CALCULATION OF INJECTION PERIODS AND DOSAGES OF MBC-PHOSPHATE FOR FLEXIBILITY IN DUTCH ELM DISEASE CONTROL

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ABSTRACT

A method of calculating dosages of MBC-phosphate to obtain flexibility in injection time and concentration for effective Dutch elm disease control is presented. The method was tested on 15 healthy, mature elms during the summer of 1974 and showed that a reasonable measure of predictability of chemical coverage and uptake time can be expected. This should allow the commercial operator some flexibility in his daily tree injection program.

RÉSUMÉ

Les auteurs présentent une méthode de calculer les doses efficaces de phosphate MBC lors de la lutte contre la Maladie hollandaise de l'Orme ou sa prévention, en vue d'obtenir des temps et périodes flexibles d'injection. Ils essayèrent cette méthode sur 15 Ormes matures et sains au cours de l'été de 1974 et trouvèrent que des prédictions raisonnables sur le champ d'application chimique et le temps d'absorption peuvent être faites. De la sorte, le préposé en service commercial peut préparer un programme assez flexible d'injections journalières.

ACKNOWLEDGEMENTS

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INTRODUCTION

Injection of chemical solutions by root, trunk or root flare into mature elms for Dutch elm disease (DED) control is time-consuming and therefore costly. If tree injection is to be a practicable method of control for commercial operators, costs must be kept to a minimum and an adequate level of disease control or prevention must be maintained.

Four years' study of tree injection with various types of equipment and different methods of injection have shown that injection of elms with large volumes of water-soluble salts of Methyl-2-benzimidazole carbamate (MBC) (200-900 litres at concentrations of 250 ppm) over a period of 24 to 48 hours provides the optimum chemical distribution throughout the tree (Kondo and Huntley 1973, and unpublished data). Furthermore, injection over a relatively long period at low concentrations of 250-1000 ppm virtually eliminates any possibility of phytotoxicity to the elms and results in optimum disease control or prevention (Kondo et al. 1973). Considerable time can be saved by reducing the injection period, increasing the chemical concentration, and decreasing the total volume injected. This report presents a method of calculating dosages of MBC-phosphate (MBC-P) for effective DED control or prevention to obtain flexibility in injection time and concentration. It also shows the resulting distribution of MBC-P within elms injected with the calculated dosages under field conditions.

CALCULATION OF INJECTION DOSAGES AND PREDICTION OF INJECTION PERIODS

The data appearing in this section of the report were obtained from 38 treated diseased elms which formed part of more extensive root-injection field trials conducted in 1972 and 1973. In these trials 193 diseased elms were injected with MBC-P at concentrations varying from 250 to 1000 ppm, with injection periods ranging from 2 to 113 hours. However, only the data from 38 treated elms injected with 250 ppm MBC-P for 48 hours were employed because preliminary analysis of the 1972 and 1973 data revealed that satisfactory success in disease remission was obtained with injection of the chemical at a concentration of 250 ppm for 24 to 48 hours. Since this indicated that diseased elms, injected with solutions of MBC-P at higher concentrations over the same time-span, were, in fact, subjected to an overdose of the chemical, they were eliminated from this analysis.

The method used to calculate effective dosages is shown in figures 1 and 2, which were constructed from empirical data. Figure 1 presents the average volume uptake[1], by diameter class, in elms successfully treated with MBC-P at a concentration of 250 ppm. The relationship is interpolated

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[1]Averages were employed to give equal weight to all diameter classes.

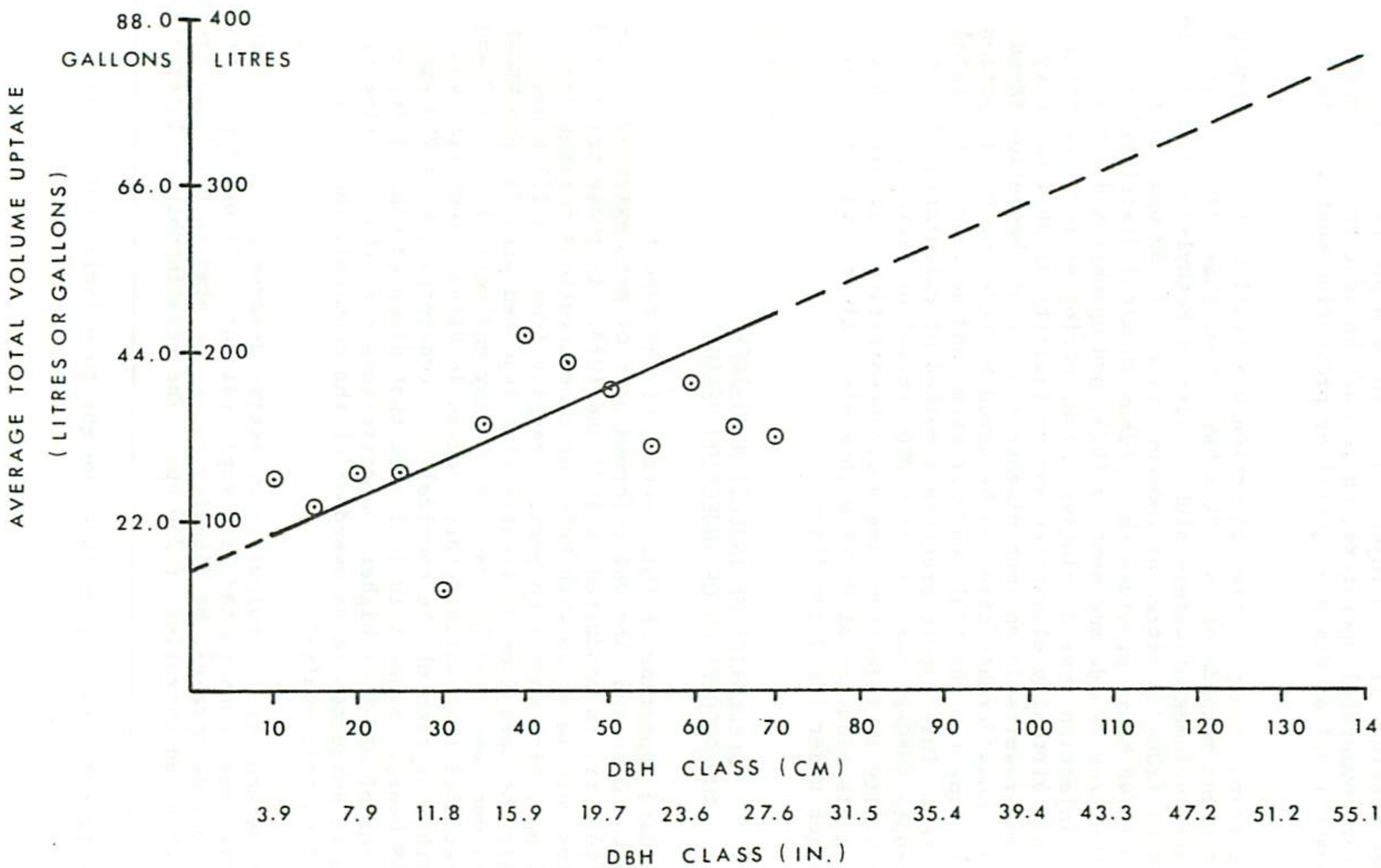

Figure 1. Average total volume uptake, by diameter class, of 38 diseased elms successfully treated with 250 ppm MBC-P during the 1972 and 1973 field trials.

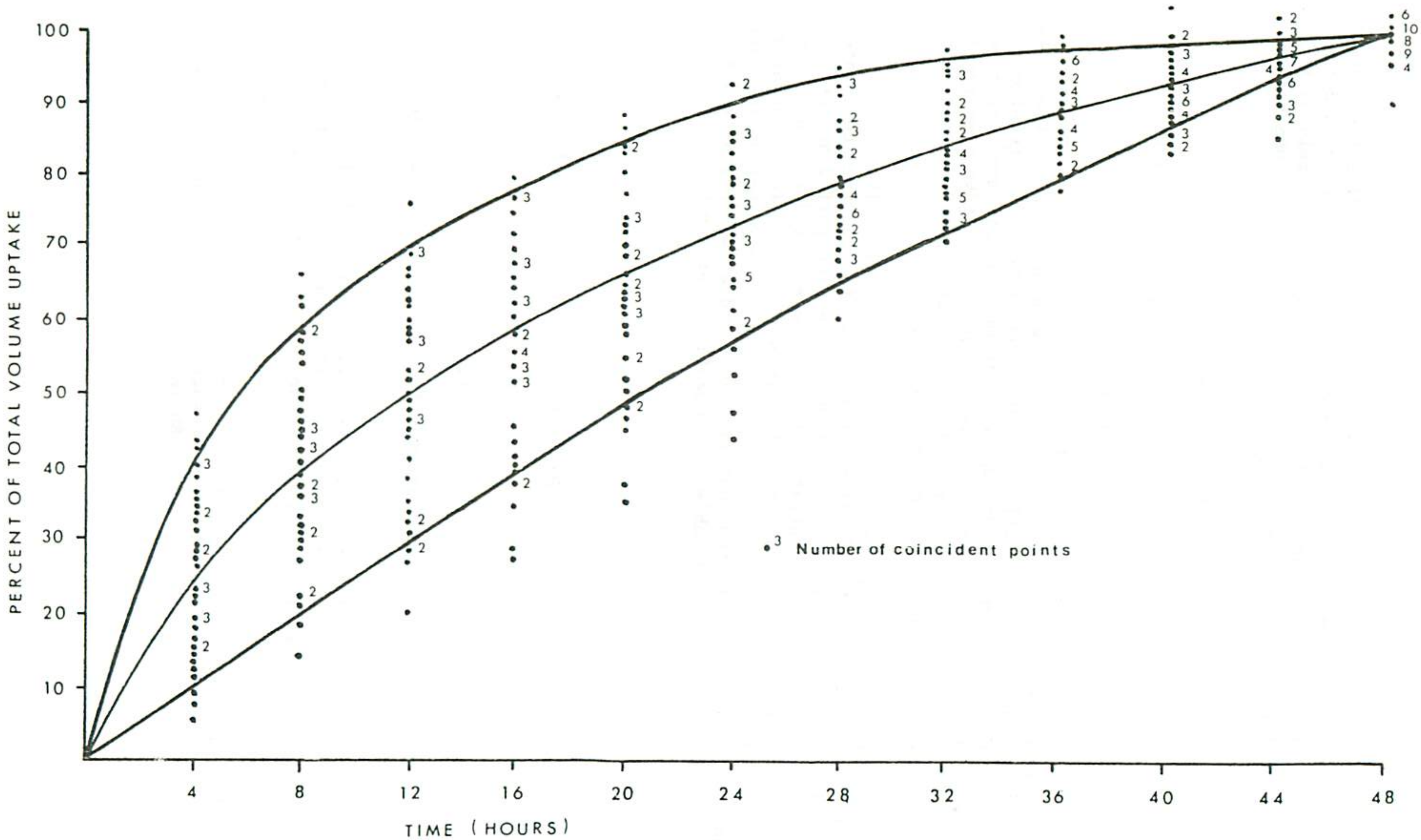

Figure 2. Percent uptake of chemical solution over 48 hours.

as a straight line. Since data were available only for elms 10-70 cm DBH, the line was projected into the lower and upper DBH classes by a dotted line. It should be stressed that this line is presented merely as a first approximation; as more data are made available it should become better defined. The line is described by the following equation[2].

$$Y = 70.0 + 2.22\ X \quad \text{... (Equation No.1)}$$

where Y = average total volume uptake in litres

X = DBH in centimetres

Figure 2 presents the relationship between the percentage of the total volume taken up by the elm and the corresponding uptake time. As there was a substantial variation in the actual time period required for any particular percentage volume uptake, minimum and maximum curves were drawn, in addition to the average. The variation in uptake time required is due to environmental, seasonal and weather differences, disease condition, tree condition and selection of roots.

By employing figures 1 and 2 one can either arbitrarily choose a particular concentration and volume of the solution and then calculate the injection period, or select a suitable injection period and determine the corresponding concentration and volume required for injection in order to achieve adequate control. This allows the commercial operator a certain amount of flexibility in the operation and a reduction in injection time. It is anticipated that figures 1 and 2 can be improved as additional data become available from ongoing experiments.

Examples

(a) The volume of the solution at 250 ppm required to treat a tree 60 cm DBH can be calculated by employing equation 1 as follows:

$$\begin{aligned} Y &= 70.0 + 2.22\ X \\ &= 70.0 + 2.22 \times 60 \\ &= 203.2 \text{ litres} \end{aligned}$$

The "Y" value can be read directly from Figure 1 but with less precision.

(b) Since concentration varies inversely with volume, the following equation can be used to calculate a different concentration or a different volume once one or the other is arbitrarily chosen.

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[2]English equivalent equation: $Y = 15.4 + 1.24\ X$
where Y = average total volume uptake in gallons
X = DBH in inches

$$\frac{\text{concentration 1}}{\text{concentration 2}} = \frac{\text{volume 2}}{\text{volume 1}} \quad \text{(Equation No. 2)}$$

For instance, to decrease the volume in example (a) from 203.2 litres to 100 litres and yet maintain the same amount of active chemical, Equation No. 2 can be used to determine the new concentration. That is, where concentration 1 = 250 ppm
volume 1 = 203.2 litres
volume 2 = 100 litres

$$\frac{250}{\text{concentration 2}} = \frac{100}{203.2}$$

$$\text{concentration 2} = \frac{203.2 \text{ X } 250}{100}$$

$$= 508 \text{ ppm}$$

(c) The injection period can be determined from Figure 2 for any given concentration by calculating the proportion of the volume required at 250 ppm to inject the same amount of the chemical at the new concentration.

For example, where the new concentration equals 508 ppm

$$\text{Percent of volume required at new concentration} = \frac{250}{\text{new concentration}} \text{ X } 100\%$$

$$= \frac{250}{508} \text{ X } 100\%$$

$$= 49.2\%$$

The time required for injection of 49.2% of the total volume at 250 ppm can be read directly from Figure 2. That is, the time required for injection of 100 litres at 508 ppm would range from 6 to 22 hours, averaging 12 hours. The time required to inject a tree 60 cm DBH has been reduced from a period of 24-48 hours (average 36) to a period of 6-22 hours (average 12), by increasing the concentration to 508 ppm from the standard 250 ppm.

FIELD TESTING AND ANALYSIS

To determine the effectiveness of the foregoing dosage calculation for tree injection, the method was tested on 15 healthy, mature elms in Ottawa, Ontario during the summer of 1974. Treatment was by root-flare injection or root-collar injection, employing wooden injector heads as described by Kondo and Huntley (1975) and root injection with MBC-P in filtered water at either 500 or 1000 ppm. Distribution of the chemical MBC-P was determined by random sampling of each major branch in the tree crown. The samples (leaves, buds and twigs) were then bioassayed against *Penicillium expansum* Link. as outlined by Kondo et al. (1973).

Table 1. Calculated dosage, predicted injection period and percent chemical distribution for 15 healthy, mature elms injected with MBC-P in Ottawa, Ontario (1974).

Tree no.	Injection date	DBH (cm)	MBC-P (ppm)	Volume uptake (litres)		Injection period (hours)		Sampling date	% MBC-P coverage
				Calculated	Actual	Predicted	Actual		
Root Injection									
074- 46	July 3	12.2	1000	24.3	40	2-12	6	July 9	100
074- 48	July 3	15.2	1000	25.9	25	2-12	6	July 9	100
074- 49	July 3	25.4	1000	31.6	70	2-12	6	July 9	66
074- 47	July 3	32.0	1000	35.3	47	2-12	6	July 9	50
074- 55	July 3	37.1	1000	38.1	38	2-12	1.25	July 9	16
Root-flare Injection									
074-106	Aug. 19	59.7	500	101.3	100	6-22	4	Nov. 4	85.7
074-164	Sep. 16	61.2	500	102.9	120	6-22	1	Nov. 1	66.6
074-105	Aug. 16	86.4	500	130.9	145	6-22	20	Nov. 4	59
074- 69	July 26	16.3	500	53.1	52	6-22	48	Nov. 5	100
074- 29	July 23	87.6	500	132.2	135	6-22	2	Nov. 21	20
074- 54	July 4	20.8	1000	29.0	30	2-12	6	July 9	33
074- 53	July 4	25.7	1000	31.8	35	2-12	6	July 9	50
074- 52	July 4	27.9	1000	33.0	45	2-12	6	July 9	50
074- 59	July 10	51.1	1000	45.9	45	2-12	2	July 22	33
074- 58	July 10	104.4	1000	75.4	80.0	2-12	1.3	July 22	11

Table 1 presents the calculated dosage, the predicted injection period and percent chemical distribution for each injected elm obtained from the bioassay of elm branch samples. Injection of the calculated MBC-P dosage by root or root flare resulted in adequate chemical coverage except in three instances when the injection time was considerably less than the minimum predicted injection period. In this experiment the injection period was determined mainly by the uptake rate. As soon as the required volume of chemical solution was taken up by the tree, injection was terminated. Variation in uptake time among treated elms was probably due to differences in site, weather, and tree conditions (Kondo et al. 1973), and in a few cases to failure to stop the treatment when the calculated volume was reached.

Table 1 also confirms our earlier findings that chemical distribution within the elm improves with time after injection (ibid.). Trees generally showed poorer chemical distribution when sampled 5 to 6 days after injection than when sampled several weeks after injection. Therefore, the distribution pattern would be much improved after several weeks for trees injected at 1000 ppm. The five trees subjected to root injection at 1000 ppm, which averaged 24.4 cm DBH, showed an average coverage of 66.4% after 6 days. This coverage can be compared with that of trees 074-52, 074-53, and 074-54, which were in the same size class (average DBH 24.6 cm) and were subjected to root-flare injection at the same concentration; these trees showed an average of 44.3% coverage after 5 days. Had the latter trees been sampled one day later for an even more valid comparison, the difference in rate of coverage provided by root injection and root-flare injection would have been even less!

CONCLUSION

The proposed method of dosage calculation allows some measure of predictability of chemical coverage and uptake time. This should allow the commercial operator some flexibility in his daily tree injection program and assure him that he is obtaining adequate chemical coverage to control or prevent DED effectively in treated elms.

The method of calculation of MBC-P chemical dosage and injection time could serve as a guide for other water-soluble chemicals for DED control and prevention, once the levels of effective concentration and phytotoxicity have been determined in the laboratory and greenhouse.

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