

## INTRODUCTION

Oak wilt, one of the most destructive tree diseases in the United States, is killing oak trees in Texas at epidemic proportions (fig. 1). Oak wilt is an infectious disease caused by the fungus *Bretziella 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 (now Texas red) 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 but may also 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 among adjacent trees. Successful management of oak wilt depends on correct diagnosis and an understanding of how the pathogen spreads in different oak species.

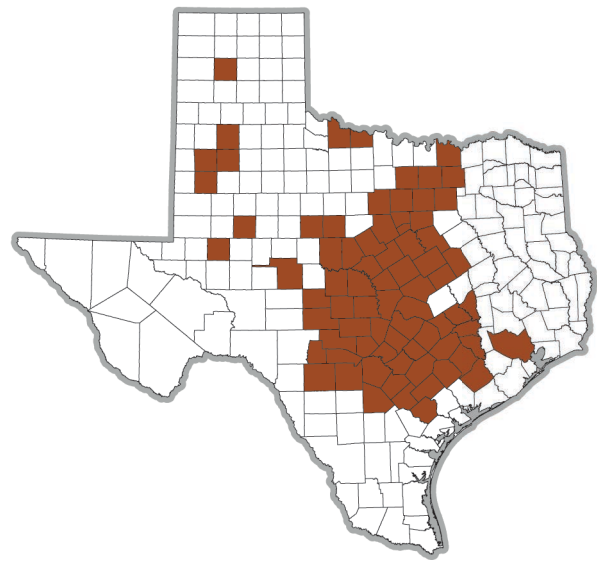


Figure 1 - Shaded areas indicate counties in Texas with confirmed cases of oak wilt.

## 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 identification 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 3 to 6 month period following the 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 altogether or may be less susceptible to the fungus and apparently remain unaffected by the disease. Red oaks seldom survive oak wilt and often die within 4 to 6 weeks following the initial appearance of symptoms. During summer months, diseased red oaks can often be spotted from a distance because of their premature autumn-like coloration in contrast to the surrounding greenery.

### FOLIAR SYMPTOMS

Leaves on diseased live oaks often develop yellow (chlorotic) veins that eventually turn brown (necrotic), a symptom of oak wilt that specialists call "veinal necrosis" (fig. 2). Defoliation may be rapid, and dead leaves with brown veins can often 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. In white oaks, occasionally marginal necrosis, tip burn, or flagging are observed.



Figure 2 - Live oak leaves showing a symptom of oak wilt known as veinal necrosis.

### FUNGAL MATS

Fungal mats (fig. 3a, b) are reliable indicators for diagnosis of oak wilt. These specialized spore-producing structures most often form in the spring on red oaks that developed advanced symptoms of oak wilt during the previous late summer or fall. Fungal mats are not known to occur on live oaks or white oaks. Oak wilt infections of red oaks in late spring and summer usually do not give rise to fungal mats due to high temperatures and low 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 removing loose bark.



Figure 3 - (a) Exposed fungal mat on a Texas red (Spanish) oak; (b) Multiple oak wilt fungal mats on a dead red oak.

### LABORATORY DIAGNOSIS

Oak wilt diagnoses may be confirmed 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 A&M Forest Service representative, or trained arborist should be consulted for proper collection and submission of samples. Other diagnostic labs / companies may be available depending on location.

## SPREAD OF OAK WILT

### ESTABLISHMENT OF NEW INFECTIONS

Red oaks play a key role in the establishment of new infection centers. The oak wilt fungus may be spread overland by insect vectors and through the movement of wood from infected red oaks to other locations. Fungal mats form beneath the bark of certain diseased red oaks in late winter 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 sap-feeding nitidulid beetles. The fungus is transmitted by these small beetles as they emerge from mats and visit fresh wounds on healthy trees, including 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 expand at an average rate of 75 feet per year, varying from no spread to 150 feet in any one direction. Occasionally, the oak wilt fungus is transmitted through connected roots between red oaks, but movement through roots is slower among red oaks and occurs over shorter distances than in live oaks.

## DISEASE MANAGEMENT

There are currently four primary approaches used for oak wilt management in Texas. Successful control usually depends on an integrated program incorporating measures from all four 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. Thirdly, injections of the fungicide propiconazole 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. Finally, the recommended method to reduce the occurrence of oak wilt is to plant and maintain a diversity of native tree species in the landscape, monitor tree health, and treat oak wilt infections as soon as they are detected.



## PREVENTING NEW INFECTIONS

Infected red oaks that die in late summer or fall should be cut down and burned, chipped, 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 feet above the soil line. Drying of the wood before fall discourages the formation of fungal mats.

All wounding of oaks (including pruning) should be avoided from February through June. The least hazardous 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. While oak wilt cannot be transmitted by burning infected firewood, fungal mats may form on unseasoned firewood in storage, allowing beetles to continue spreading fungal spores. 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 firewood locally 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 THE SPREAD THROUGH ROOTS

Measures can be taken to break root connections between live oaks or dense groups of red and white oaks to reduce or stop root transmission of the oak wilt fungus. Though not 100% effective, the most common technique is to sever roots by trenching at least 4 feet deep with trenching machines, rock saws, or ripper bars. Trenches more than 4 feet deep may be needed to ensure 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 feet beyond these symptomatic trees, even though there may be "healthy" trees at high risk of infection inside the trench. Trees within the 100-foot 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 is the only fungicide scientifically tested and proven effective (when properly applied prior to infection) 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 a trained applicator.

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 to select 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% of the crown, it is unlikely that a fungicide injection will be effective. Injections of non-symptomatic trees at greater distances from symptomatic trees (i.e., 75 to 150 feet) 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 root flares, connecting the injection apparatus to the tree, and monitoring uptake must be done according to label specifications and directions. Treatment may take several hours. Detailed information and videos can be found at [texasoakwilt.org](http://texasoakwilt.org). Information and training are available through county extension or Texas A&M Forest Service offices. The services of a professional arborist or other experienced person may be required to ensure proper injection.

## INTEGRATED OAK WILT MANAGEMENT

Early detection and prompt action are essential to successful oak wilt management. 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 and during land management activities, from February through June, and immediately paint all wounds and fresh stumps, regardless of the season.
- Handle oak firewood cautiously, burn all firewood before spring, and never store unseasoned red 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 THE SPREAD THROUGH ROOTS

- Install a trench at least 4 feet deep and 100 feet beyond the perimeter of infection centers to break up root connections.
- Cut or uproot all trees within the 100-foot 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 a certified applicator license) for treatment of susceptible trees with injections of propiconazole.
- For guidance on selecting an arborist, visit [isatexas.com](http://isatexas.com).

### 4 DIVERSIFY YOUR LANDSCAPE

- Favor a diversity of tree species in the landscape by planting trees that are native and adapted to your area.
- For tree planting information, visit [texastreeplanting.tamu.edu](http://texastreeplanting.tamu.edu).
- For more information on oak wilt in Texas, visit [texasoakwilt.org](http://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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# TEXAS OAK WILT

## HOW TO IDENTIFY & MANAGE OAK WILT IN TEXAS



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