pruning/wound sealer, or shellac is recommended.

Timely removal and proper treatment or disposal of diseased oaks is also critical for preventing insect spread. This is most important for oak wilt-killed red oak species because fungus mats are commonly produced on them. Trees that wilted during the growing season should be felled in the fall or winter and either treated on the property or promptly transported to an approved wood waste utilization site. Options for treatment on the property include debarking of the trunk, burying the main stem and large branches, or cutting logs into firewood lengths and stacking to allow for drying. If diseased trees or firewood are not removed before spring, the cut and stacked logs should be covered with four to six mil clear plastic and sealed at the ground line by late March of the year following tree wilt to prevent beetles from reaching the spore mats. The plastic then can be removed at the end of September of the year following tree wilt and the logs can be safely used for firewood.

Firewood

In general, people should not move logs or firewood from recently wilted oaks to areas where oak wilt is not present. Oak wilt mats may form on these logs. Long distance movements of firewood has resulted in the establishment of oak wilt in distant areas that previously had been unaffected by the disease.

Table 1. Risk of oak wilt fungus spread by sap beetles and advisory comments by general time of year in Minnesota.

Time of Year*	Risk of insect spread	Advisory notes
April through mid-July	High	Don't wound, prune or fell oaks in oak wilt counties during this time period. Immediately cover unavoidable wounds with paint or shellac.
Mid-July through late October	Low	Depending on weather conditions and insect populations, infections could occur but would be rare. Immediately treat pruning wounds, stump surfaces of felled trees and other wounds if desired.
November through March	Safe	Fungal pathogens and insect vectors are inactive

* Exact dates for beginning and end of each time period may vary from year to year. See current risk status at http://www.myminnesotawoods.umn.edu/2010/03/oak-wilt-risk-status-in-minnesota/

Chemical protection

Systemic injection with propiconazole by qualified arborists may prevent oak wilt symptoms for up to two years in healthy oaks if the oaks are not already infected with oak wilt. Propiconazole will not prevent movement of oak wilt through oak roots, and is not a substitute for severing root grafts. Propiconazole treatment of white oaks already exhibiting early symptoms of oak wilt (less than 30% of crown affected) can prevent further disease development for at least two years, but treatment of red oaks already showing symptoms is not recommended.

Integration of control methods

Early detection and accurate diagnosis of oak wilt should always precede implementation of on-site treatments. The greatest success in oak wilt control is obtained with coordinated use of multiple management actions. For example, an integrated management approach for a property with oak wilt could involve root cutting, treatment of high value trees with fungicides, removal of wilted red oaks that are potential oak wilt mat producers, and proper disposal of logs from wilted trees.

Summary

- In Minnesota, oak wilt covers a large area. Check the DNR website for an up-to-date oak wilt disease map.
- Management strategies include stopping belowground spread, preventing spread by insects, not moving firewood from oak wilt-infected areas, and chemical protection.
- Pruning, wounding, or felling oaks should be avoided from early April to mid-July.

Additional resources

Oak wilt risk status in Minnesota (MyMinnesotaWoods)

Plant Disease Clinic (University of Minnesota, Department of Plant Pathology)

How to recognize common diseases of oaks in the Midwest: a quick guide (US Forest Service-Northeastern Area, State and Private Forestry)

What is oak wilt? (Minnesota Department of Natural Resources)

Managing oak wilt: what are the options? (University of Wisconsin Extension)

Figure 9. Keep up-to-date on the current oak wilt risk status at MyMinnesotaWoods

Photo credits: Jennifer Juzwik and Brian Schwingle

This publication was reviewed by Joe O'Brien (US Forest Service) and Kyoko Scanlon (Wisconsin Department of Natural Resources).

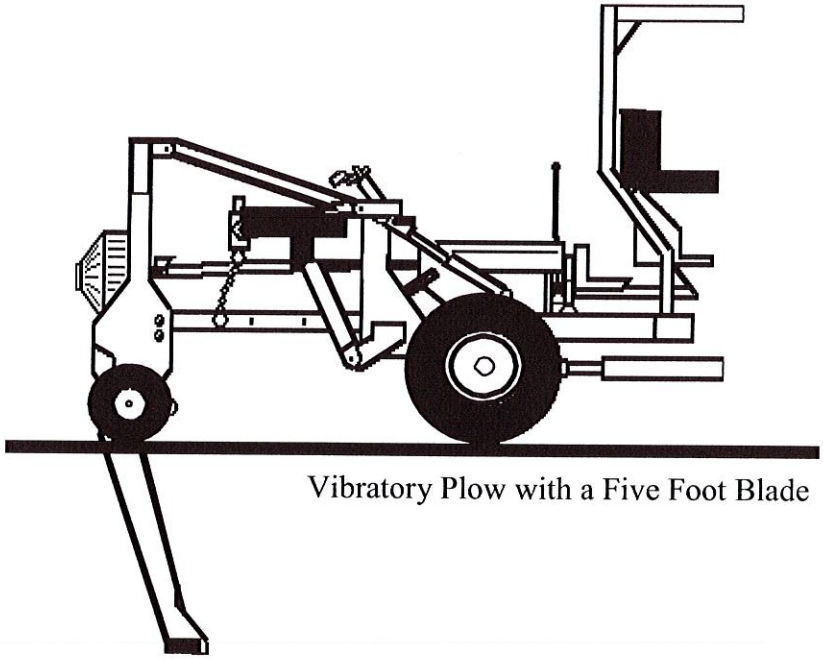
University of Minnesota Extension Publication original location:

http://www.extension.umn.edu/environment/trees-woodlands/oak-wilt-in-minnesota/

Root Graft Barriers for Oak Wilt Control

Minnesota Department of Agriculture

2007



Vibratory Plow with a Five Foot Blade

Oak wilt is responsible for killing more shade trees each year in Minnesota than any other disease causing organism or fungus. Fortunately, it can be successfully controlled if proper measures are taken. Oak wilt, caused by a fungus (*Ceratocystis fagacearum*), attacks the vascular or water- conducting system of oaks, located in the outer ring of sapwood just beneath the bark. In an attempt to protect itself from the fungus, the tree produces gums and tyloses which plug the water conducting vessels. Unable to contain the faster fungus, the tree ultimately cuts off its water and nutrient supply between roots and crown. Visible symptoms (wilting and discoloration of leaves) begin at or near the tree's top or branch ends and progress down and in, accompanied by rapid defoliation. The oak wilt fungus spreads both overland and underground.

DO NOT PRUNE IN MAY OR JUNE. Overland, the oak wilt fungus is spread by picnic beetles (family *Nitidulidae*). These small insects can inoculate a healthy tree only in May or June, and then only when fresh wounds are present. Although less than 10 percent of the oaks dying of oak wilt are believed to be infected this way, it is the only way a new pocket of wilt can start. Control for this type of spread is easy -- oak trees should NOT be cut, pruned or injured from April 15 to July 1.

Root transmission is responsible for 90 percent or more of the trees becoming infected from oak wilt. Roots of adjacent oaks (of the same species) within 50 feet of each other are often grafted together, forming a common root system (see figure 1).

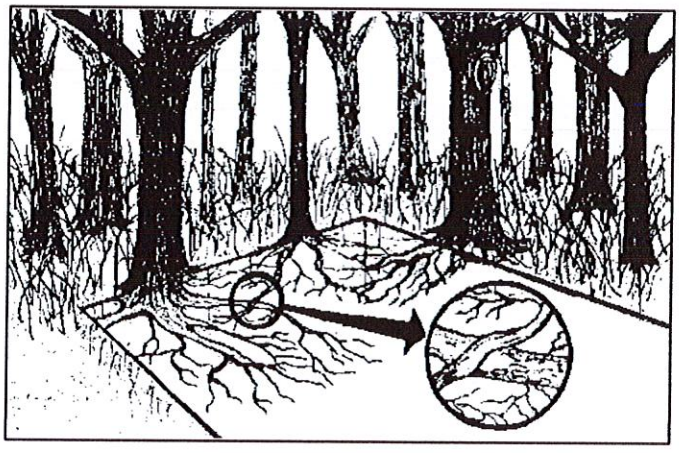


Figure 1. Oak roots often fuse (graft), forming a common root system on wooded sites. The oak wilt fungus can spread from infected to healthy oaks through these root grafts.

The oak wilt fungus spreads through a diseased tree's vascular system, down into its own roots, then through the root grafts into adjacent trees, infecting them as well. What can be done when oak wilt is diagnosed? The answer depends on the species of oak.

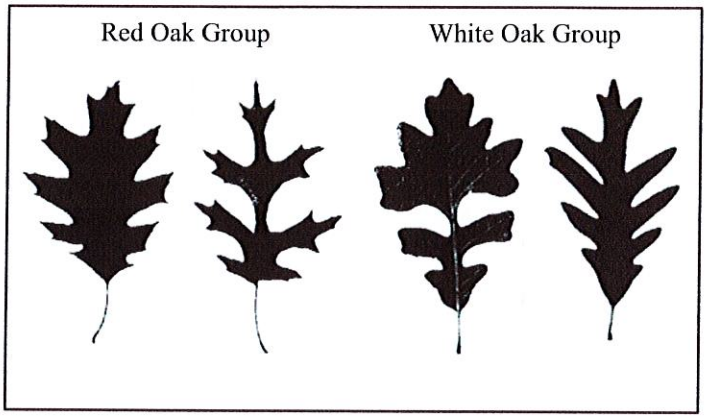


Figure 2. The four most common species of oak in Minnesota from left to right: northern red oak, northern pin oak, bur oak, and white oak.

WHITE OAKS RESISTANT Trees in the white oak group are resistant to oak wilt. If they become dis- eased, they may take several years to die or possibly even recover. Bur oaks are intermediate in resistance. Diagnosis of oak wilt and control recommendations in white oaks should be made on an individual basis by a shade tree professional experienced in oak wilt control.

RED OAKS SUSCEPTIBLE Trees in the red oak group are highly susceptible to oak wilt and do not recover if infected. Once symptoms appear, the tree will wilt completely within a few weeks. If other red oaks are nearby, steps should be taken immediately to prevent spread into healthy trees. When oak wilt symptoms are first noticed in red oaks, the fungus has already spread throughout the tree and into the roots. In fact, the fungus often has already infected the root system of adjacent trees, although they may still look healthy because visible symptoms are not yet apparent.

EFFECTIVE TRENCHING PROVIDES BARRIER Control involves severing or breaking the root connections between diseased and healthy oaks (root graft barriers). The most effective barriers are those placed between the first ring of apparently healthy trees adjacent to the infected ones, and the next set of healthy trees (called primary barriers - see figure 3). A barrier placed between diseased and the first apparently healthy oaks (called a secondary barrier) may not stop the disease because the oak wilt fungus may already be in the adjacent ring of trees, but symptoms are not yet visible. To be successful, all roots between infected and healthy oaks must be cut. Mechanical barriers involve physically cutting the roots with either a trencher or a vibratory plow. This work is most effective when a blade or trencher at least five feet long is used.

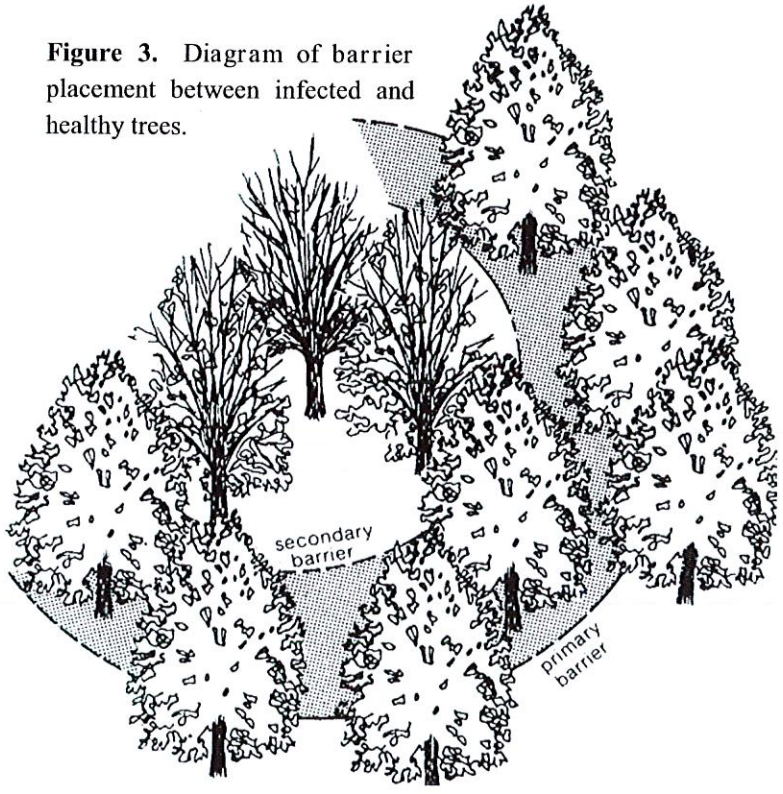


Figure 3. Diagram of barrier placement between infected and healthy trees.

A vibratory plow has a shaker attachment that vibrates a 1-inch thick steel blade up and down (see sketch on the front cover). Its action is similar to that of an electric knife. This machine is fast, and creates only a narrow slit in the ground. Since earth is not removed, backfilling is unnecessary. (Both the vibratory plow and the trencher are typically pulled by large, heavy tractors equipped with flotation tires to minimize soil disturbance.) This method is generally the most cost-effective.

A trencher has a boom or blade with a cutting chain that spins around, cutting a trench four to six inches wide. Its action is similar to that of a chainsaw. The trenching blade has a tendency to 'ride up' in the soil, and care should be taken to ensure it remains extended to its' maximum depth. Because a trencher removes earth as it cuts, it is significantly slower than a vibratory plow. Persons hiring contractors with trenchers should ask whether the price includes backfilling the trench.

CHEMICAL BARRIER POSSIBLE Another option is a chemical barrier using a soil sterilant known as SMDC or Vapam. One- to two-inch-diameter holes 18 to 24 inches deep are drilled along the barrier line at four-inch intervals, a Vapam solution is poured into the holes, and the holes covered. Vapam kills all roots, including grass and other plants along a strip about 18 inches wide. Commercially, Vapam may be used only by companies licensed with the state for pesticide application.

Whichever barrier method is used, underground utility lines **must** be located in advance.

*Diseased trees **should not** be removed until the root graft disruption work is completed*, if trees wilted that same year. If Vapam is used, infected trees should be left standing for two weeks after application. Removing a tree before root systems are separated may actually speed up the spread of oak wilt. (Note: Trees which are structurally weak may present a hazard to people and property, and immediate removal may be warranted - if in doubt, check with a professional.)

EFFECTIVENESS VARIES Mechanical barriers are the most effective method of stopping the spread of oak wilt -- with a success rate approaching 85 percent (with a 5-foot blade). The success rate for chemical barriers is about 55 percent, and is recommended only in areas where use of a plow or trencher isn't feasible (inaccessible to plow, steep slopes, etc.). Correctly locating these root graft barriers is **extremely** important to their effectiveness. For the greatest success, seek the advice of a shade tree professional experienced in laying out these lines. Other factors which may affect the success of root graft barriers are soil type, tree size and spacing, and the history of disease in the area. (Note: a map of barrier locations can be invaluable if follow-up work is necessary.)

At first, costs for oak wilt control may seem excessive. But the alternative costs of doing nothing (loss of value of healthy trees dying from oak wilt, property value decline, tree removal and increased heating and cooling costs) may be far more expensive. Some contractors charge by the job, by the foot or by the hour. All have a minimum charge to cover the cost of equipment, insurance and transportation. Oak wilt control on a neighborhood or community level is strongly recommended; it can significantly decrease costs while increasing the effectiveness of control work.

Persons hiring contractors to do oak wilt control work on their property should ask for references, inquire about experience, and be sure the contractor is insured.

This brochure was originally developed by David Stephenson with technical assistance from D.W. French, professor of plant pathology at the University of Minnesota. Figure 3 used with permission of the University of Minnesota Extension Service. Figure 1 courtesy of Ken Holman. The oak wilt control program in Minnesota is a multi-agency effort involving the Department of Agriculture, Department of Natural Resources, Minnesota Extension Service, University of Minnesota, USDA Forest Service, and counties and communities across the state.

University of Minnesota- Forest Resources Extension & Outreach, 2007.

Adapted from Minnesota Department of Agriculture, RJH 1999 version.

Oak wilt reviewer, Jennifer Juzwik, USDA Forest Service- Research Plant Pathologist

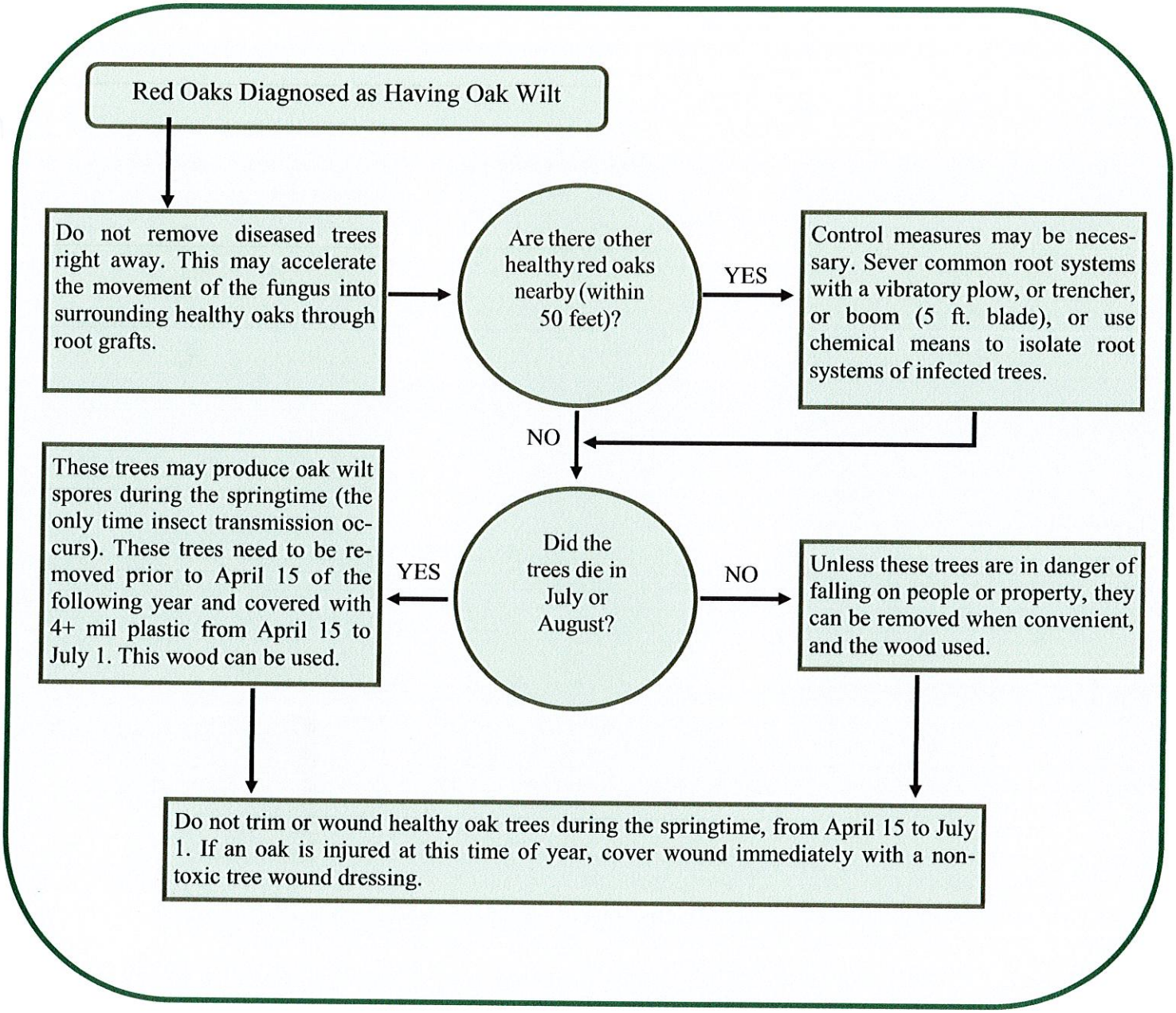


Figure 4. Flowchart - Oak wilt control in red oaks

Control: Dutch Elm Disease vs. Oak Wilt

Minnesota Department of Agriculture

1999

	Dutch Elm Disease	Oak Wilt
Sprea	Over 90% is overland by beetles	Over 90% is through root grafts
Con-	Bark beetle reduction	Root graft disruption
	Root Transmission and control	
When symptoms are first visible	The fungus is in the general area of the wilt symptoms (when infection is from beetles).	The fungus is throughout the tree and into the root system.
Control	1. Immediate removal to prevent movement of fungus into roots. Radical if wilt is very isolated. 2. If the infection is from root transmission, root graft disruption should be done first!	Root graft disruption if healthy oaks (of the same species) are near-by. Do not remove the tree first!
	Aerial Transmission and Control	
Beetle characteristics	1. Attracted specifically to elms 2. Can chew through bark 3. Can travel long distances 4. Active all summer 5. Breeds in dead or dying bark-intact elm wood	1. Not attracted specifically to oaks 2. Can only enter a tree through fresh wounds 3. Does not travel very far 4. Active primarily in springtime 5. Does not breed in oak wood
Control	Remove and dispose of all dead/ dying bark-intact elm wood. This will remove the breeding sites of the beetle.	1. Don't prune in April, May and June! 2. Locate, remove and dispose of diseased oaks producing spores in early spring (March and April).