

periods for pruning are during the coldest days in midwinter and extended hot periods in mid- to late summer. Regardless of season, all pruning cuts or other wounds to oak trees, including freshly-cut stumps and damaged surface roots, should be treated immediately with a wound or latex paint to prevent exposure to contaminated insect vectors.

Transporting unseasoned firewood from diseased red oaks is a potential means of spreading the oak wilt fungus. Oak wilt cannot be transmitted by burning infected firewood, but fungal mats may form on firewood in storage. Presently, no vectors have been proven to transmit the fungus from live oaks to other oak trees, but diseased wood from any oak species should never be stored near healthy oak trees unless precautions are taken. It is best to purchase wood that has been thoroughly dried for at least one full year. If firewood from diseased trees is stored near healthy oak trees, it should be covered with clear plastic with the edges buried to prevent insects from leaving the pile.

Stopping Spread Through Roots

Measures can be taken to break root connections between live oaks or dense groups of red oaks to reduce or stop root transmission of the oak wilt fungus. The most common technique is to sever roots by trenching at least 4 ft deep with trenching machines, rock saws, or ripper bars. Trenches more than 4 ft deep may be needed to assure control in deeper soils. Although not required, commercially-available root barriers may be inserted in the trench to reduce the potential for trench breakouts. Correct placement of the trench is critical for successful protection of uninfected trees. There is a delay between colonization of the root system by the fungus and appearance of symptoms in the crown. Therefore, all trees with symptoms should be carefully identified first. Then, the trench should be placed a minimum of 100 ft beyond these symptomatic trees, even though there may be “healthy” trees at high risk of infection inside the trench. Trees within the 100-ft barrier, including those without symptoms, may be uprooted or cut down and removed to improve the barrier to root transmission. Tree removal should be initiated after trenching, starting with healthy trees adjacent to the trench and gradually working inward to include symptomatic trees.

Oak wilt infection centers are more easily suppressed when detected early, before they become too large. The untreated trees immediately outside the treated area should be closely monitored for several years. If the pathogen appears to have crossed a barrier, the same measures (new trenching and treatment of trees within the barrier) should be repeated while the diseased site is still small.

Fungicide Treatment

Propiconazole (Alamo™) is the only fungicide scientifically tested and proven effective (when properly applied prior to in-

fection) for use as a preventative treatment to protect live oaks. Limited success also may be achieved in trees treated with therapeutic injections during the earliest stages of infection. The fungicide is injected into the tree’s water-conducting vascular system through small holes drilled into the root flares at the base of the tree. Treatment success depends on the health of the candidate tree, application rate, and injection technique. Injection should be done only by trained applicators.

Fungicide injection does not stop root transmission of the fungus. This treatment, therefore, is used best in conjunction with trenching or to protect individual high-value trees in situations where trenching is impractical. Healthy live oaks at high risk of infection in advance of an expanding infection center are preferred candidates for injection. Foliar symptoms can be used in selecting trees as candidates for preventative or therapeutic treatments. A tree with foliar symptoms of oak wilt, as well as any non-symptomatic tree immediately adjacent to a tree with symptoms, should receive a therapeutic treatment. If symptoms are observed in more than 30 percent of the crown, it is unlikely a fungicide injection will be effective. Injections of nonsymptomatic trees at greater distances from symptomatic trees (i.e., 75 to 150 ft) will yield the best results for preventative treatments.

There are several steps in the injection process that require careful attention following tree selection. Mixing the fungicide solution, exposing and drilling holes in the flare roots, connecting the injection apparatus to the tree, and monitoring uptake must be done according to label specifications and directions. Treatment may take several hours. Information and training are available through county extension or Texas Forest Service offices. The services of a professional arborist may be required to assure proper injection.

Integrated Oak Wilt Management

Early detection and prompt action are essential for successful management of oak wilt. The specific measures taken depend on several circumstances outlined in this brochure, but should include appropriate combinations of the following:

1. Prevent New Infections

- Cut and dispose of diseased red oaks immediately.
- Avoid wounding oak trees, including pruning, from February through June, and paint all wounds and fresh stumps regardless of season.
- Handle oak firewood cautiously, burn all firewood before spring, and never store unseasoned oak wood from infected trees near healthy oaks.
- Cover unseasoned firewood (from infection centers and unknown origins) with clear plastic, and bury the edges of the plastic.

2. Stop Spread Through Roots

- Install a trench at least 4 ft deep and 100 ft beyond the perimeter of infection centers to break up root connections.
- Cut or uproot all trees within the 100-ft barrier (except those injected with fungicide).

3. Inject High-Value Oaks with Fungicide

- Identify susceptible, high-value oak trees in proximity to expanding oak wilt infection centers.
- Consult a trained and licensed arborist (with certified applicator’s license) for treatment of susceptible trees with injections of propiconazole (Alamo™).

4. Plant New Trees

- Plant trees not susceptible to oak wilt.
- Favor a diversity of tree species in the landscape by planting trees that are adapted to central Texas.
- Avoid wounding susceptible oaks during planting.

For more information on oak wilt in Texas, visit the internet website www.texasoakwilt.org

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CAUTION

Pesticides used improperly can be injurious to humans, animals, and plants. Follow directions and heed all precautions on the label.

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HOW TO Identify and Manage Oak Wilt in Texas



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Introduction

Oak wilt, one of the most destructive tree diseases in the United States, is killing oak trees in central Texas at epidemic proportions (fig. 1). Oak wilt is an infectious disease caused by the fungus *Ceratocystis fagacearum*, which invades and disables the water-conducting system in susceptible trees. All oaks (*Quercus* spp.) are susceptible to oak wilt to some degree, but some species are affected more than others. Red oaks, particularly Spanish oak (*Q. buckleyi*), Shumard oak (*Q. shumardii*), and blackjack oak (*Q. marilandica*), are extremely susceptible and may play a unique role in the establishment of new oak wilt infections. White oaks, including post oak (*Q. stellata*), bur oak (*Q. macrocarpa*), and chinkapin oak (*Q. muehlenbergii*), are less susceptible to the fungus and rarely die from oak wilt. Live oaks (*Q. virginiana* and *Q. fusiformis*) are intermediate in susceptibility to oak wilt, but are most seriously affected due to their tendency to grow from root sprouts and form vast interconnected root systems that allow movement (or spread) of the fungus between adjacent trees. The successful management of oak wilt depends on correct diagnosis and an understanding of how the pathogen spreads between different oak species.

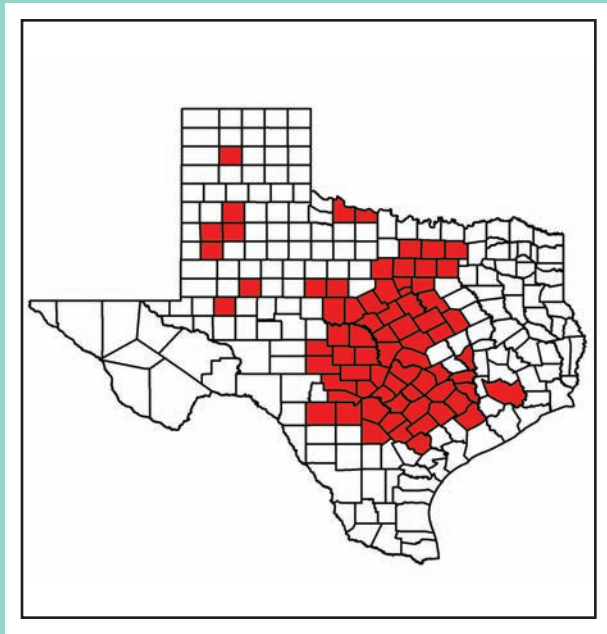


Figure 1. – Texas counties with confirmed cases of oak wilt are shown in red.

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Identification of Oak Wilt

Foliar symptoms, patterns of tree mortality, and the presence of fungal mats can be used as indicators of oak wilt. However, laboratory isolation of the fungus is recommended to confirm the diagnosis. A trained expert should be consulted when in doubt.

Patterns of Tree Mortality

Most live oaks defoliate and die over a 1- to 6-month period following initial appearance of symptoms. Some live oaks take longer to die, and a few untreated trees may survive many years in various stages of decline. A few live oaks in oak wilt centers escape infection or may be resistant to the fungus and apparently remain unaffected by the disease.

Red oaks seldom survive oak wilt and often die within 3 to 4 weeks following the initial appearance of symptoms. During summer months, diseased red oaks often can be spotted from a distance because of their bright autumn-like coloration in contrast to the surrounding greenery.

Foliar Symptoms

Leaves on diseased live oaks often develop chlorotic (yellow) veins that eventually turn necrotic (brown), a symptom called veinal necrosis (fig. 2). Defoliation may be rapid, and dead leaves with brown veins often can be found under the tree for months after defoliation. Leaves may exhibit other patterns of chlorosis and necrosis, such as interveinal chlorosis, marginal scorch, or tip burn, but these symptoms are less reliable than veinal necrosis for diagnosing oak wilt in live oaks.

Foliar symptoms of oak wilt on red oaks are less distinct. In early spring, young leaves simply wilt, turning pale green and brown. Mature leaves develop dark green water soaking symptoms or turn pale green or bronze, starting at the leaf margins and progressing inward.

Fungal Mats

Fungal mats (fig. 3a, b) are reliable indicators for diagnosis of oak wilt. These specialized spore-producing structures most often form in spring on red oaks that developed advanced symptoms of oak wilt the previous late summer or fall. Red oak infections in late spring and summer usually do not give rise to fungal mats due to high temperatures and low soil moisture conditions. Fungal mats can be found by looking for inconspicuous narrow cracks in the bark of dying red oaks leading to hollow areas between the bark and wood. They often have a distinctive odor similar to fermenting fruit. Fungal mats can be exposed for inspection by chopping away the loose bark.

Laboratory Diagnosis

Oak wilt diagnoses may be confirmed by isolating the fungus from diseased tissues in the laboratory. Samples can be submitted to: Texas Plant Disease Diagnostic Laboratory, 1500 Research Parkway, Suite A130, Texas A&M University Research Park, College Station, TX 77845. A county extension agent, Texas Forest Service forester, or trained arborist should be consulted for proper collection and submission of samples.



Figure 2. – Live oak leaves showing oak wilt symptom known as veinal necrosis.

Spread of Oak Wilt

Establishment of New Infections

Red oaks appear to play a key role in the establishment of new infection centers. The oak wilt fungus may be spread overland by insect vectors and by man through movement of wood from infected red oaks to other locations. Fungal mats form beneath the bark of certain diseased red oaks in late fall and especially in spring, but do not form on live oaks. Individual fungal mats produce spores for only a few weeks. The fruity odor of fungal mats attracts many kinds of insects, the most important of which are believed to be sap-feeding nitidulid beetles. The fungus possibly may be transmitted by these small beetles as they emerge from mats and visit fresh wounds on healthy trees, both red oaks and live oaks. Fungal mats are most commonly formed on standing trees, but they can also develop on logs, stumps, and fresh firewood cut from diseased red oaks.

Spread Through Roots

Live oaks tend to grow in large dense groups (called motts) with interconnected roots. The fungus may be transmitted from one tree to another through these root connections. Root transmission is a proven means of spread from one live oak to another. As a result, patches of dead and dying trees (infection centers) are formed. Infection centers among live oaks in Texas



Figure 3. – Fungal mats on oak: (a) crack in bark caused by fungal mat, (b) exposed fungal mat on Spanish oak.

expand at an average rate of 75 ft per year, varying from no spread to 150 ft in any one direction. Occasionally, the oak wilt fungus is transmitted through connected roots between red oaks, but movement through roots is slower in red oaks and occurs over shorter distances than in live oaks.

Disease Management

There are currently three primary approaches used for oak wilt management in Texas. Successful control usually depends on an integrated program incorporating measures from all three approaches. The first approach attempts to prevent the formation of new oak wilt infection centers by eliminating diseased red oaks, handling firewood properly, and painting wounds on healthy oaks. The second approach involves trenching or other measures to disrupt root connections responsible for root transmission of the pathogen. Finally, injections of the fungicide propiconazole (Alamo™) into individual, high-value trees help reduce crown loss and may extend the life of the tree. These measures will not cure oak wilt, but will significantly reduce tree losses.

Preventing New Infections

Infected red oaks that die in late summer or fall should be cut down and burned or buried soon after discovery to prevent insects from transmitting spores from fungal mats that may form on these trees in the fall or following spring. If this is not possible, the trees should be injected with herbicide or deeply girdled with an ax and stripped of all bark 2 to 3 ft above the soil line. Drying of the wood before fall discourages formation of fungal mats.

All wounding of oaks (including pruning) should be avoided from February through June. The least hazardous