A LARGE-CAPACITY INJECTION SYSTEM FOR CHEMICAL SOLUTIONS IN DUTCH ELM DISEASE CONTROL

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ABSTRACT

This report describes a large-capacity injection system and its operation under field conditions. The system consists of a 45-gal (170.1-litre) reservoir, a nitrogen gas bottle, a metal stand, a sheet metal hood, standard lengths of plastic tubing with connectors and quick-connect units for injection heads. Various injection operational procedures were greatly facilitated by this system. Three types of injection heads (trunk, root-flare and root) were easily adapted for use with this system.

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INTRODUCTION

There are advantages to injecting exogenous water-soluble chemical compounds into the xylem tissue of trees at relatively low concentrations and large volumes for control of various tree diseases (Kondo and Huntley 1973). Since fungi and trees are quite similar biochemically and physiologically, it is not surprising that chemicals which are toxic to fungi are also toxic to trees. Fortunately, in most instances trees are more tolerant to a given concentration of a chemical compound than are fungi and, therefore, the concentrations toxic to fungi are not necessarily the same as those toxic to trees. Thus, any exogenous chemical compound should be introduced into the tree's xylem system at a concentration as low as possible and yet high enough to be effective in control of the fungus. This would reduce chemical toxicity to the tree to a minimum at the point of injection.

Some chemicals are poorly water-soluble and can be solubilized only at low concentrations. Others can be solubilized only by drastically reducing the pH to very low levels. Although it would appear that the xylem sap of elms (*Ulmus americana* L.) (pH 6.8 to 7.5) is well buffered, solutions with low pH can cause considerable damage to the xylem tissue, at least in the area of injection (Gagnon 1967, Kondo 1970). Thus, relatively large volumes of the chemical solution must, of necessity, be injected into the tree to be effective and yet not toxic to the tree.

Work in the root injection of elms for treatment of DED has demonstrated that injection of large volumes of chemical solutions over a period of 48 hours generally results in good distribution of the chemical throughout the tree (Kondo and Huntley 1973). For example, it was found that a tree with a dbh of 70 cm (27.3 in.) would require approximately 600 litres (156 gal) of chemical solution for adequate distribution. In addition, the larger the tree, the greater the volume of chemical required.

It is apparent, therefore, that a large-volume injection system should be developed (a) to accommodate any type of injector head or apparatus such as those used for root, trunk or root-flare injection; (b) to allow direct injection of any water-soluble chemical compounds such as systemic fungicides, insecticides, herbicides, fertilizers, etc.; (c) to hold enough liquid in a reservoir to cover an injection period of 24-48 hours and to withstand rugged operational use.

In this report we describe an injection system that meets the above requirements and the field testing of this system.

DESCRIPTION OF THE INJECTION APPARATUS

The major components of the large-volume injection system are a 45-gal (170.1-litre) plastic reservoir, a nitrogen gas bottle, a

Figure 1. Injection Reservoir

Number	Name and Description of Part	
1	pressure relief valve	Gas delivery and safety relief valve fixture
2	tee coupling	
3	hose coupling (quick connector)	
4	aluminum adapter	
5	high pressure gas hose	
6	reservoir	
7	metal hood	
8	lock holes for padlock	
9	anchor pin holes	
10	supporting legs (3)	
11	outlet hole for tubing to root adapter	
12	gas cylinder and stand support	
13	metal stand	
14	nitrogen gas cylinder	
15	single-stage gas regulator	
16	gas cylinder regulator valve	
17	aluminum adapter	Inlet-outlet fixture
18	Kwik-Tite body assembly	
19	90^{o} 1 1/4-in. (3.17-cm) pipe coupling	
20	gate valve	
21	quick-connect hose coupling	

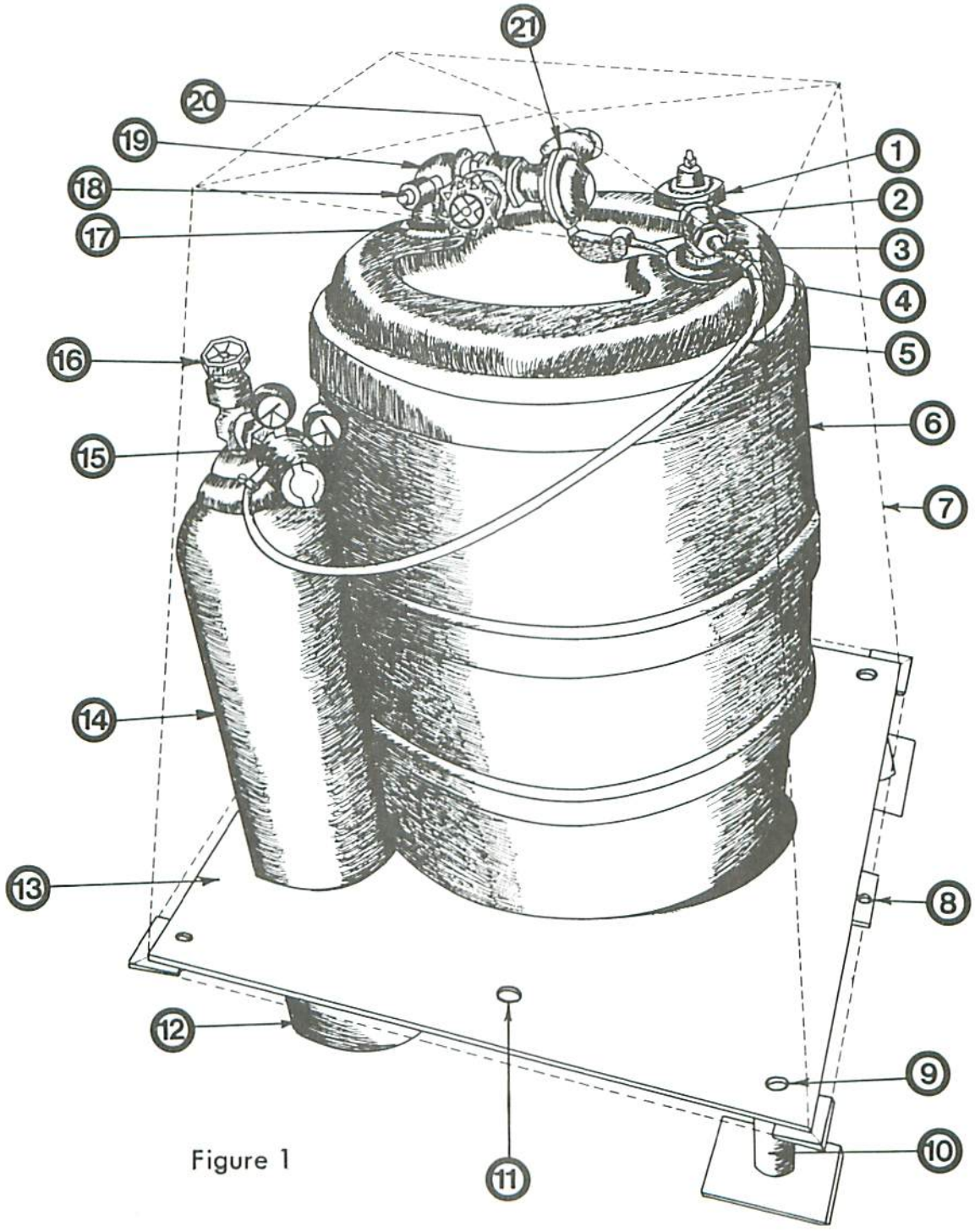

Figure 1

metal stand, standard lengths of plastic tubing and fittings and a sheet-metal hood which encloses the apparatus.

The stand (13) of 1/8-in. (.31-cm) steel plate is constructed to support both the reservoir (6) and gas cylinder (14) in an upright position as shown in Figure 1. All fixtures on the reservoir and gas cylinder are positioned as in the figure. Steel pins (9) are driven through the hollow supporting legs to anchor the apparatus. The hood and stand can be locked together with padlocks through two 1/2-in. (1.27-cm) diameter holes (8) for added security.

A single-stage gas regulator (13) provides continuous reading of the tank pressure and accurate delivery pressure to the plastic reservoir through the high pressure gas tubing (5). A variable-pressure safety relief valve (1) is attached to the tee coupling (2) on the reservoir for safety. The gas delivery and safety-relief valve fixture is connected to the reservoir with an aluminum adapter (4).

The inlet and outlet for the chemical solution from the reservoir have been incorporated into one fixture (inlet-outlet fixture, parts 17 to 21 inclusive). A 1/2-in. (1.27-cm) outlet pipe has been welded to an opening in the wall of the 1 1/4-in. (3.17-cm) inlet 90° pipe connector (19) and a Kwik-Tite body assembly attached to the outside portion of the 1/2-in. (1.27-cm) welded pipe. The other end of the outlet pipe extends to the bottom of the reservoir for complete emptying of the liquid. The Kwik-Tite body assembly is normally in the closed portion so that no liquid can escape until the Kwik-Tite hose insert is attached. The inlet portion of the inlet-outlet fixture consists of a 1 1/4-in. (3.17-cm) gate valve (20) which is attached between the 90° connector and a quick-connect hose coupling (21) for rapid refilling of the reservoir.

The tubing from the reservoir to the injection head is composed of standard 2-m (6.56-ft) lengths of 1/4-in. (.63-cm) diameter plastic tubing fitted with Poly-flo union and union-tee tube fittings, to permit rapid connection with the injection heads. In this manner any number of injection points on one tree, at any distance, may be injected from one reservoir.

The injection apparatus is conveyed as a complete unit to each tree that has been selected for treatment and prepared for injection. A single unit consists of all those items shown in Figure 1, plus the tubing and the selected injector heads.

USING THE INJECTION APPARATUS

The base of the apparatus is first placed in the most convenient level location with respect to the distribution of the injection points

to minimize the length of connecting tubing required. The base is leveled and secured with the steel pins. The empty reservoir and the full nitrogen gas cylinder are placed in their respective positions in the base. The reservoir is then filled by opening the gate valve on the inlet-outlet fixture, connecting an input hose to this fixture by means of the quick-connect coupling, and introducing the chemical solution under pressure. The full reservoir is connected to the gas regulator by the gas quick-connect hose coupling. The gas line must remain disconnected from the reservoir during filling to prevent excessive pressure from damaging the reservoir. The pressure relief valve must be preset to the selected operating pressure of the injection system (20 psi maximum). The outflow valve of the gas regulator is then opened and adjusted to the correct operating pressure.

The next step is to connect the plastic tubing units in such a manner as to reach each injection head, being certain that the connections are tight and that the last unit on each line contains a Kwik-Tite body assembly at its extremity. The method of attachment to the tree for injection is described in the literature accompanying the various injection heads. The hose unit closest to the reservoir is run through the outlet hole in the apparatus base and connected to the Kwik-Tite body assembly on the inlet-outlet fixture by means of a Kwik-Tite nose insert. Air trapped in the tubing is expelled by depressing the valve of those Kwik-Tite body assembly units attached to the end of the hose system. Any injection head can be attached to the hose system by means of a Kwik-Tite nose insert.

Once a tree has received a prescribed amount of solution, any chemical remaining in the reservoir is pumped back into the delivery tank by re-attaching the input hose to the reservoir while it is still under pressure. When empty the apparatus is disassembled and transported to the next tree to be injected.

TESTING OF THE INJECTION SYSTEM

Initial testing of the injection system in the field in Sault Ste. Marie, using various injection heads--(1) root adapter (Kondo 1972), (2) model 102 pressure-injector tees (Elm Research Institute[1]), (3) tree injection lances (Cooper, Pegler and Co. Ltd.[2])--yielded the following information:

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[1] Elm Research Institute,
60 W. Prospect Street,
Waldwich, New Jersey,
U.S.A. 07463

[2] Cooper, Pegler Co. Ltd.,
Burgess Hill,
Sussex, England, RH15 9LA.

(a) All three injection heads were easily adapted to the large-volume injection system employing the basic Kwik-Tite connectors.

(b) A 500-gal (2,270.00-litre) tanker truck facilitated both the filling and emptying of the chemical solution in the reservoir.

(c) Volume uptake was easily monitored through the translucent wall of the reservoir which was calibrated with a vertical scale.

(d) The quick connector made removal of air bubbles easy from the entire tubing system, thereby ensuring no introduction of air into the tree.

(e) The quick connectors, tees and uniform lengths of tubing allowed multiple hook-ups and/or any combinations of trunk, root flare and root injection.

(f) The injection system allowed accurate and uniform delivery of the chemical solution to the various injection heads from 1 to 20 psi.

(g) A single person could handle all aspects of the actual injection, but a two-man crew was the most efficient.

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