

How to Inject Elms With Systemic Fungicides

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(To be used in conjunction with Extension slide set #333 "Elm Tree Injection" available from: Visual Aids, Agricultural Extension Service, 1 Coffey Hall, 1420 Eckles Ave., University of Minnesota, St. Paul, MN 55108)

Dutch elm disease is a problem that affects all species of elm trees (figure 1). It is caused by a fungus that lives and multiplies in the tree vessels. The presence of the fungus triggers chemical reactions in the tree that plug up the vessels and block the water movement. Thus, the tree wilts and ultimately dies.

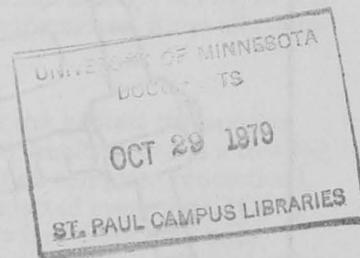
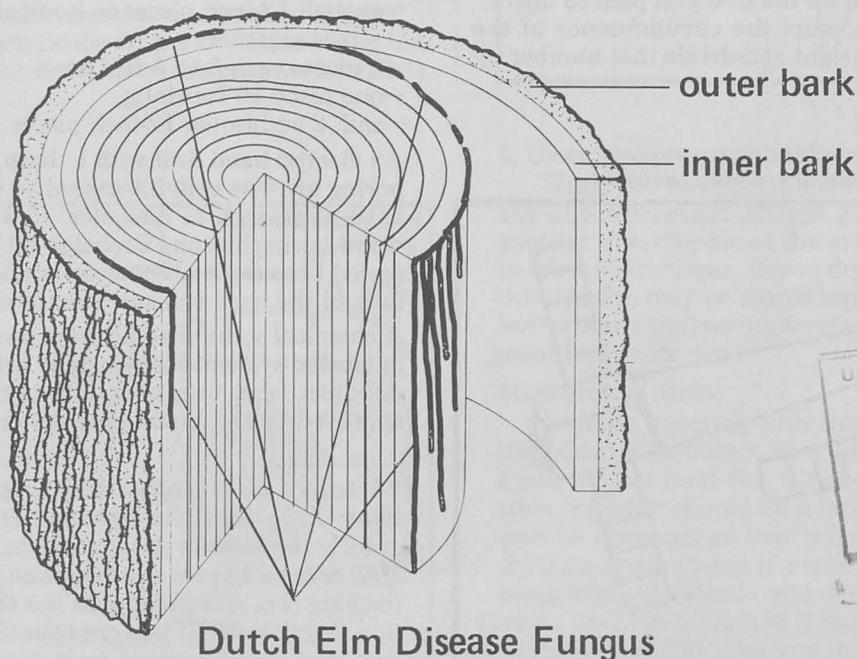
Since the mid 1930s many chemical treatments to control Dutch elm disease have been tested. Of these, injecting chemicals into the vascular system of the tree—right where the fungus lives—seems to be the most effective. Chemical injection has been aided by the development of "systemic fungicides." These are chemicals that can move within the tree and thus provide protection to portions of the tree far from the injection sites. Injection with systemic fungicides

rarely cures a tree of Dutch elm disease, though, and can fail to protect even healthy trees. In addition, such injection causes physical damage to the tree that may bring on other kinds of disease problems. Therefore, it is important to analyze your own situation carefully before you get involved with injection.

SELECTING A TREE TO INJECT

In general, you should consider injecting only those elms that are particularly valuable to you. Because injection is most effective as a preventive measure, the best candidates are healthy trees. Treating trees that have Dutch elm disease is less successful and generally is recommended only when there is no more than 5 percent crown wilt (1 or 2 small branches) and then only if symptoms appear after mid-July. Injection will not cure trees with massive wilt because the disease is usually well established in the main trunk and this interferes with fungicide movement. Likewise, injection cannot help trees infected through root grafts because the fungicide has a limited ability to move downward.

Figure 1. Dutch elm disease fungus in vessels of a tree



WHEN TO INJECT

Elms may be injected at any time during the growing season (June-September), however, the best time is soon after the leaves reach full size. In Minnesota, this is usually not until the second or third week in June. Injecting before the tree is fully leafed out will not be effective because the tree is not able to adequately take up and transport the chemical to the uppermost branches. For the same reason, you should not inject trees late in the summer or those that have been defoliated by cankerworms or other causes. In the case of defoliated trees, it is best to wait until the second flush of leaves has appeared before you inject.

EQUIPMENT AND CHEMICAL

You will need the following items for injection. Most can be purchased at garden stores.

A **corrosion-proof injection tank** with a large volume capacity—preferably one that will hold 30 or more gallons of solution. These tanks come in a wide variety of sizes.

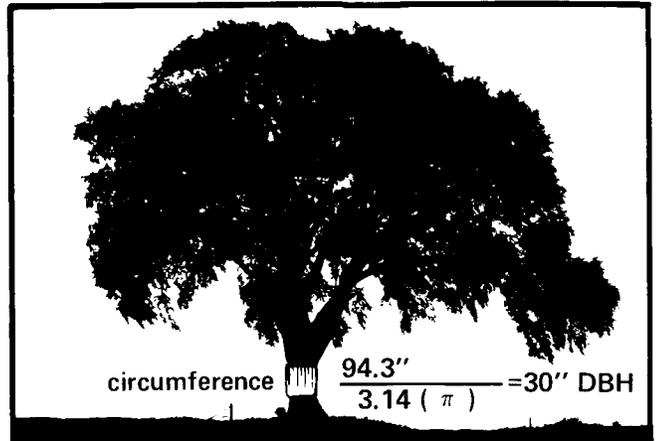
A **pressure system** that will provide a constant 5 to 12 pounds of pressure per square inch throughout the injection cycle.

Connecting tees and injection tees (figure 2). Any type of injection tees are satisfactory as long as they meet the following requirements:

- the tees should fit into holes between 3/16 and 5/16 of an inch in diameter.
- they should not leak.
- they should not penetrate into the sapwood far enough to block the outermost growth rings.
- and, they should not injure the tree excessively.

The number of injection tees needed is calculated on the basis of the trunk diameter at breast height measured in inches (DBH). This is approximately 4½ feet above the ground on the tree you plan to inject. To find the DBH, measure the circumference of the tree trunk at breast height and divide that number by

Figure 3. Circumference measured approximately 4½ feet above ground



3.14 (pi). Example: tree circumference of 94.3 inches \div 3.14 inches = 30 inches DBH (figure 3). For best results, you should have 1½ to 2 sites, and thus tees, for each inch of DBH. Therefore, a tree with a DBH of 30 inches would require at least 45 and preferably 60 injection tees.

30'' x 1½ tees/inch DBH = 45 tees

30'' x 2 tees/inch DBH = 60 tees

High quality polyvinyl tubing. You will need about 12 inches of tubing between each two injection tees and another 16 to 18 feet to hook the injection tees to the supply tank. Cut this tubing into the following sizes before you begin:

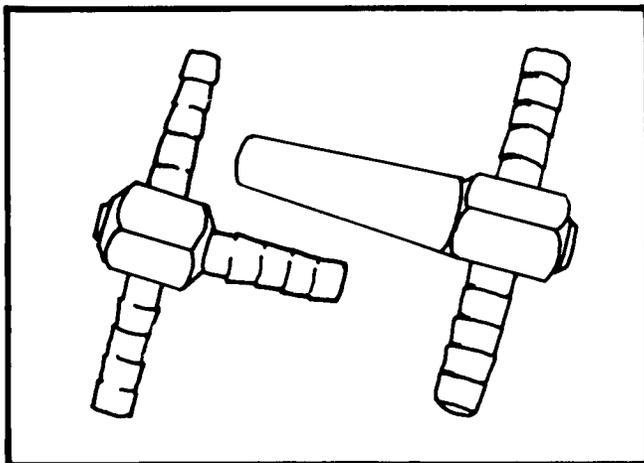
- enough 12-inch pieces to hook all of the injection tees together.
- 2 pieces each 3 to 4 feet long.
- one piece 10 feet long.
- and, 2 additional 12-inch pieces.

An electric hand drill with a sharp, high quality wood boring bit. The drill bit should be between 3/16 and 5/16 of an inch in diameter. Cleveland High Helix wood boring bits and Greenley #177 spur bits are suggested because they cut clean holes. This facilitates up-take of the chemical and minimizes injury to the tree.

A chemical solution. The most promising commercially labeled systemic fungicide is Arbotect 20-S.* The Arbotect label lists several dosages which have been approved by the Environmental Protection Agency

**Arbotect has recently been available in two formulations—Arbotect S and Arbotect 20-S. Both contain exactly the same active ingredient, with the Arbotect 20-S being 20 times stronger than the Arbotect S. In the long run, it is cheaper to use the stronger formulation, particularly if you are injecting more than one tree.*

Figure 2. Connecting tees (left) and injection tees (right)



and thus are legal to use. Research has shown that even higher dosages protect a tree more effectively. However, because these higher dosages are not currently legal, the best treatment available is the highest approved label dose—four ounces of the Arbotect per five inches of DBH.

To determine the total amount of Arbotect you will need, multiply the DBH of your tree by 4/5 (4 ounces per 5 inches DBH). For example, a tree with a DBH of 30 inches would require 24 ounces of Arbotect 20-S.

$$30'' \text{ DBH} \times 4/5 = 24 \text{ oz. Arbotect 20-S}$$

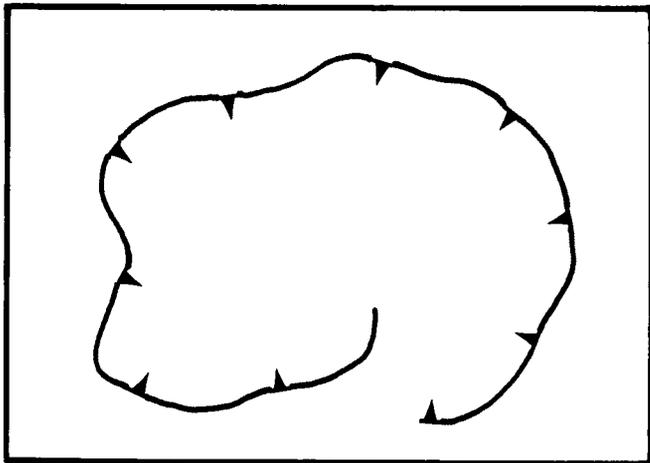
INJECTION STEPS

With these items assembled, you can begin setting up the equipment for injection.

1. Assemble the injection harness.

You must put together the injection harness first. Using the 12-inch lengths of polyvinyl tubing you cut earlier, connect all of the injection tees together (figure 4).

Figure 4. Injection harness assembled



2. Prepare root flares of tree.

The goal of tree injection is to distribute the chemical completely and uniformly throughout all branches and the twigs of the crown. Therefore, placement of the injection tees on the tree is crucial. University of Minnesota research has shown that the best place for the tees is at the root flares at points below the ground line (figure 5a). This results in a uniform uptake and good distribution of the chemical solution. Injection at any level above ground will cause the chemical to be distributed unevenly (figure 5b).

Figure 5a. Correct placement of injection tees on root flares

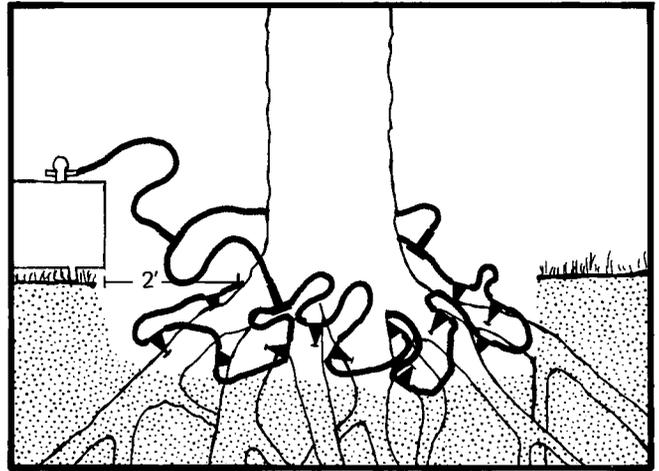
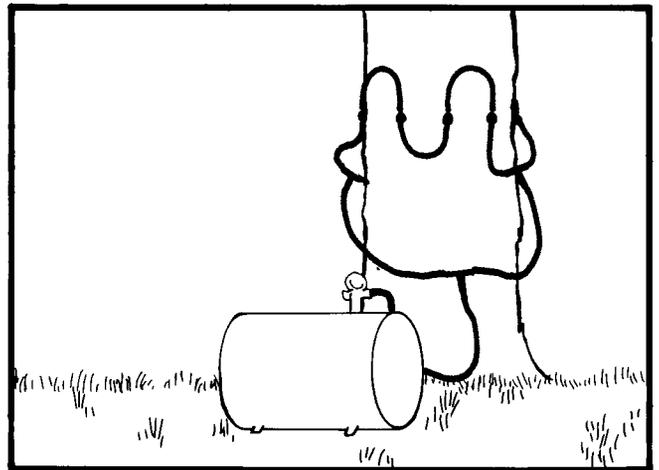


Figure 5b. Injection tees incorrectly placed on tree trunk



To properly prepare the tree for root flare injection, first excavate the sod and soil from the base of the tree, taking care not to injure the parts of the tree below ground. The excavated area should extend 2 to 3 feet away from the base of the tree and be from 8 to 18 inches deep.

3. Prepare chemical solution.

To find out the amount of water needed, using label recommendations, multiply the amount of Arbotect 20-S you found previously by 40. For example,

$$24 \text{ oz. Arbotect 20-S} \times 40 = 960 \text{ oz. water or } 7\frac{1}{2} \text{ gallons water}$$

To mix the solution, first pour the chemical into the injection tank and then add the required volume of

water. By mixing the solution in this order, you eliminate the chances that the chemical will settle out and make the solution ineffective.

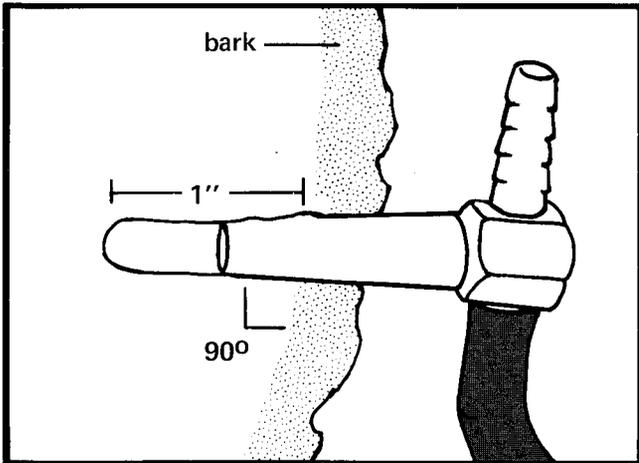
Most local water supplies from rivers or lakes are satisfactory for mixing with Arbotect 20-S. However, you should avoid well water because it may be hard and will cause the main ingredient to settle out.* You can check your water source for hardness ahead of time by adding one teaspoon of the Arbotect to 4 fluid ounces of the water to be tested and stir. Observe the solution for 2 to 3 hours for cloudiness or settling. If either occurs, the water is unsuitable and should not be used. In such cases, distilled or deionized water is suggested.

4. Insert injection tees into tree.

The best procedure for inserting the injection tees is to have one person drill the holes and another follow closely behind and tap the tees in place. In this way the holes do not dry out. (Dry holes reduce the rate of chemical uptake and thus increase the time needed to inject a tree.)

Drill injection holes perpendicular to the root flare surface and not deeper than 1 inch into the sapwood (figure 6). The holes should be spaced from 4 to 8 inches apart around the tree. They will be furthest apart on the widespread buttress roots and closest together where there is no flare. If you cannot excavate the root flares as suggested because of obstacles such as sidewalks, then place the injection tees as low on the trunk as possible and closer together than you normally would (i.e. 2 to 4 inches apart rather than 4 to 8 inches).

Figure 6. Injection holes drilled perpendicular to root flare surface



*Even hard water that has passed through a water softener is not suitable because it will still cause the chemical to settle out.

5. Hook injection tank to harness around tree.

When you have inserted all the injection tees into the tree you are ready to connect them to the injection tank with the extra pieces of tubing you cut previously. First hook one end of the 10-foot length to the injection tank and attach one of the connecting tees to the other end (figure 7). Then attach the 3-foot lengths of supply tube to this first connecting tee and place one of the remaining two connecting tees on the ends of each of these second pieces of tubing (figure 8). Finally, add one of the 12-inch pieces of tubing to each of these two end connecting tees.

Figure 7. 10-foot length of tubing connected to supply tank

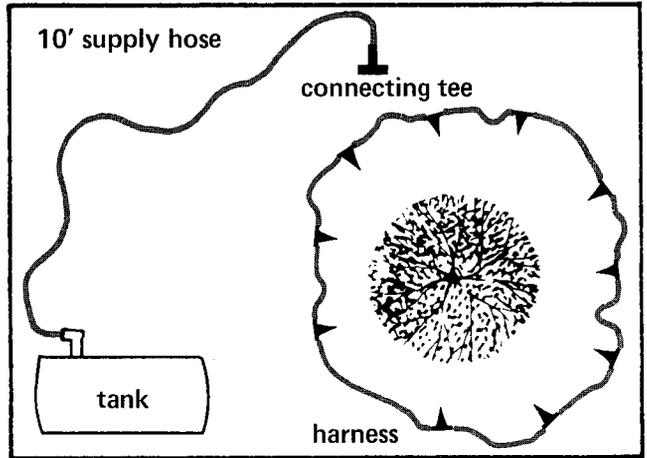
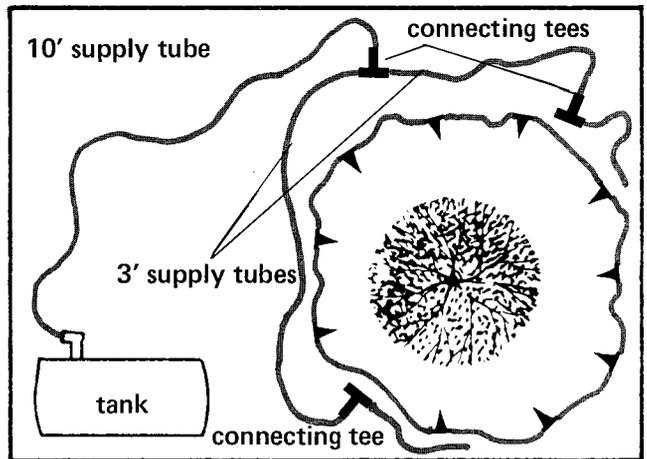


Figure 8. 3-foot lengths of tubing hooked in



You can now attach this supply hose to the injection harness around the tree by pulling out a piece of hose from two tees at opposite sides of the tree and hooking in the connecting tees (figure 9). By setting up the apparatus in this way, you eliminate differences in pressure and unequal distribution of the chemical between injection tees on the harness (figure 10).

Figure 9. Supply tubing connected to injection harness

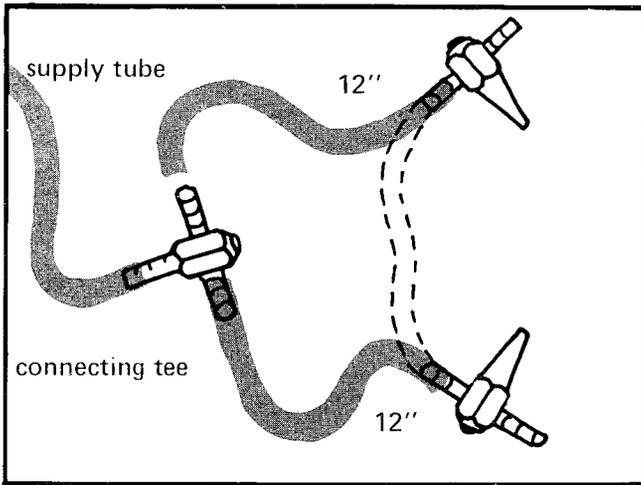
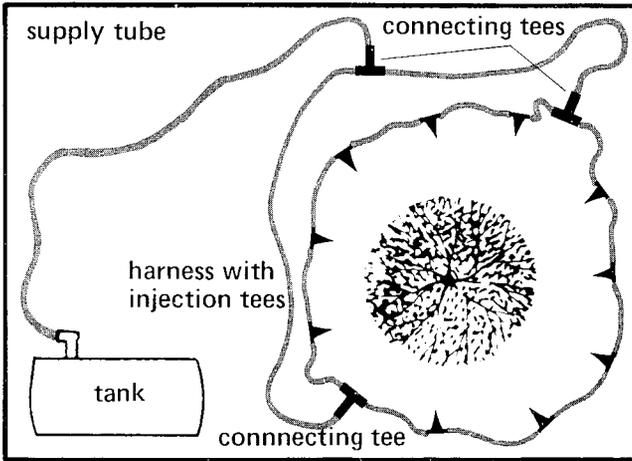


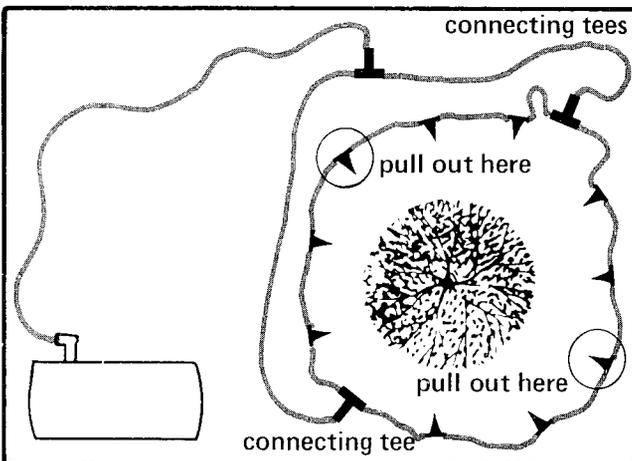
Figure 10. Injection equipment fully assembled



6. Evacuate air from the system.

Pull out two injection tees on opposite sides of the tree and perpendicular to the two connecting tees you just hooked in and turn on the supply (figure 11).

Figure 11. Tees pulled out to evacuate air from system



Wait until the solution comes out from these injection tees. When most of the air has been evacuated and the solution comes out from both directions, tap these last two injection tees back into the tree. Injection is now underway.

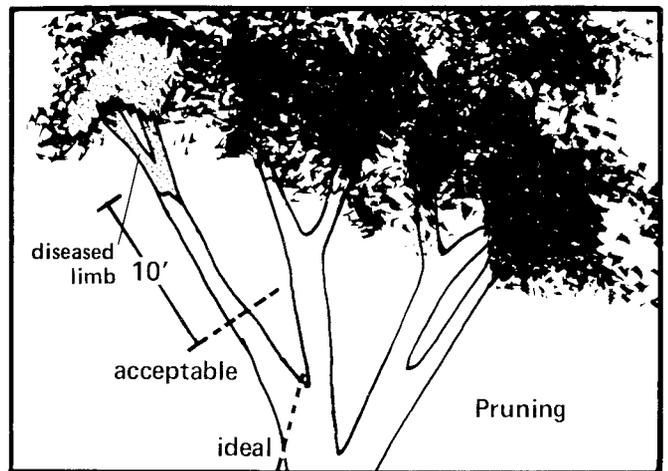
7. Remove injection heads.

When the tree has absorbed all of the solution or it has been several hours since the tree stopped taking up any chemical, remove the injection tees. (Don't leave the injection harness on the tree for more than 48 hours.) Allow the holes to air dry for at least 30 minutes before you fill in the excavation. Wound dressings are not necessary and you should never use wooden dowels to plug the holes.

8. Prune infected branches.

If you treated a diseased tree, you must prune off the infected portion to the main stem immediately following injection. If you can't prune to the main stem, prune to 10 feet below the end of the internal Dutch elm disease symptoms on the branch (brown streaks on the wood under the bark) (figure 12).

Figure 12. Pruning diagram for diseased trees

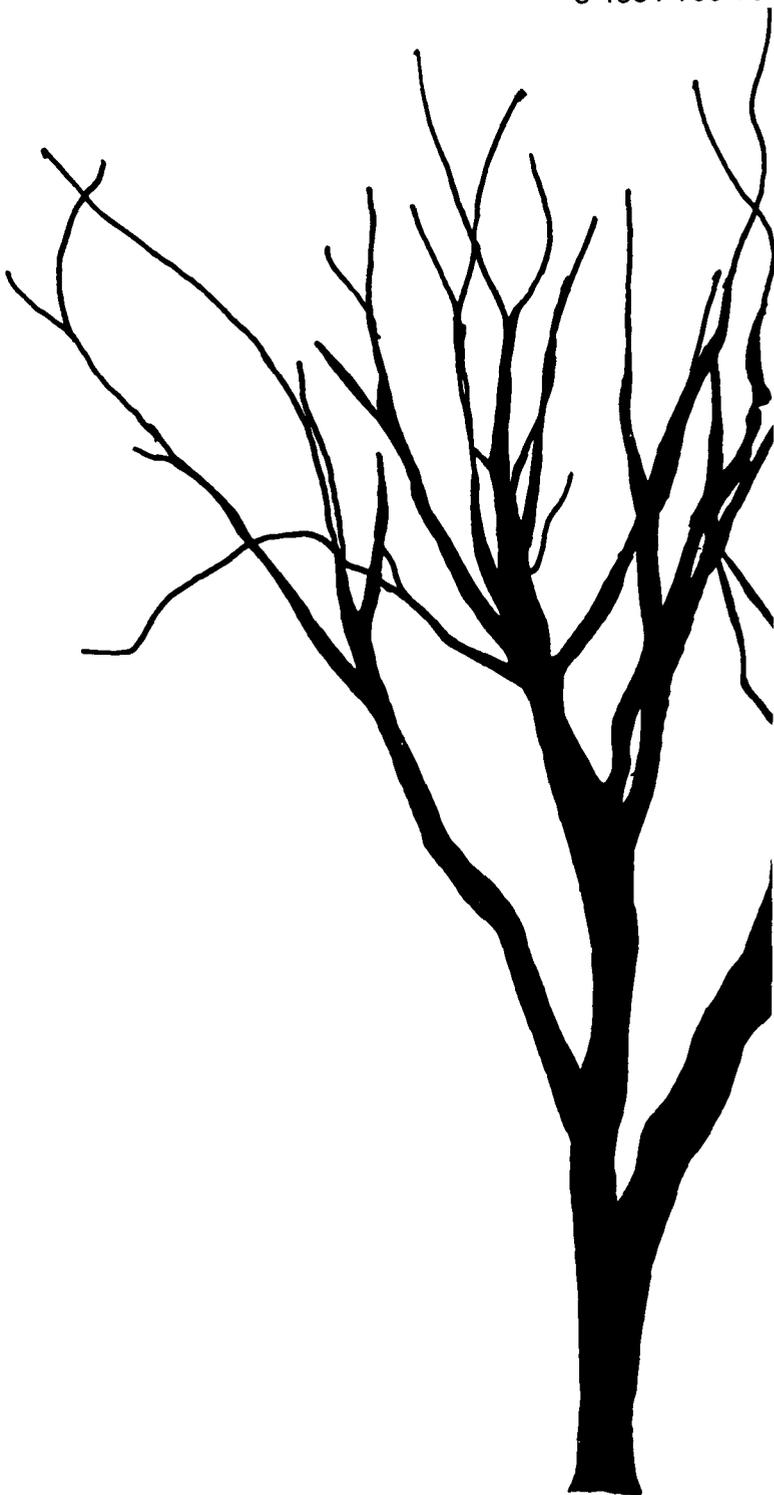


9. Clean equipment and take care of extra solution.

When you have completed injection, if there is any of the chemical left and you don't plan to inject another tree, dispose of the extra solution according to label instructions. If you do plan to inject again, the solution may be stored indefinitely, as long as it is not exposed to freezing temperatures. Rinse all equipment before storing.

10. Injecting again.

Because injecting with the highest therapeutic label dose of Arbotect 20-S usually protects a tree for a year or less (and this is not complete protection), trees generally should be injected every year. It may even be necessary to treat a tree more than once during a single season if a tree becomes infected after being injected. Should you decide to inject your tree again, drill the holes 2 to 3 inches above or below and to the side of the holes you made previously.



SOME FINAL NOTES

- There is another registered chemical on the market for injection against Dutch elm disease—Lignasan. However, it is not very effective against the disease at label doses because, once injected, it moves into the leaves and drops to the ground with them in the fall.
- Arbotect 20-S costs approximately \$156.60 per gallon and Lignasan about \$10.95 per gallon. The two main distributors of these chemicals in Minnesota are the Castle Chemical Company (12505 Xenwood Ave. South, Savage MN 55378) and Turf Supply Company (2970 Dodd Rd., St. Paul MN 55121).
- Another Dutch elm disease treatment which has been publicized recently is a bacterial antibiotic. Research on the antibiotic is still in its preliminary stages and a substantial amount of work is needed before the effectiveness of the antibiotic can be demonstrated.
- Injection equipment currently on the market is very frequently sold in sets (i.e. tank, tubing, tees etc. together). However, these sets often don't include enough tees to properly inject anything but a small tree. In addition, the tees that are included may be the wrong type. Consequently, it is usually best to buy injection equipment as individual items so you will pay for only what you really need.
- If you don't want to inject your tree yourself, there are professionals available who will do it for you. Shop for this service carefully, though. Make sure you select someone who understands the disease and how the injection chemical works in a tree. And, try to be present when your tree is injected so you can see that the proper amount of chemical is injected in the correct way. If you want help in evaluating injection services in your area, contact your county extension office or the Department of Plant Pathology at the University of Minnesota.

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