The Plant Doctor's LANDSCAPE TIPS

By Dr. David L. Roberts, *The Plant Doctor LLC a.k.a. The Tree Doctor*

OAK WILT MANAGEMENT BY TIER TREE PART 2: TREE INJECTIONS

Photo 1: Many people love their trees. So, when trees become infected from overland spread through pruning wounds, Oak Wilt frequently threatens many other oaks on the property as is the case with this resort site.

INTRODUCTION

Oak Wilt, caused by *Bretziella fagacearum*, is a lethal disease of oak trees (*Quercus* sp.). Members of the red oak family (northern red oak, scarlet oak, black oak, pin oak, etc.) tend to be highly susceptible and die rather quickly (Photo 1), while members of the white oak family (white oak, English oak, Chestnut oak, swamp white oak, etc.) tend to be more tolerant of the disease. As an exception, Burr oak, a member of the white oak family, can be seriously affected by Oak Wilt and may be the most susceptible of the white oak group.

The Oak Wilt fungus spreads by two major methods: **1) "Overland,"** by sap beetles and possibly other insects usually to fresh wounds on oak trees, and **2) "Underground,"** through root graft connections between nearby oak trees, most commonly of the same species. Once detected, Oak Wilt is extremely difficult and costly to manage. There seems to be confusion among the arborists/landscapers and the public who desire to try to contain and eradicate the disease from infested properties. Much of that confusion apparently originates from the people giving a wide variety of conflicting and confusing advice. The source of disparate advice includes University scientists and government agencies.

In the first part of this series, *Oak Wilt Management by Tier Tree, Part 1: Root Graft Disruption (The Landsculptor, November 2019)* I described how the Tier Tree Model evolved over the last 36 years since I devised this Oak Wilt Remediation method. Starting as a Root Graft Disruption Model (RGD) in 1984, adopted from my work on Dutch Elm Disease, I have since adapted The Tier Tree Model to Tree Injections as well as an herbicide technique I created called Glyphosate/Stump Cup (Figure 1). The Tier Tree Model has many advantages over the Forest Management Model, which was developed strictly for forests and woodland situations where trees are of relatively low value (Figure 2). In general, the FMM should be used primarily in forest environments for which it was developed, and not in urban/residential locations where its implementation would likely require the sacrifice of many valuable trees. The Tier Tree

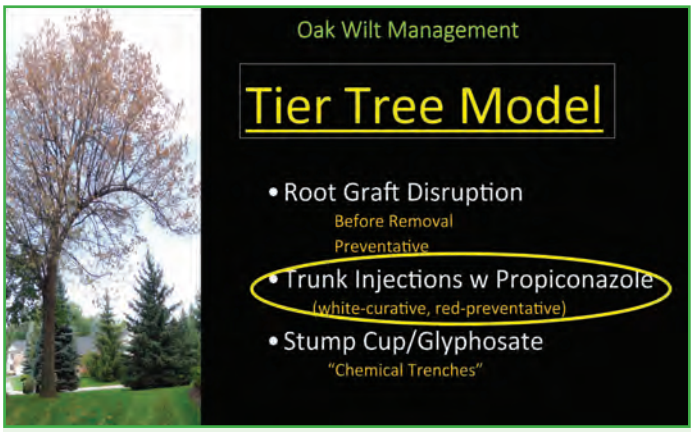

Figure 1: The Tier Tree Model was developed by the author starting in 1984. Over the ensuing decades, the Tier Tree Model has evolved into three major remediation methods: Root Graft Disruption, Tree Injections and the Glyphosate/Stump Cup Treatment. Tree injections will be discussed in this article.

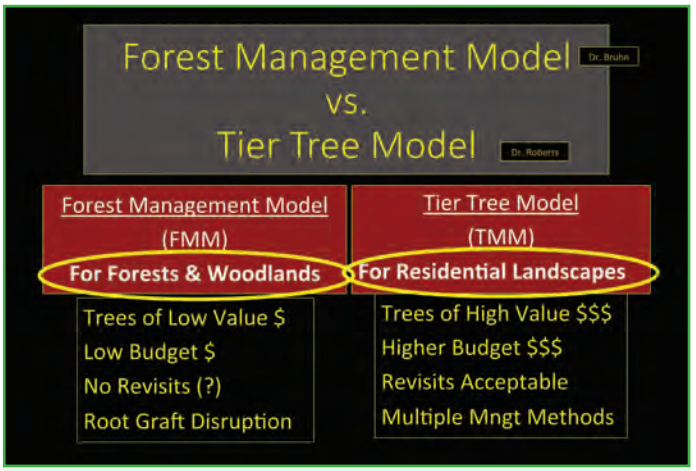

Figure 2: A comparison of the two major Root Graft Disruption Models shows that the Forest Management Model (Bruhn) was designed *strictly* for forest situations with trees of relatively low value while the Tier Tree Model was designed for locations with trees of higher value, such as those in urban/residential areas, parks, resorts, nature preserves, etc.

Model can also be used in woodlands and forests (Arboreta, Forest Preserves, Nature Centers, etc.) if property owners/managers determine to preserve as many trees as possible from the destruction by Oak Wilt. The present article will be devoted to Tree Injections and where/when such procedures might be useful.

Continued on page 16

The Plant Doctor's LANDSCAPE TIPS

OAK WILT MANAGEMENT BY TIER TREE PART 2: TREE INJECTIONS

Continued from page 15

TYPES OF TREE INJECTION SYSTEMS

There are a variety of Tree Injection Systems on the market that are used for a variety of reasons (Photos 2, 3 & 4). Each of the injection systems has its advantages and disadvantages. Hence, it is not unusual for an arborist company to have several types of injection equipment. Tree injection systems may be used for disease and pest management, for correcting nutritional disorders and for delivering growth regulators. Perhaps tree injection systems can be arbitrarily divided into two major types: Micro and Macro Injection, aka. Macro and Micro "Infusion". Whether a system is considered Micro or Macro largely depends on the volume of solution delivered. Simply put, those that inject larger amounts of fungicide (often diluted with water) are termed "Macro" and those that inject smaller volumes (concentrated) are considered "Micro". With more systems coming on the market all the time, the differences between Macro and Micro may become blurred. It has been the observation of the author that more volume is better for thorough distribution of the product throughout the tree and to avoid phytotoxicity. Depending on the injection system, some tree injections are administered in the lower trunk and some are administered in the root flares. In my opinion, as a rule, tree injections should not be performed as a routine arboriculture practice to ameliorate minor problems with trees. Rather, tree injections are especially beneficial in life and death situations such as that with Oak Wilt and Emerald Ash Borer.

TREE INJECTION PROTOCOL FOR MANAGEMENT OF OAK WILT

Tree Injections are usually applied for two reasons: 1) Increased insurance to back up other remediation efforts such as RDG, and 2) as a primary tool when no other reasonable options are available for certain situations. In regard to #2, there are some instances where RDG is not recommended; these situations include where application of RDG in too tight of quarters might result in excessive damage to other trees or the subject tree's roots (see Critical Root Zone below) and where RDG is not advisable due to the presence of abundant underground utilities. Essentially, trees can be injected at almost any time they will take up the product. As one supplier put it, "propiconazole is more effective in the tree rather than sitting on the shelf" – there's probably a lot of wisdom in that statement. Many arborists find that trees take up the propiconazole much more readily in the (early) morning and that the trees essentially "shut down" by late morning to afternoon.

Propiconazole is the fungicide used in Tree Injection Systems for management of Oak Wilt. Although the rates on the labels may vary from 10 ml to 20 ml per trunk diameter inch at 4.5 feet (dbh=diameter at breast height), the author has noticed failures in the management of Oak Wilt with any rate less than 20 ml, regardless of the injection system employed.

It is currently believed that propiconazole, the fungicide used in Tree Injections systems for management of Oak Wilt, will provide protection against root graft transmission for two years. This has been my observation in numerous field tests. It is also believed that the Oak Wilt fungus may survive in infected tree roots for at least 4-5 years. Hence, it is advisable to treat symptomless red oaks for at least 6-8 years . . . in other words, every other year (every two years), for at least 3-4 treatments. The goal of tree injections is to protect trees within root graft range for a sufficient period of time until the fungus dies within roots of nearby infected trees before the protected tree is invaded and killed by the OW fungus.

Tree injection may be somewhat costly; it is not unusual for an average cost to be $200-400 per tree for one treatment, depending on the size of the tree. So, if the tree needs treatment three or four times over 6-8 years, the cost to save a tree could accumulate to possibly $800

Photos 2, 3 & 4: Tree injection systems can be utilized for a variety of reasons. Although there are currently many such injection systems on the market, three of the more common ones include: Rainbow Tree's Macro-Infusion (Photo 2), ArborJet's Tree I.V. (Photo 3) and Arborsystem's Wedgle (Photo 4-Portal System here). Most companies market several different types of injection equipment. Also, most companies market their own propiconazole products for Oak Wilt and other disease management: Rainbow Tree's Alamo, ArborJet's Propizol and Arborsystems' Shephard.

to more than a $1000 per tree over that period of time. Contrasting those investments, it is virtually impossible to grow a tree of a significant size during a human generation.

TREE INJECTIONS BY TIER: CAUTION!

Research performed in Texas a couple of decades ago disclosed that tree injections with propiconazole may not prevent the Oak Wilt fungus from "passing through" injected trees, allowing the fungus to attack unprotected trees in the 2nd or 3rd tier. Hence, it would be advisable to treat more than one tier of trees or utilize a RGD trench to prevent transfer of the fungus to unprotected trees. I have often used tree injections in combination with RGD with good success.

CRITICAL ROOT ZONE (CRZ)

The CRZ is the root area of a tree that should not be invaded if we want to maintain tree viability and health. Invading the CRZ by mechanical means such as trenching may result in tree damage or tree decline (Photo 5). CRZ is generally defined as follows: for every inch trunk diameter at breast height (dbh=4.5 feet), there should be a foot of undisturbed roots one-foot radius from the trunk of the tree (Photo 5). A not uncommon situation where tree injections might provide some benefit is where RDG cannot easily be utilized . . . such as where trees are too close and RDG might harm the very trees we'd like to save. Photo 6A shows such a situation at the onset of Oak Wilt and five years later (Photo 6B). Considerations of the CRZ, the allotted budget and how important the trees are to the property owner will provide guidance into what procedures should be utilized.

Photo 5: The Critical Root Zone is defined as, for every inch of trunk diameter at chest/breast height (dch or dbh) there should be at least one-foot of undisturbed root zone measured as radius from the trunk of the tree. With the transplant of this large 32 inch dbh oak, there should be at least 32 feet of undisturbed root zone measured radially (radius) from the trunk. Clearly the root zone of this transplanted tree was inadequate, the reason the tree died the following summer.

Photo 6A: At this site near Grand Rapids, Michigan, overland spread of Oak Wilt occurred to this landscape after the trees were trimmed in the spring. The two trees in the center of the photo somehow escaped infection, but many others in both directions succumbed to the disease. Because of the proximity of the two symptomless trees to infected trees, RGD (trenching) could not be used without invading their CRZ, possibly severely harming the two apparently healthy trees. Trunk injections alone were used to protect the two symptomless trees from root graft transmission (see Photo 6B).

Photo 6B: The two trees in the center landscape in Photo 6A were saved by tree injections only. This photo was taken 5 years after Oak Wilt was introduced into the landscape by overland transmission. Note the "4 Sale" sign in the front yard, possibly creating an ethical dilemma for me and the arborist who is treating the site. At least one, possibly two tree injection cycles are still needed. Did the sellers disclose Oak Wilt disease on the property to the buyers?

Photo 7: In this photo, the red oak on the right became infected by overland spread to a pruning wound at this landscape near Grand Rapids. Note the smaller tree (left) that turned brown due to phytotoxicity from propiconazole trunk injections. The weird aspect of this phenomenon is that the large tree just to the right of the smaller oak (center of photo) was also injected but exhibited no phytotoxic symptoms. Luckily, the arborist and I had warned the property owner of possible phytotoxicity prior to injections. (Photo Credit: Bill Drews, Woodland Tree Service)

Implementation of the Tier Tree Model will likely result in the salvation of as many trees as possible, especially compared to the destructive Forest Management Model.

PROPICONAZOLE PHYTOTOXICITY

Propiconazole is the primary fungicide used in tree injection systems for control or inhibition of Oak Wilt. Technically, propiconazole is a "Fungistat" and not a fungicide, per se; like many "fungicides" propiconazole inhibits spore germination and fungal growth, which is the reason it is often considered "Fungistatic." Where it might possibly exhibit "fungicidal" capabilities is when the fungus dies because of its inability to grow and reproduce. With respect to Oak Wilt and injection of oak trees, it is not unusual for propiconazole to be phytotoxic to plants that are exposed to the chemical. Phytotoxicity means "plant toxicity." For some reason that is not well understood, some trees react to propiconazole exposure by shedding leaves and/or exhibiting scorched or brown foliage (Photos 7 & 8). Others don't. Perhaps in some situations, 10-20% of the injected trees might exhibit phytotoxicity symptoms. When a phytotoxic response

Continued on page 18

OAK WILT MANAGEMENT BY TIER TREE PART 2: TREE INJECTIONS

Photo 8: At this site in Traverse City, note the abundant leaf fall on the lawn that resulted from a recent injection of propiconazole to prevent root graft infection. The tree recovered just fine.

Continued from page 17

occurs, I sometimes have had to step between a homeowner and the arborist to minimize an altercation . . . because the property owner automatically assumes the arborist has killed the treated tree, probably by infecting it with Oak Wilt. In every case of phytotoxicity I have encountered, trees have recovered very nicely either the same year or the following year, depending on when the phytotoxicity occurs (early or late in the season). In my opinion, when performing tree injections for Oak Wilt control, I strongly recommend that clients be warned about the potential for phytotoxicity of the fungicide as a preemptive measure, which could forestall "shock and awe" and build credibility if such phytotoxicity occurs. When educating a client about phytotoxicity, I often use the analogy of hair loss in cancer patients undergoing chemotherapy.

TREE INJECTION CONTROVERSY AND FAILURES

I have seen tree injections for managing Oak Wilt both fail and succeed. On this basis, that tree injections for Oak Wilt management sometimes fail, some individuals and entities present a dismal view of tree injections. Why do tree injections occasionally fail? I think there are a multitude of possible reasons. First, I don't think that some applicators are administering the fungicide correctly.

Photo 9: This red oak began shedding leaves in 2018 from root graft infection of Oak Wilt. Oak Wilt was confirmed by lab tests. Oak Wilt had been spreading at this site in SW Michigan for several years. The property owner wanted to save this valuable, visible tree at all costs. The arborist, who had been experimenting with high rates, injected the tree in the fall at 40 ml/ per dbh, double the usual dose. The tree leafed-out just fine in the spring of 2019 and remained healthy-appearing throughout the year, showing some potential promise for therapeutic rates of propiconazole in red oaks.

Second, I suspect in some cases, insufficient product is being administered. Third, some trees may already be infected by the Oak Wilt fungus without showing symptoms; in general, red oaks that are infected by the OW fungus most likely cannot be saved. There is some research occurring where much higher rates of propiconazole are being administered to infected red oaks with positive results (Photo 9).

In general, preventative, prophylactic treatments with Tree Injections of propiconazole are not recommended, unless the risk from root graft transmission is imminent. Some individuals might also decide that preventative treatments could be warranted if *unmanaged* Oak Wilt epicenters are very close by but, perhaps, just out of root graft range.

Photo 10: It is not unusual for trees that are drilled for the injection procedure to weep through the injection sites after the procedure is completed. Seepage may occur for months or even years.

Tree injections may be controversial due to the injury the equipment causes on trees. For most injection systems, drilling into the trunk or root flare is required. This injury is generally not lethal to trees unless some disease agent invades the wounded area. The injury caused by injections may cause seepage of liquids from the injection site for quite some time (Photo 10). The seepage may be comprised of sap or may indicate a slime flux/bacterial wetwood infection. Neither should be harmful in the long term. However, we want to be careful about over injecting trees (Photo 11).

Photo 11: At the property owner's insistence, this tree was injected every year for six years. Note the physical damage on the lower trunk due to annual injections rather than the recommended treatment every other year schedule. Such damage could result in gradual decline and dieback of the tree.

THERAPEUTIC PROPICONAZOLE TREATMENTS

To protect members of the red oak family from root-graft transmission, propiconazole is administered *preventatively*. Many Oak Wilt experts consider preventative treatments as the *only* procedure for red oaks. In the case of white oaks afflicted with Oak Wilt, it is usually believed that tree injections provide a therapeutic effect; such treatments can "cure" white oak family members of Oak Wilt. In the past decade or so, I have been experimenting with higher doses of propiconazole on red oaks to determine if red oak family members can be cured after infection by the Oak Wilt fungus. Some of my treatments have definitely prolonged the lives of infected red oaks for many years. Some arborists and scientists have recently engaged in similar attempts to save infected red oak family members (Photos 12A & 12B). The results are interesting, so stay tuned.

ETHICAL CONSIDERATIONS

Because Oak Wilt remediation efforts can be long term, especially with tree injections, ethical problems may occasionally occur. In some cases, property owners may demand more frequent than normal treatment rates (Photo 11) – this is ill advised. In other situations, property owners may decide to move and sell their home before the recommended treatment schedules are completed. Hopefully, the seller will inform the buyer of the need for further treatment as part of the disclosure process. If not, is it up to the arborist to inform the new homeowners (Photo 6B)?

DISCUSSION

Tree Injection can be a valuable tool for remediation of Oak Wilt. It can be used singly or in combination with other procedures such as RGD. There are occasional circumstances where RGD alone may not isolate all trees to be saved from root graft transmission of Oak Wilt; those situations are where tree injections might prove useful (Photos 6A, 6B & Photos 12A & 12B).

None of the Oak Wilt treatment methods are guaranteed to control Oak Wilt. That's why it's important to solicit the most highly qualified people when considering Oak Wilt remediation. Having honed the Tier Tree Model for nearly 36 years, most of the sites on which I've provided guidance have been 100% successful in remediating Oak Wilt, if the proper procedures are followed. If Oak Wilt management according to Tier Tree fails, the failure can usually be traced back to insufficient propiconazole usage or inadequate RGD depth, etc.

Photo 12A: At this site near Onekama, Michigan, the Oak Wilt epicenter developed due to pruning a couple of trees near a sidewalk leading down to the lake (see Photo 12B). Many of the trees on the property benefited from two RGD tiers, the first between diseased trees and the next tier of healthy trees, the second between the next tiers of healthy trees . . . for added insurance.

Photo 12B: The trees in this photo were isolated ***with*** the diseased trees by the first RGD trench. In other words, no RGD occurred between the diseased trees (foreground, now removed) and the initially unaffected trees in the background. Only tree injections were used to save them from root graft infections with the diseased trees. Photo was taken several years after remediation.

Dr. David Roberts has retired from Michigan State University but intends to remain active with the industry. He is CEO and CBW (Chief Bottle Washer) for The Plant Doctor, LLC. Contact information: 248/320-7124 and treedoctordave@gmail.com.