PRELIMINARY FIELD EVALUATION OF PHOXIM AND ORTHENE® AGAINST SPRUCE BUDWORM ON INDIVIDUAL TREES APPLIED AS SIMULATED AIRCRAFT SPRAY

PROJECT CC-2-006

by

P.C. Nigam and W.W. Hopewell

Chemical Control Research Institute

Ottawa Ontario

Information Report CC-X-60

Canadian Forestry Service

Department of Environment

December 1973

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INTRODUCTION

Phoxim and Orthene ® have been tested in the laboratory as candidate insecticides against forest insect pests since 1969 (Nigam 1969 a&b, 1970, 1971 a,b&c, 1972 a&b, Lyon 1972, 1973). Phoxim is very effective against lepidopterous larvae (Nigam 1969a, 1971c, Robertson et al 1973 a&b). It is approximately 2.5 times more toxic to fifth instar spruce budworm[1] larvae than fenitrothion as a contact insecticide (Nigam 1969a, 1971c). The mammalian and fish toxicity of phoxim is low and it appears to be less hazardous than fenitrothion in this respect (Nigam 1970 and 1971c). Orthene also has shown high toxicity against spruce budworm (Nigam 1972b) and has low mammalian, bird and fish toxicity (Chevron 1973). It is also a systemic insecticide (Lyon 1973), which may be an added advantage over a contact insecticide.

This report gives the results of tests in which phoxim and Orthene were applied as simulated aircraft sprays to individual small spruce trees carrying a natural infestation of spruce budworm larvae.

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1 *Choristoneura fumiferana* (Clem.). Lepidoptera: Tortricidae

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RÉSUMÉ

Les insecticides phoxime et Orthene ® se sont révélés aussi efficaces que le fénitrothion pour lutter contre les larves de tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* Clem. En simulant une pulvérisation aérienne, on en a appliqué différents mélanges, individuellement, sur de petites épinettes blanches, *Picea glauca* (Moench) Voss, croissant en plantation et modérément attaquée par la tordeuse des bourgeons. D'après les résultats de la présente recherche et de travaux faits précédemment en laboratoire, il y aurait lieu de faire en 1974 des essais de pulvérisation aérienne d'Orthène ® contre la tordeuse des bourgeons de l'épinette.

ABSTRACT

The insecticides, phoxim and Orthene ®, showed activity equal to fenitrothion for control of spruce budworm larvae, *Choristoneura fumiferana* (Clem.). The formulations were applied as simulated aerial spray deposits to individual small white spruce trees, *Picea glauca* (Moench) Voss, growing in a plantation and carrying a moderate infestation of budworm. Orthene ® is recommended for aerial spray trials against spruce budworm in 1974 on the basis of the present investigation and previous laboratory findings.

Fenitrothion formulations applied in the same way were used as the standard insecticide for comparison.

MATERIALS AND METHODS

1. Spruce plantation and spruce budworm infestation

The work was carried out on a tree farm near Shawville, Quebec, on which a variety of species have been planted over the past 20 years. The trees selected for the tests were within an area of approximately one acre in a stand of white spruce, *Picea glauca*, (Moench) Voss, ranging in height from 5 to 25 feet. Infestation on these young trees was generally moderate; nearby mature trees supported a heavy infestation.

Trees were selected on the basis of size (8 to 10 feet) and proximity of other trees (to keep to a minimum the amount of trimming of adjacent trees necessary for working space around test trees). The branches of these trees were then examined visually for budworm infestation and, if judged satisfactory, four branches were tagged on each tree 5 to 6 feet above ground level, one from each quadrant. The tagged branches were examined visually, with care not to disturb the larvae, for an approximate count of the visible larvae (Table I). At the time of the tests, most larvae were in fifth and sixth instar (L_5 and L_6).

TABLE I

Total Budworm Larvae Observed on the 4 Tagged Branches of each Tree during Prespray Tree Selection (6 June '73)

Tree No.	Total Larvae	Tree No.	Total Larvae
1	22	9	16
2	37	10	26
3	16	11	15
4	19	12	19
5	11	13	25
6	31	14	23
7	18	15	19

2. Insecticides and their Formulations

Three organophosphorus insecticides, phoxim, (phenylglyoxylonitrile oxime 0,0-diethyl phosphorothioate), Orthene® (0,S-dimethyl acetylphosphoramidothioate), and fenitrothion (0,0-dimethyl 0-(4 nitro-m-tolyl) phosphorothioate) were used in this study. Fenitrothion field formulations with and without Atplus® 526 spreader-sticker were used. Fenitrothion emulsifiable concentrate as used by Forest Protection Limited (FPL) in large scale operational control of spruce budworm was used as a standard for comparative study with the new fenitrothion formulation and the other candidate insecticides. The details of the insecticide and their source are as follows:

(i) Phoxim: supplied under the trade name Volaxon® by Chemagro Division of Baychem Corporation, Research and Development, Box 4913, Kansas City, Missouri, 64120 in 1972. The concentration of active ingredient (AI) in the emulsifiable concentrate was 47% or 4 lb.

Volaxon active per U.S. gallon.

(ii) Orthene: supplied as technical grade with 97.6% active ingredient (AI) by Chevron Chemical Company, Research Laboratories, Richmond, California, in 1972. The identification codes of the samples were S.P. #2217 and PP-61B. Orthene is soluble in water, so no emulsifying agent or solvent was used in its formulation.

(iii) Fenitrothion: Forest Protection Ltd., (FPL) field formulation was prepared from premium grade Sumithion containing 98.7% active ingredient, supplied by Sumitomo Chemical Co. Limited, Osaka, Japan in 1972. lot No. 993. The FPL formulation was prepared as 80% AI fenitrothion EC by mixing 81 % Sumithion, 9% Atlox 3409 and 10% Texaco Arotex 3470. Atplus® 526 supplied by Atlas Chemical Industries Inc., Wilmington, Delaware 19899, U.S.A., was added at the rate of 0.6% by weight.

All insecticide preparations were diluted to 10% active ingredient (Wt/vol) for use with distilled water containing 0.1% Rhodamine B dye as a tracer. The final spray preparations used in this study were:

A. Orthene 10% - water solution

B. Fenitrothion 10% - water emulsion

C. Fenitrothion 10% + 526 - water emulsion

D. Phoxim 10% - water emulsion

3. Application of Insecticide

The spray solutions were applied to individual trees as a simulated aircraft spray by use of an apparatus and procedure developed by the junior author *. A portable shelter 8 feet in height, and surrounding an area 7 x 7 feet was erected around the tree to be treated. A measured 1.75 ml of the insecticide solution was then emitted from the spinning disc device while it was moved systematically over the enclosed area during the 90 second emission time, (Fig. 1). This is a nominal application rate of 52 fl. oz/acre (5.2 oz AI/acre using 10% solution). The trees were treated on 7 June 1973 from 10:00 to 15:00 hrs. The weather was warm and sunny with windspeed above optimum at times in the afternoon, which caused uneven distribution on some trees. Treatments were replicated on 3 trees and every fourth tree left as an untreated check.

4. Spray deposit sampling and assessment

Samples of spray deposit were taken at two positions (A & B) during application, on opposite sides of the tree, approximately 2 feet from the tree stem. The sample units, a petri dish for colorimetric assessment of deposit density and a Kromekote card for droplet count and sizing were mounted on staked holders 4 feet above ground level and clear of overshadowing foliage. The samples were returned to the laboratory for processing. Volume (fl. oz/acre) and number of drops/cm^2 were derived from a count and sizing of drop stains on the Kromekote samples.

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* Hopewell, W.W. - A device and technique for applying measured amounts of simulated aircraft spray to individual small trees. (ms in preparation).

The postspray observations for assessment of effects of spray treatments were made 5 days after treatment. Each branch was clipped offand the larvae and pupae separated from the foliage by use of the apparatus and techniques described by DeBoo et al (1973) and Martin and Benoit (1973), (Fig. 2). Number of larvae in each instar were counted and recorded.

Comparison of the effects of the different treatments was made on the basis of the total number of surviving budworm on the tagged branches (12 per treatment), as compared with that on check trees. Since the average number of visible larvae per tree on the treated trees at time of selection was at least as great as that on check trees it is safe to assume that population density was approximately equal on each group of 3 trees at time of treatment.

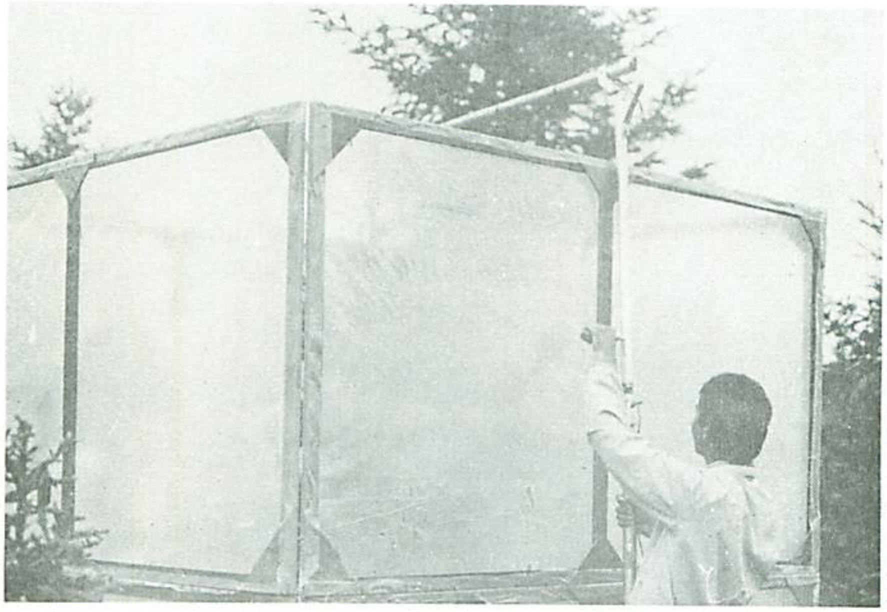

Fig. 1. Applying simulated aerial spray

Fig. 2. Separating budworm from branch sample foliage.

RESULTS AND DISCUSSION

The count of the total number of surviving budworm on the tagged branches of test trees 5 days postspray are given in Table II along with the percent budworm control for each treatment as indicated by these data. The percent control (mortality of budworm) was determined by the reduction in total budworm on each group of treated trees as compared with that on untreated check trees. Both phoxim and Orthene appear to surpass the fenitrothion formulations in activity to control the budworm, since all were applied at the same rates and in the same manner. However, some qualification must be made here when actual spray deposit, as recorded on Kromekote card samples, on the various trees is considered (Table III). It is seen that for some reason, possibly weather conditions at the time, the average deposits of phoxim and Orthene were somewhat higher both in fl. oz/acre and number of drops per cm^2 than for both fenitrothion treatments. This is especially the case in treatment 'C' where deposit was light on one side of each of the 3 trees. This accounts for the lower mortality in this treatment than for fenitrothion without Atplus 526. It is considered probable that with equal deposits in all tests that Orthene and phoxim would have shown at least equal effectiveness to fenitrothion. It is clear that the total numbers of larvae in the phoxim and Orthene treatments were significantly reduced as compared with check trees.

At time of postspray count all surviving budworm were classified as to larval stage and pupae. These data have been summarized to show the distribution of budworm development as percent 4th and 5th

TABLE II

Total Budworm on 4 Tagged Branches 5 Days Postspray (11 June '73)

Treatment	Tree No.		No. of budworm	Indicated Mortality (%)
A. Orthene	1		9	
	2		12	
	3		2	
		Total	23	76
B. Fenitrothion	5		11	
	6		12	
	7		15	
		Total	38	60
C. Fenitrothion + 526	9		9	
	10		22	
	11		14	
		Total	45	53
D. Phoxim	13		5	
	14		13	
	15		4	
		Total	22	77
Checks	4		12	
	8		47	
	12		37	
		Total	96	0

TABLE III

Spray Deposit Volume Rate and Drop Density from Samples taken during Application

		Fl. oz/acre			Drops/cm^2		
Treatment	Tree	A	B	Avg.	A	B	Avg.
A. Orthene	1	51	46	48	25	26	26
	2	26	42	34	12	19	15
	3	42	43	42	24	19	22
			mean	41		mean	21
B. Fenitrothion	5	27	12	20	19	9	14
	6	49	12	30	21	11	16
	7	20	28	24	14	12	13
			mean	25		mean	14
C. Fenitrothion + 526	9	6	24	15	10	26	18
	10	1	22	11	2	16	9
	11	44	7	26	28	8	18
			mean	17		mean	15
D. Phoxim	13	37	88	62	13	41	27
	14	36	23	30	12	17	15
	15	39	10	25	28	5	16
			mean	39		mean	19

instar ($L_4 + L_5$), L_6 and pupae. The distribution of budworm development on check trees was about equal above and below L_6, i.e., 16 and 19% respectively, with 65% L_6 (Table IV). In the Orthene treated group it appears that growth was retarded (or later stages killed off) as there were no budworm present in pupal stage and an increased proportion in L_4 and L_5 as compared with distribution on check trees.

TABLE IV

Distribution of Surviving Budworm Development Stages on Treated and Check Trees 5 Days Postspray (total from each group)

Treatment	Total Number Living Budworm	Percent in Stage		
		$L_4 + L_5$	L_6	Pupae
A. Orthene	23	30	70	0
B. Fenitrothion	38	16	66	18
C. Fenitrothion + 526	45	7	75	18
D. Phoxim	23	26	61	13
Checks	96	19	65	16

SUMMARY AND CONCLUSIONS

Orthene and phoxim appear at least equal in activity to fenitrothion for control of spruce budworm on white spruce. Orthene seems to be highly active against later stages of the budworm as shown by a decrease from 16% pupae in the check population to no pupae in the Orthene-treated population 5 days postspray.

Of the two compounds, Orthene appears at present to have the greater potential for operational use and it is therefore recommended for aerial spray trials against budworm in 1974 on the basis of the following:

(a) Good results in these simulated aerial spray tests for control of budworm.

(b) Lower toxicity than fenitrothion to mammals, birds and fish.

(c) Systemic activity.

(d) Available commercially for large scale use.

(e) Registered by USDA for home and garden use.

ACKNOWLEDGEMENTS

Thanks are extended to Mr. Geo. Eades who kindly invited us to carry out the work on his tree farm near Shawville, Que., and allowed full use of its facilities. The assessment of the Kromekote samples was done by Messrs. W. Haliburton and G. Lafrance. The technical assistance of Messrs. Keith Bertrim and Michael Hobbs is also appreciated. Mr. C.S. Goche, of Atlas Chemical Industries Ltd., Montreal, also assisted during spray application.

REFERENCES

Chevron Chemical Co., 1973. - Orthene Technical Information.

DeBoo, R.F., L.M. Campbell, and A.G. Copeman. 1973. A sampling technique for estimating numerical trends in larval populations of insect defoliators on conifers. Phytoprotection 54: 9-22.

LaHue, D.W., and E.B. Dicke. 1971. Phoxim as an insect protectant for stored grains. J. Econ. Entomol. 64: 1530-1533.

Lyon, R.L. 1972. Reports from Project PSW-2203. USDA, For. Serv., Pacific South W. For. Range Exp. Sta.

Lyon, R.L. 1973. Reports from the insecticide evaluation Project PSW-2203. USDA, For. Serv., Pacific South W. For. Range Exp. Sta.

Martineau, R., and P. Benoit. 1973. A sampling technique for estimating numerical trends in larval populations of insect defoliators on conifers. Part II. Phytoprotection 54: 23-31.

Nigam, P.C. 1969a. Laboratory evaluation of insecticides against fifth instar spruce budworm larvae, *Choristoneura fumiferana* (Clem.) in 1969. Can. Dept. Fish. and For., Can. For. Ser., Information Report CC-X-2, 35 pp.

Nigam, P.C. 1969b. Summary of laboratory evaluation of insecticides against various species of forest insect pests - 1969. Can.

Dept. Fish. and For., Can. For. Ser., Information Report CC-X-3, 9 p.

Nigam, P.C. 1970. Summary of laboratory evaluation of insecticides against forest insect pests during 1970. Can. Dept. Fish. and For., Can. For. Ser., Information Report CC-X-5, 10 pp.

Nigam, P.C. 1971a. Comparative contact toxicity of insecticides against fourth instar red-backed pine sawfly larvae, Neodiprion lecontei (Fitch). Can. Dept. Environ., Can. For. Ser., Information Report CC-X-7, 59 p.

Nigam, P.C. 1971b. Summary of laboratory evaluation of insecticides against forest insect pests during 1971. Can. Dept. Environ., Can. For. Ser., Information Report CC-X-12, 14 p.

Nigam, P.C. 1971c. Insecticide evaluation for aerial application against forest insect pests. Proc. of Seventh Northeast Aerial Applicators, Conf., Cornell Univ., Ithaca, N.Y., pp. 131-143.

Nigam, P.C. 1972c. Contact toxicity of insecticides against white-pine weevil, Pissodes strobi (Peck), Can. Dept. Environ., Can. For. Ser., Information Report CC-X-17, 38 p.

Nigam, P.C. 1972b. Summary of contact and residual toxicity studies of insecticides against forest insect pests during 1972. Can. Dept. Environ., Can. For. Ser., Information Report CC-X-27, 9 p.

Robertson, J.L., and R.L. Lyon. 1973a. Elm spanworm: Contact toxicity of ten insecticides applied to larvae. J. Econ. Entomol. 66: 627-628.

Robertson, J.L., R.L. Lyon, F.L. Shon, and N.L. Gillette. 1939b. Contact toxicity of twenty insecticides applied to _Symmerista canicosta._ J. Econ. Entomol. _65_: 1560-1562.