PLANTATION RESEARCH: V. MISTBLOWER APPLICATIONS OF DILUTE INSECTICIDE SOLUTIONS FOR CONTROL OF *CHORISTONEURA FUMIFERANA* ON WHITE SPRUCE IN QUEBEC, 1972

by

R.F. DeBoo and L.M. Campbell

Chemical Control Research Institute
Ottawa, Ontario

Information Report CC-X-21

Canadian Forestry Service
Department of the Environment
September, 1972

TABLE OF CONTENTS

INTRODUCTION

Aerial applications of the insecticide fenitrothion at rates of 2-5 oz/acre are used extensively in eastern Canada for the protection of spruce (Picea spp.) and balsam fir (Abies balsamea L.) stands threatened by the spruce budworm (Choristoneura fumiferana (Clem.)). Fenithrothion, however, is not available in small package lots, and at present has restricted federal registration for use only "following consultation with regional forestry officials and in accordance with their directions" (Chemical Control Research Institute 1972).

Of the three insecticides presently having extensive label recommendation for control of insect pests on trees and shrubs - carbaryl, dimethoate and malathion - only dimethoate has specific federal registration for control of the spruce budworm. Malathion, however, is most commonly recommended by provincial and federal extension officers for ground spray applications. Thus, the choice of insecticides is limited and the situation may be confusing where only a few ornamental trees or small forest areas require treatment.

The recent extensive budworm outbreak in eastern Canada and the many requests received by this Institute from authorities from Manitoba to the Maritime Provinces for control information have intensified evaluations of synthetic chemicals and bioinsecticides by staff of the Canadian Forestry Service. In conjunction with these projects, and as part of Institute research on ground spraying, time was allocated during the period May 30 to June 15, 1972, to:-

(1) Determine the efficacy of several short-residue insecticides applied by ground sprayer for optimum protection of foliage.

(2) Evaluate several very dilute solutions (0.1-1.0% active ingredient) of these insecticides for possible future recommendation by extension personnel.

(3) Provide information on the suitability of a conventional truck-mounted mistblower as would be required for optimum mobility and spray coverage in open plantations, parks, picnic sites, and along roadsides.

Since time and staff were limiting factors, only six of the dozen or more chemical insecticides known to be effective against the spruce budworm were applied during this experiment. Also, rates of application were based on suggestions from technical representatives of the manufacturers and on previous experiences of the authors. It is not implied, therefore, that the chemicals and the application rates used have exclusive endorsement of the Canadian Forestry Service. This paper is intended primarily as a summary of evaluations of insecticides which are (or may soon be) readily available for budworm control.

MATERIALS AND METHODS

Treatment Area. Portions of a 172-acre plantation tree farm located approximately two miles north of Shawville, Quebec, were selected for the experimental spray applications. Host trees were fully-crowned white spruce (P. glauca (Moench) Voss) averaging 25 feet in height. The trees occurred along roadways or in groups due to selective removal and/or planting failure (Fig. 1).

Budworm Population Density. The spruce budworm had occurred at damaging levels for the first time during 1971 when only light defoliation was

was observed on a few trees. An intensive moth migration into the plantations was observed on July 10, 1971. Subsequent egg sampling by the authors during the following month showed a well-dispersed population on host trees with light to moderate defoliation forecast for 1972: 205 egg masses/100 sq. ft. of foliage, indicated potential for up to 80% defoliation of new shoots. Sampling results for 3rd and 4th instar larvae on May 30, 1972, supported this prediction when an average of 16 larvae/18-in. branch tip was found (based on 130 randomly selected samples).

Insecticides. Six insecticides (carbaryl, dimethoate, Gardena®, Imidan®, malathion, methonyl) were chosen for application by mistblower at concentrations [1] normally used for high volume hydraulic sprayers (Table I). The insecticides, at the rates selected for evaluation were considered to cause minimal disturbance, if any, to the natural plantation environment. Using normal precautionary measures, these insecticides (including methomyl = Lannate®) also present only minimal hazard to the applicator Fig. 2).

Application Equipment. All insecticides were applied by model J-3 Campbell Mistblower (Fig. 3). The model J-3 was equipped with a 13 HP Wisconsin gasoline engine, a Hypro nylon roller pump and a centrifugal fan producing air velocities and volumes up to 150 mph and 3,527 cu. ft/min., respectively. Effective vertical delivery is over 100 ft. The sprayer was operated at 25 psi and 1/4-to full-throttle depending upon the proximity to target trees, branch density, tree spacing and direction of prevailing wind.

Experimental Design. Ten plots ranging from 0.5 to 1.7 acres in size were

---

1. Designated rates of application are given as active ingredient unless specified otherwise.

established for the experiment. Nine spray treatments and an untreated check area were assigned to these plots by random number. From 90 to more than 1,500 trees were located in each plot of this nonreplicated block design which included both ornamental roadside and plantation trees.

Spray Applications. Treatments were made June 3, 6 and 7, being interrupted during the interim period by inclement weather. At that time, 3rd - to 5th - instar budworm larvae were present and feeding damage was still negligible. All spray mixtures (Table I) were water-based and prepared in 45 gallon lots at a central location (Fig. 4). A two man crew (vehicle operator, spray applicator) and a 3/4-ton pickup truck were utilized in these applications. Each tree was sprayed thoroughly and from opposite directions for optimum coverage whenever possible. Stand openings and roadways were used for access to target trees. Spray was delivered over the tops or through crown openings of trees in several areas where stand density impeded direct access.

Sampling Methods. One 18-inch branch from the mid-crown of each of 10 trees was randomly selected in each plot as the basic sample unit for estimating change in budworm population density. Samples were collected once before (May 30, June 3) and once after (June 13, 14) spray applications. The technique developed by DeBoo, Campbell and Copeman (1972) for processing branch samples and the apparatus (Fig. 5) as modified by Martineau and Benoit (1972) were employed during this operation. Abbott's Formula (1925) was used for adjustment of natural population mortality during the pre- and post-spray period. Both aerial and ground surveys were conducted in August and September for visual estimates of defoliation and general tree vigor.

RESULTS AND DISCUSSION

The results of the mistblower applications indicated that dilute water-based sprays of carbaryl, dimethoate or methomyl will provide excellent protection of spruce foliage. Results were less conclusive with applications of Imidan, Gardona and malathion. A brief discussion of each insecticide treatment and comparisons with conventional rates of application follows herewith.

Carbaryl. Both formulations (Sevin 80S, 50WP) selected for evaluation provided excellent control of the spruce budworm at the rates of 0.5% and 0.2%. The most dramatic effect of these sprays was the almost immediate "knockdown" and cessation of feeding of larvae on treated trees. The rates of application were well below those given as guidelines for mistblower (2-3.5%) and hydraulic sprayer (16-24oz/100 gal.) applications for control of pests on ornamentals. In addition, these rates approximate the federally registered dosage (9.8 fl. oz/ac.) for control of the gypsy moth (Porthetria dispar L.) in forest stands.

Dimethoate. The dilute application of Cygon 4E (i.e. 0.1% = approx. 0.2 lb a.i./ac.) also gave excellent control of the budworm. The rate was equivalent to that amount recommended on the Cygon 4E label for hydraulic sprayer application and did not exceed the federal use level of 8-9.6 oz/ac. for aerial sprays.

Methomyl. Lannate 90WP has been used extensively in western Canada for control of bertha armyworm (Mamestra configurata Walker) at 3-4 oz/ac. The 0.2% solution (= approx. 0.4 lb/ac.) applied at Shawville

Figure 1. Fully-crowned white spruce at the Shawville, P.Q., plantation selected for experimental spray treatments.

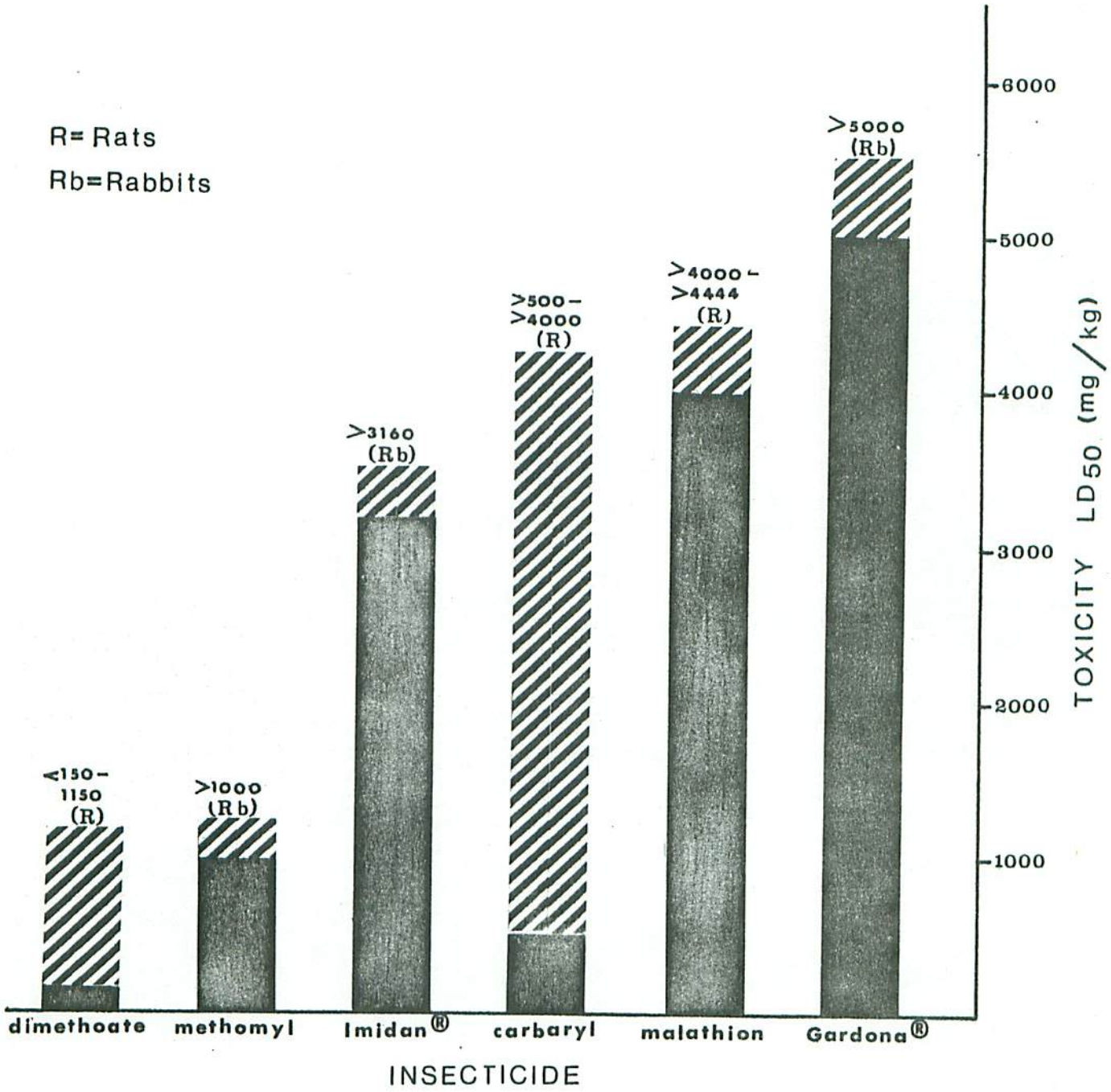

Figure 2. Acute dermal toxicity values of insecticides selected for field experimentation (after Kenaga and Allison 1971). Hatching of bars signifies range of LD_{50} values.

Figure 3. The Campbell J-3 mistblower mounted in a 3/4-ton pickup truck.

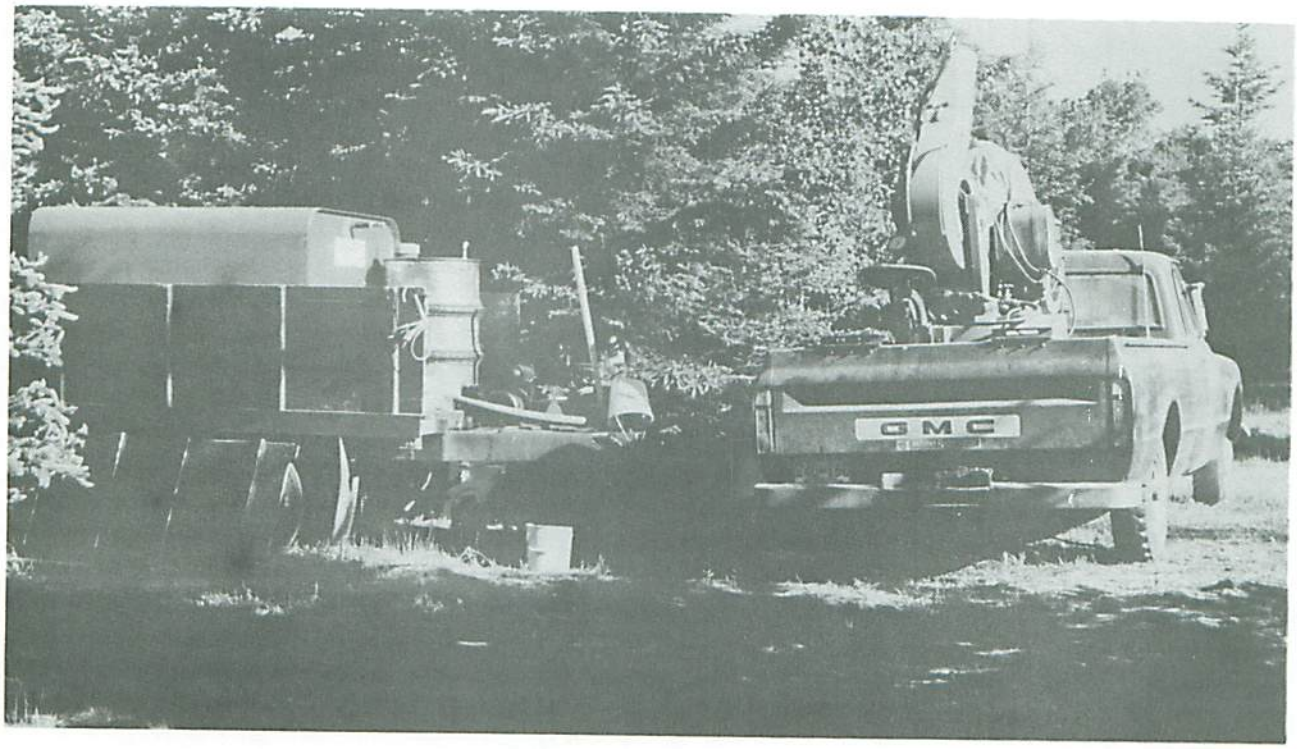

Figure 4. The central spray mixing station which included a 500 gal. capacity water "nurse" tank mounted on a double-axle utility trailer.

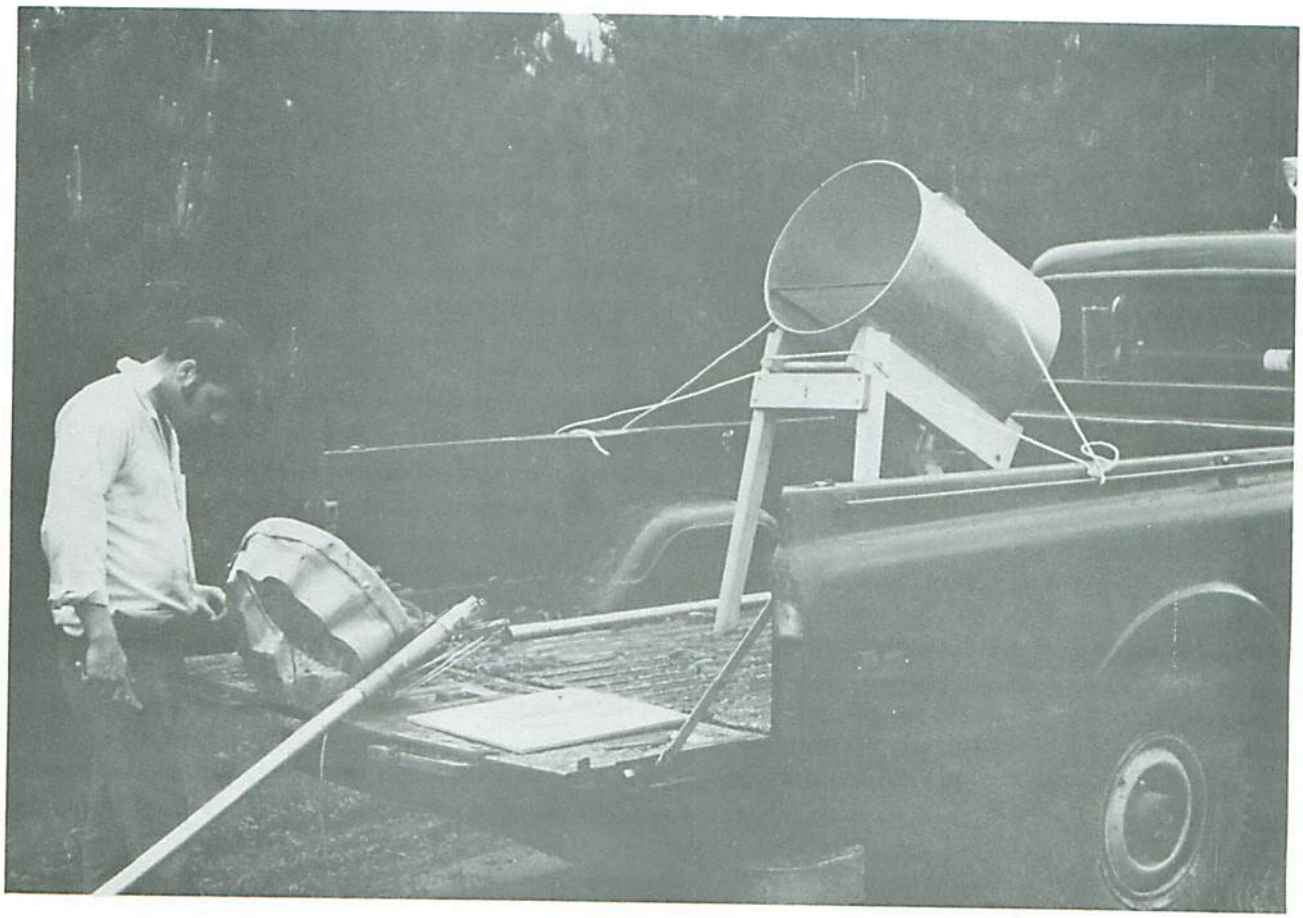

Figure 5. The modified branch sampling apparatus mounted in a pickup truck for obtaining indices of budworm population levels at treatment plots.

gave excellent control of spruce budworm and protection of foliage at this slightly higher rate. It is expected that an even more dilute solution (i.e. 0.1%) at the above agricultural rate of 3-4 oz/ac. would provide equivalent results.

Gardona®. Laboratory spray tower trials by Nigam (1969, 1970) and unpublished data of the U.S. Forest Service on topical application tests have indicated that this insecticide is about as effective as DDT for control of spruce budworm. Results of the mistblower application at 0.5% (approx. 2.2 lb/ac.) verified this information as greater than 80% reduction similar to rates recently evaluated experimentally in Europe and the United States for forest insect control, but exceeded the permissible rate of 1.3 lb/ac. registered for gypsy moth control in the U.S. Gardona has a very low mammalian toxicity, and for this reason might be a good selection for use by the homeowner. Two or more applications at 5- to 7-day intervals, however, most likely would be required to attain the high level of control necessary on ornamentals.

Imidan®. A significant differential in results occurred between the high (0.4%) and low (0.2%) rates of application. The 0.4% concentration was more than twice as effective as the 0.2% spray, and approached that level of control achieved by the Gardona treatment. Imidan has a low mammalian toxicity level and might also be suitable for budworm control in urban areas (at agricultural rates, e.g. 1.25 to 2 lb/ac.).

Malathion. A report on previous applications of malathion for control of jack-pine budworm, Choristoneura pinus pinus Freeman, indicated that this insecticide provided only marginal foliage protection at 1 qt.

Table I

Formulations and Amounts of Insecticides
Used for Control of Spruce Budworm at Shawville, P.Q.

Insecticide	Chemical Designation	Concentrations (% a.i. by vol.)[1]	Approx. amt. a.i. (lb)/ac	Emitted spray mix. (gal)/ac[2]
Carbaryl (Sevin® 80S)	1-naphthyl methylcarbamate	0.5	1.5	25
Carbaryl (Sevin® 50WP)	1-naphthyl methylcarbamate	0.2	0.5	20
Dimethoate (Cygon® 4E)	0,0-dimethyl S-(N-methyl= carbamoylmethyl) phosphoro= dithioate	0.1	0.2	27
Gardona® 75WP	2-chloro-1-(2,4,5-tri= chlorophenyl) vinyl dimethyl phosphate	0.5	2.2	42
Imidan® 50WP	0,0-dimethyl S-phthalimido= methyl phosphorodithioate	(a) 0.4 (b) 0.2	(a) 1.3 (b) 0.8	(a) 20 (b) 46
Malathion 50EC	diethyl mercaptosuccinate, S-ester with 0,0-dimethyl phosphorodithioate	(a) 1.0 (b) 0.5	(a) 4.0 (b) 2.2	(a) 30 (b) 20
Methomyl (Lannate® 90WP)	methyl N- (methylcarbamoyl) oxy thioacetimidate	0.2	0.4	42

[1] Concentration of insecticide (active ingredient) in water.

[2] Variation in volumes due to differences in stand density. Approximately 10 fl. oz. of spray mixture was applied per 25 ft. tree.

Table II

Results of experimental spray applications at Shawville, P.Q. for control of spruce budworm on white spruce

Treatment[1]		Spray Concentration (%)	Av. No. larvae/18" branch		% Population Reduction[2]
			Prespray	Postspray	
I	Carbaryl	0.5	22.1	0.1	99.4
II	Methomyl	0.2	9.6	0.3	96.4
III	Carbaryl	0.2	21.6	1.0	94.7
IV	Dimethoate	0.1	9.9	1.0	88.7
V	Gardona®	0.5	15.0	2.2	83.1
VI	Imidan®	0.4	19.0	3.5	78.8
VII	Malathion	1.0	19.6	5.3	68.9
VIII	Imidan®	0.2	10.6	5.7	38.0
IX	Malathion	0.5	14.2	8.3	32.7
X	Untreated check	-	13.6	11.8	13.3

1 Ranked according to efficacy.

2 Corrected by Abbott's Formula (1925).

57% EC/100 gal. (DeBoo and Hildahl 1972). Similarly, the mistblower applications at 1.0% and 0.5% did not provide satisfactory mortality of spruce budworm. More concentrated sprays or repetitive applications would be required to obtain results similar to those achieved with the aforementioned treatments of carbaryl, methomyl or dimethoate. The registered dosage of 10 to 20 oz/ac. for shade tree and ornamental pests is below either of the amounts evaluated (i.e. 4.0 and 2.2 lb/ac.), and consequently must be considered questionable for use in budworm control even with high volume hydraulic sprayers.

Results of previous evaluations (DeBoo and Hildahl 1972) have shown that excellent protection of foliage can be achieved with a variety of ground spray equipment. The choice of equipment will depend upon the nature of the stand and the terrain to be traversed. Obviously, when stocking, height and/or acreage limit the practicability of ground sprayers, aerial applications should be considered. Ground equipment, however, should be given priority wherever small, high-value and accessible stands are threatened due to the better spray coverage and resultant higher insect mortality.

A combination of aerial and ground spraying may be feasible under certain conditions also. For example, the recent severe spruce budworm infestation at the Spruce Woods Provincial Park in Manitoba might warrant this treatment. This unique area contains several thousand acres of white spruce (Fig. 6) similar to those at Shawville, but twice the size. Trees in high use areas such as in campgrounds and along riding trails could easily be treated with ground sprays for optimum protection, whereas the

survival of trees in the remaining sections of the park could be ensured through low-dosage aerial applications of an insecticide such as fenitrothion.

Several other insecticides (e.g. aminocarb, arprocarb, fenitrothion, phosphamidon, trichlorphon) have been applied experimentally by ground sprayers at low dosages and are known to be highly effective in the protection of foliage from budworm attack (DeBoo and Hildahl 1972). Most of these insecticides, and those evaluated during 1972, are used extensively in agricultural spraying and several have extensive registered use in the control of insects on ornamental trees and shrubs. Several also have been applied successfully by aircraft in large scale experimental and operational programs in both Canada and the United States for control of spruce budworm, gypsy moth and other forest pests. It follows that, after appropriate reviews of use patterns and toxicological information pertaining to hazard (e.g. to fish, birds and other life forms), these insecticides should be considered for federal registration and small scale use as outlined in this report. The current registration of only one insecticide for control of the spruce budworm by ground application is inadequate to satisfy the various and diverse requirements across Canada.

SUMMARY AND CONCLUSIONS

1. Results of applications of dilute solutions of carbaryl, dimethoate and methomyl by mistblower provided excellent control of spruce budworm and protection of foliage on white spruce. Applications of Gardona and Imidan also induced high budworm mortality, but higher dosages were required. Malathion gave poor results at the dosage evaluated.

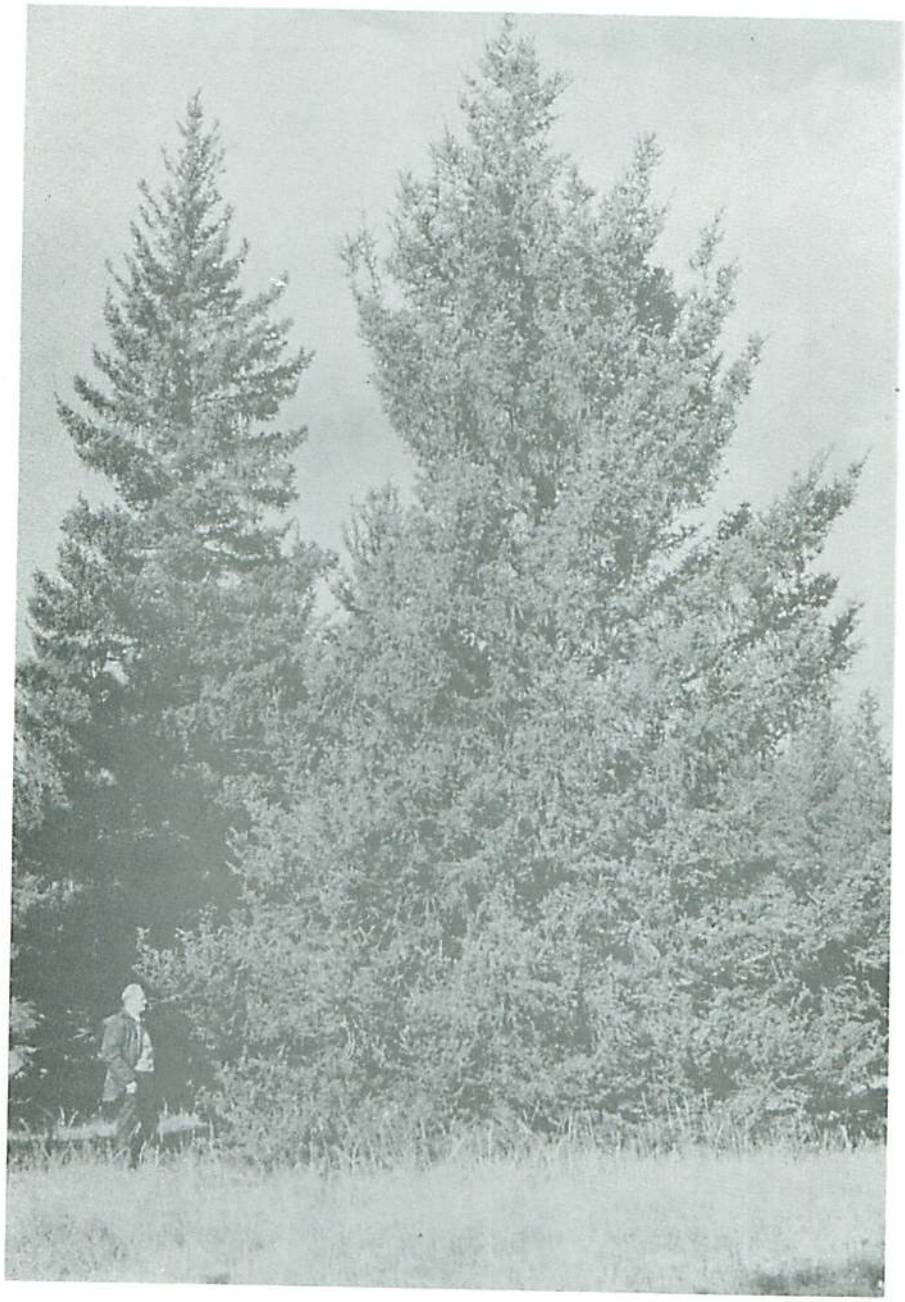

Figure 6. Large, fully-crowned white spruce threatened by spruce budworm attack in the Spruce Woods Provincial Park, Manitoba.

2. The model J-3 Campbell mistblower used for these applications operated efficiently and provided excellent spray coverage to the foliage of heavy branched trees at approximately one-fifth the spray mixture volume required for conventional high pressure hydraulic sprayers.
3. It is suggested that several of these non-persistant and low hazard insecticides be considered for federal registration to allow recommendation by pest control extension officers to concerned tree growers and foresters.

ACKNOWLEDGEMENTS

We wish to extend our thanks to Mr. George Eades for permission to conduct the spray evaluations at his Tree Farm, to Cyanamid of Canada, Ltd., DuPont Canada Ltd., Shell Canada, Ltd., Stauffer Chemical Co., and Union Carbide Canada, Ltd., for quantities of insecticides, and to Dr. P.C. Nigam and Mr. W.W. Hopewell of the Chemical Control Research Institute for their advice and comments in the review of the manuscript.

LITERATURE CITED

Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. Jour. Econ. Ent. 18: 265-267.

Chemical Control Research Institute. 1972. Compendium on pesticides for use in Canada - 1971 - for forests, trees, shrubs, and ornamentals. Department of Environment, Can. For. Serv. Inf. Rept. cc-x-19, 129 pp.

DeBoo, R.F., L.M. Campbell and A.G. Copeman. 1973. A sampling technique for estimating numerical trends in larvae populations of insect defoliators on conifers. I. Development and experimental evaluation of the technique. Phytoprotection 54: In Press.

DeBoo, R.F., and V. Hildahl. 1972. Chemical control of the jack-pine and spruce budworms with ground application equipment in Manitoba. Man. Ent. 5: 57-67.

Kenaga, E.E., and W.E. Allison. 1971. Commercial and experimental organic insecticides. Bul. Ent. Soc. Amer. 15: 85-148 (Revision).

Martineau, R., and P. Benoit. 1973. A sampling technique for estimating numerical trends in larval populations of insect defoliators on conifers. II. Modification and operational use of the technique for extensive sampling of spruce budworm populations in Quebec. Phytoprotection 54: In Press.

Nigam, P.C. 1969. Laboratory evaluation of insecticides against fifth-instar spruce budworm larvae, Choristoneura fumiferana (Clem.) in 1969. Dept. Fish. and For., Can. For. Serv. Inf. Rept. cc-x-2, 35 pp.

Nigam, P.C. 1970. Summary of laboratory evaluation of insecticides against forest insect pests during 1970. Dept. Fish. and For., Can. For. Serv. Inf. Rept. cc-x-5, 10 pp.