DISTRIBUTION OF DYE IN ELMS AFTER TRUNK OR ROOT INJECTION

by Francis W. Holmes

Abstract. Acid fuchsin dye, when injected under 1.1 kg/cm^2 pressure through hollow, tapered spiles that had been driven into 1.5 cm diameter holes drilled 4 cm deep into elm tree trunks, came up in all the xylem vessel layers intersected by the holes *except in the current year's layer* of the xylem. When the same dye was injected into comparable trees through the severed ends of roots, however, nearly all of it came up in the xylem vessel layer of the current year. This result may help to account for variable success in controlling Dutch elm disease by trunk injection of fungicides.

After the encouraging results of early experiments with Benlate® benomyl phosphate solutions injected into the trunks of elm trees (1, 2), both the arboricultural industry and the Shade Tree Laboratories have experienced highly variable results from their use of this chemical (3) when trying to control Dutch elm disease (DED), caused by *Ceratocystis ulmi* (6).

In trying to understand this variability, one should note that the first reports of complete halt of DED in infected elm trees, in Ottawa, Canada, always involved the chemical's having been introduced through the cut ends of small roots — up to six roots in the case of larger elms (4, 5).

Street elm trees in the United States, however, when treated with benomyl phosphate, nearly always have been injected through holes drilled into their trunks, whether at ground level or up to several feet higher. This practice resulted from the difficulty in locating, and the very high labor costs of digging up, these elms' root systems.

When a tapered spile is driven into a cylindrical hole in an elm trunk, of course, it is likely to grip tightly against the outermost layer of wood (the bark being relatively soft and spongy). Therefore it may largely occlude the vessels of the current annual layer of xylem. Different individuals have introduced the fungicide solution under pressures that have ranged from 0 to 70 pounds per square inch, commonly 10 p.s.i. (1.1 kg/cm^2). However, where did this fungicide then go?

Materials and Methods

In each of two consecutive summer seasons (June 1978 and July 1979), we prepared several gallons of 1% acid fuchsin dye, to allow for the wastage inherent in its use with standard elm-injection tanks and accessory tubing. The devices we used were those sold by the Elm Research Institute (ERI), Harrisville, New Hampshire. We injected 8-year-old American elms (*Ulmus americana*), which had been grown from seed in the Univ. Mass. Shade Tree Laboratories' research nursery in Hadley, Mass. The trees used ranged from 7 to 10 cm diameter at 3.5 m height. Three trees were used for each injection method each year, a total of 12 trees.

Trunk injection holes were 1.5 cm diameter and were made either one, two or three per tree to a depth of 4 cm at 15 cm above the ground. Standard, plastic, T-shaped, tapered, hollow, ERI spiles were driven snugly into the holes, until they gripped well enough not to pop out when fluid was injected at a pressure of 1.1 kg/cm^2. We chose this pressure for the experiment because it had been for several years the rate taught to arborists who took the label-required training for the use of benomyl-phosphate injection.

In the case of severed-root injection, one or two roots of about 2 cm diameter were selected after careful excavation, so as not to wound the roots. When all needed roots had been exposed, each such root was cut across at right angles with a sharp knife. Plastic tubing was at once fitted over the cut end of the root, by use of a rubber faucet-adapter, with a metal band, tightened by the turn of a screw. The fluid was supplied through the plastic tubing at a pressure of 1.1 kg/cm^2.

The trees were sacrificed 2 to 4 hours later on the same day, and their trunks cut across at 1 m, 2 m, 3 m, etc., above the point of injection. Location and extent of spread of the dye in the tree trunks were noted.

Results

The dye moved rapidly upward in all trees, and extended into the twigs. Color was observed in some cases even in the leaves. In the trees that had been injected with ERI spiles driven into holes drilled in the trunks, characteristically little or no dye color was visible in cross-section in the ring of the current season's xylem layer. Dye, however, moved upward in the other (four to six) rings that had been intersected by the drilled hole.

In some cases, the dye spread rapidly circumferentially, so that the dyed rings looked like crescents in the trunk cross-sections. In other cases, however, the dye was held strictly to the column of wood immediately above the drilled holes, so that it created an approximate "shadow" of the shape of the hole. Because fluid dye tended to smear somewhat over the surface at the time of cutting the sections, better observations could be made by whittling the surface slightly.

On the other hand, with the elms that were root-injected, essentially all the dye moved upwards in the trunk in the single layer of wood produced during the current season. There was little or no staining of the elm tree wood in the "rings" (layers) of earlier years. The little staining found in other layers turned out to have resulted from smearing of the dye during the cutting of the cross sections (Fig. 1).

Discussion

The injection spiles may well have interfered with the motion of solutions into the vessels of the current season's xylem. Solutions put into such holes, under the pressures we applied, can be expected to be driven upward into vessels of any earlier years' wood that is intersected by the injection hole, regardless of whether these vessels ordinarily still function to move water toward the leaves.

Since the fungus of DED ordinarily acts as a pathogen in the current year's xylem vessels, and since it appears unable to harm the elm tree after it has been buried in vessels of earlier years, any fungicide that is meant to control DED must abundantly pervade the current year's xylem vessels. Apparently the root-severing method of injection puts the fungicide "on target" whereas the trunk-hole method to a conspicuous degree fails to do so.

It appears, therefore, that improvement in the art of application to the current year's xylem is more needed than improvement in the fungitoxicity of the chemicals now in use as chemotherapeutants against *C. ulmi*, for control of DED.

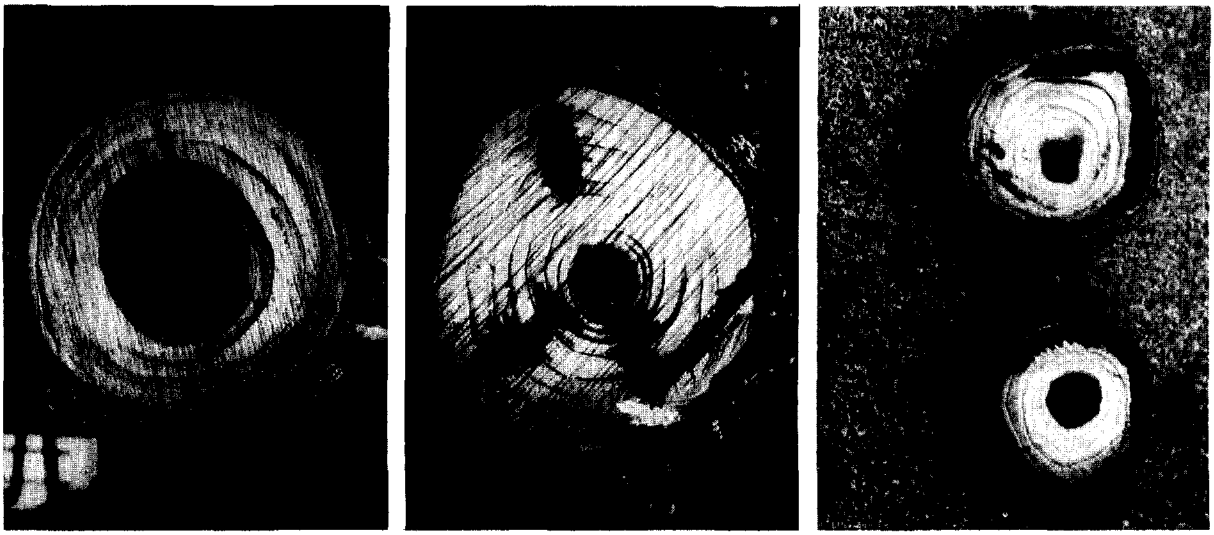

Fig. 1. Appearance of acid-fuchsin dye in cross-sections of elm tree trunks after injection via (A,B) holes drilled in trunks, and (C) cut ends of severed roots.

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ABSTRACTS

Karnosky, D.F. and T.R. Myers. 1982. **Specify tolerant trees for air polluted areas.** Weeds, Trees & Turf 21(3): 56, 60, 62.

This paper will examine methods of reducing air pollution problems on shade trees. Theoretically, all air pollution problems can be prevented by controlling pollutant sources. Unfortunately, we will be faced with some major pollutant problems on trees for many decades to come. As long as the automobile remains our principal source of transportation, for instance, we will likely continue to be faced with two related problems: ozone generated from photochemical reactions involving automobile exhaust products and salt spray related to the use of deicing salts for maintaining clear winter roads. Because trees vary greatly in their responses to air pollutants, some pollutant problems to shade trees can also be minimized by selecting pollution-tolerant trees for plantings in areas where a known pollutant prevails. This paper examines variation in pollutant responses of trees and discusses how this information can be used.

Benson, D.M., J.T. Walker, and K.R. Barker. 1982. **Controlling nematode damage.** Am. Nurseryman 155(4): 85-89.

Several genera of plant-parasitic nematodes can cause severe damage on various woody ornamentals. However, it is only in the last 30 years that they have been regarded as serious pests of these plants. These pests damage plants in various ways. For example, some invade susceptible roots and cause large galls to form. These pests are called endoparasites. In contrast, other nematodes feed externally. These pests are called ectoparasites. Typically, nematodes are most damaging to plants in light-textured, sandy soils in the coastal plain regions of the Southeast. Woody ornamentals grown in areas that experience periodic droughts are more likely to suffer nematode damage than are plants grown in areas with adequate moisture. These problems can be minimized by a combination of strict sanitation, careful plant selection and chemical soil treatments.