TREE INJECTION: PERSPECTIVE MACRO-INJECTION/MICRO-INJECTION

by Arthur C. Costonis

Abstract. This paper discusses the advantages and disadvantages of injection technologies currently in use. It presents evidence to demonstrate that the risk of injury produced by micro-injections (wounds 3/16" or less in diameter to a depth of ¾" or less into the xylem) is much reduced when compared to the macro-injections (wounds 3/8" or greater in diameter to a depth of 1" or more into the sylem). Emphasis is placed on the need for in the field training to develop correct injection technique. Evidence is presented to demonstrate the efficacy of current injection technology, pointing out modifications and improvements of the current injection technology.

Leonardo da Vinci early recognized the value of systemic injection when he injected apple trees with arsenic to control would be apple stealers (5). With the recent development of injection procedures for the treatment of Dutch Elm Disease in elm trees an increased interest in tree injection has developed. In view of the disparate results obtained from this renewed activity, it has become clear that in many ways we have not progressed much beyond the information known by da Vinci. Recognizing this undisciplined approach to injections, a "state of the art" symposium was held in 1978 at Michigan State University to serve as a reference for systemic chemical treatments in tree culture (7). This symposium filled a need. It is highly recommended reading for anyone contemplating employing systemic techniques.

The objectives of this paper are to discuss those injection methods most widely in use today by professionals in the field. It discusses the advantages and disadvantages of these methods culminating in current trends of the technology.

Macro-injection versus Micro-injection

The injection subject is approached from two points of view: a) macro-injection (MAI) and b) micro-injection (MII). This approach focuses on the wound created by the method of injection, recognizing that all injection methods create a wound in the tree. Shigo defines a wound as "any break in the bark that exposes the wood' (13). What I want to emphasize, as does Shigo, is that "there are *degrees of injury* caused by wounds." In other words, does the potential benefit gained by current injection techniques outweigh the risk of the wound caused by the treatment?

A macro-injection wound (MAI) as defined in this paper is a wound that has a diameter *3/8" or greater* and penetrates into the xylem *one to several inches* (Figure 1). A micro-injection wound (MII) is one that has a diameter of 3/16" or less and penetrates into the xylem ¾" or less.

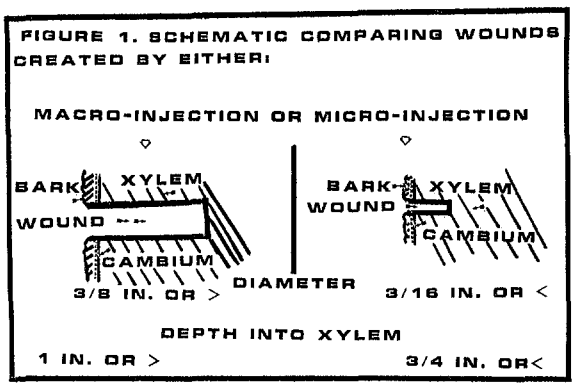
Examples of the MAI would be the system or modifications thereof marketed by Elm Research Institute, Harrisville, N.H., the Arbotech System (Merck Co.) or the root-flare or root-injection systems developed by Kondo (9). The system employed by Medi-caps® (Fremont, NE), although an implantation, method sensu Wilson (17) is classified as a macro-injection because of the size of the wound.

An example of a micro-injection is the system developed by the J.J. Mauget Co., Burbank, CA. In this technique a metal "feeder tube" with a diameter of 3/16" is driven into the xylem with an insertion tool to a depth of ¾". A capsule containing the desired chemical is attached to this feeder tube to allow the material to enter the tree.

Risk/Benefit

Clearly the smaller the wound the less potential for the "degree of injury caused by the wound" (13) to come into play. Accordingly, if we have procedures that will reduce the wound effect these should be employed. Several authors have evidence to demonstrate that the potential risk from macro-injections is quite high when weighed against the benefit (1,2,4). Recent well documented research by Shigo (13) has shown that micro-injection wounds caused by the Mauget technology can be well tolerated by the tree even when made in the stem approximately 4.5' above ground.

More recent work by the author (4) has demonstrated that the accepted Mauget technique has been improved upon by replacing the in-



sertion tool with an 11/64" diameter bit in a portable drill to make the wound in the root flare. The resulting drill wound is cleaner edged and the depth is under more precise control. These factors greatly facilitate wound closure because the degree of injury resulting from the mechanical wound is minimized. In addition the injected material is more rapidly translocated away from the injection site (4).

It should be clear from the above that when injecting trees, micro-injection offers the greatest benefit to the tree, while significantly minimizing the risk inherent in the macro-injection technique.

Other relevant factors

Location of injection site. Evidence has been presented to demonstrate that the injection site should be on the root flares (4, 9, 14).

Size and type of wound. The wound should be as clean edged, small and shallow as possible. Several investigators make a strong case for this type of wound (4, 9, 11, 13, 14).

Wound closure. Do not place wood dowels into the wound. In most cases these impede the natural closure of the wound by the tree (4, 9). Injection sites on the root flare close more rapidly than those made higher on the stem (4, 9).

Areas requiring more research. This paper has focused on the mechanical wound. Of equal importance is the phytotoxic potential of the chemicals being introduced into the tree via injection. Much work is required in this area. It is the author's opinion that most formulations currently on the market should be reevaluated with emphasis on modifying the pH and concentrations of these chemicals to be more compatible with the biochemistry of the plant. It must be emphasized that a number of these products are currently tolerated by the tree and are efficaceous. Campana (3) discusses this product formulation concept in detail.

In the field training. Training sessions under the guidance of competent professionals in injection technology are mandatory to the correct development of injection procedures. Kondo (9) of the Canadian Forest Service has pioneered this concept of correct field training for injection techniques. He states, ". . . unless we continue to emphasize sound injection techniques, the ever increasing failures in tree injections will eventually cause systemic chemical treatments in tree culture to fall into disrepute." Shigo (14) of the U.S. Forest Service agrees in principle stating, "When used properly, the injection method does have the potential to benefit trees. But when used improperly, it will cause more harm than help."

Annual injections. The application of macro-injections annually could increase the risk of subsequent damage to the tree (1, 2, 4, 13, 14). They should not be employed. The use of annual micro-injections for pest control has been under study for the past seven years by the author with good results relative to wound closure (4). This factor requires more study. When annual injections are employed, the injection sites must be staggered (9).

Current and future role of injections. There is significant evidence now to establish the efficacy of the current injection technology in the management of our tree populations whether for fertilization needs or pest management (5, 8, 9, 12, 15, 16).

It is time to put into practice the current *modifications* and *improvements* in the "injection" technology. It is no longer valid to group all "injections" as essentially the "same." *They are not.* The difference between a macro-injection in the stem and a micro-injection on the root flare is as great as the difference between a live tree and a wooden telephone pole. Although both are "trees," they are not the "same."

Unless we objectively evaluate "injections" and categorize them appropriately by results and keep

current with the modifications and improvements in both technique and material formulations we have the potential to regress to the information already known by Leonardo da Vinci 900 years ago when he injected his apple trees. This could result in the loss of a technology that can become an important component of integrated systemic tree care programs.

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ABSTRACT

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Tests include: 1) cooperative gypsy moth control tests initiated by USDA and Davey, 2) fall vs. spring applications of dormant oil, 3) water pH in spray tank may spell success or failure, 4) acidifying alkaline soil — two-year progress report, 5) proportioning pesticides, 6) establishing plots for herbicide injury research, 7) evaluating insecticide control of European chafer grub, 8) effect of lawnscape mixes on tank fiberglass materials, 9) evaluation of 1979 foliage-stem applications, 10) evaluation of 1979 woody plant control application, and 11) 1980 foliage-stem spray application.