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Original Technique for Liquid Injection in Tree Trunks

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Abstract. **The injection of liquids into tree trunks is a procedure that has become widespread in recent years. However, the hardness of woody tissues, their in extensibility and the narrow sap conduits make it difficult to inject large volumes of liquids (1-3 liters) with the techniques currently available. This research deals with the development of a procedure to introduce from 100 to 3,000 ml of liquid into the vascular system of the tree through the trunk. This technique consists of a hydro-pneumatic chamber connected to a liquid injector that delivers the prepared solutions according to specific needs. This method was used to inject fosetyl-Al ([aluminum-tris-O-ethylphosphonate]; Aliette ^{R},) into avocado trees *(Persea americana* Mill. cv. Hass) to control *Phytophthora cinnamomi.* Visible improvement in the health of the treated trees was observed suggesting that the technique was efficacious.**

The injection of liquid fosetyl-Al into the trunk or thick scaffolding branches of trees is a relatively new procedure. The first report of which we know is Darvas (1983). It deals with injection using special plastic syringes that allow the introduction of approximately 20 mL of liquid per syringe. To our knowledge, no procedure has been described that might permit the introduction of sufficient amounts of liquids necessary for therapeutic or nutritional purposes at a single injection site in the trunk of the tree.

The hard structure of wood and the narrowness and inextensibility of sap conducting tissue make it difficult to inject large volumes of liquids (1-3 liters) with the techniques currently available. This paper describes an original technique we designed, "trunkclisis", which allows the efficient and safe introduction at a single injection site in the tree trunk of the larger volume of liquids required to control certain diseases or nutrient deficiencies.

Materials and Methods

This technique was developed in avocado plantations *(Persea americana* Mill, cv. Hass) located in the municipality of Tinguindin, Michoacan, Mexico; primarily to inject fosetyl-Al to combat *Phytophthora cinnamomi* infestation. The basic equipment required is similar to that used in the intravenous transfusion of liquids to humans. Some

modifications were made which permit the adaptation of this equipment for injecting liquids into trees.

Materials. The equipment consists of the following components (Fig. 1):

- a glass bottle (500-1000 mL) [1], sealed with a rubber stop- per that can be easily perforated [2]. This bottle acts as a hydropneumatic pressure chamber.
- a transparent plastic collecting chamber, 6 cm long by 2 cm diameter [3], is connected to the pressure chamber by a rigid, tapered pipet [4] inserted through the rubber stopper [2].
- a pneumatic bulb [5] is used to pump air into the collecting chamber through the retention valve [6], thus increasing internal pressure in the system.
- a piece of thick-walled rubber tubing [7], approximately 1 m long with a 4 mm internal diameter conducts the liquid from the pressure chamber to the liquid-injecting device [8].

The liquid-injecting device is shown in detail in Figure 2. The injector is plastic (preferably nylon), which consists of an irregularly shaped cylinder composed of two sections: the first cylindrical [9] and the second slightly cone-shaped [10] to facilitate penetration into the tree trunk. The injector's interior is hollow from the narrow point to the middle of the first cylindrical section as illustrated in Fig. 3. The liquid-injecting device is connected to the rubber tubing ([7] in Fig. 1) by an orifice that enters at the middle of the cylindrical section's side at a 90° angle ([11] in Fig. 2).

Methods. To inject liquids into a tree:

Step 1 - Fill the glass bottle ([1] in Fig. 1) with the liquid to be injected.
Step 2 - Connect the glass bottle to the collecting chamber [3] and via the rubber tubing [7] to the liquid-injecting device [81.
Step 3 - Make a perforation in the trunk, 6 mm in diameter and approximately 6 mm deep, preferably using an electric drill.
Step 4 - Turn the glass bottle upside-down to remove the air in the system.
Step 5 - Insert the liquid injector into the perforation in the trunk and secure it in place by lightly tapping with a hammer.
Step 6 - Using the pneumatic bulb, increase the air pressure in the system.

Once this sequence is completed, the liquid starts flowing into the tree. The speed of flow can be monitored by counting the drops flowing through the tapered pipet [4] into the collecting chamber.

Results

Liquids pass into trees at speeds between 30 and 60 drops per minute. An amount of 500 to 1000 mL was injected in less than 24 hours. We have injected 5% glucose or sugar solutions in amounts up to 3 liters without seeing obstructions in the flow of liquid.

All liquids applied must be true solutions. Colloidal suspensions of gum, pectins or undissolved particles quickly obstruct the conducting tissues and flow ceases.

The injection of solutions of fosetyl-Al with concentrations varying between 2% and 5% does not harm the tree's trunk, despite a low pH (approx. 1.5). When higher concentrations are used, one can see phytotoxicity in the leaves, particularly the older ones. These concentrations also damage the medium-size branches. This is observed the day after the injection, indicating that the liquid has been translocated to tissues distant from the injection site. The observed recovery of the tree is an indication that the injected material reached the roots. The incision in the trunk for the liquid-injecting device healed through the formation of new tissue in roughly six months.

Discussion

With the technique described above, we have been able to inject avocado trees with large volumes of liquid (500-3,000 mL) in a safe, easy and economical way. Two workers with some training can inject 80 or more trees per day. Furthermore, among the advantages of this technique are the following: (i) trees can be treated despite having suffered severe damage, defoliation, or severe pruning; (ii) dosage can be calculated exactly, i.e., as opposed to the inaccuracies associated with foliar or soil treatments where the actual amounts taken up by each tree are unknown; (iii) each tree can receive an individual dose, and as often as required; and (iv) as much as one liter per tree can be applied in less than 24 hours and in a single application. This technique opens up possibilities for new injector-applied treatments, using insecticides, fungicides, antibiotics, hormones, and macro- or micronutrients. In the United States, three different devices have been patented that function similarly to this device. Their patent numbers are 2,853,833, 3,691,683, and 4,833,824. The original technique presented in this paper is now in the process of being patented with the registration number of 25,212.

Literature Cited

Darvas, J.M. 1983. In AVOKAD, Journal of South African Avocado Growers Assn. 3:6, 11

Fig. 1. Material of original technique for liquid injection in tree trunks. Explanation of the numerical indications included in the text.

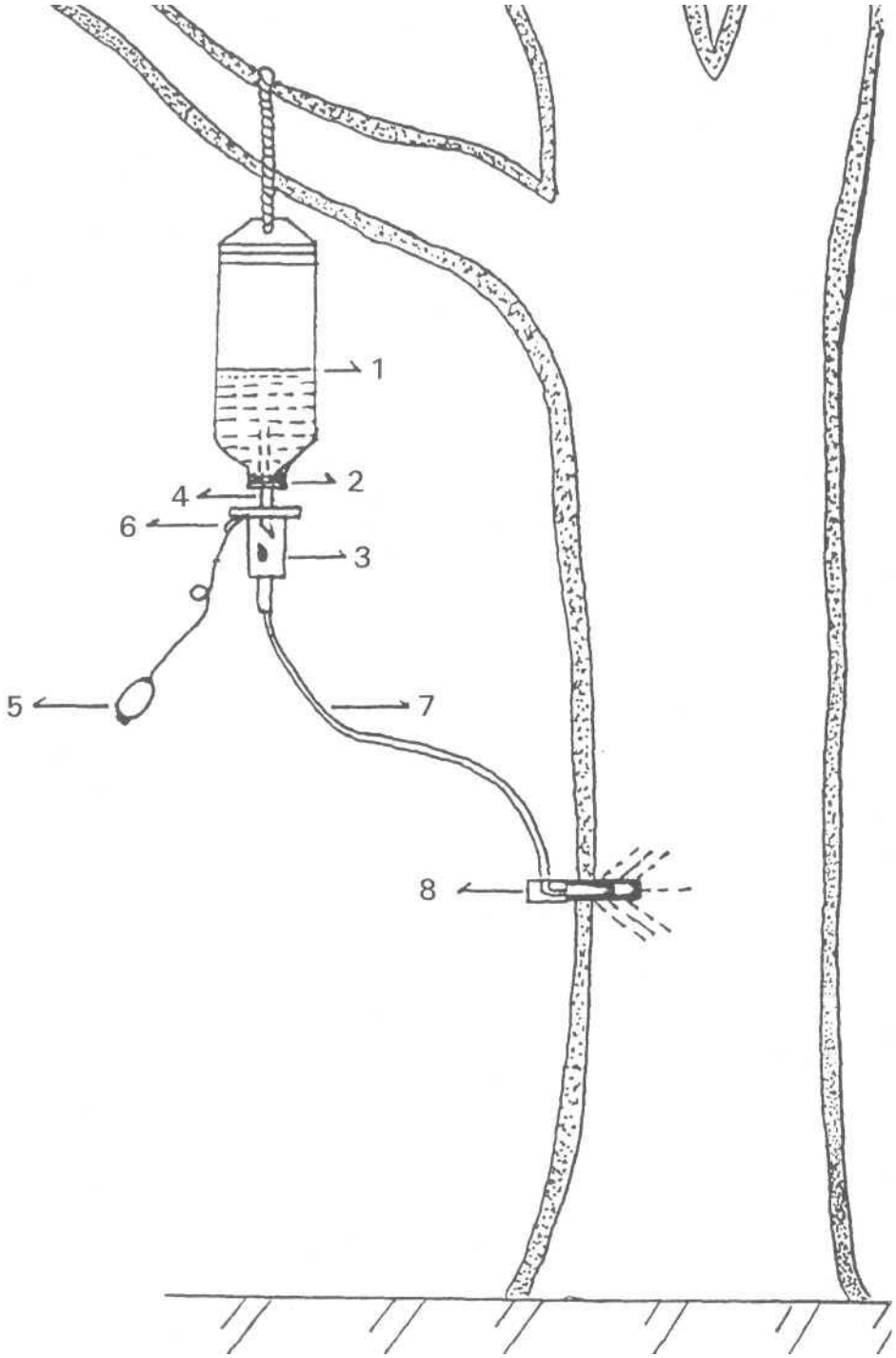

Fig. 2. Injector of liquids for tree trunks. Explanation of the numbers included in the text.

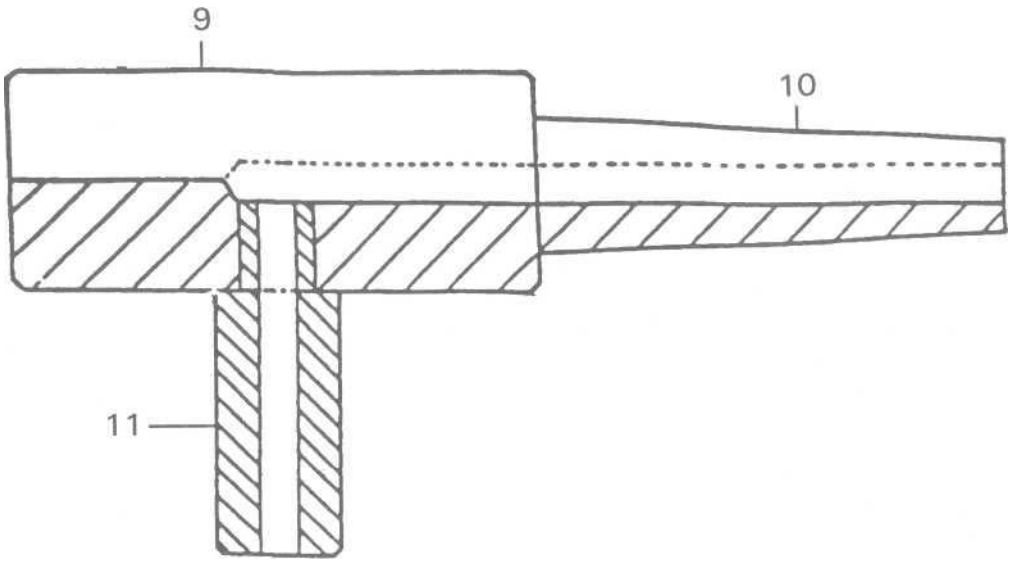

Fig. 3. Interior of the injector. Explanation of the numbers included in the text.