TRANSLOCATION OF BENOMYL IN ELM (ULMUS AMERICANA L.)

VII. Application of the Trunk-Injection Technique for Suppression of the Dutch Elm Disease (Ceratocystis ulmi Buism) Moreau in Landmark and Historical Trees

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RÉSUMÉ

Des injections de chlorure MBC faites sous pression dans le tronc d'arbres ayant une valeur historique ou autre situé en quatre endroits du Québec et de l'Ontario, ont arrêté la propagation de la maladie, prolongé l'espérance de vie et maintenu les arbres en une santé et une vigueur raisonnables pendant au moins deux ans. On n'a remarqué aucun effet néfaste de la forte pression sur la survie des arbres. Le coût estimé du traitement a varié d'un arbre à l'autre, allant de $80 à $475 l'arbre. On propose d'effectuer des recherches plus approfondies pour améliorer la méthode de traitement afin de pouvoir réduire les frais et être sûr de la protection offerte.

INTRODUCTION

Traditionally, elm trees have not been only planted for their shade and aesthetic value in cities, parks and backyards but they have also been planted to commemorate historic occasions, as founding of an institution (universities, hospitals, mansions, cottages, farm houses, etc.). For example, many university campuses in Canada bear founder's elm on their premises as do Parliament Hill, The Governor General's residence and embassies of various foreign nationalities in Ottawa. Life expectation in elms could be over 300 years and with advanced maturity and senescence, these trees become more prone to infections of the Dutch elm disease (DED). Because of the historical values attached to such trees, the problem of protection assumes high priority and if the life expectation can be prolonged, a high cost of treatment can be justified. With this objective in mind, some historical and landmark trees in the Ottawa and Montreal area were selected and the present report describes problems associated with the suppression of the DED in such trees.

MATERIALS AND METHODS

(i) Landmark and Historical Trees

Four trees of known histories and locations were selected whose details are given below:

TABLE I

A Brief Description of the Landmark and Historical Trees

Tree	Location	History	Ht	Remarks
The Manotick Tree	Hwy 16, Ottawa Ontario	80 yr; planted 1895 during establishment of a farm home	65'	One limb diseased in 1973
The Burritts Rapids Tree	Burritts Rapids, Ottawa.	134 yr; planted in memory of a family farm around 1840	55'	Two limbs showing disease symptoms in spring, 1974.
The Finch Tree	Finch (Winchester), Ontario.	174 yr; a landmark tree planted ca 1800.	85'	One limb showing disease, spring, 1974.
The University Tree	McGill University Campus, Montreal, Quebec.	154 yr; planted to commemorate the foundation of the University by James McGill, 1851.	132'	1/4 tree diseased & showing signs of flagging & wilting summer, 1973.

These trees were of high aesthetic and historic values and were mentioned in local folklore and history of the town, farm or the University. Photographs of some are shown in Figs. 1 and 2.

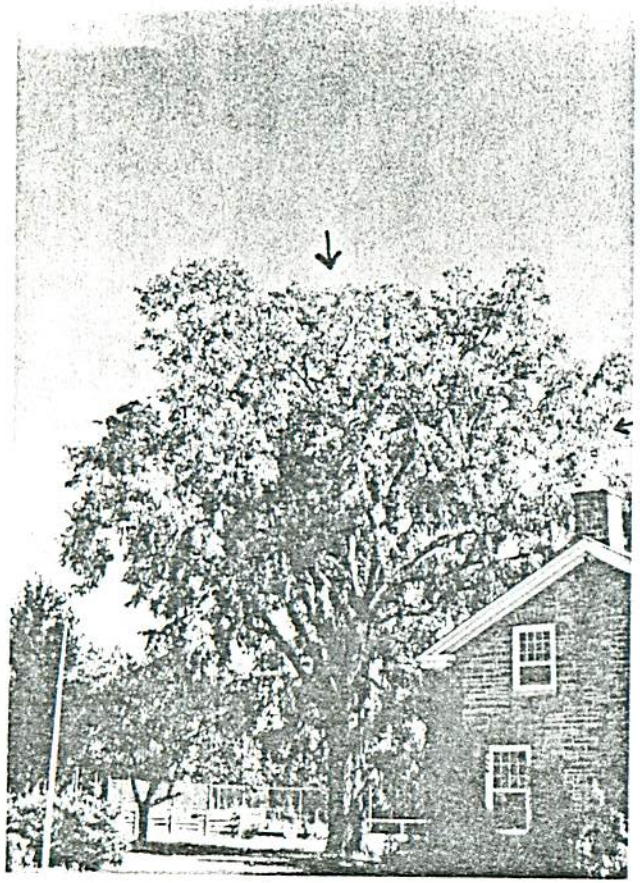
(ii) Method of Treatment

All four trees were treated with the pressurized trunk-injection technique as described by Prasad and Travnick (1974). Briefly each tree was injected with a certain volume of the MBC-chloride or Lignasan® sample (a Dupont product containing 12.5% MBC-chloride) for varying periods of time until the required volume and concentration was absorbed into the sap of the tree. Following table illustrates the details:

TABLE II

Injection of Fungicides into Elm Trees

Tree	DBH (Inches)	Dosage Applied (ppm)	Time (hrs)	Volume Injected (gals)	Remarks
Manotick	22	4000	1.5	4	Double application '73 & '74
Burritts Rapids	42	1500	2	5	Single application '74
Finch	72	16000	2.5	5	Single application '74
University	60	4000	9	25	Double application '73 & '74



(a)

(b)

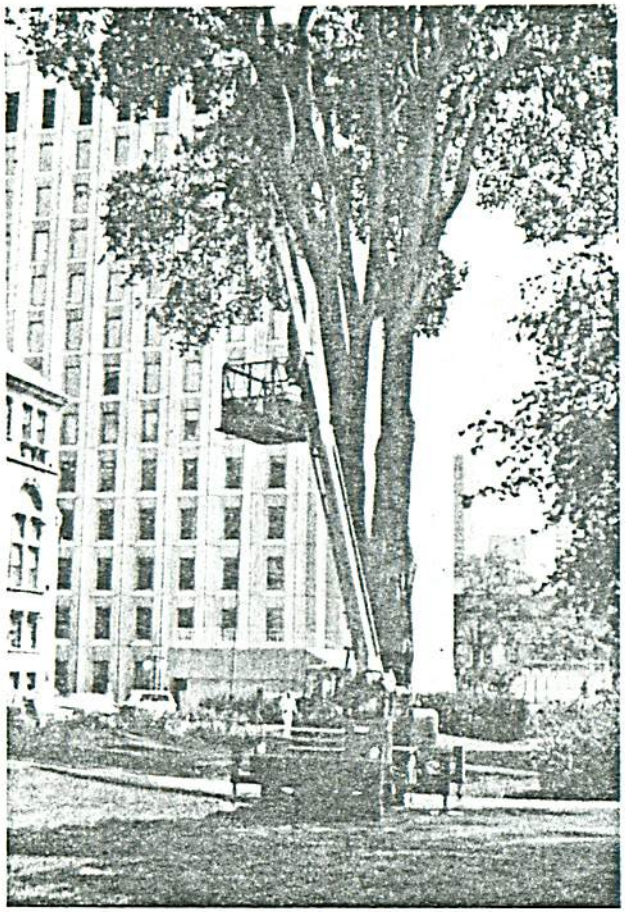
Fig. 1. Landmark and historical trees. (a) The Burritts Rapids Tree. (b) The Finch tree. Arrows indicate the damage done to crowns by the Dutch elm disease.

Since the dosage and volume injected depended upon the girth and severity of infection, necessary measurements of d.b.h. and DED infections were carried out before injection of the fungicide solution. In the case of the McGill tree, a modified procedure of the trunk injection system was used. Here the pesticide solution was pumped into each individual limb (10) of the tree at a height of 63-65 ft. by use of a "cherry picker" (Fig. 2(a) and (b)). Since the solution had also to be pumped against gravity, a longer pressurized hose and a more powerful motor (9 h.p.) was used as shown in the Figs. 2 & 3. Normally the pump pressure ranged from 120-150 p.s.i. but to measure the pressure precisely at site of injection a gauge was attached; usually the pressure at a height of 65 ft. was 100-125 p.s.i.

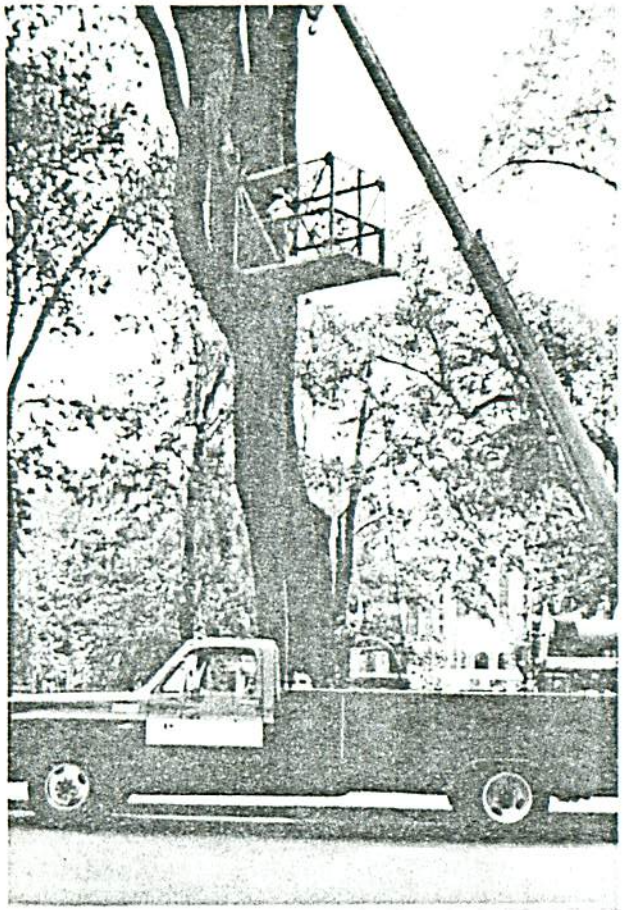
Determination of Fungicides & Disease Protection

Samples of core, bark, branches and leaves were collected with either a pole pruner or by the cherry picker and bioassayed in the laboratory for the presence and distribution of MBC-chloride with the aid of the standard Penicillium expansum technique (Prasad & Travnick 1972).

Disease protection was assessed by the degree of crown damage. The treatments were prophylactic and tended to halt further onslaught of the disease into the healthy branches. Flagging and wilting scores were maintained visually and the trees were inspected periodically for any further damage to the crown. If the branches contracted disease (as indicated by flagging and wilting) after the injection treatment, it was



(a)



(b)

Fig. 2. Method of trunk injection of MBC-chloride into the Founder's Elm at McGill University (a) a view of the tree with large limbs. (b) drilling of holes for insertion of injectors into the limbs.

(a)

(b)

Fig. 3. Method of trunk-injection of MBC-chloride into Founder's Elm McGill University. (a) Injector screws. (b) Plugging of the injector holes with a wound dressing compound.

considered that there was no protection in that particular season; if the uninfected part of the tree remained healthy and green following treatments, it was considered to be protected. Further observations were made in the following spring and summer for subsequent disease progression. The proportion of dying and dead branches were counted on each tree and this was related to the whole crown to calculate a percentage of the crown infected.

Estimation of Cost of Treatments

The cost of the treatment was apportioned into various components; price of the material, cost of equipment and labour, and was calculated on the basis of the fair market value. It was realized that only an approximation could be made. Therefore, since this activity was part of the research program, a true commercial value for the treatments would be slightly higher than the estimated costs presented herewith.

RESULTS AND DISCUSSION

Trunk-injection with MBC-chloride produced positive responses in all trees. In two trees treated in the previous year, the leaf flush was normal in the spring, the subsequent leaf expansion was also normal and finally the whole canopy became green and healthy. Only branches that were diseased at the time of treatment or before did not flush normally the following year. This is in agreement with findings of other workers (Smalley 1973, Kondo 1973, Gregory, McWain & Jones 1973). It seems most of the action of MBC-chloride is preventive (fungistatic) and

eradication of the pathogen from the dying or dead tissue is not accomplished by the treatments. On the other hand, Gregory, McWain & Jones (1973) have claimed curative protection as well but in the present finding, it appears protection was by arrestation of the pathogen. Perhaps higher concentrations (up to 24 gms/l) could have afforded cure but owing to the high cost of the material and possible phytotoxicity, it was not deemed desirable to attempt higher dosages. It may be that repeat applications (twice a year) are more effective than one large single treatment and further investigation should be directed towards this in future. In some trees (Montreal's Founder Elm) the treatments appeared to prolong senescence of the Fall leaves and consequently the tree remained green for longer periods. This is possible since benzimidazoles are known to produce kinetin-like effects in plant tissues (Person et al 1957, Waygood 1965).

The distribution pattern of MBC-chloride in the injected trees was monitored in 1973 and 1974. Some branches and core samples showed fungitoxity, others did not. Sampling of top branches was made difficult because of inaccessibility at such heights but some samples that were picked at upper limit of the cherry picker showed distribution in the branches and leaves. Generally, the fungicide moved from the site of injection and travelled upwards towards the crown. Some movement into the basal trunk region also took place.

In all four trees, dissemination of the disease within the tree was curtailed after the application of the pesticide. However, a few new infections appeared in some new branches the following year, probably

TABLE III

Suppression and Prevention of DED in Landmark and Historical Trees Following Trunk Injection with MBC-Chloride

	Percentage Crown Diseased During 1973		Percentage Crown Diseased During 1974	
Tree	Before Treatment	After Treatment	Before Treatment	After Treatment
Manotick	5-7	5-7	5-7	5-7
Burritts Rapids	--	--	10-15	10-15
Finch	--	--	1-2	1-2
University	5-10	5-10	5-10	5-10

due to re-infection by bark beetles or probably the MBC-chloride did not distribute and persist uniformly in all the newly infected branches. More research is needed to clarify these points. According to Kondo (1973) MBC salts can persist in elm trees for 2-3 years and our investigations have also demonstrated (Prasad and Travnick 1972) that benomyl and MBC-SO4 can persist on elm bark for over 24 months under the extremes of weather conditions. Therefore, it may be possible to treat the diseased trees once in every 2 or 3 years.

No permanent injury seemed to result from the trunk-injection save for a few holes which, when filled with a wound dressing compound (Braco or grafting wax) encouraged rapid healing and formation of calluses. Several hundred trees have been injected by Gregory, McWain and Jones (1973), Kondo (1973) and Prasad (1974) and few, if any, died as a result of pressure injection. Therefore it seemed reasonable to suppose that neither wounding by injectors nor the impact of high pressures (80-120 p.s.i.) have any deleterious effect on the physiology and survival of trees for at least a period of three years. The effects of high pressures on the vascular system is largely unknown and it was unlikely the trees would collapse if there was a rapid callus formation mechanism. Some local phytotoxicity at the site of injection had been recorded by some investigators (Gregory, McWain& Jones 1973, Prasad and Travnick 1974) with very high concentration(16,000 ppm) of MBC-chloride, but it is doubtful if this injury was due to the fungicide per se. Rather it appeared to be associated with lower pH (acidity) of the toxicant formulation. In this connection,

it is necessary that MBC-chloride be injected at lower pH (2-3) levels otherwise its solubility is affected (Prasad 1972) and once the fungitoxicant precipitates, further injection under pressure would choke the vascular system and thus impede the flow of the sap. High-pressure injection of solution has yet another undesirable feature in aesthetic trees: rupture and peeling of the bark from cambium sometimes does take place but here again this has a transient and local effect. Nevertheless, callus formation takes place and the new periderm soon replaces the old bark tissues. Rigorous control against occasional blow-out of high pressures must be resorted to and utmost care and safety precautions must be practised by the applicators. Wearing of a spray suit, a pair of safety gloves, goggles and helmet is recommended.

Cost Analysis of the Treatment

A balance sheet for the necessary expenditures involved during the protection of trees by trunk injection was maintained. From Table IV, it is evident that cost of the treatment varies with size, location, equipment, etc., and must be accepted with caution.

TABLE IV

Cost of Treating Landmark and Historical Trees with Pressurized Trunk Injection

Tree	Cost in Dollars			
	Material	Labour	Equipment	Total
Manotick	30	30	20	80
Burritts Rapids	30	30	24	84
Finch	35	45	20	100
University	45	110	320	475

Thus the mean cost value of treating an average historical or landmark tree would be around $90/tree. But for a special tree (Founder's Elm) at the McGill University the cost was high. This was due to rental of the cherry picker and a special pump which was required to treat each limb of this tree at an exceptionally large height of 60-65 feet. However, the owners of the tree were quite agreeable to the high price levels since they wanted to prolong the life expectation of their high value trees. The cost could possibly be reduced by improvements in the method of injection. Use of a pressurized gas-tank rather than a motor pump could certainly cut down the price of the treatment. Finally, it must be stressed that elms don't live forever and older trees are victims of other types of infections, viz; wet wood and elm phloem necrosis (EPN) caused by bacteria and mycoplasma respectively. Therefore before trunk injection against the DED is administered or advocated it is essential that the cause of the malady be established.

SUMMARY AND CONCLUSIONS

Pressurized trunk injections of MBC-chloride into diseased landmark and historical trees from four locations in Ontario and Quebec, suppressed the spread of the disease, prolonged the life expectation and maintained the tree in reasonable health and vigour for at least two years. No adverse effects of high pressures on the survival of the trees were noted. The estimated cost of treatment varied from tree to tree and ranged from $80 to $475. It is suggested that further research be

carried out to improve the method of treatment so that the costs can be reduced and a guarantee of protection can also be given.

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