AERIAL APPLICATIONS OF AMINOCARB FLOWABLE TO CONTROL EASTERN SPRUCE BUDWORM *CHORISTONEURA FUMIFERANA* (CLEM.) IN NEW BRUNSWICK (1981)

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B. L. Cadogan

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Forest Pest Management Institute
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A PRELIMINARY REPORT

by

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Aerial Applications of Aminocarb Flowable to Control Eastern Spruce Budworm *Choristoneura fumiferana* (Clem.)

Aminocarb (Matacil®) dissolved in a phenol, usually nonylphenol, to form an oil soluble concentrate (OSC) has been used successfully to control the Eastern spruce budworm *Choristoneura fumiferana* (Clem.) since 1970. Recent concern, however, of the effects of nonylphenol to human health has initiated research on Matacil® formulations containing no phenols which would therefore be acceptable environmentally yet be as efficaceous as the nonylphenol formulation.

This report presents the preliminary findings of aerial spray trials conducted in 1981 to determine (a) the field efficacy of a 'flowable' (suspension concentrate) formulation of aminocarb (Matacil® 180F) compared against the nonylphenol formulation and b) the insecticidal activity of Atlox® 3409F an emulsifying component of the flowable formulation.

MATERIALS AND METHODS

Experimental Site

The trials were conducted in Gloucester county approximately 25 km SW of the city of Bathurst, New Brunswick, Canada. The experimental area was bound by 65° 30'W, 66° 30' W longitude and 47° 15' N, 47° 35 N latitude (Fig. 1).

Treatment blocks were 50 ha in area (0.5 x 1.0 km) in mature forests comprised of various combinations of Balsam fir, *Abies balsamea* (L.) Mill., spruce, *Picea* spp. and hardwoods. Two

transect lines, divided into 33 equal segments, were cleared across each block (Fig. 2) and 25 to 30 sample trees were selected within easy access of each line. Trees, particularly hardwoods, which neighboured the sample trees were judiciously removed to create small clearings approximately 7-8 m in diameter. These facilitated relatively unrestricted movement of spray droplets in the vicinity, thus enabling droplet deposition at the forest-floor level as well as onto the sample tree itself. The untreated block was an unsurveyed area which remained undisturbed in order to measure spruce budworm larval population decline due to factors other than the insecticide treatments. Characteristics of the sample trees are given for each block in Table 1.

CHEMICAL APPLICATION

Aircraft Data

The treatments were applied by a Cessna Ag-truck aircraft fitted with four AU3000 Micronair® atomisers. The rate of flow was controlled from the cockpit via a flow control unit and adjusted to emit 24.0 l/min and a swath width of 60 m. The aircraft's flight lines were generally at right angles to any prevailing wind (see Fig. 2). Data relevant to the aircraft are presented in Tables 2a and 2b.

Tank Mixes

The insecticides were mixed as summarized in Table 3. Water was used as the diluent (solvent) in treatments applied to

blocks 1 and 2 and Atlox® 3409F used as an emulsifier. Insecticide diluent 585 was the carrier in blocks 3, 4 and 8 whereas Sunspray®-6N oil was used in blocks 5 and 6. Atlox in water was applied as a treatment to block 9. To facilitate spray deposit assessment, Automate 'B' red dye was incorporated into sprays applied to blocks 3, 4, 5, 6 and 8 while Rhodamine 'B' red dye was used in blocks 1, 2 and 9.

Two treatments were applied to each block (Tables 2a and b). The first when the buds were fully flared and the shoots measured ($\overline{X}$ = 2.8 cm; n = 379) on white spruce and ($\overline{X}$ = 2.2 cm, n = 382) on balsam fir. The buds on red spruce were still unopened. The larval development of the spruce budworm just prior to this application was approximately 45% 3rd instar and 35% 4th instar. When the second treatment was applied the population had developed to approximately 26% 5th instar and 34% 6th.

Meteorological Conditions

Weather conditions were monitored for the time period 1.5 h prior to, to 1 h after each spray application using a Heathkit weather computer Model 4001. An anemometer/vane was attached to the top of a 12.8 m mast to measure windspeed and direction. Temperatures were recorded at 12.6 m and 2.0 m levels and used to determine the thermal flow stability. Wet and dry bulb readings were used to calculate the relative humidity. These data (Table 2a and 2B) assisted in determining when spraying conditions were suitable.

Table I: Experimental Site Characteristics

Block	Treatment	Species composition		Transect	Number of trees per transect			Sample tree characteristics			
								Tree height		Diameter at 1.60 metres	
		Conifer %	Hardwood %		Balsam fir	White spruce	Red spruce	(m) $\bar{x}$	±S.D.	(cm) $\bar{x}$	±S.D.
1	180F + H_2O + Atlox	70	30	A	23	5	2	15.20	1.82	25.90	5.86
				B	20	0	8	14.36	2.84	24.68	5.05
2	180F + H_2O + Atlox	85	15	A	28	0	2	13.39	1.80	22.97	4.53
				B	29	0	1	13.69	2.06	23.93	4.66
3	180F + I.D. 585	50	50	A	16	14	0	15.03	2.12	26.06	6.66
				B	23	0	2	13.28	2.63	21.33	5.52
4	180F + I.D. 585	65	35	A	16	5	7	14.46	2.13	26.54	6.18
				B	18	7	3	13.82	1.16	23.60	3.56
5	1.5 OSC + 6N	60	40	A	16	4	5	13.17	1.39	21.62	5.71
				B	17	8	0	13.16	1.64	21.72	6.27
6	1.5 OSC 6N	80	20	A	21	1	5	13.73	2.23	22.07	4.72
				B	19	2	6	13.21	2.56	21.66	4.44
8	1.5 OSC I.D. 585	50	50	A	17	5	3	13.83	1.74	22.67	5.08
				B	17	5	3	13.52	1.12	22.89	6.18
9	Atlox + H_2O	50	50	A	15	4	6	13.22	1.88	24.59	6.70
				B	15	6	4	13.89	1.58	23.36	6.35
Check	Untreated	90	10	-	30	15	15	13.06	1.60	22.27	3.71

Table 2a

A Summary of Spray, Aircraft and Weather Data for Aminocarb Efficacy Trials (Bathurst N.B. 1981)

	Block 1 and 2		Block 3 and 4		Block 5 and 6	
	1st applic.	2nd applic.	1st applic.	2nd applic.	1st applic.	2nd applic.
Date	12-06-81	18-06-81	12-06-81	18-06-81	13-06-81	18-06-81
Time (hrs)	1940	0620	2100	0715	2010	2015
Insecticide	Aminocarb 180F		Aminocarb 180F		Aminocarb 1.5 OSC	
Volume active	70 g/ha		70 g/ha		70 g/ha	
Solvent	H_2O		*Shell I.D. 585 oil		Sunspray 6N oil	
Plot size	50 ha		50 ha		50 ha	
Aircraft data						
Type	Cessna 188 Ag Truck		Cessna 188 Ag Truck		Cessna 188 Ag Truck	
Speed kmph	160		160		160	
Applic. height	22-24 m	27 m	24 m	27-30 m	27-30 m	27-30 m
Applic. equipment	(4) Micronairs AU 3000		(4) Micronair AU 3000		(4) Micronair AU 3000	
Emission rate	23.5 l/min		23.5 l/min		23.5 l/min	
Applic. rate	1.5 l/ha		1.5 l/ha		1.5 l/ha	
Blade angle	25°		25°		25°	
Blade rpm	Maximum		Maximum		Maximum	

	Block 1		Block 2		Block 3		Block 4		Block 5		Block 6	
Weather data	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Temp.°C (mean)	13.00	10.25	13.00	10.75	10.00	13.75	10.00	13.75	16.50	22.25	17.25	20.75
RH % (mean)	80	100	83	96	96	73	96	73	73	58	69	56
Wind speed (mean)	.25	1.0	.25	2.0	0.0	5.0	0	5.0	0.0	1.5	0.0	1.0
Wind direction	E	W	E	SW-W	E	W	E	W	SE-SW	W	SE-S	W
Inversion**	↓	↓	↓	↓	↔	↓	↔	↓	↓	↓	↓	↓
Cloud cover	1/10	0/10	1/10	1/10	0/10	0/10	0/10	1/10	0/10	0/10	0/10	0/10

* I.D.--Insecticide diluent

** ↓--inversion
↑--lapse
↔--neutral (isothermic)

Table 2b

A Summary of Spray Aircraft and Weather Data for Aminocarb Efficacy Trials

(Bathurst, N.B. 1981)

	Block 8		Block 9	
	1st applic.	2nd applic.	1st applic.	2nd applic.
Date	16-06-81	19-06-81	15-06-81	19-06-81
Time (hrs)	0600	0715	2020	0600
Insecticide	Aminocarb 1.5 OSC		Atlox	
Volume active	70 g/ha			
Solvent	Shell I.D. 585*		H_2O	
Plot size	50 ha		50 ha	
Aircraft data				
Type	Cessna 188 Ag Truck		Cessna 188 Ag Truck	
Speed kmph	160		160	
Applic. height	27 m	24-27 m	27-30 m	24 m
Applic. equipment	(4) Micronair AU 3000		(4) Micronair AU 3000	
Emission rate	23.5-24.2 l/min	23.5 l/min	23.8 l/min	23.5 l/min
Applic. rate	1.5 l/ha		1.5 l/ha	
Blade angle	25°		25°	
Blade rpm	Maximum		Maximum	
Weather data				
Temp. °C (mean)	10.0	18.0	12.5	13.75
RHZ (mean)	100	87	77	85
Wind speed (mean)	.50 kmph	1.0 kmph	.50 kmph	0.0 kmph
Wind direction	S-SW	W-NW	SE-S	SW
Inversion*	↑	↓	↑	↓
Cloud cover	10/10	0/10	10/10	0/10

* I.D.--insecticide diluent

** ↓--inversion
↑--lapse
↔--neutral (isothermic)

Table 3: The composition of the treatments applied aerially in the Aminocarb trials (New Brunswick 1981)

Block Number	Treatment	Volume/ha							
		Insecticide		Solvent*			Emulsifier		Dye**	
		ℓ	%		ℓ	%	ℓ	%	ℓ	%
1, 2	Aminocarb 180F	0.389	25.93	H_2O	1.084	72.27	Atlox 0.019	1.27	Rh 0.008	0.53
3,4	" "	0.389	25.93	ID585	1.081	72.07			Au 0.030	2.00
8	" 1.5	0.389	25.93	ID585	1.081	72.07			Au 0.030	2.00
5,6	" "	0.389	25.93	SS-6N	1.081	72.07			Au 0.030	2.00
9	Atlox 3409F	0.043	2.87	H_2O	1.449	96.60			Rh 0.008	0.53

* ID 585 - Shell insecticide diluent
SS-6N - Shell Sunspray 6 N oil
** Rh - Rhodamine "B" red dye
Au - Automate "B" red dye

Chemical Assessment

To assess the spray efficiency of the various formulations, a sample unit comprising a Kromekote® card (10 x 10 cm) and 2 glass slides (5.0 x 7.5 cm) as described by Randall (1980) was placed strategically in the clearings adjacent to each sample tree. These units were placed approximately 30 min before the spray and retrieved approximately 50 min after its completion. The cards and slides were stored in a dry condition prior to evaluation. The Kromekote® cards were sent to the National Aeronautical Establishment (N.A.E.), Ottawa, where they were analysed by a Flying spot scanner (Drummond 1980) to determine droplet density and other characteristics of the spray spectra.

Each glass slide was washed in 0.75 ml of tolulene to remove the dye content which was then analysed colorimetrically using a Bausch and Lomb spectronic 100 spectrophotometer. Thus a quantitative and qualitative assessment of the % spray recovered at ground level was possible.

BIOLOGICAL ASSESSMENT

Larval sampling

Samples consisting of two 46 cm branches, one each from the upper and midcrown areas were taken from each sample tree using pole pruners with attached baskets. One pre-spray and 4 post-spray samples were taken from each spray block. Each branch was placed in a large (16.0 kg capacity) paper bag and stapled shut

to prevent larval escape. The samples were taken to a 'counting mill' at the field laboratory in Bathurst where the number of viable buds and living spruce budworm larvae were counted and recorded.

Assessing Population Reduction

The % population reductions in all the blocks were assessed by calculating the number of larval budworm per bud at each sampling date for each sample tree. These were plotted and a curve [$Y = a\ e^{bx}$]* generated to fit the seasonal population data of the three host species in each block.

Because the sampling dates of the treated and untreated blocks were not always identical, the % population reductions recorded in the treatment blocks were corrected for natural mortality using the generated population curves of the treated and untreated blocks and applying Abbott's formula (Abbott, 1925):

$$\frac{C - T}{C} \times 100$$

where C = % living in untreated check

T = % living in treatment check

Assessing Defoliation

After pupation and subsequent emergence of budworm moths had occurred, a similar quantity of branch samples were taken from the same areas of the crown of each sample tree to determine the extent of defoliation. This was evaluated using Kettela's method (Kettela, personel communication) which involves a combination of Fettes' (1950) method (taking the number of shoots) and using a smaller number of classes for classifying shoot damage.

*Y = Larvae/bud; x = Sample date.

Evaluation of Treatments

To satisfy the objectives of this study the following criteria were used to evaluate the treatments:

i) reduction in larval population of spruce budworm on balsam fir and spruce

ii) % defoliation of the host trees

iii) the chemical efficiency of sprays

a) No. of drops cm^{-2}

b) VMD

c) NMD

d) Volume recovered

iv) Other observed traits of the insecticide

RESULTS AND DISCUSSION

Reduction of Larval Populations

Tables 4-6 illustrate the % larval population reduction on the three host species. The percentages are presented with the larval density data (Tables 7-9) from which they were derived and viewed comprehensively are more representative than percentages *per se*. These data indicate that the 180F formulations gave as good a larval control as the nonylphenol formulation. The correction of population reduction is influenced by the rate of the population decline in the untreated block and this decline is in turn influenced by the early and later populations. When rates of decline in treated and untreated blocks are desparagingly different, very high or very low "corrected" reductions might result. The latter, as evidenced within the white spruce host species (Table 5) do not often reflect the performance of the treatment. Where these apparent phenomena are observed the

larval densities should also be consulted to determine if the "corrected" has merit or as in Table 8 where the density data suggest that the low "corrected" attributed to Block 2 in Table 5, might be false. An unusually high larval density was calculated at the final count for the nonylphenol formulation on white spruce (Table 8, block 8). This was caused by less than optimum branch samples each having only 1 living bud instead of the average number of >60. Even so the 54% defoliation recorded for the same treatment (Table 5) suggests that an adequate explanation should await correlation with the deposit data.

Atlox and water alone gave very little control as evidenced by the low % population reduction (Tables 4-6) and the decline in larval densities, which almost paralleled those in the untreated block (Tables 7-9).

Host Tree Defoliation

Summarized data of host tree defoliation are presented in Tables 4-6 and confirm the earlier evidence of the effectiveness of the flowable formulation. Even where low corrected mortalities were recorded for this formulation, satisfactory percent defoliation was nevertheless observed as long as the larval densities declined to low levels; (<2/100 buds) thus reinforcing the concept that multiple criteria, assessed comprehensively, should be used to evaluate the efficacy of a compound.

Atlox treatments which registered low percent population reduction, and no appreciable larval population decline suffered host tree defoliation comparable to the untreated check block.

Chemical Efficiency of the Spray

The analyses of these data are incomplete at time of writing.

INCIDENTAL OBSERVATIONS OF THE TREATMENTS

Some degree of acaricidal toxicity was observed as small numbers of spiders (*Araneae*) were knocked down in blocks treated with both the flowable and nonylphenol formulations.

Occupational

The 'flowable' mixed without difficulties, and presented no undue on-site occupational problems. Clean up of the site and equipment was considerably easier with the flowable formulation than the nonylphenol formulation and the flowable exhibited a much less offensive odour.

CONCLUSIONS

These data indicate that under the experimental conditions tested, (i) Aminocarb 180F in both water and ID-585, were equally as effective in controlling spruce budworm, *C. fumiferana* on Balsam fir and spruce as the oil soluble concentrate on Aminocarb 1.5D. ii) the 180F formulation effected very good foliage protection, and iii) Atlox® 3409F sprayed in water, possesses no discernible insecticidal activity against *C. fumiferana*.

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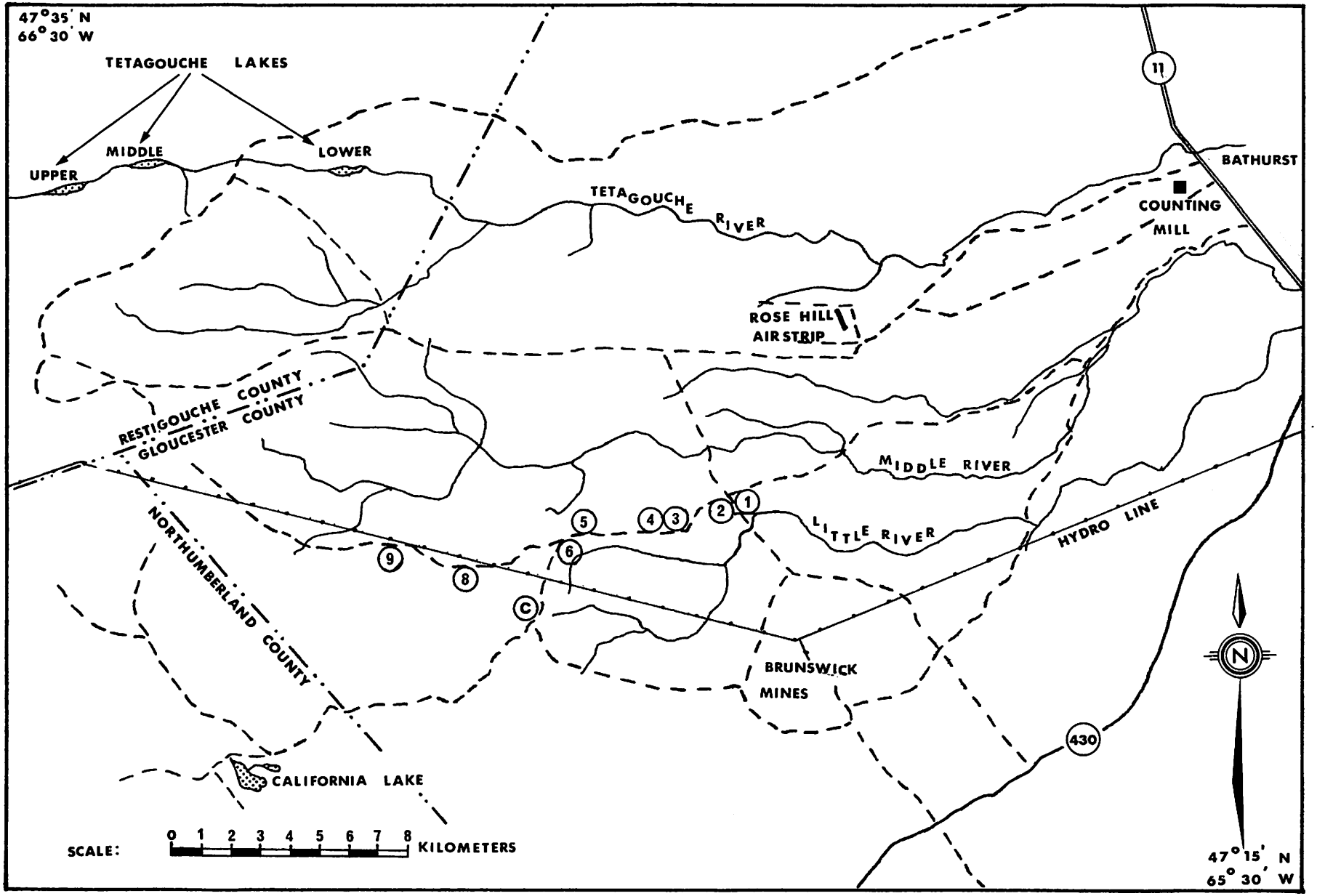

FIG. 1; THE AMINOCARB EXPERIMENTAL RESEARCH SITE NEAR BATHURST, NB. SHOWING (①-⑨) THE SPRAY BLOCKS AND Ⓒ, THE UNSPRAYED CHECK AREA. (1981)

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Table 9: Population Densities of Spruce Budworm Larvae in Experimental Areas (Bathurst, N.B. 1981)

Host Tree: Red Spruce

Block	Spray formulation	Date	No. of samples	Population densities per bud				
				Prespray	Count 1*	Count 2**	Count 3**	Count 4**
1	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	20	0.082	0.040 2	0.023 2	0.022 6	0.015 10
2	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	6	0.028	0.014 2	0.015 2	0.021 6	0.007 10
3	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	4	0.047	0.006 3	0.005 2	0.016 7	0.003 11
4	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	20	0.042	0.028 3	0.025 3	0.011 7	0.013 11
5	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	10	0.032	0.009 5	0.002 4	0.002 8	0.003 12
6	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	22	0.022	0.024 4	0.024 4	0.016 8	0.006 12
8	Aminocarb 1.5 OSC[1] + Shell 585 (70 g/ha A.I.)	16-06-81 19-06-81	20	0.053	0.062 2	0.051 4	0.036 8	0.032 12
9	Atlox + H_2O	15-06-81 19-06-81	20	0.061	0.066 3	0.153 4	0.097 8	0.101 12
Check	Untreated	N/A	30	0.082	0.126	0.151	0.172	0.156

[1] OSC-- oil soluble conc.
* denotes days after 1st application
** denotes days after 2nd application

Table 8: Population Densities of Spruce Budworm Larvae in Experimental Areas (Bathurst, N.B. 1981)

Host Tree: White Spruce

Block	Spray formulation	Date	No. of samples	Population densities per bud									
				Prespray	Count 1*		Count 2**		Count 3**		Count 4**		
1	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	10	0.394	0.170	2	0.050	2	0.055	6	0.016	10
2	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	0	-	-		-		-		-	
3	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	28	0.195	0.178	3	0.063	2	0.072	7	0.122	11
4	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	24	0.195	0.217	3	0.338	3	0.515	7	0.051	11
5	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	24	0.221	0.096	5	0.057	4	0.023	8	0.016	12
6	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	6	0.198	0.092	4	0.042	4	0.006	8	0.005	12
8	Aminocarb 1.5 OSC[1] + Shell I.D. 585 (70 g/ha A.I.)	16-06-81 19-06-81	20	0.432	0.213	2	0.105	4	0.544	8	1.305	12
9	Atlox + H_2O	15-06-81 19-06-81	20	0.339	0.454	3	1.332	4	2.510	8	0.286	12
Check	Untreated	N/A	30	0.365	0.297		2.307		1.502		0.132	

[1] OSC-- oil soluble conc.

* subnumeral denotes days after 1st application

** subnumeral denotes days after 2nd application

Table 7: Population Densities of Spruce Budworm larvae in Experimental Areas (Bathurst, N.B. 1981)

Host Tree: Balsam Fir

Block	Spray formulation	Date	No. of samples	Population densities per bud								
				Prespray	Count 1*		Count 2**		Count 3**		Count 4**	
1	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	86	0.221	0.093	2	0.023	2	0.022	6	0.009	10
2	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	114	0.133	0.083	2	0.021	2	0.018	6	0.011	10
3	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	78	0.084	0.059	3	0.011	2	0.015	7	0.007	11
4	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	68	0.095	0.046	3	0.014	3	0.017	7	0.025	11
5	Aminocarb 1.5 OSC[1] + Sunspray 6N (70 g/ha A.I.)	13-06-81 18-06-81	66	0.077	0.043	5	0.015	4	0.004	8	0.006	12
6	Aminocarb 1.5 OSC[1] + Sunspray 6 N (70 g/ha A.I.)	13-06-81 18-06-81	80	0.192	0.115	4	0.007	4	0.002	8	0.004	12
8	Aminocarb 1.5 OSC[1] + Shell I.D. 585 (70 g/ha A.I.)	16-06-81 19-06-81	68	0.185	0.115	2	0.032	4	0.028	8	0.007	12
9	Atlox + H_2O	15-06-81 19-06-81	60	0.173	0.193	3	0.255	4	0.285	8	0.357	12
Check	Untreated	N/A	60	0.232	0.258		0.510		0.446		0.817	

[1] OSC-- oil soluble conc.
* denotes days after 1st application
** denotes days after 2nd application

Table 6

Summarized Data of Spruce Budworm Larval Population Reduction and Host Tree Defoliation in 9 Experimental Blocks

(Bathurst, N.B. 1981)--Host Tree: Red Spruce

Block	Spray formulation	Date	No. of samples	% Population reduction (corrected)				Defoliation %
				Count 1*	Count 2**	Count 3**	Count 4**	
1	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	20	55.1 2	77.7 2	80.0 6	87.2 10	3.8
2	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	6	61.1 2	62.5 2	50.0 6	84.1 10	1.6
3	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	4	85.7 3	92.5 2	77.5 7	95.9 11	0.1
4	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	20	49.1 3	58.3 3	82.5 7	80.0 11	2.8
5	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	10	79.6 5	95.7 4	95.8 8	94.0 12	1.5
6	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	22	17.2 4	22.6 4	51.5 8	82.4 12	4.8
8	Aminocarb 1.5 OSC[1] + I.D. 585 (70 g/ha A.I.)	16-06-81 19-06-81	12	42.6 2	56.4 4	71.4 8	75.2 12	9.2
9	Atlox + H_2O	15-06-81 19-06-81	20	15.4 3	0.0 4	0.0 8	0.0 12	19.7
Check	Untreated	N/A	30	N/A	N/A	N/A	N/A	26.5

[1] OSC--oil soluble conc.
* denotes days after 1st application
** denotes days after 2nd application

Table 5

Summarized Data of Spruce Budworm Larval Population Reduction and Host Tree Defoliation in 9 Experimental Blocks

(Bathurst, N.B. 1981)--Host Tree: White Spruce

Block	Spray formulation	Date	No. of samples	% Population reduction (corrected) Count 1*	Count 2**	Count 3**	Count 4**	Defoliation %
1	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	10	57.8 (2)	88.1 (2)	87.2 (6)	96.4 (10)	30.9
2	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	0	-	-	-	-	-
3	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	28	12.7 (3)	71.2 (2)	68.1 (7)	47.0 (11)	24.4
4	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	24	0 (3)	0 (3)	0 (7)	77.8 (11)	31.0
5	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	24	60.7 (5)	77.2 (4)	91.0 (8)	93.9 (12)	17.3
6	Aminocarb 1.5 OSC[1] + 6N Sunspray (70 g/ha A.I.)	13-06-81 18-06-81	6	57.2 (4)	81.1 (4)	97.4 (8)	97.8 (12)	27.8
8	Aminocarb 1.5 OSC[1] + Shell I.D. 585 (70 g/ha A.I.)	16-06-81 19-06-81	20	54.1 (2)	78.1 (4)	0.0 (8)	0.0 (12)	54.1
9	Atlox + H_2O	15-06-81 19-06-81	20	0.0 (3)	0.0 (4)	0.0 (8)	36.9 (12)	73.4
Check	Untreated	N/A	30	N/A	N/A	N/A	N/A	76.3

[1] OSC oil soluble conc.
* subnumeral denotes days after 1st application
** subnumeral denotes days after 2nd application

Table 4

Summarized Data of Spruce Budworm Larval Population Reduction and Host Tree Defoliation in 9 Experimental Blocks

(Bathurst, N.B. 1981)--Host Tree: Balsam Fir

Block	Spray formulation	Date	No. of samples	% Population reduction (corrected) Count 1*	Count 2**	Count 3**	Count 4**	Defoliation %
1	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	86	63.9 2	93.8 2	94.9 6	98.1 10	10.4
2	Aminocarb 180F + Atlox + H_2O (70 g/ha A.I.)	12-06-81 18-06-81	114	57.0 2	90.2 2	92.0 6	95.3 10	13.9
3	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	78	52.8 3	91.9 2	89.5 7	95.3 11	10.4
4	Aminocarb 180F + Shell I.D. 585 (70 g/ha A.I.)	12-06-81 18-06-81	68	67.4 3	90.8 3	89.4 7	84.9 11	9.5
5	Aminocarb 1.5 OSC[1] + Sunspray 6N (70 g/ha A.I.)	13-06-81 18-06-81	66	63.6 5	88.0 4	97.0 8	95.6 12	6.1
6	Aminocarb 1.5 OSC[1] + Sunspray 6N (70 g/ha A.I.)	13-06-81 18-06-81	80	59.6 4	97.7 4	99.4 8	98.9 12	23.2
8	Aminocarb 1.5 OSC[1] + I.D. 585 (70 g/ha A.I.)	16-06-81 19-06-81	68	56.3 2	88.9 4	91.0 8	97.8 12	20.7
9	Atlox + H_2O	15-06-81 19-06-81	60	21.5 3	5.6 4	0.0 8	0.0 12	62.3
Check	Untreated	N/A	60	N/A	N/A	N/A	N/A	75.5

[1] OSC oil soluble conc.
* denotes days after 1st application
** denotes days after 2nd application

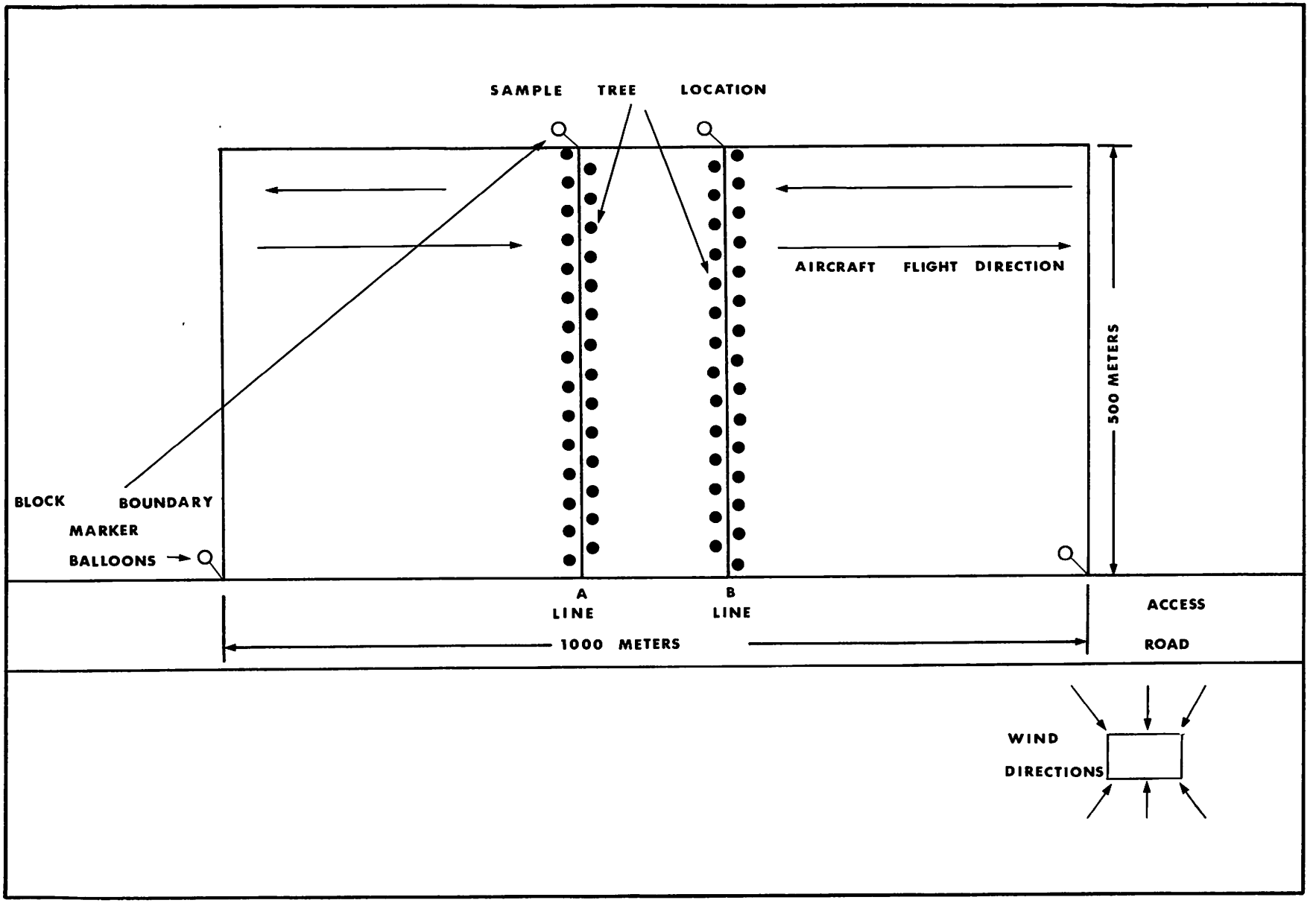

FIGURE 2 ; DESIGN OF EXPERIMENTAL BLOCK, SHOWING LOCATION OF SAMPLE LINES, MARKER BALLOONS, HYPOTHETICAL SAMPLE TREE POSITION AND PREFERRED WIND DIRECTION.