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How to Inject Elms With Systemic Fungicides

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Dutch elm disease affects all species of elm trees. It is caused by a fungus that lives and multiplies in the tree vessels. The presence of the fungus triggers reactions in the tree that plug the vessels and block water movement, causing the tree to wilt and die.

Since the mid-1930s, many chemical treatments to control Dutch elm disease have been tried. Of these, injecting systemic fungicides into the vascular system of the tree, where the fungus functions, seems to be most effective. Systemic fungicides can move within the tree and provide protection to portions of the tree far from the injection sites. Injection can protect healthy trees for at least 2 years and may cure infected trees that are in the early stages of the disease. It is a difficult and expensive procedure, and injection may cause some physical damage to the tree.

Selecting a Tree to Inject

Because injection is expensive, it should be considered only for valuable elms. Injection is most effective as a preventive measure; the best candidates are **healthy trees**. Treating trees with Dutch elm disease is less successful. It is recommended only on **beetle-inoculated trees** that have no more than **5 to 10 percent of the crown wilted**, and then **only if symptoms first appear after July 1**. Injection will not cure trees once the fungus is well established in the main trunk. Likewise, injection can neither prevent nor help trees that have been infected through root grafts because the fungicide has a limited ability to move downward.

When to Inject

Preventive injection of healthy elms may be done anytime during the growing season (June-September). The **best time is after the leaves reach full size**. Protection over subsequent years may be better if treatment is administered late in the summer. Do not inject trees that have been defoliated until they have refoliated.

Therapeutic injection of diseased elms has more chance of success on trees that develop symptoms after July 1. Injection before July 1 is not recommended because of the extremely fast movement of the fungus in the springwood vessels. Moreover, wilting prior to July 1 is most likely due to infection during the previous year, which means the fungus may be well established.

Equipment and Chemical

You will need the following items for injection. Most are obtainable at garden stores.

- **A corrosion-proof injection tank** of large volume, preferably one that holds 30 or more gallons of solution.
- **A pressure system** that will provide a constant 5 to 12 pounds of pressure per square inch.
- **Connecting tees and injection tees** (figure 1). Injection tees should meet the following requirements:
 - they 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 and block the outermost growth rings.
 - they should not injure the tree excessively.

The number of injection tees needed is calculated on the basis of the trunk diameter at 4.5 feet above ground (diameter at breast height; DBH). To determine the diameter, measure the circumference of the tree trunk in inches at DBH and divide that number by 3.14. Example: circumference of 94.3 inches \div 3.14 = 30 inches DBH. At least 1 1/2 and preferably 2

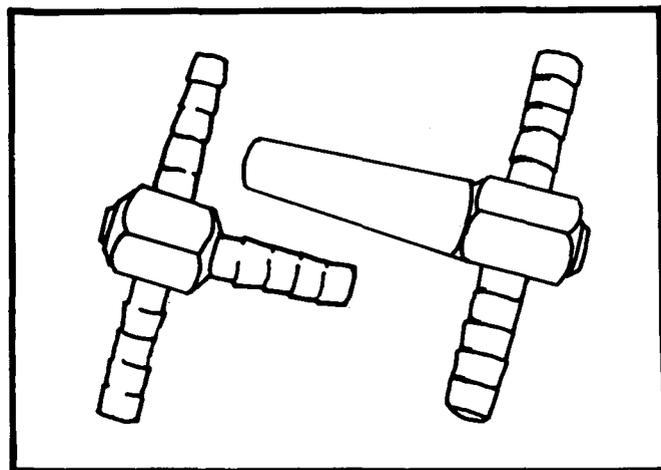


Figure 1. Connecting tees (left) and injection tees (right).

tees are needed for each inch of DBH. Therefore, a tree with a DBH of 30 inches requires 45 to 60 injection tees.

● **High quality polyvinyl tubing.** You will need 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 the tubing into the following sizes before beginning:

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

● **An electric hand drill with a sharp, high quality wood boring bit.** The 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, which facilitates uptake of the chemical and minimizes injury to the tree.

● **A chemical solution.** The best commercially labeled systemic fungicide is Arbotect 20-S.*

To determine the total amount of Arbotect you need, multiply the DBH of the tree by 12/5 (12 ounces per 5 inches DBH). For example, a tree with a DBH of 30 inches requires 72 ounces of Arbotect 20-S. Other rates recommended on the label are ineffective; do not use them.

Injection Steps

With these items assembled, you can prepare the equipment for injection.

1. ASSEMBLE THE INJECTION HARNESS.

Connect the injection tees using the 12-inch lengths of polyvinyl tubing.

2. PREPARE THE TREE FOR ROOT FLARE INJECTION.

Placement of the injection tees in the tree is crucial for distributing the chemical completely and uniformly throughout all portions of the crown. **The best place for the tees is in root flares below the ground line** (figure 2). This placement results in uniform uptake and good distribution of the chemical solution. Injection above ground will result in uneven distribution and can actually harm the tree, discoloring the foliage. Below ground injection also allows you to drill holes farther apart.

To prepare the tree for root flare injection, excavate the sod and soil from the base of the tree, taking care not to injure 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, depending on the accessibility of the root flares.

3. PREPARE THE CHEMICAL SOLUTION.

To determine how much to dilute the fungicide, divide the amount of Arbotect 20-S you need by 1.92. This calculation will give the total volume of solution in gallons. For example, if you need 72 ounces of Arbotect, you need 37.5 gallons of solution (72 ounces Arbotect 20-S ÷ 1.92 = 37.5 gallons solution). An abbreviated dosage schedule for trees 14 to 40 inches in diameter is provided in table 1. Using extra water will not affect the efficacy of the fungicide; however, using too little water can harm the tree.

Most water from rivers or lakes is satisfactory for mixing with Arbotect 20-S. Do not use well water; it may cause the

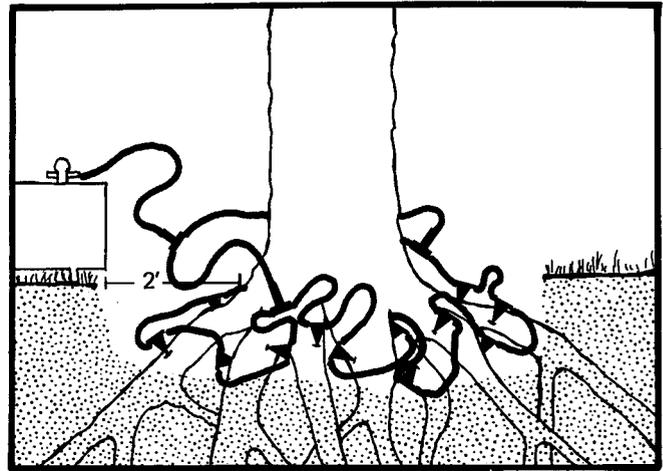


Figure 2. Correct placement of injection tees on root flares.

Arbotect to settle. Hard water that has passed through a water softener is not suitable because settling still will occur. To check a water source for hardness, add 1 teaspoon of Arbotect to 12 fluid ounces of the water to be tested and stir. If cloudiness or settling occurs during the next 2 to 3 hours, the water is unsuitable and should not be used. In such cases, use distilled or deionized water.

To mix the solution, **put the chemical into the injection tank and then add enough water to reach the required volume.** By mixing the solution in this order, there is less chance that the chemical will settle and result in an ineffective solution.

4. INSERT THE TEES.

It is best 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 excessively. (Dry holes reduce the rate of chemical uptake, increasing the time needed to inject a tree.)

Drill the injection holes in the root flares **perpendicular to the surface and not deeper than 1 inch** into the sapwood (figure 3). Space the holes 4 to 8 inches apart in the root flares all around the tree. Holes should be farthest apart on the widespread buttress roots and closest together where there is no root flare. If you cannot excavate the root flares because of obstacles such as sidewalks, place the injection tees as low on the trunk as possible and closer together (i.e., 2 to 4 inches apart rather than 4 to 8 inches). Use a lower dosage (8 ounces per 5 inches DBH) for trunk injection.

Table 1. Volume of chemical solution needed

Tree diameter (inches)	Arbotect 20-S (fluid ounces)	Solution (gallons)
14	33.6	17.5
16	38.4	20.0
18	43.2	22.5
20	48.0	25.0
22	52.8	27.5
24	57.6	30.0
26	62.4	32.5
28	67.2	35.0
30	72.0	37.5
32	76.8	40.0
34	81.6	42.5
36	86.4	45.0
38	91.2	47.5
40	96.0	50.0

* Arbotect is available in two formulations: Arbotect S and Arbotect 20-S. Both contain exactly the same active ingredient, but Arbotect 20-S is 20 times stronger than Arbotect S. It is cheaper to use the stronger formulation, particularly if you inject more than one tree.

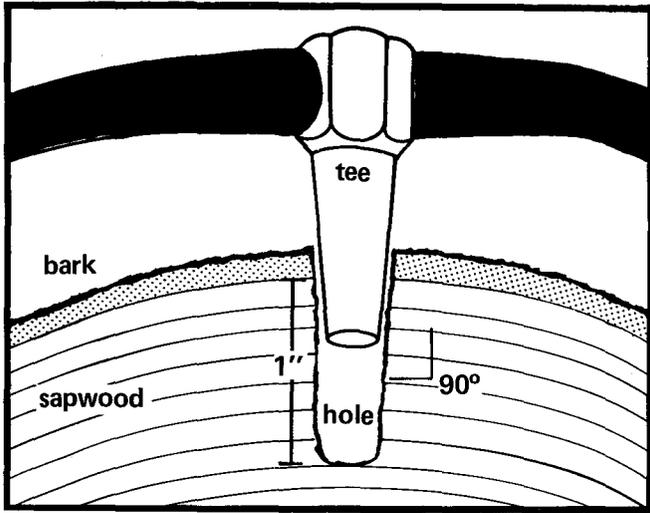


Figure 3. Injection holes drilled perpendicular to root flare surface.

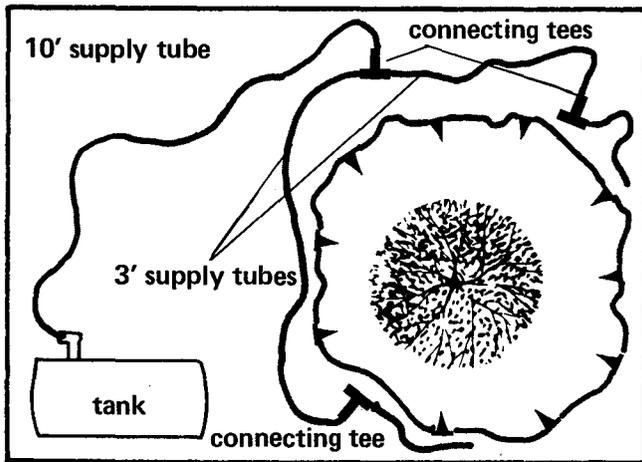


Figure 4. Three-foot lengths of tubing hooked in.

5. CONNECT INJECTION TANK TO HARNESS.

When all the injection tees are in the tree, connect them to the injection tank with the extra pieces of tubing you cut previously. Connect one end of the 10-foot length to the injection tank and attach one of the connecting tees to the other end (figure 4). Then attach 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 4). Finally, add one 12-inch piece of tubing to each of these two end connecting tees.

Attach the supply hose to the injection harness around the tree by pulling a piece of hose from one injection tee and hooking in one of the connecting tees (figure 5). Do the same thing with an injection tee on the opposite side of the tree. Setting up the apparatus in this way eliminates differences in pressure and unequal distribution of the chemical between injection tees on the harness.

6. EVACUATE AIR FROM THE SYSTEM.

Remove two injection tees on opposite sides of the tree and at right angles to the supply lines and open the supply valve (figure 6). When most of the air has been evacuated and the

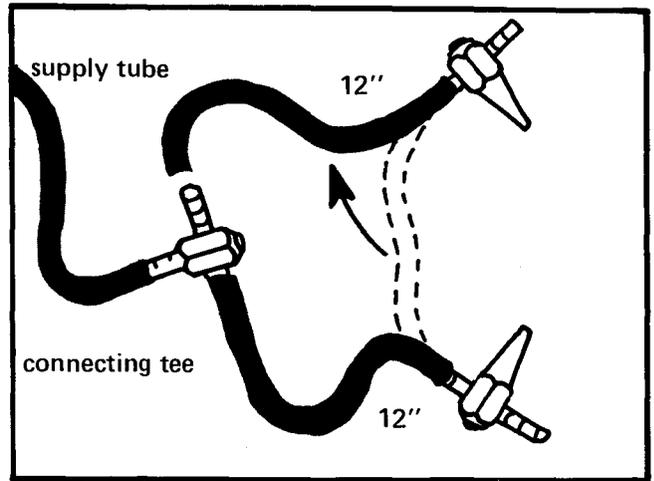


Figure 5. Supply tubing connected to injection harness.

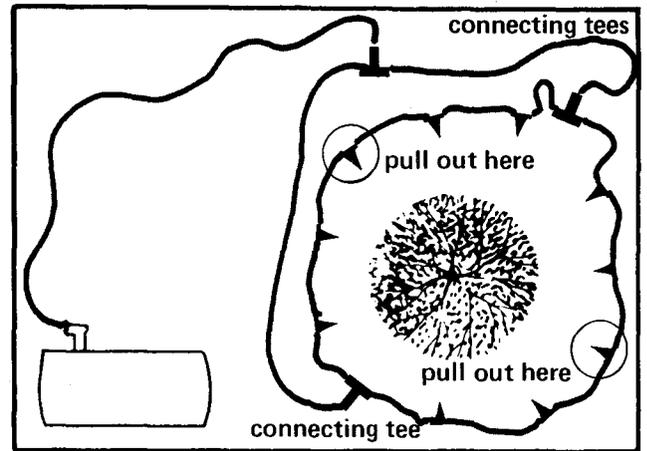


Figure 6. Tees pulled out to evacuate air from system.

solution comes out from both directions, tap these last two injection tees back into the tree. Injection is now under way.

7. REMOVE INJECTION TEES.

When the tree has absorbed all of the solution or it has been several hours since the tree stopped taking chemical, remove the injection tees. Allow the holes to dry for at least 30 minutes before filling the excavation. Wound dressings are not necessary. **Do not plug the holes with wood dowels.**

8. CLEAN EQUIPMENT AND DISPOSE OF EXTRA SOLUTION.

If any of the chemical remains after injection is complete, dispose of it according to label instructions. If you plan more injections, you can store the solution indefinitely, as long as it is not exposed to freezing. Clean all equipment thoroughly before storing it.

9. REMOVE INFECTED BRANCHES.

Remove all wilted branches within a month after injection. It is important that you remove as much of the wilted portions of the tree as possible without unnecessarily disfiguring the tree. If wilting occurs later in the season, additional pruning will be necessary.

Repeated Injections

If injected properly, the dosages of Arbotect 20-S now permitted will protect elm trees for at least two growing seasons, so treatment need not be repeated more than once every third year. To reinject a tree, drill holes 2 to 3 inches above or below and to the side of the previous holes.

Injection is only a small part of a successful Dutch elm disease management program. For more information, see the following publications of the University of Minnesota Agricultural Extension Service:

The Dutch Elm Disease, AG-BU-0518

Dutch Elm Disease — Cause and Prevention,
AG-FO-0831

Identifying Elm Wood, AG-FS-1418

Native Elm Bark Beetle Control, AG-FS-1420

Root Graft Spread of Dutch Elm Disease, AG-FS-1401

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