Environment Canada | Environnement Canada
Forestry Service | Service des Forêts

PERMETHRIN FOR CONTROL OF SPRUCE BUDWORM: EXPERIMENTAL APPLICATIONS BY MISTBLOWER IN QUEBEC, 1975-1977

by

R. F. DeBoo

File Report No. 82 November, 1977.

Forest Pest Management Institute, Ottawa, Ontario
(Formerly Chemical Control Research Institute)

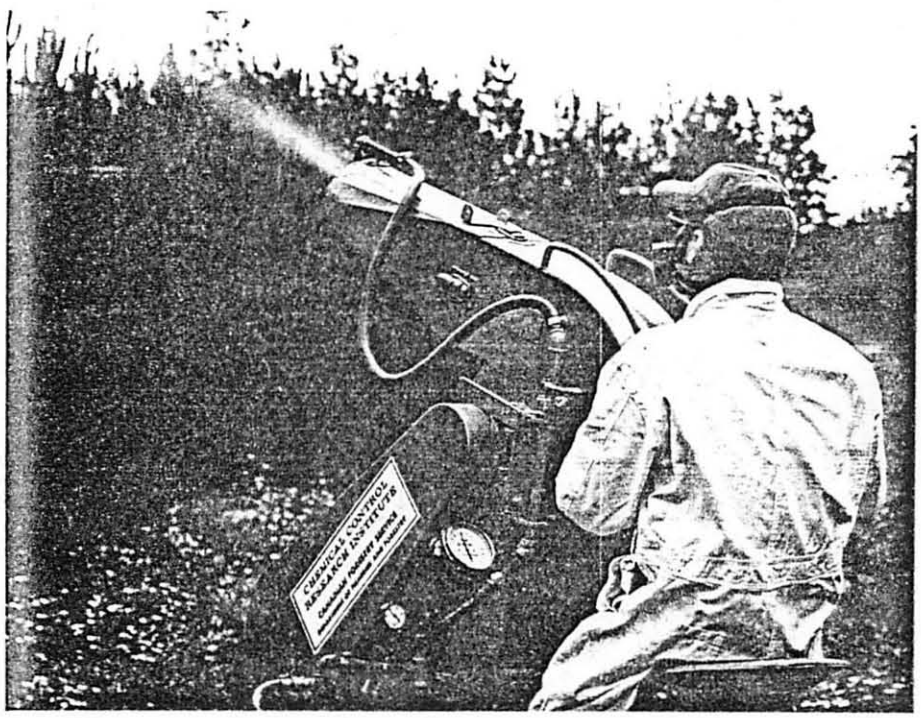

TABLE OF CONTENTS

INTRODUCTION

Application of insecticides by mistblower have been an important component of recent field experimentation for the development of groundspray methods suitable for commercial use in control operations against *Choristoneura fumiferana* (DeBoo and Campbell 1972, 1974 a, 1974 b). Also, mistblower studies have provided an opportunity to acquire preliminary data on the efficacy of selected dosages of insecticides prior to more expensive and intensive experimentation utilizing small spray aircraft (Armstrong and Nigam 1975, DeBoo 1975, Morris *et al.* 1977).

The synthetic pyrethroid permethrin (NRDC-143, FMC 33297) is one of several insecticides which has been given considerable attention by staff of this Institute since 1975. Nigam (1975, 1976) has reported on laboratory toxicological studies, Hopewell (1975, 1977) has conducted simulated aerial sprays on young trees, and results of small-scale aerial spray trials have been reported by Armstrong (1976) and DeBoo (1976, 1977).

This report summarizes results of those companion studies undertaken from 1975 to 1977 on the efficacy of permethrin when applied as dilute aqueous emulsion by mistblower. The report is intended primarily as a progress statement for the consideration of resource managers and regulatory authorities concerned with pesticides and outbreak populations of the spruce budworm.

In keeping with policies of the Canadian Forestry Services and the Forest Pest Management Institute, mention of trade names and proprietary products implies neither endorsement nor recommendation for operational use.

MATERIALS AND METHODS

Research Areas. Accessible portions of white spruce (*Picea glauca*) plantations near Grand' Mère, Quebec, were selected for treatment during 1975 and 1976. Trees designated for spray treatment were 6 to 15 m in height and located along roadways and hydro line rights-of-way. Foliage on these trees was dense in most cases and with living crown extending downwards to ground level.

A private estate located near Ste.Anne des Monts in the Gaspé Peninsula of Quebec was selected for experimentation during 1977. Trees at this location were 6 to 10 m tall balsam firs (*Abies balsamea*) with crowns extending from one-half to two-thirds of their total height. The natural stand had been thinned for aesthetic purposes and access to trees was by irregular passage over the lawn area surrounding the proprietor's home.

Spruce Budworm Population Densities. Moderate to severe outbreaks of the spruce budworm have been recorded at the Grand' Mère Plantations since 1968 (Gagnon 1972, DeBoo 1975). Peripheral trees in the plantation blocks sustained population densities of ca. 40-100 fourth-instar (L_4) larvae per 45 cm branch tip during 1974 and 1975. Defoliation of current year's shoots during each of these years was about 70%. The population declined to 10-20 larvae/45 cm branch during 1976 due mainly to starvation of L_3-L_5 larvae the preceeding year.

Trees at the Ste.Anne des Monts experimental site had suffered serious defoliation (ca. 60%) for the first time in recent years during 1976. Population densities of L_2 and L_3 larvae during 1977 averaged about 60/45 cm branch tip indicating high potential for continued severe defoliation.

The Insecticide Permethrin. Several new synthetic pyrethroid insecticides are known to be extremely effective in controlling a wide variety of pests (Badar 1976; Elliott *et al.* 1973 a,b , Embree and Estabrooks 1977; Hasting and Jones 1976; Robertson *et al.* 1976; Sharma *et al.* 1977). The major advantages of these new chemicals are increased residual toxicity and photostability when compared with natural pyrethrins and earlier synthetics introduced for field experimentation ca. 10-15 years ago (Barlow and Hadaway 1975). Permethrin (phenoxybenzyl(±)-*cis,trans*-2,2-dimethyl-3-(2,2-dichlorovinyl)cyclopropanecarboxylate) is a broad spectrum insecticide representative of this new group.

Recent laboratory toxicological studides by Robertson *et al.* (1976) have indicated that permethrin (NRDC-143) and other pyrethroids may be from 5-30 times more effective for control of western spruce budworm (*c. occidentalis*) than fenitrothion. Similar observations have been made by staff of this Institute during preliminary studies on control of the eastern spruce budworm using quantities of permethrin supplied by industrial sources.

Technical data from the Agricultural Chemical Division of FMC Corporation and Chipman Chemicals Ltd. indicated permethrin to have low mammalian toxicity characteristic of natural pyrethrins:

Acute Oral Toxicity - Technical Material	LD_{50} - mg/kg
Rat	>4000
Mouse	>4000
Guinea Pig	>4000
Rabbit	>4000
Acute Dermal Toxicity	
Rat	>4000
Rabbit	>2000

Permethrin has low toxicity to birds: The acute oral LD_{50} for mallard duck, pheasant, and Japanese quail are greater than 23,000, 23,000, and 13,500 mg/kg, respectively. Fish toxicities (48-hour tests) range from 1.8 (bluegill sunfish) to 38.5 µg (mirror carp) technical permethrin/ℓ. Figures for salmon and trout range from 1.8-18.5 µg/ℓ. Recent studies by Kingsbury (1976, 1977) indicate that the major environmental impact of concern for forest aerial spray application may be to aquatic ecosystems, particularly to the quantity and quality of aquatic invertebrates which serve as fish food.

Quantities of permethrin for field experimentation were supplied by Chipman Chemicals Ltd. (NRDC-143) and FMC Canada Ltd. (FMC 33297). Formulations used were:

1975 - NRDC-143, 25% emulsifiable concentrate
- FMC 33297, 40% " "

1976 - NRDC-143, 50% " "
- FMC 33297, 40% " "

1977 - NRDC-143, 50% " "

Dosages selected for evaluation ranged from 0.1 oz AI/acre (7 g AI/hectare) to 1.0 oz AI/acre (70 g AI/hectare) based on information provided by Nigam (1975, 1976), Hopewell (1975, 1977) and representatives of the suppliers. Aqueous spray volumes at ca. 10-25 U.S. gal total mixture/acre (94-234 ℓ/ha) were derived from pervious experience (DeBoo and Campbell 1972, 1974b) and from calibration trials conducted prior to each series of spray applications. Chevron Spray Sticker^{R} was the only adjuvant added to each of the spray mixtures. For all practical purposes of these studies, the FMC formulation was considered identical to the products supplied by Chipman Chemicals.

Application Equipment. Sprays during 1975 were applied by a trailer-mounted Campbell J3 mistblower (title page); an FMC Rotomist model 100 HT (Fig. 1) was used for all applications during 1976 and 1977. Brief descriptions of the mechanical components and operational procedures are given by DeBoo and Campbell (1972, 1974b) and in the Appendix section of this report.

Experimental Design. Treatment blocks at the Grand' Mère Plantations were aligned randomly along roadways and hydro rights-of-way. Effective penetration of spray droplets (width of blocks) was calculated at 1 chain (66 feet, ca. 20 meters). Linear travel of the sprayers along borders of plantations (length of blocks) ranged from 4 chains (264 ft., 80.5 m) to 20 chains (1320 ft., 402 m). Areas treated, then, ranged from 0.4 acres (0.16 hectares) to 2.0 acres (0.81 hectares) based on measurements of the distances travelled by the mistblowers and the effective spray droplet penetration.

Similar blocks were established at the Ste.Anne des Monts estate but with irregular boundaries due to the absence of suitable roads. Blocks were calculated at 2 and 2.5 acres (0.81, 1.01 ha) based on measurements of the distance travelled by the mistblower.

Representative untreated check blocks of equivalent size were reserved for comparative purposes during each series of spray applications. A total of 22 experimental forest blocks were established accordingly over the three-year period: 5 treatments, 1 untreated check area in 1975; 12 treatments, 1 check during 1976, and 2 treatments, 1 check during 1977.

Dosages ranging from 0.1 oz AI/ac (7 g AI/ha) to 1.0 oz AI/ac (70 g AI/ha) were selected for evaluation from 1975 to 1977. Replication

of several dosages (notably 0.125, 0.25, 0.50, 1.00 oz AI/ac) were accomplished during this time for the variety of infestation levels and host tree condition encountered in the selected treatment blocks.

Spray Applications. Spray mixtures (permethrin, sticker, water) were prepared immediately before each application. All sprays were thoroughly premixed with subsequent agitation through the by-pass system of each mistblower. Sprays to individual trees were carefully applied by a two-man crew (mistblower operator, vehicle driver) along the preselected route near each spray block. Rate of travel was 1 mile/hour (0.6 km/hr) or less, depending upon tree heights, density of foliage and distance from the sprayer to the base of target trees (usually 10-20 ft or 3-6 m). Most applications were completed within a 10-20 minute timespan.

Weather conditions during all applications were recorded with available meteorological equipment. In most cases, temperature, relative humidity, wind speed, and estimates of sky condition (clear, overcast) were tabulated. Sprays were not applied when trees were wet, when rain threatened, or when winds were in excess of 8 miles/hr (13 km/hr).

Timing of applications was primarily for the peak occurence of L_4 larvae with the exception of an early spray series during 1976 when larvae were approximately 60% L_2 and 40% L_3.

Treatment Assessment Methods. Larval population densities of the spruce budworm were sampled once before treatment and twice afterwards in each experimental block. Two 45-cm branch tips were clipped randomly by pole pruner from the mid-crown zone of each of from 3 to 5 trees at each

location during each sampling exercise. Population decline trends were then calculated using Abbott's Formula (1925) to account for natural mortality during the prespray to final postspray sample period.

Defoliation of new branch shoots was estimated after the completion of the larval feeding period using the method developed by Fettes (1951).

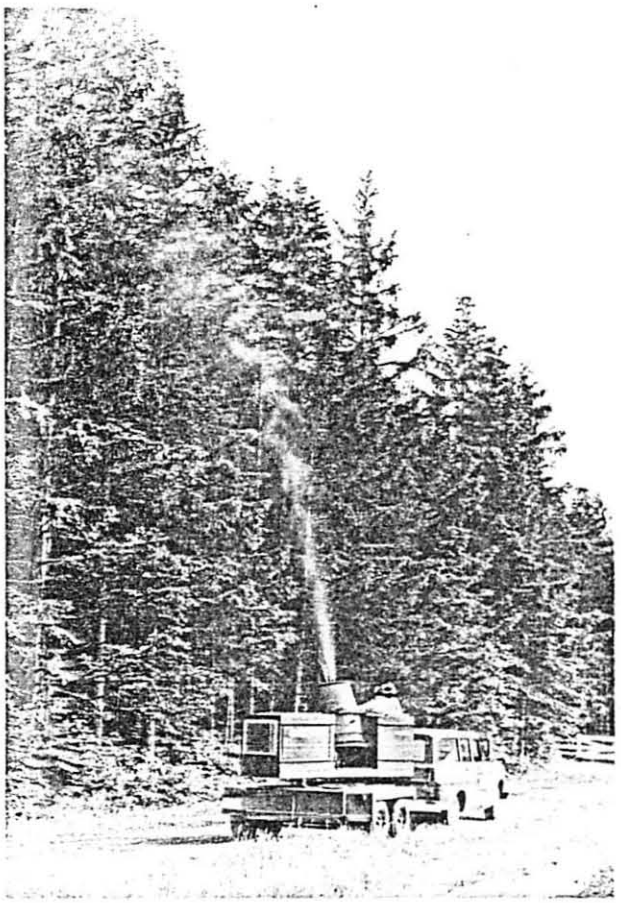

Figure 2. The FMC Rotomist 100HT in use at the Grand' Mère Plantations.

RESULTS AND DISCUSSION

Results of all mistblower applications during the period 1975-1977 have been summarized in Table 1 and in the appendix section of this report. Calculations of population reduction for each treatment clearly indicated the effectiveness of permethrin for control of spruce budworm larvae. The most dramatic effect was the great reduction in larval densities when sampled 1 to 5 days after treatment. Surviving larvae one to two weeks after treatment usually numbered fewer than 10 per 45-cm branch sample. Survivors were most probably located where accuracy of spray application was inferior.

The light infestation levels which occurred at Grand' Mère during 1976 were considered minimal for purposes of experimentation. Initially, branch samples collected about one week prior to treatment date indicated population densities of ca. 20 L_2 per 45-cm branch (moderate infestation level), but at spray time larval averages had declined to only about half this figure (light infestation). However, the 1976 series of treatments, with some exceptions, support the results of similar treatments during other years.

Applications timed near the peak occurrence of the fourth larval instar were more effective than those sprays applied earlier (vs. L_2, L_3). Dosages in the range of 0.25 to 0.50 oz AI/acre (17 - 35 g AI/ha) provided very acceptable levels of population mortality and foliage protection. Applications at 1.0 oz AI/acre (70 g AI/ha) were most effective; results of applications below 0.25 oz AI/ac. indicated that carefully applied sprays at very low concentrations (dilutions to ca. 40 ppm = 0.1 oz AI/ 20 U.S. gal water) may also be effective for mistblower operations against the spruce budworm but further experimentation would be recommended for

purposes of verification.

Estimates of foliage protection from branch samples and visual appraisals of tree crowns after completion of the larval feeding period verified the efficacy of permethrin for control of spruce budworm. Defoliation of treated trees harbouring severe populations of the budworm (ca. 40-100 or more larvae/45 cm branch tip) was usually 20% or less. Compared to the range of defoliation of untreated check trees (50-100%), all treatments was considered very effective for the protection of foliage on new branch shoots. Fluctuations in protection levels between trees in any one series of treatments was most likely due to differences in spray droplet coverage, particularly for treatments at 0.25 oz AI/ac (17 g AI/ha) and above.

Table I. Summary of results of applications of permethrin by mistblower for control of spruce budworm 1975 - 1977

Formulation	oz AI/ac	Year	Larval Stadia	Avg. No. Larvae/~~18~~ 45 cm in branch			Corr. % Pop. Reduction[1]	% Defoliation[2]
				Prespray	1-5 days Postspray	6-15 days Postspray		
NRDC 143	0.10	1975	L_4	56	10	16	65	26
NRDC 143	0.125	1976	L_2, L_3	6	7	-	0	-
NRDC 143	0.125	1976	L_4	5	1	0	100	-
FMC 33297	0.17	1975	L_4	46	12	7	82	7
NRDC 143	0.25	1976	L_2, L_3	10	-	2	67	-
FMC 33297	0.25	1976	L_2, L_3	4	4	4	0	-
FMC 33297	0.25	1976	L_4	13	1	1	89	-
NRDC 143	0.25	1976	L_4	8	1	1	85	-
FMC 33297	0.34	1975	L_4	58	8	2	96	10
NRDC 143	0.50	1975	L_4	54	13	1	98	7
NRDC 143	0.50	1976	L_2, L_3	11	1	3	62	-
FMC 33297	0.50	1976	L_2, L_3	11	-	8	12	-
FMC 33297	0.50	1976	L_4	7	1	1	87	-
NRDC 143	0.50	1976	L_4	3	1	1	67	-
NRDC 143	0.50	1977	L_4	58	10	6	84	21
NRDC 143	1.00	1975	L_4	56	3	2	95	7
NRDC 143	1.00	1977	L_4	56	6	5	85	14
FMC 33297	1.00	1976	L_2, L_3	13	2	2	75	-
FMC 33297	1.00	1976	L_4	7	1	1	87	-
Untreated Check	-	1975	L_4	49	52	40	-	70
Untreated Check	-	1976	L_2, L_3	10	-	6	-	-
Untreated Check	-	1976	L_4	6	-	5	-	-
Untreated Check	-	1977	L_4	63	43	38	-	85

1. Corrected by Abbot's formula (1925), based on no. of larvae present at last postspray sampling date.
2. After Fettes (1951); defoliation not estimated during 1976 due to low population densities.

SUMMARY AND CONCLUSIONS

Experimental treatments of permethrin were applied by mist-blower for control of larvae of the spruce budworm infesting white spruce and balsam fir trees during the three year period 1975-1977. Results of these treatments, ranging from 0.1 to 1.0 oz AI/ac (7-70 g AI/ha), indicated that:

(1) Permethrin as supplied by Chipman Chemicals Ltd. (NRDC-143) and FMC Corporation (FMC 33297) was one of the most efficaceous insecticides evaluated to date.

(2) For commercial purposes, application in the range of 0.25 to 0.50 oz AI/ac (17 - 35 g AI/ha) should reduce larval populations to acceptable levels and provide satisfactory protection of foliage on new branch shoots when applied near the peak occurrence of L_4 larvae.

(3) In situations where infestations are extreme (100 or more larvae/45 cm branch tip) or where applications are late (post L_4 in larval development) and complete defoliation is imminent, dosages to 1.0 oz AI/ac (70 g AI/ha) may be required.

(4) One of the significant characteristics observed during all applications was the ability of this insecticide to induce a quick 'knock-down' of larvae within a few hours of treatment. During some applications, an anti-feeding effect was indicated but not documented.

(5) Confined applications to selected trees in high-value forests (i.e. recreation areas, parks, plantations, woodlots), where aquatic fauna would not be affected adversely, would be logical locations for initial use of this insecticide at dosages in the range indicated in (2) and (3) above.

(6) Further experimentation on dosages below 0.25 oz AI/ac (17 g AI/ha) is required to confirm results obtained to date.

(7) Studies of environmental impact, especially to aquatic invertebrates, should be continued with particular reference to aerial application. Careful use of permethrin by mist-blower in areas where no significant contamination of lakes, rivers, and streams would occur and judiciously applied by licensed commercial applicators would provide the forest manager with an otherwise very acceptable insecticide for control of spruce budworm.

ACKNOWLEDGEMENTS

Sincere thanks are extended to Mr. R.P. Gardiner, Chipman Chemicals Ltd., Stoney Creek, Ontario, and Mr. Lloyd Curtis, formerly with FMC, Burlington, Ontario, for their technical advice and assistance during spray applications. Mr. Marc Michaud, Quebec Department of Lands and Forests, Grand Piles, Quebec, Mr. John Conway, Consolidated-Bathurst Ltd., Grand' Mère, Quebec, and Mr. J. Keable, Ste.Anne des Monts, Quebec, provided forested areas suitable for the experiments. The comments of Mr. W.W. Hopewell of this Institute and Mr. R.P. Gardiner in the review of the manuscript are greatly appreciated.

LITERATURE CITED

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

ARMSTRONG, J.A. 1976. Studies of the synthetic pyrethroid, NRDC-143 for control of the spruce budworm. Environ. Can., Can. For. Ser. Rep. For. Pest Control Forum, Nov. 23-24, 1976, Hull, Que., pp. 117-121.

ARMSTRONG, J.A., and P.C. NIGAM. 1975. The effectiveness of the aerial application of Orthene^{R} against spruce budworm at Petawawa Forest Experiment Station during 1974. Environ. Can., Can. For. Ser. Rep. CC-X-82, 29 pp.

BADAR, A. 1976. Recent advances in synthetic pyrethroids. *Aldrichimica Acta* 9(3): 49-51.

BARLOW, F., and A.B. HADAWAY. 1975. The insecticidal activity of some synthetic pyrethroids against mosquitoes and flies. *Pans* 21: 233-238.

DEBOO, R.F. 1975. Plantation research: XV. Experimental aerial applications of methomyl, phoxim and trichlorfon for control of *Choristoneura fumiferana* on white spruce in Quebec, 1975. Environ. Can., Can. For. Ser. Rep. CC-X-105, 21 pp.

DEBOO, R.F. 1976. Plantation pest control research: spruce budworm. Environ. Can., Can. For. Ser. Rep. For. Pest Control Forum, Nov. 23-24, 1976, Hull, Que., pp. 123-125.

DEBOO, R.F. 1977. Pesticide efficacy research: spruce budworm. Environ. Can., Can. For. Ser. Rep. For. Pest Control Forum, Dec. 6-7, 1976, Ottawa, 5 pp.

DEBOO, R.F., and L.M. CAMPBELL. 1972. Plantation research: V. Mistblower applications of dilute insecticide solutions for control of *Choristoneura fumiferana* on white spruce in Quebec, 1972. Environ. Can., Can. For. Ser. Inf. Rep. CC-X-21, 17 pp.

DEBOO, R.F., and L.M. CAMPBELL. 1974a. Evaluation of commercial preparations of *Bacillus thuringiensis* with and without chitinase against spruce budworm. Part C. Assessment of effectiveness by mistblower and aerial application, Spruce Woods, Manitoba. Environ. Can., Can. For. Ser. Inf. Rep. CC-X-59, 31 pp.

DEBOO, R.F. and L.M. CAMPBELL. 1974b. Plantation research: XII. Experimental applications of insecticides by mistblower for control of *Choristoneura fumiferana* on white spruce in Quebec, 1974. Environ. Can., Can. For. Ser. Rep. CC-X-88, 24 pp.

ELLIOTT, M., A.W. FARNHAM, N.F. JONES, P.H. NEEDHAM, D.A. PULMAN, and J.H. STEVENSON. 1973a. A photostable pyrethroid. *Nature* 246: 169-170.

ELLIOTT, M., A.W. FARNHAM, N.F. JONES, P.H. NEEDHAM, D.A. PULMAN, and J.H. STEVENSON. 1973b. NRDC 143, a more stable pyrethroid. Proc. 7th British Insect. and Fung. Conf., pp. 721-728.

EMBREE, D.G., and G.F. ESTABROOKS. 1977. Field tests of NRDC-143 (permethrin) against the white marked tussock moth in Nova Scotia. Environ. Can., Can. For. Ser. (manuscript in preparation).

FETTES, J.J. 1951. Investigations of sampling techniques for population studies of the spruce budworm on balsam fir in Ontario. Univ. Toronto, Ph.D. Thesis, 212 pp.

GAGNON, J.D. 1972. Grand' Mère Plantations, an example for future reforestation. Environ. Can., Can. For. Ser. Inf. Rep. Q-X-30, 27 pp.

HASTINGS, F.L., and A.S. JONES. 1976. Contact toxicity of 29 insecticides to southern pine beetle adults. USDA For. Serv. Res. Note SE-245, 4 pp.

HOPEWELL, W. W. 1975. Field evaluation of Orthene^{R}, Phosvel^{R}, FMC 33297 and TH 6040, against *Choristoneura fumiferana*, applied as a simulated aerial spray. Environ. Can., Can. For. Ser. Rep. CC-X-115, 29 pp.

HOPEWELL, W. W. 1977. Field evaluation of the pyrethroid NRDC-143, compared with fenitrothion, acephate and chlorpyrifos-methyl as simulated aerial spray deposit for control of the spruce budworm, *Choristoneura fumiferana* Clem. Environ. Can., Can. For. Ser. Rep. CC-X-132, 31 pp.

KINGSBURY, P. D. 1976. Studies on the impact of aerial applications of the synthetic pyrethroid NRDC-143 on aquatic ecosystems. Environ. Can. Can. For. Ser. Inf. Rep. CC-X-127, 111 pp.

KINGSBURY, P.D. 1977. A preliminary report on studies of the impact of permethrin on trout streams in the Gaspé, 1977. Environ. Can., Can. For. Ser., Chem. Control Res. Inst. File Rep. 81, 9 pp., appendix.

MORRIS, O.N., J.A. ARMSTRONG and M.J. HILDEBRAND. 1977. Aerial field trials with a new formulation of *Bacillus thuringiensis* against spruce budworm, *Choristoneura fumiferana* (Clem.). Environ. Can. Can. For. Ser. Rep. CC-X-144, 23 pp., appendices.

NIGAM, P. C. 1975. Summary of laboratory evaluations of insecticides against various species of forest insect pests during 1975. Environ. Can., Can. For. Ser. Inf. Rep. CC-X-124, 9 pp.

NIGAM, P.C. 1976. Summary of laboratory evaluation of insecticides against various species of forest insect pests during 1976. Environ. Can., Can. For. Ser. Rep. For. Pest Control Forum, Nov. 23-24, 1976, Hull, Que., pp. 143-153.

ROBERTSON, J.L., N.L. GILLETTE, M.LOOK, B.A. LUCAS, and R.L. LYON. 1976. Toxicity of selected insecticides applied to western spruce budworm. *Jour. Econ. Ent.* 69: 99-104.

SHARMA, R.K., N.C. TOSCANO, H.T. REYNOLDS, K. KIDO, R.M. HANNIBAL, and W.M. QUILLMAN. 1977. Tobacco budworm invades Imperial Valley cotton. *Cal. Agric.* 31 (6): 16-18.

SUMMARY REPORT

1975 MISTBLOWER APPLICATIONS

GRAND'MÈRE PLANTATIONS, QUEBEC

Target Species: *Choristoneura fumiferana* on *Picea glauca*.

Treatments: Permethrin (Ambush^{R}, NRDC-143) - 25% EC (spray blocks 1, 4, 5); Permethrin (Pounce^{R}, FMC 33297) - 40% EC (spray blocks 2,3). Chevron Spray Sticker added at 0.0125% to all mixes.

Timing: Peak fourth-instar (L_4) larval development period.

Date of Application: June 4 (0730-1015).

Larval Development: Prespray (June 3): 8% L_3, 65% L_4, 25% L_5.
1st Postspray (June 5): 42% L_4, 35% L_5, 10% L_6.
2nd Postspray (June 10): 25% L_4, 30% L_5, 38% L_6.

Weather Conditions: Temperature 16°C, RH *ca.* 60%, wind calm, sky overcast.

Sprayer: Campbell Model J3 mistblower; single Spraying Systems nozzle with hollow Conejet^{R} tip and no. 8 disc; operated at 150 p.s.i. at full throttle; volume emitted *ca.* 14 U.S. gal/ac (*ca.* 130 ℓ/ha)/ treatment.

Spray Blocks: 6 Blocks, including untreated check, each at 0.4 acres (0.16 ha).

Results:

Block No.	Dosage oz AI/ac	Dosage g AI/ha	Avg. No. Live Larvae/45-cm Branch Prespray	1st Postspray	2nd Postspray	Corr. % Population Reduction[1]	Percent Defoliation[2]
1	0.10	7	56	10	16	66	26
2	0.17	12	46	12	7	82	7
3	0.34	24	58	8	2	96	10
4	0.50	35	54	13	0.5	99	4
5	1.00	70	56	3	2	95	7
6	Untreated check		49	52	41	-	70

[1] Corrected by Abbott's Formula (1925) based on larval survivorship at 2nd postspray sample date, 6 days after treatment.

[2] After Fettes (1951).

Remarks: Good spray application conditions; excellent knockdown of larvae from trees within 2 hours of application, especially at higher dosages; impact on spruce coneworm larvae (*Dioryctria reniculelloides*), a defoliator with similar feeding habits, appeared to be the same as recorded for spruce budworm.

SUMMARY REPORT

1976 MISTBLOWER APPLICATIONS

GRAND'MERE PLANTATIONS, QUEBEC

Target Species: *Choristoneura fumiferana* on *Picea glauca*.

Treatments: Permethrin (Ambush^R, NRDC-143)-50% EC (spray blocks 1, 2, 4, 7, 8, 10); Permethrin (Pounce^R, FMC 33297)-40% EC (spray blocks 3, 5, 6, 9, 11, 12). Chevron Spray Sticker added at 0.0125% to all mixtures.

Spray Applications: Early series vs. 60% L_2, 40% L_3 (May 25, 27); Late series vs. 50% L_4, 30% L_5 (June 7, 9).

Larval Development: Prespray, early series (May 24): 63% L_2, 36% L_3, 1% L_4.
Postspray, early series (June 6): 3% L_3, 63% L_4, 32% L_5.
Prespray, late series (June 7): 55% L_4, 30% L_5, 15% L_6.
Postspray, late series (June 14): 10% L_5, 86% L_6, 4% P.

Weather Conditions:

Date	Time	Temp.	RH	Wind
May 25	2000-2230	N.A.	N.A.	N.A.
May 27	2130-2320	9°C	80%	calm
June 7	2120-2350	22°C	46%	calm
June 9	2130-2315	15°C	77%	N.A.

Sprayer: FMC Rotomist Model 100HT @ half- to full-throttle, 300 p.s.i., 3 Micromist^R nozzles. Volume emitted *ca.* 15 U.S. gal/acre (140 ℓ/ha).

Spray Blocks: 13 blocks, including 1 untreated check, each at 1.0 acres (0.4 ha).

Results:

Block No.	Dosage oz AI/ac	Dosage g AI/ha	Avg. No. Live Larvae/45-cm branch Prespray	Avg. No. Live Larvae/45-cm branch Postspray	Corr. % Population Reduction[1]
			Early Series		
1	0.125	9	6.0	6.8	0
2	0.25	18	10.0	2.0	67
3	0.25	18	4.3	3.8	0
4	0.50	35	11.0	2.6	61
5	0.50	35	11.4	8.0	0
6	1.00	70	13.0	2.0	75
CK	Untreated Check		10.2	6.2	-

Block No.	Dosage oz AI/ac	Dosage g AI/ha	Avg. No. Live Larvae/45-cm branch Prespray	Avg. No. Live Larvae/45-cm branch Postspray	Corr. % Population Reduction
			Late Series		
7	0.125	9	5.4	0	100
8	0.25	18	10.0	1.2	84
9	0.25	18	13.0	1.0	89
10	0.50	35	2.6	0.4	80
11	0.50	35	6.6	0.4	92
12	1.00	70	7.4	0.6	89
CK	Untreated Check		6.2	4.6	-

[1] Corrected by Abbott's Formula (1925).

Remarks: Larval population densities of the spruce budworm light-moderate due to starvation of large numbers of larvae during the 1975 feeding period and poor weather conditions (i.e. wet, cold) during the 1976 feeding period. Natural mortality rate estimated at double that observed in other years indicating non-vigorous and possibly diseased populations. Defoliation was very light (*ca.* 10% or less) on both treated and untreated trees.

SUMMARY REPORT

1977 MISTBLOWER APPLICATIONS

KEABLE ESTATE, STE. ANNE DES MONTS, QUEBEC.

Target Species: *Choristoneura fumiferana* on *Abies balsamea*.

Treatments: Permethrin (Ambush®, NRDC-143)-50% EC. Chevron Spray Sticker added @ 0.0125% to both spray mixtures.

Timing: Peak fourth-instar (L_4) larval development period.

Date of Application: Treatment 1 - June 14 (1600-1650); treatment 2 - June 15 (2205-2240).

Larval Development: Prespray (June 10): 34% L_3, 40% L_4, 16% L_5.
1st Postspray (June 18): 7% L_3, 64% L_4, 23% L_5.
2nd Postspray (June 29): 30% L_4, 17% L_5, 52% L_6.

Weather Conditions: Treatment 1 - Temp. 18°C, RH 56%, wind calm, sky clear.
Treatment 2 - Temp. 13°C, RH 75%, wind calm, sky clear.

Sprayer: FMC Rotomist model 100HT @ half- to full-throttle, 300 p.s.i., 3 Micromist® nozzles; volume emitted *ca.* 20 U.S. gal/acre (*ca.* 186 ℓ/ha)/treatment.

Spray Blocks: Treatment 1 - 2.0 acres (0.8 ha); treatment 2 - 2.5 acres (1.0 ha); untreated check - 1.0 acre (0.4 ha).

Results:

Block No.	Dosage oz AI/ac	Dosage g AI/ha	Avg. No. Live Larvae/45-cm Branch Prespray	1st Postspray	2nd Postspray	Corr. % Population Reduction[1]	Percent Defoliation[2]
1	1.0	70	56	6	5	85	14
2	0.5	35	58	10	6	84	21
CK	Untreated Check		63	43	38	-	85

[1] Corrected by Abbott's Formula (1925) based on larval survivorship at 2nd postspray sample date, 6 days after treatment.

[2] After Fettes (1951).

Remarks: Good spray application conditions; some difficulty reaching inaccessible trees on property; excellent knockdown of larvae *ca.* 1 hour after applications; impact on larval population densities most dramatic within 24-48 hour period; general condition of trees excellent as

a result of treatments, proprietor very satisfied; residual larval populations after sprays (*ca.* 5-10/45 cm branch) due to ineffectual spray coverage rather than to concentrations of spray mixtures used.