Oak Wilt

Part 2: Prevention & Management Strategies

1A

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Introduction

Oak Wilt (OW) is caused by the "invasive" fungus, *Ceratocystis fagacearum,* and is an increasingly important issue of concern for the forests and landscapes in Michigan (Photos 1A & 1B). Oak Wilt is one of the costliest diseases in the landscape (Figure 1), largely due to efforts to try to contain and eradicate the deadly disease once established in the landscape. It is of the utmost importance that we learn how to avoid oak wilt, and how to contain and eradicate the disease from landscapes when encountered.

The Theory of Oak Wilt Management

We can use our current knowledge about the biology, infection cycle, and spread of Oak Wilt to hopefully resolve Oak Wilt issues from a variety of approaches (see *The Michigan Landscape,* January/February 2016). Of considerable importance is that the lethal oak wilt fungus can only infect oak trees by two methods: **1) Overland:** Transmission of the fungus by sap beetles to tree wounds, and **2) Underground:** Transmission of the fungus through root grafts between trees. In theory, preventing either of these two infection methods will help us avoid new outbreaks of OW and manage existing cases. Obviously, avoiding OW infections is the best (and least costly) of all the management options. Once a tree becomes infected by the OW fungus, more disruptive and costly options will need to be implemented.

Avoidance of Oak Wilt

As the least costly management option, avoidance of Oak Wilt can be accomplished by pruning oak trees only during periods when sap beetles and the oak wilt fungus are dormant (= cold periods), by prompt repair of trees injured by storms during the spring and summer months, and by avoiding the transportation of contaminated wood into areas, properties and communities where no Oak Wilt exists.

Avoidance through Pruning Practices: The majority of the new OW outbreaks the author encounters every year are due to pruning oak trees at inappropriate times. Hence, probably the most important aspect of OW management is avoidance, which necessitates pruning trees, if needed, at an appropriate time of year. In Figure 2, the risks of oak wilt from tree injury (pruning or storm damage, etc.) during certain time periods of the year are summarized. "When to prune" is one of the more controversial aspects of OW, largely due to the desire of utilities, logging operations and other tree related activities to remain productive through as many months of the year as possible. The spring and early summer months are especially

Figure 1:The Costs of Oak Wilt

- **Property Value/Tree Value Losses:** Trees represent a significant contribution to the value of property, the reason people often prefer to buy or build homes in wooded areas. At a minimum, the tree value (and potential) loss should be assessed.
- **Tree Removal Costs:** Removing infected/dead trees, stump grinding, properly disposing of wood, lawn restoration, replanting etc. can be very expensive, especially in the vicinity of homes and utilities.
- **Oak Wilt Containment/Eradication:** While the above losses and costs may seem substantial, the methods needed to contain and eradicate oak wilt from a property can be even more costly. The fungus will likely move underground to infect other oaks on the same property and neighbors' properties if not contained and eradicated.

Figure 2:

A general summary of the risk of trees contracting oak wilt from pruning or storm injury during certain times of year. Note: Pests and diseases do not recognize artificial human calendars (nor property boundaries). When the climatic temperatures are cold, pests and diseases are largely dormant and pose little risk to trees that are injured. Note: Sap Beetles that transmit Oak Wilt can become active when temperatures reach 45-50 F and above.

April 1-July 15	High Risk!!!
July 15-October	Lower Risk
Dec-February	No Risk

Table 1: Forest Management Model: The placement of trench lines in relation to Oak Wilt-affected trees and apparently healthy trees. Combine the diameters (dbh= diameter at breast height) of diseased and nearby healthy trees. Distances for the trench line are in feet from the diseased tree(s) and are listed below the soil type.

Combined dbh of diseased & healthy trees (inches)	95 % Trench Sandy Soil	98 % Trench Sandy Soil	95 % Trench Loamy Soil	98 % Trench Loamy Soil
20	39	51	31	41
22	43	56	34	45
24	47	61	37	49
26	50	66	40	53
28	54	72	43	57
30	58	77	46	61
32	62	82	49	65
34	66	87	53	69
36	70	92	56	73
38	74	97	59	77
40	78	102	62	81
42	82	107	65	85
44	85	112	68	89
46	89	117	71	94
48	93	123	74	98

Note: The 95% Trench and 98% Trench (Root Graft Disruption) represent *Confidence* that the trench line will actually contain Oak Wilt to within the trenched area; they may be considered as primary and secondary trench lines. (This is an abbreviated Table.)

1A & 1B Photo 1A and 1B: Oak Wilt can initiate drastic (and costly) changes to Michigan landscapes. The owners of this residence bought this house approximately 15 years ago because of the abundance of trees. During the spring of 2015, their trees were pruned by a "professional arborist"; most of the pruned trees (except two, center) contracted oak wilt (Photo A). After removal of dead trees, trenching to sever root grafts, and trunk injections with propiconazole, they hope to save the two trees in their front yard and other trees on their property while (hopefully) preventing OW from advancing into their neighbors' properties (Photo B).

Sketch (S1) This "Artist Rendering" of the Forest Management Model shows that trench lines (dotted) are installed quite a distance from oak wilt-infected trees to provide the greatest possibility of containing the oak wilt fungus to within the trenched area.

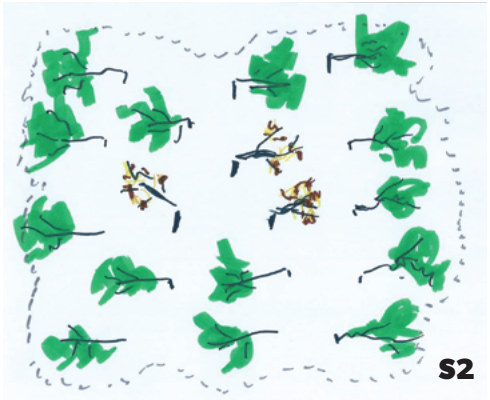
high risk. Some "experts" recommend that oak tree pruning can commence after July 15. While OW transmission to wounds by sap beetles decreases during mid-late summer and fall, the risk does not diminish to zero. Two factors influence the safe pruning periods and the desire for zero risk: the author has documented that pressure pads sometimes form during the fall following tree infection (as well as the following spring), and several cases of fall pruning have resulted in OW-tree death the following spring. Given the value of oak trees and the costs to contain and eradicate OW in residential landscapes in communities, the author advises that we be able to recommend "zero risk", which in the context of pruning is more of a matter of temperature than calendar dates.

Avoidance through Prompt Storm Repair: Similar to pruning, the OW fungus can be transmitted by sap beetles to wounds created during storms, again, during the time periods conducive for such events (Figure 2). Emergency storm repair can be accomplished by *promptly* cutting out the injured branch or branches (within hours to a couple of days) and immediately painting the new wound with a sealant to prevent visitations by sap beetles. Also, consider that because fresh wounds are attractive to sap beetles for about 5-7 days, we are not generally worried about storm damage during the winter months when sap beetles (and the OW fungus) are dormant.

Root Graft Disruption

As with Dutch Elm Disease, disrupting root grafts between diseased and uninfected trees can help prevent the spread of the Oak Wilt fungus to other nearby oak trees. Root grafts may be disrupted with vibratory plows, trenchers, backhoes, mini-excavators, and other machines and methods. After a trench is installed, the removed soil can be backfilled into the trench immediately. Please be cognizant of the fact that exposing wounded roots during periods of sap beetle transmission is risky, similar to wounded branches. Two principles may influence the efficacy of root graft disruption: time and space. In regards to "time", the longer the period of delay in implementing the severing of roots between potential root grafted trees, the greater the chance that the fungus can move beyond the root graft junction into the roots of nearby healthy trees. In regards to "space", we can assume that the greater the distance between trees, the less likely that root grafts have occurred and/or, the more time it will take for the fungus to move between trees. We should consider that tree roots may extend laterally through the soil 1.5 to 2X the height of the tree. To obtain the best results, recommended depth of trenching is usually at least 4 feet in heavy clay soils and 5-6 feet in sandy soils. Following are descriptions of two models used for root graft disruption. They are typically used for different environments but may, at times, be combined for resolving OW issues for specific situations.

The Forest Management Model (FMM) for Forests and Woodlands: Root graft disruption by the FMM is often used in woodland or forest situations where tree value is comparatively low, budgets to contain and eradicate OW are low, and greatest efficacy is needed to preclude revisits to the site. Briefly, the FMM, based on Johann Bruhn's research in the 1990s in Menominee, Michigan, attempts to define the risk of OW spread through root grafts and the best location to install trench lines to minimize the risk of root graft transmission (Table 1 & Sketch #1). Primary



Sketch (S2) This "Artist Rendering" of the Forest Management Model reveals that all trees within the trench lines must be sacrificed to prevent further spread of the oak wilt fungus. Presumably, if all goes according to plan, the Oak Wilt fungus will die out.

Photo 2 View of the destructiveness of the Forest Management Model (FMM) utilized in one of Michigan's State Parks to contain and hopefully eradicate Oak Wilt from the site. The trees in the photo were live, healthy trees that needed to be sacrificed according to the FMM. This extensive destruction is unacceptable for most residential landscapes and communities.

and secondary trench lines are often advisable to maximize OW containment and eradication. After trench lines have been installed, all diseased and healthy trees within the trenched boundary need to be destroyed (Sketch #2 & Photo 2). A step in this destruction includes treating stumps with herbicide to prevent re-sprouting and, hence, possible survival of the oak wilt fungus. Once all trees have been killed within the trenched area, the OW fungus should theoretically die and disappear. It is advisable to manage the wood from the diseased trees according to the suggestions in Wood Management (see page 47). While the FMM has been proven to be highly effective for relatively low costs in forest situations, it is, however, highly destructive because many healthy trees must be sacrificed to contain and eradicate OW from the site (Photo 2).

The Tier Tree Model (TTM) for Residential Landscapes: The TTM is recommended for situations where trees are of significant value, such as residential landscapes, and where it is desired that as many trees as possible be saved from destruction by Oak Wilt and the methods to contain and eradicate it. With the TTM, trench lines are installed much more closely between infected trees and healthy trees (Sketch #3 & Photo 3) than in the FMM. Often, if space permits, primary lines are installed between OW-infected trees and adjacent, apparently healthy trees. Obviously, the risk of OW transmission increases with delays in the installation of trench lines and with closer distances of healthy trees to infected trees. Secondary trench lines are often installed between the first and second "tier" of trees out from the diseased oak(s), between apparently healthy trees (Sketch #3). Tertiary trench lines may also be installed. The efficacy of the TTM can be enhanced with supplemental trunk injections of propiconazole (see below) in high value landscapes .The author developed and fine-tuned the TTM for more than 25 years with great success.

Propiconazole Trunk Injections

Propiconazole, sold under various trade names, is a fungicide that has been proven to be highly effective for Oak Wilt. At high label rates, the fungicide has been known to "cure" members of the white oak family. Also, at high label rates, the fungicide has prevented the transmission of the OW fungus through root grafts, even between red oaks (Photos 4 & 5). Because it is believed that OW can survive for 3-4 years in the roots of infected trees, nearby healthy trees that are likely root-grafted to diseased trees need to be trunk-injected with high rates of propiconazole for at least six years. Due to potential damage from injections and ancillary issues, the author does not recommend routine, preventative propiconazole treatments of oak trees in landscapes where OW does not exist.

Sketch (S3) This "Artist Rendering" of the Tier Tree Model (TTM) demonstrates that in high tree value situations such as landscapes, where it is undesirable to sacrifice many trees, the trench lines (dotted) are installed much closer to infected trees. Note that residential foundations and basements, serving as "natural barriers", may augment the trenching efforts. The TTM has been used with great success by the author over the last 25+ years. Trunk injections with propiconazole may provide added insurance with trenching or may be implemented in lieu of trenching….depending on the situation. Each Oak Wilt site is unique and requires consideration of best management practices by an experienced professional.

Photo 3 Primary and secondary trench lines are being installed in this residential landscape with a mini-excavator. In using the Tier Tree Model (TTM), note how close the trench lines are being installed between infected trees (left, just out of photo) and healthy trees compared to the FMM. Backed up with trunk injections of propiconazole, no further Oak Wilt outbreaks occurred on any of the trees on this property during the subsequent four years.

Photo 4 At the same location as in Photo 3, no trench lines were placed between Oak Wilt-affected trees (foreground, stump-ground areas) and the trees in the background. High rates of propiconazole, alone, applied as trunk injections have saved the trees (background) from root graft infection.

Photo 5 At the same property as in Photos 3 & 4, trunk injections of propiconazole were used as a primary line of defense within trenched areas (Photo 4) and as a carte blanche approach for the remaining trees external to trenched areas. A variety of injection systems are available; sufficient propiconazole needs to be administered to be effective.

Oak Wilt Wood Management

Because the OW fungus is essentially an obligate parasite, it is not a good, long-term survivor in oak trees it has killed. As with many diseases and pests, the transport of OW-infected wood can spread the disease to new locations, primarily during the first year after death of the tree. Protocols to minimize the survival of the OW fungus in wood can be accomplished in several ways. Chipping or debarking the wood causes rapid destruction of the OW fungus; the chips and/or bark are fine for landscape mulch. Trees that have been killed by OW are perfectly acceptable for milling into lumber. Wood from OW-trees is also fine for use as firewood; however, firewood should be covered (tarped) and "sealed" during the spring and summer months to prevent visitations by sap beetles, which may transmit the fungus from pressure pads in the firewood to newly wounded trees. The wood only needs to be covered during the fall following tree death and then the following spring and summer of the following year (about a year) because the OW fungus is rather quickly displaced by other organisms. Immediate burning, burying, etc. are other options.

Order of Implementation of OW Management Strategies

Even though OW may kill trees very quickly, often within weeks of infection, the fungus typically does not move through root grafts very quickly – only approximately one tier of trees per year (hence, the Tier Tree Model) – see Photos 6A, B & C. It has also been observed that removing infected trees (except for immediate removal of infected trees ***and stumps*** at the ***very first symptom*** expression of OW infection) ***before*** implementation of other procedures can actually hasten the spread of OW to nearby healthy trees. Following is an ordered protocol the author has advised with great results:

1) **Install Trench Lines to Sever Root Grafts…and/or**
2) **Trunk-Inject Trees with Propiconazole (allow time for dissemination of the fungicide throughout tree)**
3) **…….**
4) **Take a Vacation: See the wonders of this Great Lakes State. Yes, Michigan!!**
5) **……**
6) **Take the family to several of Michigan's wonderful County Fairs and Festivals.**
7) **……**
8) **Remove Oak Wilt-Affected Trees in Late Fall or Winter**

Oak Wilt Management Summary: The sudden appearance of Oak Wilt in a landscape is usually the result of improper pruning practices and/or storm injury during the months most conducive to spread of the lethal fungus by sap beetles to injuries on those oaks. Avoidance of OW is the most effective strategy for managing OW. Hence, it is very prudent for Counties, Townships, Neighborhoods, various Associations, and other entities to spread **The Word** about Oak Wilt and adopt policies to prevent its introduction into and spread within our communities. Once Oak Wilt is established in a residential landscape or neighborhood, efforts to contain and eradicate the disease can be daunting and costly. The proper installation of trench or plow lines to sever potential root grafts and/or the utilization of propiconazole trunk injections in certain situations takes extensive experience. Please feel free to contact the author for assistance at 248/320-7124 or at robertsd@msu.edu.

The author and MSU do not endorse any particular products. If using pesticides, be sure to read and follow label directions.

ABOUT THE AUTHOR

David L. Roberts, Ph.D is a Senior Academic Specialist at the College of Agriculture and Natural Resources, Michigan State University, with B.S. and M.S degrees in Plant Pathology from The Ohio State University and a PhD in Botany and Plant Pathology from Michigan State University. Dr. Roberts was the Director of MSU's Plant & Pest Diagnostic Clinic from 1984-1998. His current position is Senior Academic Specialist in the Deans Office at MSU's College of Agriculture and Natural Resources serving Michigan's Nursery and Landscape Industry.

Dr. Roberts has worked on many plant issues for more than 30 years. In the 1980s, his research led to the discovery of the first bacterial wilt disease of turfgrasses in North America. Subsequently, his discovery of a *Xanthomonas* bacterium that controls the weed grass, annual bluegrass, on golf courses resulted in several patents with MSU. His research interests also include Dutch Elm Disease, Oak Wilt and a number of other diseases such as Phomopsis canker on spruce, which he discovered in the late 1980s. In 2001, Dr. Roberts began work on ash decline in southeast Michigan. His research led to the discovery of the Emerald Ash Borer. He has published hundreds of articles in peer-reviewed journals, trade magazines and MSU Extension publications. As part of his Michigan State University duties, Dr. Roberts presents many lectures and workshops around Michigan and nationally.

Photos 6A, B & C: The transition of Oak Wilt in this landscape over a three year period. Photo A: First year of infection (August photo) after a spring pruning, the neighbor's lone oak tree (left) was not pruned. Photo B: The owner of the clump of diseased trees didn't believe simply pruning her trees would result in their death, so, she left them undisturbed for a second year, believing they might recover. Note neighbor's tree is still unaffected by potential root graft transmission (August photo). Photo C: During the third year, the entire clump of OW-affected trees was removed resulting in a rapid transfer of the OW fungus to the previously unaffected neighbor's tree (August photo).