

TOXICITY OF CYPERMETHRIN (WL 43467) AND
PERMETHRIN (NRDC 143) AGAINST 5th INSTAR
SPRUCE BUDWORM LARVAE AND TWO SPECIES OF
SAWFLY LARVAE IN 1980

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Confidential report

Toxicity of Cypermethrin (WL 43467) and Permethrin
(NRDC 143) Against 5th Instar Spruce Budworm Larvae
and Two Species of Sawfly Larvae

INTRODUCTION

Natural pyrethrins have been used as insecticides since the nineteenth century. Their use was restricted against household and greenhouse pests due to their poor residual toxicity and photodegradation. Various attempts were made to increase their photostability and residual toxicity by formulating them with various sun screens and by synthesizing closely related molecules so that they can be used for outdoor crops. These attempts were not successful until 1973, when permethrin was first synthesized by Dr. Elliott and subsequently cypermethrin. This study compares the toxicity of these compounds against forest insect pests.

MATERIALS AND METHODS

Field Collected Spruce Budworm - *Choristoneura fumiferana* (Clem.)

Third and fourth instar larvae of spruce budworm were collected in the field from Sault Ste. Marie area. The larvae were kept in a cold room at 5°C and approximately 50-70% RH until they were sorted for different instars. They were provided with young, tender buds of white spruce and balsam fir as food. The insects were kept in growth chambers maintained at 20-21°C, 70% RH and a photoperiod of 16 hours, until the desired size of 5th instar larvae were ready to use for the experiments.

Laboratory Reared Spruce Budworm - *Choristoneura fumiferana* (Clem.)

Late fourth and early fifth instar, laboratory reared, spruce budworm were received by the toxicology section from the Insect Production Unit of Forest Pest Management Institute. The larvae were fed on synthetic diet and reared inside an environmental chamber at 20°-21°C, 70% RH and a 16 hour photoperiod until the desired size of fifth instar was obtained for the experimental program.

Jackpine Sawfly - *Neodiprion pratti banksianae* Roh.

These sawflies were collected in the egg stage from the Almonte area near Ottawa, Ontario. The eggs were placed in growth chambers, with fresh jackpine foliage, set at 21°C, 70% RH and a photoperiod of 16 hours until the desired instar and size of larvae were available.

Larch Sawfly - *Fristiphora erichsonii* (Htg.)

The larch sawfly were collected in the egg stage from St. Joseph's Island, near Sault Ste. Marie, Ontario, and were reared in the same manner as the jackpine sawflies. Fresh larch foliage was used as food.

Tree Species Used in the Experiment

Four to five year old white spruce, *Picea glauca* (Moench) Voss., and jackpine, *Pinus banksiana* Lamb., were transplanted into pots from the Kemptville Forest Tree Nursery of the Ontario Ministry of Natural Resources. The balsam fir, *Abies balsamea* (L.) Mill., and larch, *Larix laricina* (Du Roi) K. Koch, were four to five years old and were dug up from the forest in the Sault Ste. Marie area and transplanted into pots. The trees had an even cone-shaped crown and a height of about 50-70 cm for the spruce

and 60-90 cm for the fir. The trees were potted at least three weeks before the experiment.

Insecticides and Their Formulations

Cypermethrin (WL 43467), 40% AI (^w/_v); and permethrin (NRDC 143), 25% AI (^w/_v) were used in the study. The details of their dilution for contact, stomach plus contact, and residual toxicity studies are as follows:

Contact Toxicity - Cypermethrin was diluted to 0.008% AI concentration with A.R. 60 (an aromatic solvent) containing 0.5% Dupont Oil Red dye. The permethrin was diluted to 0.03% AI concentration with A.R. 60 containing 0.5% Dupont Oil Red dye.

Stomach-Contact Toxicity - Cypermethrin was diluted with Dowanol and A.R. 60 (7:3 ratio) to a concentration of 0.008% AI containing 0.5% Dupont Oil Red dye. Permethrin was diluted with Dowanol and A.R. 60 (7:3 ratio) to a concentration of 0.05% AI containing 0.5% Dupont Oil Red dye.

Residual Toxicity - Cypermethrin was diluted with Dowanol TPM to a concentration of 0.5% AI containing 0.5% Dupont Oil Red dye. Permethrin was diluted with Dowanol TPM to a concentration of 2.0% AI containing 0.5% Dupont Oil Red dye for budworm and 1.0% for the sawflies.

Insecticide Treatment

Contact Toxicity: The larvae were sprayed under modified Potter's tower at different rates of application (0.1 to 1.0 GPA). A total of

30 larvae per dose were used in replications of 10 larvae each. The larvae were anaesthetized with CO₂ and placed on a 9 cm diameter filter paper for spraying in the tower. The dosages were calculated from deposits on filter papers. The treated larvae were then transferred into waxed cardboard ice cream cups with fresh foliage for observations at 24, 48, and 72 hours after treatment.

Stomach plus Contact Toxicity: Under a modified Potter's tower, the foliage and insects were sprayed with the same concentrations and the different rates of application as in the contact toxicity tests. Deposit assessment and observation periods were the same as those of contact toxicity.

Residual Toxicity: The insecticides were tested for residual toxicity by spraying potted balsam fir, white spruce and larch trees in a spraying chamber fitted with a ciba-turbair or spinning disc. The sprayed host trees were then exposed to weathering conditions from 0-10 days for balsam fir and white spruce, and 0-25 days for larch. The insects used for the bioassay of residues were either reared in the laboratory, after collecting eggs from the field, or collected in the field to be maintained in the laboratory until their release on the insecticide-treated foliage.

The insects were released on clipped foliage after a period of weathering (0-25 days) of the treated and check trees. The clipped foliage was placed, with the insects, inside a clear plastic dish equipped with a perforated plastic lid. These dishes were kept in an environmental chamber

that was maintained at 21°C and 70% relative humidity. The residue of the insecticide bioassayed on the same day of spraying (i.e., 4 ± 2 hours after spraying) were referred to as 0 day and these host trees were not exposed to any weathering.

OBSERVATIONS

Contact toxicity, stomach, and stomach plus contact: The treated larvae in the waxed cups were placed in a growth chamber and maintained at 21°C, 70% R.H., and a photoperiod of 16 hours. Mortality counts were taken at 24, 48, and 72 hours and/or seven days, and corrected for check mortality according to Abbott's formula.

Residual Toxicity: The treated foliage was clipped for each weathering period and placed in marked plastic dishes equipped with a snap-on perforated lid. Four samples for each weathering period were taken for each dosage; i.e., there were four replicates for each weathering period. Fifteen fifth instar spruce budworm larvae, for the budworm tests, and fifteen fourth instar sawfly larvae for the sawfly tests were used for bioassay of each replication; i.e., a total of 60 larvae per dose for each weathering period. Mortality counts were carried out at 24, 48, and 72 hours after exposure of the insects to the treated foliage. The dishes containing the treated foliage and the insects were kept in an environmental chamber at 21°C, 70% R.H., and a photoperiod of 16 hours.

RESULTS

The detailed results for contact, stomach plus contact and residual toxicity are given in experiment numbers 1 to 16 for different periods of observations. Data for 48 hours is summarized in Table 1 for contact and stomach plus contact toxicity and Table 2 for residual toxicity. It appears from Table 1 that cypermethrin is approximately 4 to 7 times more toxic than permethrin to fifth instar spruce budworm larvae in contact and stomach plus contact toxicity tests. In residual toxicity tests, cypermethrin is approximately 4 to 6 times more toxic against fifth instar spruce budworm larvae and 2 to 4 times more toxic against sawflies (Table 2). Residual toxicity experiments with cypermethrin have been carried out only one to two years and should be repeated for an additional one to two years to obtain an average of three-year weather conditions for proper comparison with permethrin.

TABLE 1

SUMMARY FOR RELATIVE EFFECTIVENESS OF CYPERMETHRIN AS COMPARED TO
 PERMETHRIN ON THE BASIS OF 48 HOUR LD₅₀ AND LD₉₅ VALUES AGAINST
 5th INSTAR SPRUCE BUDWORM LARVAE

EXPERIMENT TYPE	CYPERMETHRIN		PERMETHRIN		CYPERMETHRIN RELATIVE EFFECTIVENESS BASED ON		REFERENCE
	LD ₅₀	LD ₉₅	LD ₅₀	LD ₉₅	LD ₅₀	LD ₉₅	
CONTACT TOXICITY							
Field Collected	0.003	0.010	0.027	0.053	9.0	5.3 (times)	Exp. 1 & 2
Lab Culture (gear 8)	0.004	0.014	0.018	0.053	4.5	3.8 (times)	Exp. 3 & 4
Lab Culture (gear 16)	0.003	0.008	0.022	0.060	7.5	7.3 (times)	Exp. 5 & 6
STOMACH & CONTACT TOXICITY							
Lab Culture	0.003	0.010	0.012	0.028	2.8	4.0 (times)	TABLES 7 & 8

TABLE 2

SUMMARY OF RESIDUAL TOXICITY FOR FORTY-EIGHT (48) HOUR OBSERVATIONS

INSECT SPECIES

PERIOD AFTER TREATMENT OF PLANT	SPRUCE BUDWORM LARVAE ¹	JACKPINE SAWFLY LARVAE ²		LARCH SAWFLY LARVAE ³		
	CYPERMETHRIN** 0.5% (1 yr.)	PERMETHRIN** 2.0% (3 yr.)	CYPERMETHRIN 0.5% (2 yr.)	PERMETHRIN 1.0% (3 yr.)	CYPERMETHRIN 0.5% (2 yr.)	PERMETHRIN 1.0% (3 yr.)
0-day	96%	100%	100%	98%	99%	99%
1-day	99%	86%	96%	92%	98%	83%
3-day	94%	69%	93%	88%	77%	53%
5-day	75%	58%	100%	69%	65%	17%
10-day	41%	17%	66%	16%	56%	17%
15-day					49%	10%
20-day					52%	-
25-day					9%	7%

** AVERAGE MORTALITY FOR BALSAM FIR AND WHITE SPRUCE COMBINED

¹ Experiments 9-12

² Experiments 13&14

³ Experiments 15&16

EXPERIMENT NO. 1

Object: To determine the contact toxicity of Cypermethrin against 5th instar field collected spruce budworm.

Plan of Experiment:

Treatment: Seven levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control.

Concentration of insecticide: 0.008%

Replications: 6

No. of larvae per treatment: 60

Total No. of larvae utilized: 420

Experimental code: SBW 178 & 181

Computer code: SBW W43 24, 48, 72 46-48

Table No. 1980

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.0009	1/60	2	2	2/60	3	3	5/60	8	6
0.2	.0019	8/60	13	13	13/60	22	22	15/60	25	23
0.4	.0035	15/60	25	25	25/60	42	42	33/60	55	54
0.6	.0055	41/59	69	69	48/59	81	81	52/59	88	88
0.8	.0068	41/60	68	68	50/60	83	83	56/60	93	93
1.0	.0088	48/60	80	80	57/59	97	97	57/59	97	97
Control		0/60	0		0/60	0		1/60	2	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm. ²	FL	LD 95 ug/cm. ²	FL
24 hours	3.14	.005	.004-.005	.015	.012-.021
48 hours	3.53	.003	.003-.004	.010	.008-.012
72 hours	3.66	.003	.003-.003	.008	.007-.010

EXPERIMENT NO. 2

Object: To determine the contact toxicity of Permethrin against 5th instar field collected spruce budworm.

Plan of Experiment:

Treatment: Seven Levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control.

Concentration of insecticide: 0.1%

Replications: 3

No. of larvae per treatment: 30

Total No. of larvae utilized: 210

Experimental code: SBW 129

Computer code: SBW N43 C72 1976

Table No.

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.014	1/31	3	0	4/31	13	7	6/31	19	10
0.2	.021	6/30	20	18	8/30	27	22	10/30	33	26
0.4	.034	23/30	77	76	24/30	80	78	24/30	80	78
0.6	.051	25/30	83	82	27/30	90	89	27/30	90	89
0.8	.068	30/30	100	100	30/30	100	100	30/30	100	100
1.0	.091	30/30	100	100	30/30	100	100	30/30	100	100
Control		1/30	3		2/30	7		3/30	10	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50		LD 95	
		ug/cm. ²	FL	ug/cm. ²	FL
24 hours	5.91	.030	.026-.033	.056	.048-.071
48 hours	5.71	.027	.023-.031	.053	.045-.068
72 hours	5.24	.026	.022-.030	.054	.045-.072

EXPERIMENT NO. 3

Object: To determine the contact toxicity of Cypermethrin against 5th instar lab reared spruce budworm.

Plan of Experiment:

Treatment: Seven Levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control.

Concentration of insecticide: 0.008%

Replications: 6

No. of larvae per treatment: 60

Total No. of larvae utilized: 420

Experimental code: SBL 572, 602

Computer code: SBL W43, A1, A2, A3 46-48

Table No. June & July 1980

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.0011	0/60	0	0	1/60	2	2	3/60	5	5
0.2	.0018	2/60	3	3	5/60	8	8	5/60	8	8
0.4	.0034	2/60	3	3	24/60	40	40	30/60	50	50
0.6	.0051	5/60	8	8	38/60	63	63	45/60	75	75
0.8	.0078	6/60	10	10	38/60	63	63	53/60	88	88
1.0	.0094	30/60	50	50	57/60	95	95	57/60	95	95
Control		0/60	0		0/60	0		0/60	0	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm. ²	FL	LD 95 ug/cm. ²	FL
24 hours	2.82	.013	-----	.052	-----
48 hours	3.32	.004	.003-.007	.014	.008-.116
72 hours	3.76	.004	.003-.004	.010	.008-.012

EXPERIMENT NO. 4

Object: To determine the contact toxicity of Permethrin against 5th instar lab reared spruce budworm.

Plan of Experiment:

Treatment: Seven Levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control.

Concentration of insecticide: 0.03%

Replications: 6

No. of larvae per treatment: 60

Total No. of larvae utilized: 420

Experimental code: SBL 591, 599

Computer code: SBL N43 A1, A2, A3 40-42

Table No.

July 1980

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.0035	0/59	0	0	0/59	0	0	1/59	2	2
0.2	.0071	2/60	3	3	4/60	7	7	5/60	8	8
0.4	.0122	10/60	17	17	15/60	25	25	16/60	27	27
0.6	.0202	30/60	50	50	34/60	57	57	36/60	60	60
0.8	.0251	46/59	78	78	49/59	83	83	49/59	83	83
1.0	.0334	42/60	70	70	43/60	72	72	46/60	77	77
Control		0/60	0		0/60	0		0/60	0	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm. ²	FL	LD 95 ug/cm. ²	FL
24 hours	3.91	.020	.005-.265	.054	.029-.2058+13
48 hours	3.58	.018	.0005-5.13	.053	.027-.1000+13
72 hours	3.41	.017	.015-.019	.052	.043-.070

EXPERIMENT NO. 5

Object: To determine the contact toxicity of Cypermethrin against 5th instar lab reared spruce budworm.

Plan of Experiment:

Treatment: Seven Levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control.

Concentration of insecticide: 0.008%

Replications: 3

No. of larvae per treatment: 30

Total No. of larvae utilized: 210

Experimental code: SBL 622

Computer code: SBL W43 B1, B2, B3 53-55

Table No.

July 1980

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.0011	0/30	0	0	1/30	3	0	1/30	3	0
0.2	.0018	2/30	7	7	6/30	20	18	8/30	27	25
0.4	.0046	10/30	33	33	22/30	73	72	22/30	73	72
0.6	.0063	11/30	37	37	26/30	87	87	26/30	87	87
0.8	.0083	8/30	27	27	28/30	93	93	29/30	97	97
1.0	.0117	9/30	30	30	30/30	100	100	30/30	100	100
Control		0/30	0		1/30	3		1/30	3	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm. ²	FL	LD 95 ug/cm. ²	FL
24 hours	1.44	.017	.011-.055	.240	.068-8.904
48 hours	4.07	.003	.003-.004	.008	.007-.011
72 hours	3.96	.003	.003-.004	.008	.007-.011

EXPERIMENT NO.6

Object: To determine the contact toxicity of Permethrin against 5th instar lab reared spruce budworm.

Plan of Experiment:

Treatment: Seven Levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control

Concentration of insecticide: 0.03%

Replications: 6

No. of larvae per treatment: 60

Total No. of larvae utilized: 420

Experimental code: SBL 621, 626

Computer code: SBL N43 B1, B2, B3 43-45

Table No. July 1980

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.0045	1/60	2	2	1/60	2	0	2/60	3	1
0.2	.0082	4/60	7	7	4/59	7	5	6/59	10	8
0.4	.0140	11/60	18	18	12/60	20	18	14/60	23	21
0.6	.0230	27/60	45	45	32/60	53	52	34/60	57	56
0.8	.0335	46/60	77	77	50/60	83	83	51/60	85	85
1.0	.0407	41/60	68	68	47/60	78	78	53/60	88	88
Control		0/60	0		1/59	2		1/59	2	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm. ²	FL	LD 95 ug/cm. ²	FL
24 hours	3.14	.025	.022-.028	.083	.065-.118
48 hours	3.87	.022	.020-.025	.060	.049-.079
72 hours	3.94	.020	.018-.022	.053	.044-.067

EXPERIMENT NO. 7

Object: To determine the stomach-contact toxicity of Cypermethrin against 5th instar lab reared spruce budworm.

Plan of Experiment:

Treatment: Seven Levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control.

Concentration of insecticide: 0.004%

Replications: 3

No. of larvae per treatment: 30

Total No. of larvae utilized: 210

Experimental code: STC 76

Computer code: STC 76 A, B, C (filed under STC W43.DAT)

Table No.

February 10/81

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.0004	1/30	3	3	1/30	3	0	1/30	3	0
0.2	.0008	4/30	13	13	5/30	17	11	6/29	21	15
0.4	.0017	3/30	10	10	4/30	13	6	6/30	20	14
0.6	.0025	9/30	30	30	13/30	43	39	14/29	48	44
0.8	.0035	15/29	50	50	17/29	57	54	19/27	70	68
1.0	.0040	13/30	43	43	19/30	63	60	22/27	81	80
Control		0/30	0		2/30	7		2/30	7	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm. ²	FL	LD 95 ug/cm. ²	FL
24 hours	1.77	.005	.003-.009	.040	.016-.359
48 hours	3.38	.003	.003-.004	.010	.006-.040
72 hours	3.73	.003	.002-.003	.007	.005-.016

EXPERIMENT NO. 8

Object: To determine the stomach-contact toxicity of Permethrin against 5th instar lab reared spruce budworm.

Plan of Experiment:

Treatment: Seven Levels: Six Rates of Application (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 G.P.A.) and Control.

Concentration of insecticide: 0.03%

Replications: 3

No. of larvae per treatment: 30

Total No. of larvae utilized: 210

Experimental code: STC 78

Computer code: STC 78 A, B, C (filed under STCN43.DAT)

Table No. February 16/81

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm ²	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	.0041	0/30	0	0	1/30	3	3	1/30	3	3
0.2	.0067	3/30	10	10	3/30	10	10	4/30	13	13
0.4	.0142	18/30	60	60	18/30	60	60	19/30	63	63
0.6	.0193	23/30	77	77	23/30	77	77	25/30	83	83
0.8	.0232	27/30	90	90	27/30	90	90	27/30	90	90
1.0	.0305	30/30	100	100	30/30	100	100	30/30	100	100
Control		0/30	0		0/29	0		0/29	0	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm. ²	FL	LD 95 ug/cm. ²	FL
24 hours	5.09	.013	.011-.014	.027	.023-.034
48 hours	4.57	.012	.011-.014	.028	.024-.036
72 hours	4.54	.012	.010-.013	.027	.022-.034

OBJECTIVE: RESIDUAL TOXICITY EXPERIMENT NO. 9
 INSECTICIDE & CONCENTRATION (%) WL 43467 0.5% (1980), 1.0% (1979)
 INSECT & INSTAR: SPRUCE BUDWORM - Fifth Instar
 HOST TREE SPECIES: White Spruce USED TREE _____ OR CLIPPINGS X
 WORKING SOLUTION MADE FROM: WL 43467 (40% w/v)
 SOLVENT & DYE USED: Dowanol & 1% Dupont Oil Red (D.O.R.)
 RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
19 79	10	10	300	300
19 80	10	10	300	300
19				

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE: 1979 (1.0%)	0	80.0	0.0	100.0	0.0	100.0	3.3
	1	96.6	3.3	100.0	3.3	100.0	3.3
	3	67.8	6.7	96.5	6.7	96.5	6.7
	5	80.0	0.0	100.0	0.0	100.0	0.0
	10	6.9	3.3	60.7	6.7	70.3	10.0
DATE: 1980 (0.5%)	0	59.3	1.7	92.1	15.5	98.1	15.5
	1	81.7	0.0	98.3	0.0	98.2	3.9
	3	59.9	3.3	91.2	6.8	97.5	18.6
	5	33.9	0.0	61.8	6.8	85.1	8.5
	10	1.7	3.5	15.2	10.0	29.5	18.3
DATE:	0						
	1						
	3						
	5						
	10						
AVERAGE							
0							
1							
3							
5							
10							

	WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD		AVERAGE
	1979	1980	
TEMPERATURE...°C	12.9	13.6	
Dew Point....°C	9.3	9.2	
Rain.....mm	37.1	34.7	
Sun.....h	117.9	107.8	

EXPERIMENT NO. 10

OBJECTIVE: RESIDUAL TOXICITY

INSECTICIDE & CONCENTRATION (%) NRDC 143 2.0% (1977, 1979, 1980)

INSECT & INSTAR: SPRUCE BUDWORM - Fifth Instar

HOST TREE SPECIES: White Spruce USED TREE _____ OR CLIPPINGS X

WORKING SOLUTION MADE FROM: NRDC 143 (25% w/v)

SOLVENT & DYE USED: Dowanol & 1% Dupont Oil Red (D.O.R.)

RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
19 77	10	10	300	300
19 79	10	10	300	300
19 80	10	10	300	300

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE: 1977 (2.0%)	0	88.9	0.0	100.0	5.0	100.0	11.7
	1	52.7	2.0	77.7	4.1	88.8	4.1
	3	37.2	1.7	51.8	6.7	56.5	11.9
	5	38.6	5.0	50.8	5.0	66.6	5.2
	10	3.3	1.7	4.9	5.2	11.6	5.4
DATE: 1979 (2.0%)	0	73.3	0.0	100.0	0.0	100.0	3.3
	1	93.1	3.3	100.0	3.3	100.0	3.3
	3	21.4	6.7	39.2	6.7	53.6	6.7
	5	10.0	0.0	56.7	0.0	80.0	0.0
	10	0.0	3.3	10.7	6.7	25.8	10.0
DATE: 1980 (2.0%)	0	100.0	1.7	100.0	15.5	100.0	15.5
	1	41.7	0.0	50.0	0.0	61.1	3.9
	3	15.5	3.3	57.1	6.8	81.6	18.6
	5	11.7	0.0	30.3	6.8	49.0	8.5
	10	1.6	3.5	3.7	10.0	0.0	18.3

		AVERAGE					
1977, 1979 & 1980	0	87.4	0.6	100.0	6.8	100.0	10.2
	1	62.5	1.8	75.9	2.5	83.3	3.8
	3	24.7	3.9	49.4	6.7	63.9	12.4
	5	20.1	1.7	45.9	3.9	65.2	4.6
	10	1.6	2.8	6.4	7.3	12.5	11.2

WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD

	1977	1979	1980	AVERAGE
TEMPERATURE...°C	14.6	12.9	13.6	13.7
Dew Point....°C	7.5	9.3	9.2	8.7
Rain.....mm	34.0	37.1	34.7	35.3
Sun.....h	87.3	117.9	107.8	104.3

OBJECTIVE: RESIDUAL TOXICITY

EXPERIMENT NO. 11

INSECTICIDE & CONCENTRATION (%) WL 43467 0.5% (1980), 1.0% (1979)

INSECT & INSTAR: SPRUCE BUDWORM - Fifth Instar

HOST TREE SPECIES: Balsam Fir USED TREE OR CLIPPINGS X

WORKING SOLUTION MADE FROM: WL 43467 (40% w/v)

SOLVENT & DYE USED: Dowanol + 1% Dupont Oil Red (D.O.R.)

RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
19 79	<u>10</u>	<u>10</u>	<u>300</u>	<u>300</u>
19 80	<u>10</u>	<u>10</u>	<u>300</u>	<u>300</u>
19				

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE: 1979 (1.0%)	0	78.6	6.7	100.0	6.7	100.0	10.0
	1	100.0	3.3	100.0	3.3	100.0	3.3
	3	96.5	3.3	100.0	3.3	100.0	6.7
	5	96.7	0.0	100.0	0.0	100.0	3.3
	10	36.7	0.0	90.0	0.0	100.0	10.0
DATE: 1980 (0.5%)	0	81.7	1.7	100.0	5.0	100.0	5.0
	1	87.4	7.0	100.0	10.9	100.0	10.9
	3	65.6	1.6	96.3	8.6	100.0	11.7
	5	49.1	3.3	87.7	6.7	100.0	18.3
	10	12.3	0.0	66.3	1.3	81.2	6.7
DATE:	0						
	1						
	3						
	5						
	10						
AVERAGE							
0							
1							
3							
5							
10							

WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD

	1979	1980	AVERAGE
TEMPERATURE...°C	<u>12.9</u>	<u>13.6</u>	
Dew Point....°C	<u>9.3</u>	<u>9.2</u>	
Rain.....mm	<u>37.1</u>	<u>34.7</u>	
Sun.....h	<u>117.0</u>	<u>107.8</u>	

INSECTICIDE & CONCENTRATION (%) NRDC 143 2.0% (1978, 1979 & 1980)
 INSECT & INSTAR: SPRUCE BUDWORM - Fifth Instar
 HOST TREE SPECIES: Balsam Fir USED TREE _____ OR CLIPPINGS X
 WORKING SOLUTION MADE FROM: NRDC 143 (25% w/v)
 SOLVENT & DYE USED: Dowanol & Dupont Oil Red 1% (D.O.R.)
 RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
19 78	10	10	300	300
19 79	10	10	300	300
19 80	10	10	300	300

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE:1978	0	96.4	4.6	100.0	6.0	100.0	11.2
	1	62.8	1.3	92.7	8.0	100.0	8.0
	3	52.8	1.0	79.2	4.0	89.6	4.1
	5	16.7	0.0	56.7	0.0	58.6	3.4
	10	9.0	1.1	4.7	5.6	4.7	5.6
DATE:1979	0	96.5	6.7	100.0	6.7	100.0	10.0
	1	93.1	3.3	100.0	3.3	100.0	3.3
	3	86.2	3.3	96.5	3.3	100.0	6.7
	5	46.7	0.0	80.0	0.0	86.2	3.3
	10	20.0	0.0	33.3	0.0	40.8	10.0
DATE:1980	0	89.5	1.7	100.0	5.0	100.0	5.0
	1	82.0	7.0	98.1	10.9	98.1	10.9
	3	84.2	1.6	90.4	8.6	96.0	11.7
	5	41.4	3.3	71.4	6.7	97.9	18.3
	10	0.0	0.0	47.6	1.3	77.8	6.7
AVERAGE							
0	94.1	4.3	100.0	5.9	100.0	8.7	
1	79.3	3.9	96.9	7.4	99.4	7.4	
3	74.4	2.0	88.7	5.3	95.2	7.5	
5	34.9	1.1	69.4	2.2	80.9	8.3	
10	9.7	0.4	28.5	2.3	41.1	7.4	

WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD

	1978	1979	1980	AVERAGE
TEMPERATURE...°C	19.4	12.9	13.6	15.3
Dew Point....°C	10.9	9.3	9.2	9.8
Rain.....mm	47.4	37.1	34.7	39.7
Sun.....h	160.4	117.9	107.8	131.7

INSECTICIDE & CONCENTRATION (%) WL 43467 0.5% (1979 & 1980)

INSECT & INSTAR: JACKPINE SAWFLY - Fourth Instar

HOST TREE SPECIES: Jackpine USED TREE _____ OR CLIPPINGS X

WORKING SOLUTION MADE FROM: WL 43467 (40% W/V)

SOLVENT & DYE USED: Dowanol + 1% Dupont Oil Red (D.O.R.)

RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
19 79	10	10	300	300
19 80	10	10	300	300
19				

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE: 1979 (0.5%)	0	100.0	0.0	100.0	0.0	100.0	0.0
	1	100.0	0.0	100.0	3.3	100.0	3.3
	3	75.9	3.3	100.0	3.3	100.0	3.3
	5	53.3	0.0	100.0	0.0	100.0	0.0
	10	43.3	0.0	86.7	0.0	100.0	3.3
DATE: 1980 (0.5%)	0	93.3	0.0	100.0	1.7	100.0	5.0
	1	74.6	0.0	91.4	1.6	100.0	1.6
	3	23.3	0.0	86.7	0.0	98.3	0.0
	5	86.7	0.0	100.0	6.9	100.0	6.9
	10	8.3	0.0	45.0	0.0	62.0	3.3
DATE:	0						
	1						
	3						
	5						
	10						
AVERAGE							
1979 & 1980	0	96.7	0.0	100.0	0.9	100.0	2.5
	1	87.3	0.0	95.7	2.5	100.0	2.5
	3	49.6	1.7	93.4	1.7	99.2	1.7
	5	70.0	0.0	100.0	3.5	100.0	3.5
	10	25.8	0.0	65.9	0.0	81.0	3.3

WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD

	1979	1980	AVERAGE
TEMPERATURE...°C	8.9	13.7	11.3
Dew Point....°C	4.1	9.2	6.7
Rain.....mm	27.2	26.5	26.9
Sun.....h	50.9	84.2	72.1

OBJECTIVE: RESIDUAL TOXICITY

EXPERIMENT NO. 14

INSECTICIDE & CONCENTRATION (%) NRDC 143 1.0% (1978, 1977 & 1976)

INSECT & INSTAR: JACKPINE SAWFLY - Fourth Instar

HOST TREE SPECIES: Jackpine USED TREE _____ OR CLIPPINGS X

WORKING SOLUTION MADE FROM: NRDC 143 (25% w/v)

SOLVENT & DYE USED: Dowanol + 1% Dupont Oil Red (D.O.R.)

RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
1978	10	10	300	300
1979	10	10	300	300
1980	10	10	300	300

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE: 1976 (1.0%)	0	88.3	0.0	98.3	1.7	100.0	1.7
	1	83.3	0.0	100.0	0.0	100.0	0.0
	3	42.4	0.0	96.5	3.3	98.2	3.3
	5	100.0	3.3	100.0	3.3	100.0	3.3
	10	6.7	0.0	18.3	0.0	32.8	3.3
DATE: 1977 (1.0%)	0	81.7	0.0	100.0	0.0	100.0	0.0
	1	36.7	0.0	76.0	1.7	100.0	1.7
	3	81.7	0.0	85.0	0.0	90.0	0.0
	5	42.0	1.7	91.0	6.7	100.0	6.7
	10	1.7	0.0	25.4	0.0	34.0	1.7
DATE: 1978 (1.0%)	0	40.0	0.0	96.7	0.0	100.0	0.0
	1	16.7	0.0	100.0	0.0	100.0	1.1
	3	20.0	0.0	83.3	0.0	100.0	2.2
	5	0.0	0.0	16.7	0.0	51.2	4.4
	10	0.0	0.0	3.3	0.0	8.0	2.2

AVERAGE							
1976, 1977 & 1978	0	70.0	0.0	98.3	0.6	100.0	0.6
	1	45.6	0.0	92.0	0.6	100.0	0.9
	3	48.0	0.0	88.3	1.1	96.1	1.8
	5	47.3	1.7	69.2	3.3	83.7	4.8
	10	2.8	0.0	15.7	0.0	24.9	2.4

WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD

	1976	1977	1978	AVERAGE
TEMPERATURE...°C	20.0	18.7	18.8	19.2
Dew Point....°C	9.9	10.6	10.7	10.4
Rain.....mm	27.9	38.8	29.0	31.9
Sun.....h	9	96.0	158.6	117.1

OBJECTIVE: RESIDUAL TOXICITY EXPERIMENT NO. 15
 INSECTICIDE & CONCENTRATION (%) WL 43467 0.5% (1979 & 1980)
 INSECT & INSTAR: LARCH SAWFLY - Fourth Instar
 HOST TREE SPECIES: European Larch USED TREE OR CLIPPINGS X
 WORKING SOLUTION MADE FROM: WL 43467 (40% w/v)
 SOLVENT & DYE USED: Dowanol + 1% Dupont Oil Red (D.O.R.)
 RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
1979	16	16	480	480
1980	16	16	480	480
19				

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE: 1979 (0.5%)	0	90.0	0.0	100.0	0.0	100.0	3.3
	1	100.0	0.0	100.0	0.0	100.0	0.0
	3	23.3	0.0	76.7	0.0	86.2	3.3
	5	100.0	0.0	100.0	20.0	100.0	20.0
	10	46.7	0.0	73.3	0.0	93.3	0.0
	15	----	3.3	----	3.3	----	3.3
	20	81.9	26.7	91.8	60.0	100.0	60.0
	25	3.5	3.3	10.3	3.3	35.7	6.7
DATE: 1980 (0.5%)	0	78.3	0.0	98.3	1.7	100.0	3.3
	1	58.2	8.3	96.3	11.7	100.0	16.7
	3	39.7	3.3	77.8	10.0	100.0	16.7
	5	7.4	10.0	30.8	13.3	98.0	16.7
	10	28.8	1.7	38.0	3.3	80.4	6.7
	15	41.7	0.0	49.1	1.7	71.2	1.7
	20	1.7	1.7	12.4	3.3	38.7	3.3
	25	1.7	0.0	6.7	0.0	6.9	3.3
DATE:	0						
	1						
	3						
	5						
	10						
	15						
	20						
	25						
AVERAGE							
1979 & 1980	0	84.2	0.0	99.2	0.9	100.0	3.3
	1	79.1	4.2	98.2	5.9	100.0	8.4
	3	43.2	1.7	77.3	5.0	93.1	10.0
	5	53.7	5.0	65.4	16.7	99.0	18.4
	10	37.8	0.9	55.7	1.7	86.9	3.4
	15	----	1.7	----	2.5	----	2.5
	20	41.8	14.2	52.1	31.7	69.4	31.7
	25	2.6	1.7	8.5	1.7	21.3	5.0

WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD			
	1979	1980	AVERAGE
TEMPERATURE...°C	17.5	17.8	17.7
w Point....°C	12.6	12.9	12.8
n.....mm	37.9	42.4	40.2
.....h	284.5	271.7	278.1

OBJECTIVE: RESIDUAL TOXICITY
 INSECTICIDE & CONCENTRATION (%) NRDC 143 1.0% (1979 & 1980)

EXPERIMENT NO. 16

INSECT & INSTAR: LARCH SAWFLY - Fourth Instar

HOST TREE SPECIES: European Larch USED TREE OR CLIPPINGS X

WORKING SOLUTION MADE FROM: NRDC 142 (25% w/v)

SOLVENT & DYE USED: Dowanol & 1% Dupont Oil Red (D.O.R.)

RATE OF APPLICATION: 1 G.P.A.

YEAR	NUMBER OF TREES USED		NUMBER OF INSECTS USED	
	TREATED	CONTROL	TREATED	CONTROL
19 79	16	16	480	480
19 80	16	16	480	480
19				

Insects Released Indicated Number Of Days After Spray	Corrected Percentage Mortality After 24, 48, and 72 hours Exposure To Treated Foliage						
	24		48		72		
	Treatment	Control	Treatment	Control	Treatment	Control	
DATE: 1979 (1.0%)	0	96.7	0.0	100.0	0.0	100.0	3.3
	1	40.0	0.0	76.7	0.0	100.0	0.0
	3	63.3	0.0	80.0	0.0	100.0	3.3
	5	33.3	0.0	33.4	2.0	62.5	20.0
	10	23.3	0.0	33.3	0.0	66.7	0.0
	15	3.5	3.3	3.5	3.3	17.3	3.3
	20	81.9	26.7	100.0	60.0	100.0	60.0
	25	6.9	3.3	10.3	3.3	7.1	6.7
DATE: 1980 (1.0%)	0	90.0	0.0	98.3	1.7	98.2	3.3
	1	72.7	8.3	88.7	11.7	98.0	16.7
	3	19.0	3.3	25.3	10.0	43.0	16.7
	5	0.0	10.0	0.0	13.3	0.0	16.7
	10	0.0	1.7	0.0	3.3	5.4	6.7
	15	6.7	0.0	16.9	1.7	30.5	1.7
	20	1.6	1.7	0.0	3.3	0.0	3.3
	25	0.0	0.0	3.3	0.0	5.4	3.3
DATE:	0						
	1						
	3						
	5						
	10						
	15						
	20						
	25						
AVERAGE							
1979 & 1980	0	93.4	0.0	99.2	0.9	99.1	3.3
	1	56.4	4.2	82.7	5.9	99.0	8.4
	3	41.2	1.7	52.7	5.0	71.5	10.0
	5	16.7	5.0	16.7	7.7	31.3	18.4
	10	11.7	0.9	16.7	1.7	36.1	3.4
	15	5.1	1.7	10.2	2.5	23.9	2.5
	20	41.8	14.2	50.0	31.7	50.0	31.7
	25	3.5	1.7	6.8	1.7	6.3	5.0

WEATHER DATA FOR 10 DAY WEATHERING (TEST) PERIOD

	1979	1980	AVERAGE
TEMPERATURE...°C	17.5	17.8	17.7
Dew Point....°C	12.6	12.9	12.8
Rain.....mm	37.9	42.4	40.2
Sun.....h	284.5	271.7	278.1