Alternative Elm Story: Injection with Propiconazole

By Jay Gough, Top Notch Treecare

Elms were once considered the perfect urban tree because of their beauty, fast growth, durability and versatility. The perils of over planting and prevalence of shared root systems caused the elms to be efficiently devastated when Dutch elm disease arrived to many American cities. Dutch elm disease is caused by a fungus that affects the actively growing vascular tissue of elm trees. The fungus is spread predominantly by an elm bark beetle, during its feeding in the upper canopy, but it can also be spread by shared root systems of trees, or root grafts.

The fungus that causes Dutch elm disease creates a reaction in the vascular system of an elm that prevents water and nutrient movement into the crown. This produces a typical "wilted" appearance. Evidence of an infection can also be found by removing the bark of a limb to check for brownish staining. Often you will see a progression of wilting from branch tips down a limb, this pattern indicates that the fungus was introduced by a beetle, and is referred to as an overland DED infection. A progression of wilting down a limb helps differentiate a DED infection from natural mortality or storm damage. If a tree takes on a more uniform wilted appearance, this is a clue that the infection likely came through a root graft. Identifying Dutch elm disease can be more complicated by the fact that occasionally an infection will not become symptomatic as the tree struggles to contain the fungus.

As Dutch elm disease made it's way through the Midwest, the Twin Cities were able to learn from the experiences of other areas that had previously dealt with the disease. David French, a plant pathologist at the University of Minnesota, was very instrumental in sounding the alarm as DED approached. His work centered on best management practices for DED on a municipal level, as well as the unenviable task of attempting to procure funding through legislature. French stated that, "the simple answer to the control of Dutch elm disease is sanitation." This entails the identification of diseased trees through multiple annual inspections, and the prompt removal of diseased trees to reduce or eliminate the risk of root graft infections to neighboring elms, no small task on a massive urban scale. Good sanitation strives

to eliminate elm bark beetle breeding grounds leaving fewer beetles to carry fungal spores.

The effectiveness of the management program carried out in many Twin Cities municipalities is proven by an elm population that remains substantial, nearly 55,000 remain in Minneapolis alone. At its peak in 1977 DED claimed 32,000 trees or roughly 15% of the elm population in Minneapolis alone. For nearly twenty years loss rates hovered around 3%. Why then did mortality increase in 2002 and continue to climb to nearly 15% in 2004 after years of being held in check? There are several likely culprits to the resurgence of Dutch elm disease in the Twin Cities. The most widely accepted is a decrease in vigilance in sanitation programs. This is by no means an indictment of these programs, yet more a demonstration of the difficulty in managing for this disease. With a smaller population of elms, the disease is less visible, even if mortality climbs, so there is a decrease in public awareness. The prevalence of other exotic insects and pathogens on the horizon, such as Sudden Oak Death, Gypsy Moth, and Emerald ash borer to name a few, make it more difficult to obtain funding for a program that has been considered successful for so long.

Other theories for the resurgence center around the climate, or the pathogen and its vector. Milder winters have prevailed in the area over the last five years, which could allow more beetles to over winter successfully. There are at least two species of fungi that are proven to cause DED in Minnesota, so another more aggressive strain of fungus could be another cause. A different vector, that could possibly be more efficient at transmitting the disease could be to blame as well.

ONE COMPANIES PROGRAM

Although municipal programs controlled Dutch elm disease fairly well after the initial outbreak, some homeowners with particularly large or valuable trees began to search for additional protection from the disease. Macro-injections using systemic fungicides showed promise in protecting an elm from overland DED infections, but are not economically feasible on a large municipal scale. So Top Notch Treecare began using a propiconazole based product called Alamo, the brand name, in 1995 to protect its clients elms. The label rate at that time was 10 ml per diameter inch. One year later the dosage rate was increased to 20 ml per inch. The goal of a preventive injection is to get

the proper amount of fungicide into the tree, getting even distribution throughout the canopy, while doing the least amount of injury possible. All three of these components are critical to the long term success of the injection as well as the ability to repeatedly administer the treatment. Fungicide injections can be done therapeutically with some success but this article refers only to injections performed on trees not infected by DED. Preventively we warranty an elm injection for three growing seasons against overland DED infection. No known fungicide offers protection from a root graft DED infection. The first year of injection does count as a season so in essence the warranty covers about 2½ years.

Throughout our first eleven years of protecting elms, we have performed over 3,100 preventive injections and honed our program. There are four key components:

1) Training of the applicators and sales staff
2) Chemical selection
3) Method of application
4) Follow up and monitoring

TRAINING

Field applications of chemicals is often handled by the newest employees in arboriculture. It can be dirty, hard work that is seen as fairly simple to perform. This is certainly not the case when administering fungicides for Dutch elm prevention. Because of how rapidly DED can progress in a tree, field diagnosis and the ability to communicate well with clients about disease biology is critical to the success of a program. A week between the sale and the application can create very different site conditions, so the final diagnosis is often the duty of an applicator. Applicators must be able to differentiate symptoms at different times of the growing season from naturally occurring tree disorders. They also must be able to identify and document additional threats to a treated trees' warranty, such as nearby disease issues. This is often the only leg that we have to stand on if we need to prove that an infection is the result of a root graft infection. There also must be a willingness to get second opinions on questionable trees throughout an organization as Dutch elm disease can fool even the most experienced arborist. Cohesion between the salesperson and applicators is vital to the efficiency and effectiveness of an injection program.

CHEMICAL SELECTION

The pioneers of our Dutch elm disease program had some experience with thiabendazole hypophosphite, trade name of Arbotect 20-S, which has a good record of success in preventing DED and was the industry standard at the time. However, some concerns with the product were raised. Thiabendazole hypophosphite has a very low pH (2.7 in a 1% solution), and therefore had to be mixed with a lot of water (often 30-40 gallons) to make the solution less acidic. Soft water was also required to put this product into suspension. It often took nearly an hour to administer the injection, and the equipment required to handle the liquid volume was somewhat cumbersome. Research by Alex Shigo also showed significant damage near injection sites using thiabendazole, due to acidity.

So at Top Notch, we searched for other products or alternatives. Dave Apple, a pathologist from Texas A&M, did a study on inter-vascular injection of propiconazole in 1992 for the prevention of Oak Wilt. Oak wilt is caused by vascular wilt fungus very similar to Dutch elm disease. Propiconizole is closer to pH neutral (5.8 to 6.8 at a 1 percent solution), and it could be applied and mixed in smaller volumes, making the field application more effective and intuitively less injurious due to acidity.

Early research using bioassay with propiconazole failed to show that the chemical moved into newly formed wood, leading some to think that the injections would need to be done every year. Yet disease protection did last longer than one year in the field, creating more questions than answers. Propiconazole is a triazole compound that has plant growth regulator properties associated with increased tolerance to such things as drought, salt, and frost damage. It has been suggested that growth regulator properties may play a role in the ability of propiconazole to inhibit the growth of the fungus causing DED. There remain many questions about propiconazole use in treating for DED, but its effectiveness has been demonstrated. Something can always be said for a mystery, I have no idea how computers work, yet I use them frequently.

I think the track record of thiabendazole and propiconazole are pretty similar and that both fungicides are effective. I think our injection

process is very effective not only because of what we use, but how we use it. The most effective cancer fighting drug in the world would not work if it were administered improperly. For political reasons a lot of focus in commercial DED management is centered on what product you use, with very little attention paid to how it is injected which I assert has even greater importance.

METHOD OF APPLICATION

It is often said that arboriculture is art and science and this is especially true in dealing with macroinjections. Choosing injection sites on an elm tree is crucial to even chemical distribution in the crown. Mark Stennes in 1986 found that 2.25 is the optimum number of injection sites per diameter inch. Fewer sites may not yield adequate distribution, more could be considered unnecessarily injurious. Injection sites should be concentrated in major root flares and distributed as evenly as possible circumferentially.

Stennes also found that the preferred area to inject a fungicide was into the root flare tissue of an elm. This area is known to have greater ability to withstand and compartmentalize injury, vital for a process that must be repeated every third year. Exposing the root flare by 3-6" allowed the optimum amount of injection sites to be achieved, increasing the likelihood of even chemical distribution in the canopy of an elm.

It has been documented that fungicide solutions can cause cellular dieback near the injection sites. Therefore we teach our applicators to flush the fungicide away from the injection sites by using water in the application tank after the proper dosage has been administered. This will reduce the injury we create at the injection site and make it easier to repeatedly inject an elm.

FOLLOW-UP

Protecting an elm tree from Dutch elm disease is only partly done once the injection is complete. Every year we lose a few trees under warranty that could possibly have been saved if we had caught the disease sooner. If we notice an elm that is under warranty has become symptomatic, we can treat this tree (at our cost) and hopefully remove the existing infection by pruning. Therefore monitoring treated trees and recognizing hot beds of DED activity is essential to minimizing

losses. If an area has high incidence of DED, we may also recommend injecting some protected trees on a shorter rotation as well as document root graft risks posed by other infected elms. Monitoring is very important in limiting our risk as well as adding value to the service that people have hired us to perform. Monitoring also fosters a good relationship with the local forestry department. They monitor for disease more extensively than anyone, so by notifying inspectors which trees we have treated, we increase our chances that an infection can be caught early. This not only reduces our risk of failure, our cooperation with municipalities lends credence to our program to our customers.

Several of the key components to our program, (particularly the need to excavate a tree, flushing the fungicide from the injection site, and monitoring) are very costly from an efficiency standpoint of a business. Any business owner or manager knows that ten minutes here or there adds up very quickly in the bottom line. They are not eliminated to make us more efficient because they need to be done to make our injection program effective in preventing Dutch elm disease.

CONCLUSIONS

Data shows that injecting elms with propiconazole to prevent Dutch elm disease is effective, but it is not a silver bullet. We do issue refunds to customers whose trees have died under warranty every year. Top Notch has analyzed these losses to ascertain any trends. Over half of the losses that we have experienced in the last eleven years have occurred due to inadequate chemical distribution in the crown for two main reasons. The first reason for failure is the inability to adequately inject into the root flare due to a physical obstacle or previous mechanical damage (often a fence, deck, or wound at the base of an elm). The second is a compromised root flare due to damage or biotic reasons that affect many urban trees. This information allows us to be more exclusive with our warranty, in turn limiting our liability with trees that are more prone to fail.

Arboriculture is a very dangerous and difficult profession. We deal with patients who are almost always compromised due to their environment. We are often expected to control problems with unrealistic expectations. Part of our job is to educate the public so they can make sound decisions for their trees in the future. We can only do so if we are aware of all of the tools that our profession has at

our disposal. We can certainly recommend planting disease resistant elms for the future of the species, however maintaining the already mature specimens and the value they provide to the urban forest is another critical component.

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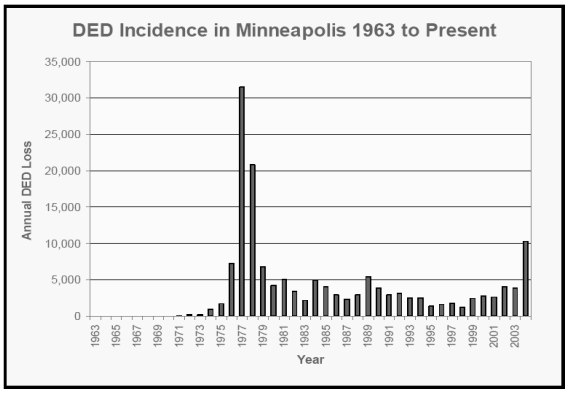
This picture represents wilting or flagging that is typically associated with an overland Dutch elm disease infection



Year	Trees under warranty	Warranty refunds given	Loss rate
1998	366	0	0%
1999	605	2	0.33%
2000	806	3	0.37%
2001	801	4	0.49%
2002	846	1	0.12%
2003	907	5	0.55%
2004	1,416	12	0.85%
2005	1,591	20	1.26%
2006	1,541	14	0.91%
2007	1,251	13	1.04%
Total	10,130	74	0.73%

Annual loss rates from DED in Minneapolis (Graph courtesy of Richard Hauer University of Wisconsin Stevens Point)

This photo shows an elm tree properly excavated and hooked up for injection into root flare tissue

Preventive statistics for Top Notch Treecare. Trees under warranty includes three seasons for each row. Loss rate includes trees lost within warranty considerations only.

Would you not want additional protection for this massive 66”American elm?