DEVELOPMENT OF A MODIFIED LOW PRESSURE TRUNK-INJECTION APPARATUS FOR PREVENTION OF THE DUTCH ELM DISEASE IN LARGE ELM TREES

by

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RÉSUMÉ

On a mis au point un appareil simple, pratique et relativement peu coûteux permettant de combattre la maladie hollandaise de l'orme chez les arbres de grande et de petite taille à l'aide de fongicides (Lignasan, MBC - Cl). Au moyen d'un injecteur manuel (capacité variant de 1 pint à 2.5 gallons), il est possible d'introduire avec une force de 20 à 30 livres par pouce^2 un pesticide (ou un élément nutritif) dans le tronc ou les branches d'un arbre; plus de 70% des arbres ainsi traités ont été protégés au cours de l'année d'application (1975). Le coût annuel de traitement atteignait environ $20 à $35 par arbre. On a donc proposé d'utiliser cet appareil pour le traitement d'autres maladies vasculaires, des infestations d'insectes et des troubles physiologiques présents chez les arbres de forte taille, en milieu urbain.

INTRODUCTION

Some of our previous investigations (Prasad 1974, VII & VIII) on the suppression of the Dutch elm disease (DED) with benomyl and its soluble salts showed that about 80% protection can be achieved in trees of 8" d.b.h. under field conditions using a pressurized trunk-injection technique. Some protection was also reported in large landmark and historical trees (Prasad 1974) following trunk injection of soluble benomyl (MBC-Cl). However, in both cases the treatment was rather expensive and this was partly due to the use of a motorized-pressure injector. Therefore, a need to develop a simpler and inexpensive method which could be easily handled by home owners and parks managers, was recognised. The present report describes a portable, convenient and relatively inexpensive device for treating elm trees to prevent or suppress the Dutch elm disease.

MATERIALS AND METHODS

A. Construction of the Hand Pump Unit

(i) Large type: A compressed-air lawn and garden sprayer (capacity 2.5 gallons) and commonly used by home owners, was purchased from Canadian Tire Corp. and modified for use. A gasoline hose, (15' x 5/16" I.D.) was cut into seven pieces, each two feet in length: one piece was connected to the sprayer and the other piece was inserted into a "Y" shaped plastic connector (3/8") from the other end. Two pieces of the two foot lengths of hose were then connected to this "Y" connector and in turn, each of these two hoses were fitted with their own "Y" connectors to the rest of the four hoses as shown in Fig. 1 (b). These last four outlets were fitted with a tapered polyethylene straight type connector

of 3/16"-3/8" (I.D.) which consisted of a male and female detachable part. When inserted into the tree, these functioned as the injectors. Pressure was measured by a gauge (0-60 psi) fitted into the hose near the tank. In addition, polyethylene valves were installed about three inches behind the injectors to regulate the flow of fungicide solution in each injector hose. The entire injection apparatus was assembled for about $50 (Table I).

(ii) Small type: This hand-pump injector was made of a plastic compressed-air sprayer (1 quart) made by Green Cross Products and was modified with essentially the same parts and features as the large size type except that there were only 2 injector outlets. The pressure can be raised to 60 psi by hand-pumping. This pump was specifically designed for local injections into branches of large elm trees (see Fig. 1 (a)).

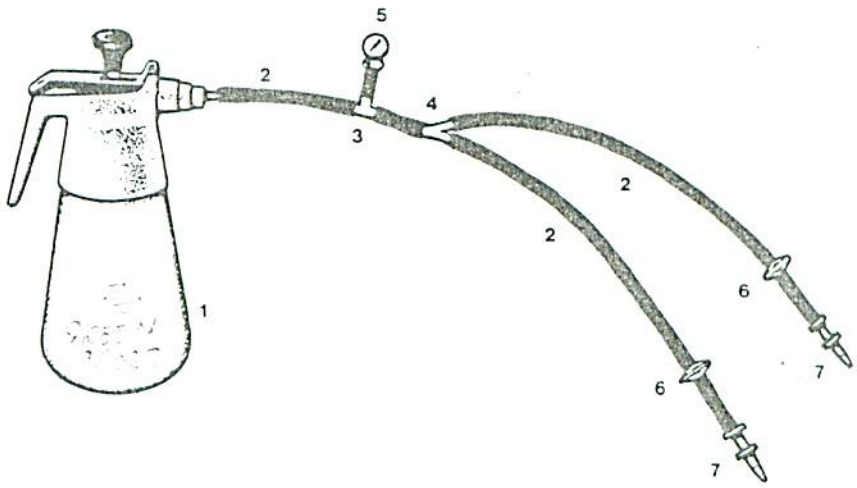
B. Operation of the Hand Pump Injectors

The tank was first filled with the fungicide solution, and then the valves at each injector were closed so as to raise little pressure in the tank after application of a few strokes of the piston. Then each valve, in turn, was slowly opened, just to drain the air and fill up the hoses with solution.

Subsequently, the four injectors were attached to the tree, one at a time. A hole ($\frac{1}{4}$ inch) was drilled to a depth of 2-3 inches into the trunk, while water from a plastic squeeze bottle was fed into the hole to maintain a continuous moisture column in the xylem vessels. After the drill was withdrawn, the hole was again filled with water. The detachable part of the injector was then inserted into the hole and tapped lightly

HAND PUMP TRUNK INJECTOR—1QUART SIZE

1. Plastic sprayer
2. Rubber hose 3/8″I.D. ; 18″lengths
3. Plastic "T" connector
4. Plastic "Y" connector
5. Pressure guage to 60 PSI
6. Plastic valves
7. Two-piece (male-female) connectors



HAND PUMP TRUNK INJECTOR—2½ GALLON SIZE

1. Metal sprayer
2. Rubber hose 3/8″ I.D.; 18″ lengths
3. Plastic "T" connectors
4. Plastic "Y" connectors
5. Pressure guage to 60 PSI
6. Plastic valves
7. Two-piece (male-female) connectors

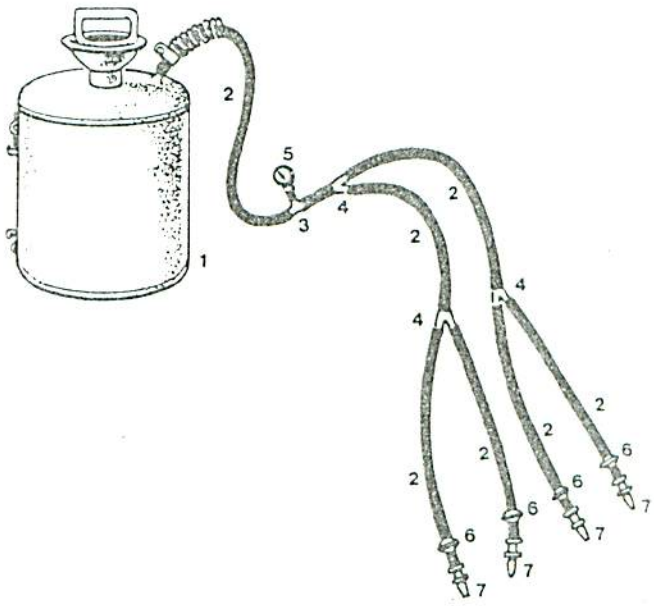


Fig. 1 (a) & (b) - A description of hand pump injectors.

with a hammer to provide a secure hold. The hose with the other half of the injector was then connected with that part which was already inserted in the tree, and as soon as the valves were opened, any air bubbles that remained in the hose were released and expelled. This is important because air bubbles block the movement of the fungicide solution into trees. The other injectors were then secured into the trunk of a tree at about 2-4 ft. above the ground level in a similar way and were spaced about 6 inches apart. The pressure was pumped up to 30 psi and usually in 10-15 minutes the solution was taken up and the tank was empty. When the outside bark was too thick or rough, an appropriate area was smoothed with a drill (1 inch) and only then injector holes were bored into the trunk.

C. Healing of Injection Wounds

Some objections have been raised against the trunk injection method of treating elm trees because of possible damage to wood. Therefore some investigations were carried out on the process of healing of wounds at the site of injections. To do that, five small trees (4-5 inches d.b.h.) which were already injected, were selected and periodic observations made on the formation of periderm in these trees. Subsequently, all these trees were felled and sections (cross and vertical) were cut through the injector holes with a hand saw in the following manner:

(a) Cross sections, (one inch thick), were cut three above and three below the point of injection.

(b) Vertical sections, (one half inch thick), were cut to the depth of injection holes.

All of these sections were subjected to microscopic observations for detailed study on the regeneration of periderm.

Table I

Cost Break-down of 1 Quart Injection Apparatus

1)	Sprayer, plastic, 1 quart size	$13.89
2)	Rubber hose 3/8" I.D., 4 feet	2.00
3)	"T" plastic connector	0.95
4)	Pressure gauge to 60 psi	6.33
5)	"Y" Plastic connector	0.79
6)	Plastic valves (2)	8.40
7)	Plastic injectors (2)	1.42
	TOTAL:	$33.78 ∴ $35

Cost Break-down of 2½ Gallon Injection Apparatus

1)	Sprayer, metal, 2½ gal. size	$15.69
2)	Rubber hose 3/8" I.D., 10 feet	5.00
3)	"T" Plastic connector	0.95
4)	Pressure gauge to 60 psi	6.33
5)	"Y" Plastic connectors (3)	2.37
6)	Plastic Valves (4)	16.80
7)	Plastic Injectors (4)	2.84
	TOTAL:	$49.98 ∴ $50

RESULTS AND DISCUSSION

The low pressure trunk-injection apparatus was used extensively during the summer of 1975 and its performance compared very favourably with a gasoline powered sprayer used during previous years for trunk injection under high pressure. For example, from Tables II and III it is evident that the rate and manner of distribution of MBC-Chloride into leaves and twigs of medium and large elm trees is very efficient with the hand pump injection. Also, there seems to be a greater uptake and translocation of the material under low pressure (30 psi) than at the high pressure (80 psi). Another advantage of this apparatus is that it is very light, easy to carry in rough terrain and relatively inexpensive. Under field conditions, six apparatuses were used and only one operator was required to rotate the units from tree to tree. To test the protection against DED, a group of 12 treated trees (average d.b.h. 8", 35 feet high) and another group of 12 trees used as controls were both inoculated with *Ceratocystis ulmi*. After four weeks none of the treated trees showed any symptoms of Dutch elm disease whereas in the control group, about seventy percent were infected with DED (Tables IV and V).

Clearly, this apparatus is very promising for future use in treatment of Dutch elm or possibly other vascular diseases in trees. Commercial applicators may be able to treat more trees in a shorter time, using a series of these devices, and home owners could treat their own trees at minimum expense. The cost of treatment including labour and material, was estimated from data obtained in the field and was approximately $20-$35 per tree per annum. This cost might be slightly higher for home owners but one must remember that the treatment may last

Table II

A Comparison of the Distribution of MBC-HCl (5000 ppm) in Small Elm Trees Using the Hand Pump Injector and the Power Injector

Distribution is measured in terms of zones of inhibition (in mm) produced by treated parts

Sample[1]	Hand Pump Injector (30 p.s.i.)				Power Injector (80 p.s.i.)			
	15	30	60	90 days	15	30	60	90 days
Leaves	2.3	13.1	10.6	11.2	2.3	5.5	6.8	3.3
Twigs	3.2	1.9	3.5	5.3	1.5	1.1	1.9	0.3

[1] Average of twelve trees (average d.b.h. 20.3 cm, 10.6 m high) from a site at Deschênes, Hull.

Table III

A Comparison of the Distribution of MBC-HCl (5000 ppm) in Large Elm Trees
Using the Hand Pump Injector and the Power Injector

Zone of Inhibition (mm)

Sample[1]	Hand Pump Injector (30 p.s.i.)			Power Injector (80 p.s.i.)		
	30	60	90 days	30	60	90 days
Leaves	2.9	5.2	5.3	0.5	0.3	2.0
Twigs	2.7	3.0	2.4	0.6	0.0	3.1

[1] Average of three large trees (average d.b.h. 50.1 cm, 20.5 m high).

Table IV

A Comparison of the Efficiency of the Power and Hand Pump Injectors on Disease Protection with Lignasan-HCl

1975[1]

Power Injected Tree[3]	DED Symptoms[2] br-1	br-2	Handpump Injected Tree[3]	DED Symptoms[2] br-1	br-2	Control Tree[3]	DED Symptoms[2] br-1	br-2
P-1	-	x	H-1	-	-	C-1	x	-
2	-	-	2	-	-	2	-	-
3	-	x	3	-	-	3	x	x
4	-	x	4	-	-	4	-	-
5	-	-	5	-	-	5	-	-
6	x	-	6	-	-	6	x	-
7	-	-	7	-	-	7	x	x
8	-	-	8	-	-	8	x	-
9	-	-	9	-	-	9	x	x
10	-	-	10	-	-	10	x	x
11	-	-	11	-	-	11	x	-
12	-	-	12	-	-	12	x	-

[1] Trees were inoculated with DED 3 weeks after injection of MBC-Chloride. Disease protection was monitored 4 weeks after inoculation of DED into two branches of each tree (br-1, br-2).

[2] Disease developed (x x). No disease developed (protection) (- -).

[3] Size of tree 8" d.b.h. 35 ft. height.

Table V

Development of DED Symptoms after Inoculation of Treated and Control Trees with *Ceratocystis ulmi* (average of 12 trees) using the Hand Pump Injection during 1975

	Amount of DED Infections Appearing 4 Weeks After Treatment
Treated Trees	0 percent
Controls	70 percent

for 2 years. Consequently, the cost of treatment per tree on an annual basis is further reduced by 50 percent. Thus this method of treatment and the cost of protection would seem to be well within the reach of the average home owner, in contrast to the root injection method that costs $150-$300 per tree (Kondo 1975 personal communication). However, further research is needed to test the efficacy of this treatment on large street trees before a valid conclusion or generalization can be made. The distribution pattern of the fungitoxicants is more complex in very large and old trees than that of young trees and caution is needed in extrapolating these results to large urban trees.

Concerning the undesirable impact of injections on the tree, it is evident from Figs. 2-6 that neither the pressurized injections nor the wounds created by the injector heads have major deleterious effects on the growth and anatomy of the trees. All injected trees were found to be living and normal about 3 years (Gregory et al 1973) after the injections and many of the wounds were healed up or were in the process of healing up. A certain proportion of the holes do not heal up completely but when they are filled up with grafting wax or pieces of dowling, the tree regains its aesthetic value. Neither do the holes seem to serve as courts of infection or infestation. These results are in agreement with findings of other workers (Gregory et al 1973, Jones et al 1973, Pinkas et al 1973, Van Alfen and Walton 1974).

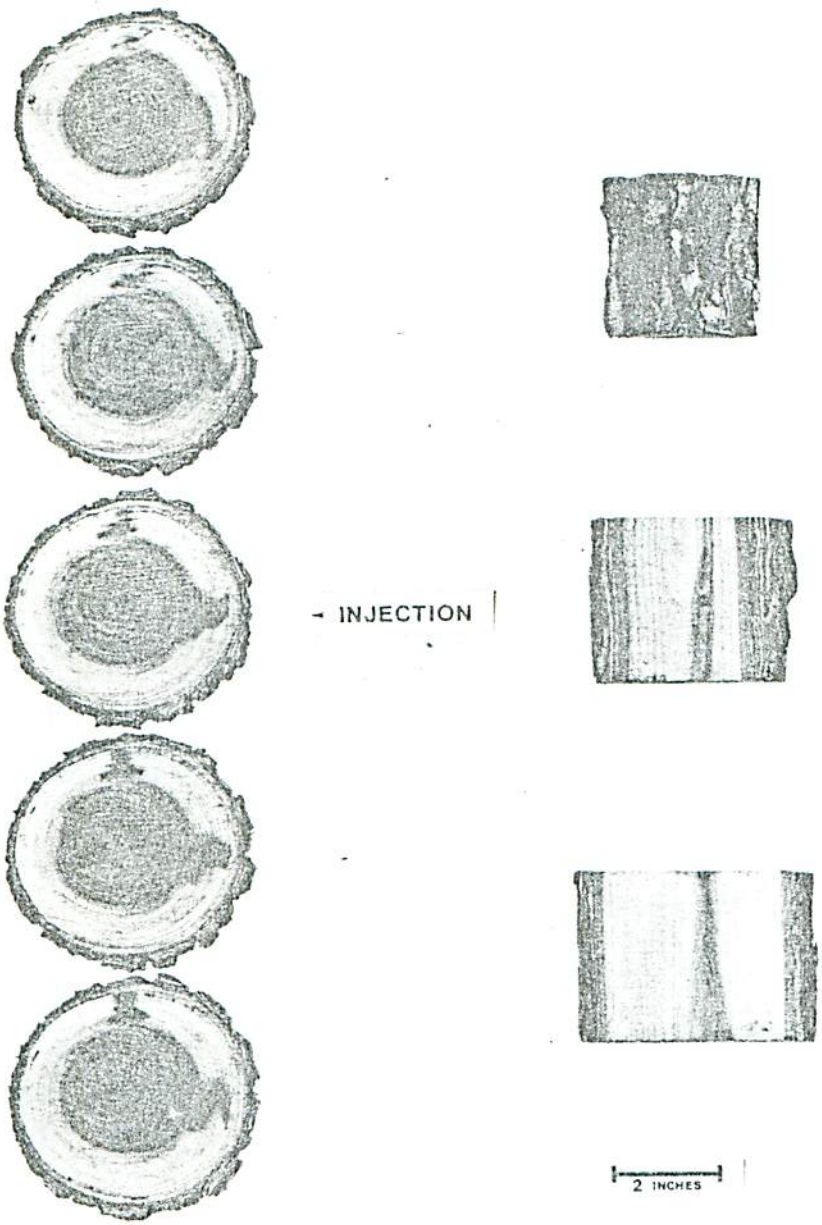


Fig. 2. Host reaction and healing of wounds in treated trees 30 days after injection with MBC-Chloride (1000 ppm).

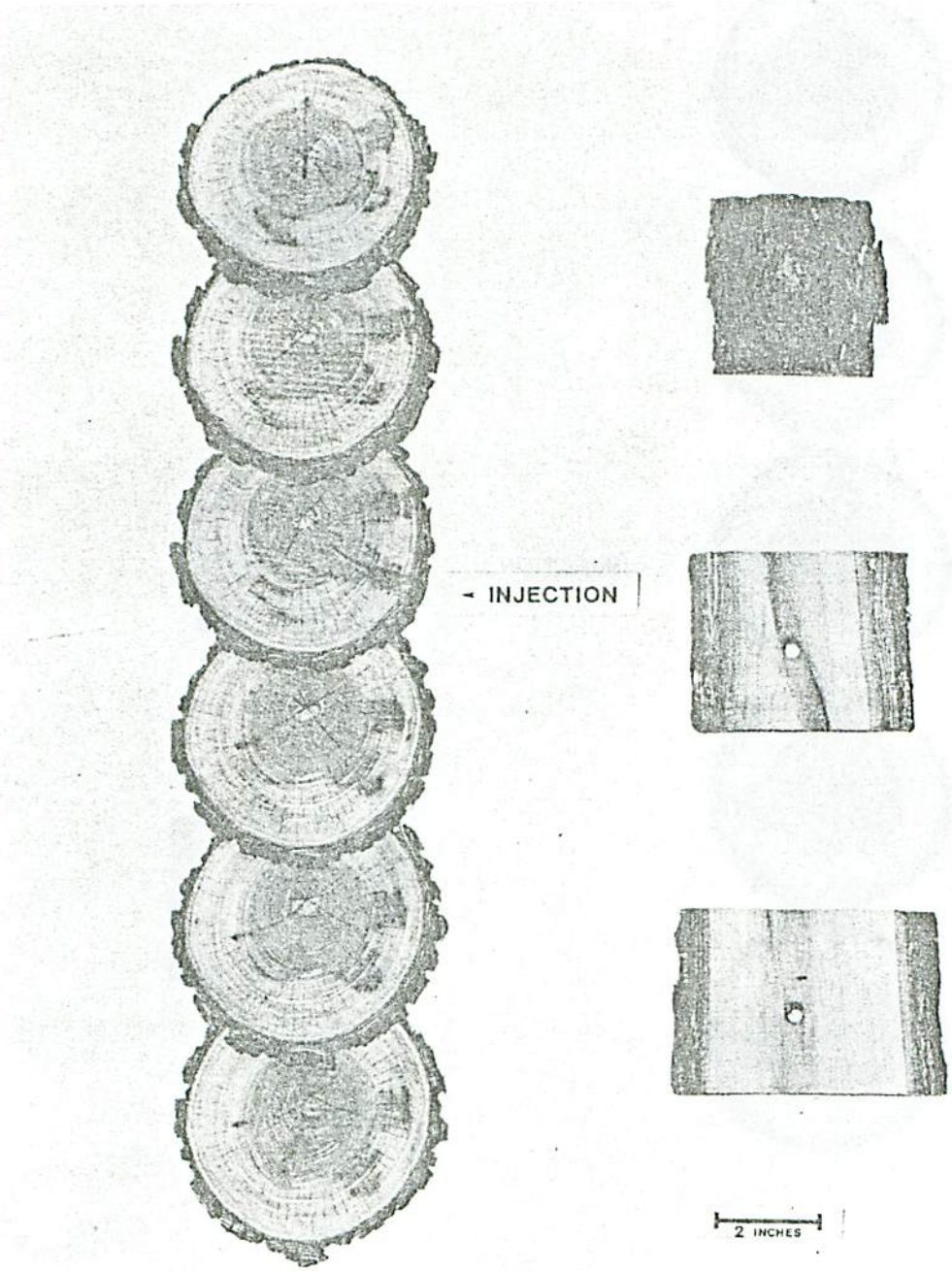


Fig. 3. Host reaction and healing of the wound in treated trees 20 months after injection with MBC-Chloride (1500 ppm).

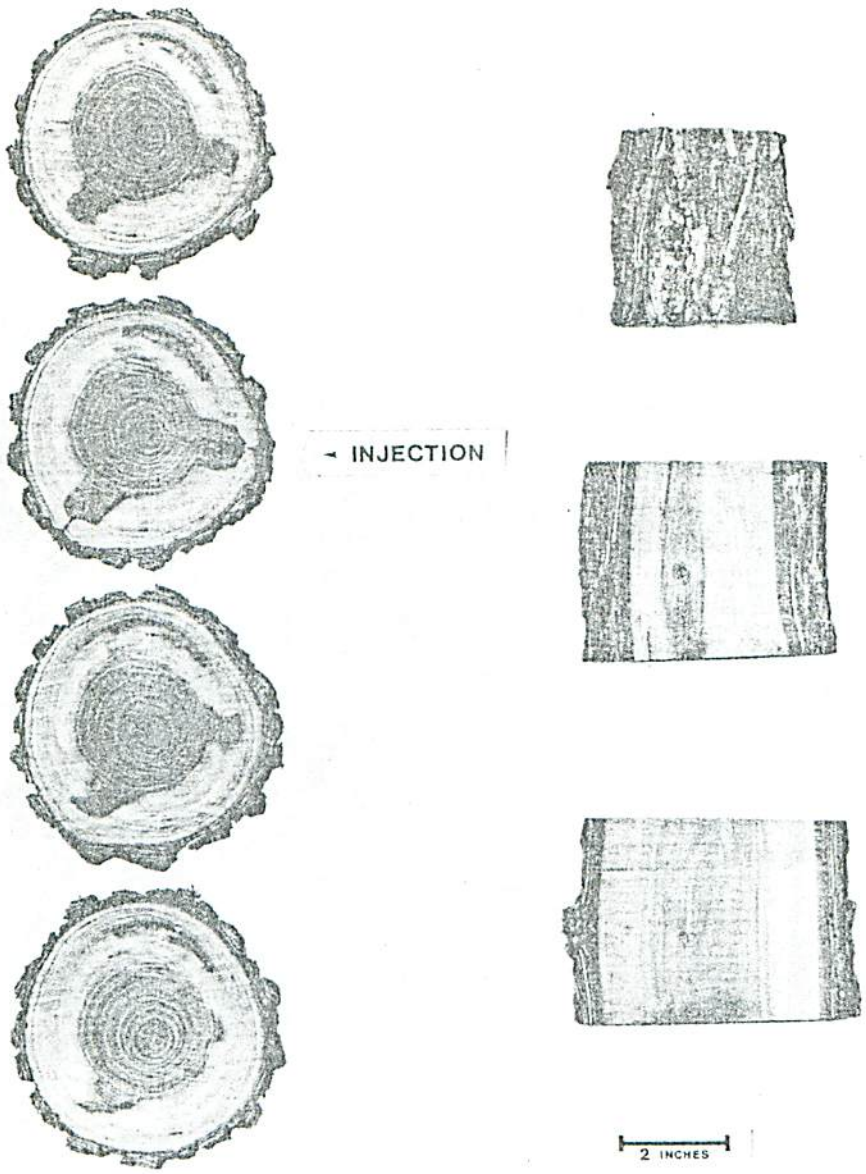


Fig. 4. Host reaction and healing of the wound in untreated (control) trees as a result of trunk injection after 20 months.

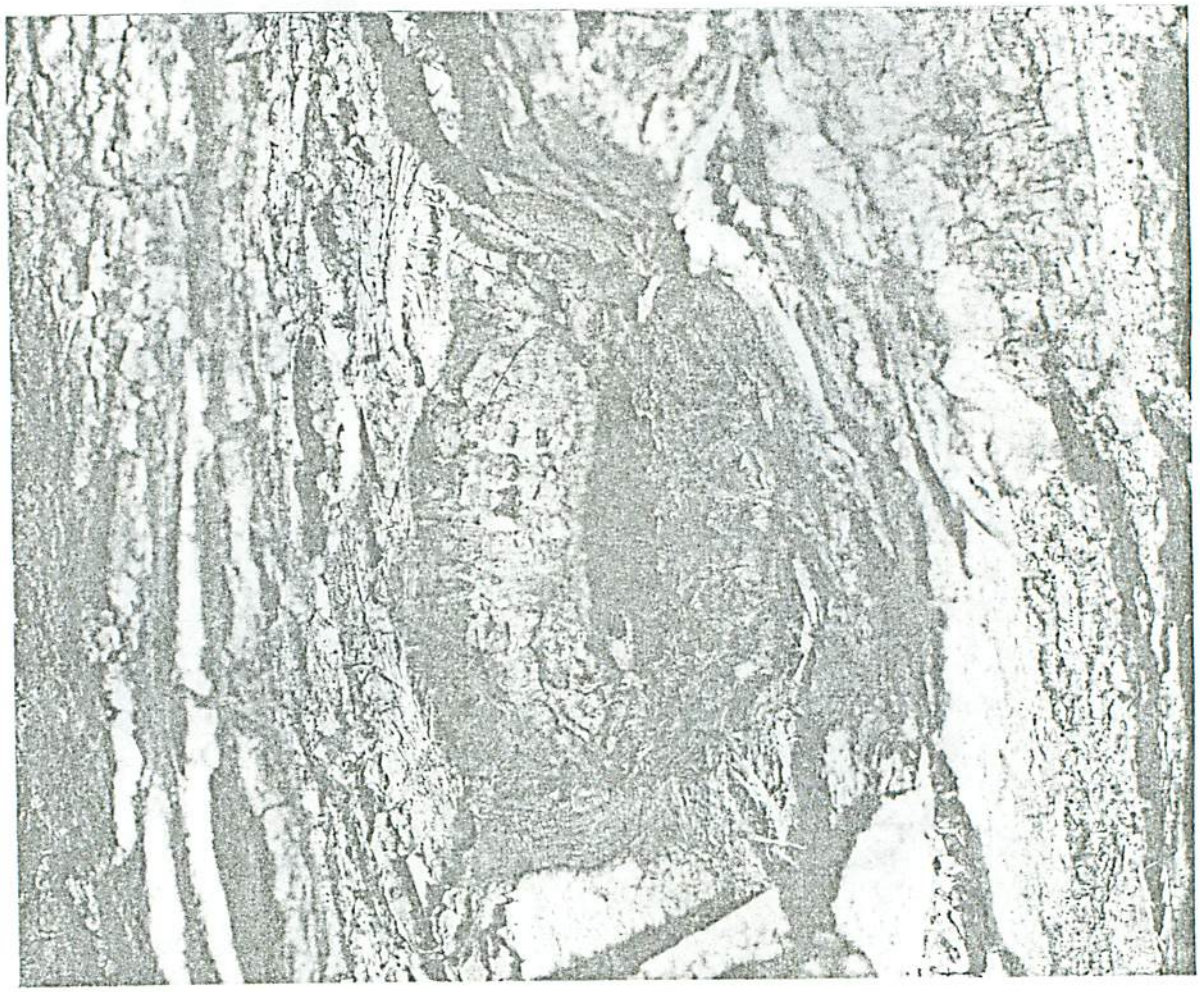


Fig. 5. Enlarged view of periderm regeneration over the injection wound after 20 months.

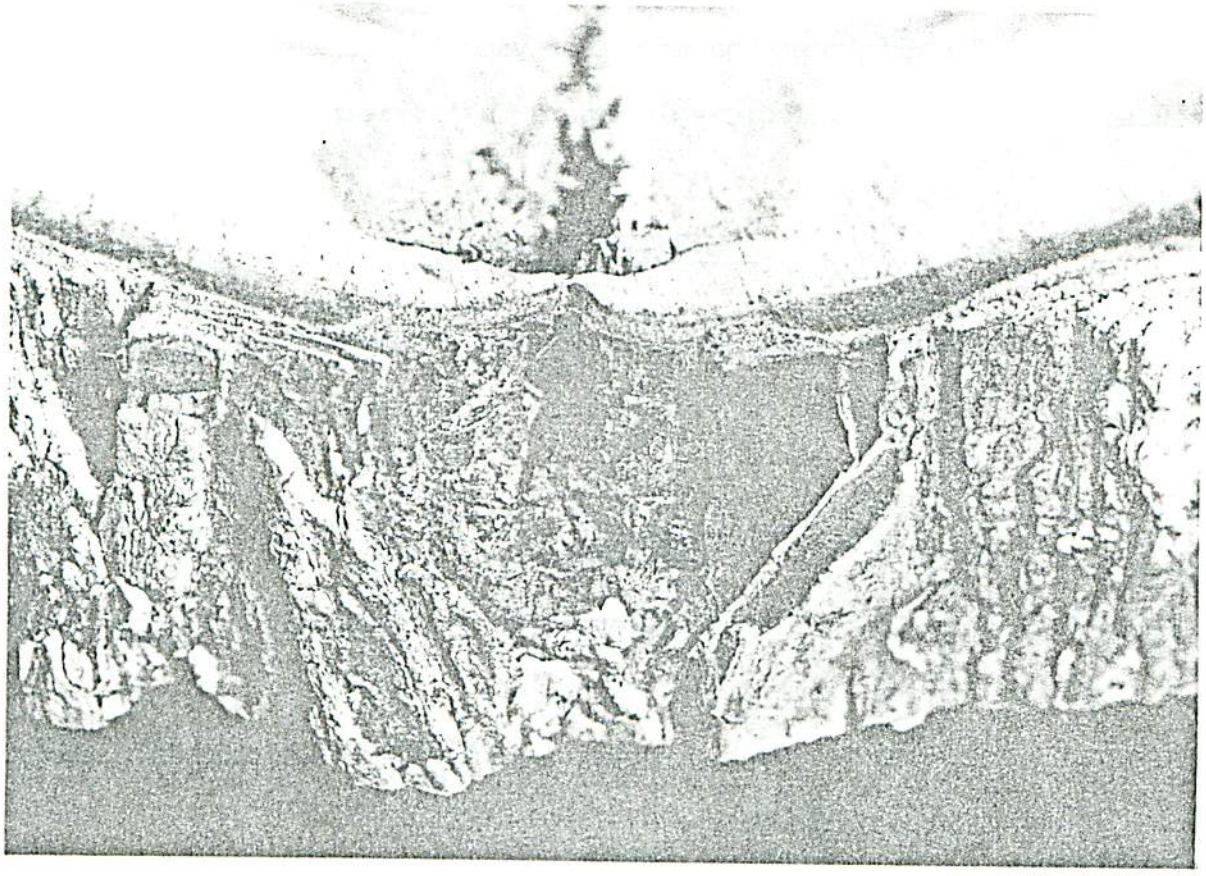


Fig. 6. Enlarged view of the healing of the wound and formation of periderm at injection site 20 months after the injection.

SUMMARY AND CONCLUSION

A simple, practical and relatively inexpensive apparatus was developed for the suppression of Dutch elm disease with fungitoxicants (Lignasan, MBC-Cl) in small and large elm trees. Injection of the pesticide can be made into the trunk or branches of the tree under pressure (20-30 psi) with a hand pump injector (1 quart or 2.5 gallon size). Over 70% of the treated trees showed effective protection during the year of application (1975). The cost of treatment per tree on an annual basis was approximately $20-$35. However, more research is needed with large trees in the urban environment before valid conclusions can be drawn. It is suggested that this apparatus should be utilized for treatment against other vascular diseases, insect infestations and physiological disorders in large urban trees.

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