

ENVIRONMENTAL CHEMISTRY OF THE
PEST CONTROL PRODUCTS
USED IN 1981

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Introduction

Large scale utilization of pest control chemicals although confer significant benefits to forestry, cause concern of their possible hazards onto the environment. The primary objective of this project is to study and examine the fate and impact of pest control products and their metabolites on the environment. This report consists of a stock-taking of some of the major advances made in laboratory and field studies conducted during the year 1981.

- (1) *The persistence and fate of three aminocarb (flowable and oil) formulations in a forest environment*

A collaborative program with studies FP9 and FP13 was undertaken to investigate the influence of additives on persistence, distribution and fate of aminocarb present in the three formulations *viz.*, 180 FE (flowable emulsion), 180 FO (flowable oil) and 180 D (oil). Each formulation of the insecticide was applied aerially twice at 70 g AI/ha to three separate 50 ha plots, PI, PIII and PV selected in a mixed coniferous forest in New Brunswick. Residue in balsam fir foliage varied according to the formulations sprayed. Usually higher values were found with the oil formulations 180 D and 180 FO compared to the water formulation 180 FE. In all the cases, the active material was lost rapidly and curvilinearly with time. Aminocarb residues were extremely low in soil compared to forest litter and persisted longer in the later. The

additives in the formulation also played a significant role in droplet spectrum and deposition characteristics.

Results are summarized in Tables 1 to 11.

(2) *The behaviour and degradation of chlorpyrifos-methyl in two aquatic systems*

Two aquatic models were set up separately in an environmental chamber at 15°C to investigate the movement, metabolism and persistence of 400 ppb chlorpyrifos-methyl in flooded soil and the behavior and degradation of 200 ppb of this chemical in natural water. Model I consisted of a 4.5 cm bottom layer of uncontaminated sandy loam, a 1.5-cm second layer containing 400 ppb of chlorpyrifos-methyl, and 80 l of lake water in a 100 l glass aquarium. Model II was similar, except all soils were uncontaminated and the water contained 200 ppb of chlorpyrifos-methyl. Both models and a control were held in an environmental chamber at 15°C for 90 days.

Chlorpyrifos-methyl was strongly adsorbed on the soil particles even when flooded; very little had desorbed and then dissolved in water. The maximum concentration in the water of Model I was 1 ppb, detected 0.7 day after incubation. Chlorpyrifos-methyl metabolized rapidly in the flooded soil; the major breakdown product was 3,5,6-trichloro-2-pyridinol. While the concentration of the parent compound in the flooded soil declined that of the pyridinol increased gradually and reached a maximum in

about 27 days, then declined thereafter. The pyridinol was never detected in water. Both compounds were almost completely dissipated in 90 days.

In Model II chlorpyrifos-methyl moved rapidly from the water to the flooded soil. After incubation for 13 days, its concentration increased from nondetectable to a maximum of 560 ppb in the flooded soil, but decreased from 200 ppb to 40 ppb in the water. Both chlorpyrifos-methyl and its breakdown product, 3,5,6-trichloro-2-pyridinol, were readily degraded in soil and water; only 0.1 ppb and 10 ppb remained in the water and in the flooded soil respectively after incubation for 83 days.

(3) *Influence of formulation on foliar deposition and persistence of fenitrothion and aminocarb (collaborative research with Study No. FP9*

Foliar deposition and persistence of fenitrothion and aminocarb was studied following simulated aerial application on to white spruce trees. Foliar concentrations were measured by gas-chromatography.

The additives in the formulation played a significant role in the degree of foliar deposition and persistence, thereby influencing the biological activity of the spray mixture. A volatile and low viscous solvent gave rise to low foliar deposition and persistence of the active ingredient. In this respect fuel oil appeared to be a better diluent than Arotex® with both insecticides. With aminocarb, however, nonyl-phenol showed definite

advantages over other additives, as it gave rise to the highest foliar deposits and persistence.

(3) *Translocation and dynamics of nonylphenol in an aquatic model ecosystem*

The dissipation of 1.0 ppm nonylphenol in stream and pond water, incubated in flasks at 16°C under simulated field conditions up to 44 days indicated that the half-life was 2.5 days if the flasks were open, and 16 days if they were closed. A transformed product was detected in the closed flasks.

Translocation and nonylphenol in water occurred when treated water samples were incubated in the presence of sediment. After 10 days, nonylphenol was detected only in the sediment, but not in water. About 80% of the nonylphenol was degraded in 71 days, but no degradation occurred if the water and the sediment were autoclaved prior to incubation

(4) *A preliminary study on the evaluation of analytical methods used in assessing aerial spray deposits (collaborative research with Study No. FP9)*

A study of spray deposit assessment was made under both laboratory and field operational conditions using the currently introduced aminocarb 180 F emulsion formulation. Deposits were collected on balsam fir foliage and on the standard Kromekote card-glass plate collection units. Two different techniques were used for deposit assessment on foliage: gas-liquid chromatography (GLC) for the active ingredient (AI) and spectrofluorometry for the fluorescence of the tracer dye Rhodamine B. Two additional techniques

were also used for the Kromekote card-glass plate units, *viz.* spot counting on Kromekote cards and use of the spread factor data, and spectrophotometry for Rhodamine B on glass plates. The measurement of aminocarb deposited on foliage using GLC gave consistently reproducible and reliable results whereas the spectrofluorometric technique following the elution of the foliage with water (or H₂O/CH₃OH) gave erratic results partly due to the strong adsorption of the dye on to cuticular waxes and to interferences due to coextractive impurities. Deposit assessment by spot counting yielded the lowest values among the four techniques used on the Kromekote card-glass plate collection system. Both spectrofluorometric and spectrophotometric techniques provided approximately similar results (inconsistent especially with field samples) with considerable standard deviation. The errors are partly due to solvent effects, interference due to coextractive impurities and adjuvants in the formulation and partly due to deviation from the Beer-Lambert law (absorbance is proportional to concentration) at extremely low dilutions (especially is the case with glass plates collected from field) indicating that both techniques have considerable limitations. Although expensive and time consuming, GLC technique gave consistently reproducible and reliable AI values in the foliage and on the glass plates collected from field and laboratory experiments.

Compared to the laboratory samples, there was a wide variation in deposits on foliage and on the forest floor. Similarly, assessment of deposits on the forest floor using the above techniques, in random locations over the entire plot, indicated that only a fraction of the insecticide released over the canopy descended to the collection units kept on the forest floor. Various physical and environmental factors at the site of collection unit can prevent spray released over the canopy from reaching the ground. Temperature inversions above the canopy, temperature gradients between the canopy and the ground, channelization of winds within the forest canopy and the little explored micro-meteorology, are some of the factors that can influence greatly the amount of deposit on the ground level.

(5) *Toxicity and metabolic fate of aminocarb formulations to fish (collaborative research with Study No. FP15)*

Fingerling rainbow trout (*Salmo gairdneri* Richardson) were used to determine the lethal toxicity of Matacil® 180 F and Matacil® 180 D ready-to-use formulations. The 96 h LC₅₀s were 21.3 mg/l for water-based Matacil® 180 F (180 FE), 29.1 mg/l for soil-based Matacil® 180 F (180 FO), and 0.36 mg/l for Matacil® 180 D.

Aminocarb (4-dimethylamino-m-tolyl N-methylcarbamate) and MA (4-methylamino-m-tolyl N-methylcarbamate) were detected in fish tissue 96 h after exposure.

More than 50% of the total residue (Aminocarb + MA) were the parent compound. The bioaccumulation ratio ranged from 1.70 to 3.32 at different concentrations of aminocarb. Both aminocarb and MA were rapidly eliminated after the fish had been transferred to clean water; the total residue declined by more than 90% in 72 hr and became nondetectable in 96 hr.

(6) *Fate and toxicity of three aminocarb formulations (180 D, 180 FO and 180 FE) added to a headwater trout stream in Searchmont, Ont. (collaborative research with Study No. 15)*

The three aminocarb spray formulations (180 D and 180 FO are oil formulations whereas 180 FE is an aqueous emulsion) were applied to different parts of a stream (down, middle and upstream) at three separate intervals of time viz., 1 week apart using a "Micron ULVA" sprayer to yield a specific aminocarb concentration for a certain period of time. Aminocarb residues in water (4 sampling sites downstream from the point of application), sediment and fish were monitored for intervals of time following application of three formulations. The aminocarb concentration in water following the injection of oil formulations decreased extremely rapidly due to the hydrophobic nature of the additives. The emulsion formulation on the other hand, due to the presence of hydrophilic component (Atlox 3409F emulsifier) in it, showed a different picture. Similar trends were also observed in sediment and fish

samples but the rate of disappearance in all the substrates was rapid. No fish mortality was noted and no significant amounts of the common aminocarb metabolite (MA is the one found in laboratory study) was found in them. Results are given in Tables 12 to 14.

(7) Miscellaneous research studies

In addition to these advances made in pesticide research, a number of other studies are either completed or in progress.

- (a) *Use of Uvitex®, a fluorescent tracer, to assess B.t. spray deposits from conifer foliage*

Current studies carried out under laboratory conditions showed that Uvitex® is unsuitable as a tracer for assessing B.t. spray deposits because the tracer is strongly adsorbed to conifer needles giving poor recoveries and also it is highly photosensitive.

- (b) Analytical testing of 1981 B.t. spray formulations for aminocarb contamination by GLC techniques.

- (c) Provision of collaborative analytical support [also ref. 7(a) and (b)] to E.I. group on analysing various aminocarb formulations, fish tissues for aminocarb and its metabolites, analysis of glassware rinses and air samples for scientists involved in evaluation of vapour toxicity to target species (FP-12), analysis of tech. materials and tank mixes of formulations, and provision of advisory support to

scientists within FPMI and other sister institutions (MFRC, PFRC, PNFI-carbofuran report, provincial agencies, universities and chemical companies).

- (d) Coordination of the Forestry Substrate Program in FICP Check Sample Program organization, development, implementation and standardization of analytical techniques and sampling methods for forestry substrates.

TABLE 1
Composition of Tank Mix, Dosage and Application Rate

Formulation	Composition of tank mix (volume %)	Plot sprayed	Dosage AI/ha	Application rate (L/ha)
180 FE	Aminocarb 25.93%, Atlox 3409F ¹ 1.27%, Water . 72.27%, Rhodamine B ² 0.53%	PI	70	1.5
180 FO	Aminocarb 25.93%, Shell I.D. 585 ³ 72.07%, Automate B Red ⁴ 2%	PIII	70	1.5
180 D	Aminocarb 25.93% Sunspray 6N oil ⁵ 72.07%, Automate B Red 2%	PV	70	1.5

¹ Atlox® 3409F emulsifier supplied by Atlas Chemical Industries, Brantford, Ont., Canada

² Rhodamine B (dye tracer) supplied by Allied Chemicals, Morristown, New Jersey, U.S.A.

³ Shell Insecticide diluent 585 supplied by Shell Canada Ltd., Toronto, Ont., Canada

⁴ Automate B Red (dye tracer) supplied by Morton Williams Ltd., Ajax, Ont., Canada

⁵ Sunspray 6N oil supplied by Sun Oil Co., Philadelphia, Pa., 19103, U.S.A.

TABLE 2
Deposit Data for Plots PI, PIII and PV

Studies	PI		PIII		PV	
	1st application	2nd application	1st application	2nd application	1st application	2nd application
Drops/cm ²	6 ± 6	0.5 ± 0.4	13 ± 6	3 ± 1	16 ± 6	13 ± 6
D min. (µm)	7	7	16	4	4	4
D max. (µm)	73	73	85	85	105	105
Number mode (µm)	30-40	15-35	35-45	10-40	50-60	50-80
N.M.D. (µm)	28 ± 3	23 ± 3	35 ± 6	21 ± 3	50 ± 7	58 ± 8
V.M.D. (µm)	36 ± 5	33 ± 5	41 ± 5	39 ± 6	65 ± 9	68 ± 9
S.F.	3.1 ± 0.1	3.1 ± 0.1	5.0±0.1 - 5.7±0.2	5.0±0.1 - 5.7±0.2	3.8±0.1 - 5.5±0.2	3.8±0.1 - 5.5±0.2
Spot counting (g/ha)*	0.57 (0.81%)	0.05 (0.07%)	2.2 (3.1%)	0.23 (0.32%)	8.5 (12%)	9.9 (14%)
GLC (g/ha)*	1.98 (2.8%)	0.26 (0.37%)	5.95 (8.5%)	0.87 (1.2%)	11.7 (17%)	13.5 (19%)
Colorimetry (g/ha)*	2.45 (3.5%)	0.91 (1.3%)	7.50 (11%)	1.03 (1.5%)	9.95 (14%)	12.5 (18%)
Dosage (g AI/ha)	70	70	70	70	70	70
Vol. sprayed (L/ha)	1.5	1.5	1.5	1.5	1.5	1.5
Conc. of AI in tank mix (GLC)(Wt/vol)%**	4.73	5.78	4.38	4.69	4.39	4.71

* Values in parenthesis represent the percent of AI reached the forest floor

** Spray formulation is supposed to contain 4.67 g AI/100 ml

TABLE 3
Aminocarb Residues in Balsam Fir Foliage from Plot PI

Time after spraying	Aminocarb concentration (ppm)					
	1st Application			2nd Application		
	As sampled	% Moisture content	Oven-dry*	As sampled	% Moisture content	Oven-dry*
0.5 h	2.41	60	6.03	0.75	66	2.21
1.0 h	1.86	61	4.77	0.96	65	2.74
4.0 h	1.54	62	4.05	0.85	63	2.30
12.0 h	1.37	66	4.03	0.70	64	1.94
15.0 h	1.12	64	3.11	0.66	58	1.57
1 d	0.88	58	2.10	0.68	59	1.66
2 d	0.48	63	1.30	0.63	61	1.62
3 d	0.35	69	1.13	0.58	60	1.45
4 d	0.27	66	0.79	0.55	58	1.31
5 d	0.20	65	0.57	0.51	60	1.28
6 d				0.45	62	1.18
8 d				0.35	64	0.97
10 d				0.29	60	0.73
12 d				0.24	57	0.56
21 d				0.14	59	0.34

* Moisture content was determined as per the A.O.A.C. Official Methods of Analysis, 8th Edn. 1955 by drying 2 x 10 g duplicates of each sample at 105°C for 16 hrs in a thermostatic oven

TABLE 4

Aminocarb Residues in Balsam Fir Foliage from Plot PIII

Time after spraying	Aminocarb concentration (ppm)					
	1st Application			2nd Application		
	As sampled	% Moisture content	Oven-dry	As sampled	% Moisture content	Oven-dry
0.5 h	2.27	61	5.82	0.85	56	1.93
1.0 h	1.98	61	5.08	1.79	57	4.16
4.0 h	1.67	62	4.40	1.44	59	3.51
12.0 h	1.45	66	4.26	1.16	62	3.05
15.0 h	1.36	62	3.58	1.12	62	2.95
1 d	1.31	57	3.05	1.06	63	2.86
2 d	1.14	59	2.78	1.02	64	2.83
3 d	0.79	62	2.08	0.98	66	2.83
4 d	0.57	60	1.43	0.88	64	2.44
5 d	0.38	64	1.06	0.69	65	1.97
6 d				0.58	64	1.61
8 d				0.51	58	1.21
10 d				0.48	60	1.20
12 d				0.44	61	1.13
21 d				0.32	59	0.78

TABLE 5

Aminocarb Residues in Balsam Fir Foliage from Plot PV

Time after spraying	Aminocarb concentration (ppm)					
	1st Application			2nd Application		
	As sampled	% Moisture content	Oven-dry	As sampled	% Moisture content	Oven-dry
0.5 h	0.77	58	1.83	2.35	56	5.34
1.0 h	1.30	60	3.25	2.76	58	6.57
4.0 h	1.15	61	2.95	2.69	58	6.41
12.0 h	1.01	63	2.73	2.04	62	5.37
15.0 h	0.96	62	2.53	1.92	64	5.33
1 d	0.87	62	2.29	1.68	64	4.67
2 d	0.72	63	1.95	1.59	63	4.30
3 d	0.68	64	1.89	1.43	61	3.67
4 d	0.61	63	1.65	1.36	60	3.40
5 d	0.52	62	1.37	1.23	63	3.32
6 d				1.19	59	2.90
8 d				0.97	63	2.62
10 d				0.92	59	2.24
12 d				0.84	60	2.10
21 d				0.64	61	1.64

TABLE 6

Aminocarb Residues in Forest Litter from Plot PI

Time after spraying	Aminocarb concentration (ppm)	
	1st application	2nd application
0.25 h	0.018 (0.024)	0.016 (0.021)
0.50 h	0.023 (0.031)	0.018 (0.023)
1.0 h	0.022 (0.029)	0.015 (0.022)
3.0 h	0.023 (0.029)	0.016 (0.021)
5.0 h	0.018 (0.024)	0.016 (0.022)
12.0 h	0.015 (0.021)	0.014 (0.019)
1 d	0.018 (0.024)	0.012 (0.015)
2 d	0.015 (0.022)	0.012 (0.016)
3 d	0.017 (0.024)	0.010 (0.012)
4 d	0.014 (0.020)	0.007 (0.009)
5 d	0.015 (0.020)	0.006 (0.008)
6 d		0.007 (0.008)
8 d		0.005 (0.007)
10 d		0.006 (0.009)
12 d		T
21 d		N.D.

T = Trace, <0.005 ppm based on wet weight of litter

N.D. = Not detectable; detection limit 0.003 ppm based on wet weight in litter

Values in parentheses are for oven-dry litter samples

Percent moisture content of litter samples are not given since they can be calculated from the following expression:

$$\text{Percent moisture content of litter} = \frac{[(\text{Aminocarb in oven-dry - (Aminocarb in wet)} \times 100]}{(\text{Aminocarb in oven-dry litter sample}) \quad (\text{litter sample})}$$

TABLE 7

Aminocarb Residues in Forest Litter from Plot PIII

Time after spraying	Aminocarb concentration (ppm)	
	1st application	2nd application
0.25 h	0.038 (0.052)	0.042 (0.052)
0.50 h	0.054 (0.072)	0.044 (0.049)
1.0 h	0.086 (0.146)	0.046 (0.060)
2.0 h	0.080 (0.106)	0.044 (0.056)
3.0 h	0.077 (0.100)	0.049 (0.066)
5.0 h	0.074 (0.099)	0.036 (0.044)
12.0 h	0.072 (0.096)	0.040 (0.049)
1 d	0.068 (0.088)	0.026 (0.032)
2 d	0.064 (0.079)	0.019 (0.028)
3 d	0.052 (0.069)	0.017 (0.026)
4 d	0.045 (0.060)	0.017 (0.024)
5 d	0.034 (0.046)	0.016 (0.021)
6 d		0.015 (0.022)
8 d		0.014 (0.019)
10 d		0.013 (0.018)
12 d		0.010 (0.014)
21 d		N.D.

See footnotes in Table 6

TABLE 8
Aminocarb Residues in Forest Litter from Plot PV

Time after spraying	Aminocarb concentration (ppm)	
	1st application	2nd application
0.25 h	0.132 (0.175)	0.126 (0.172)
0.50 h	0.159 (0.211)	0.144 (0.188)
1.0 h	0.178 (0.227)	0.206 (0.269)
2.0 h	0.188 (0.240)	0.216 (0.269)
3.0 h	0.160 (0.199)	0.215 (0.263)
4.0 h	0.146 (0.181)	0.196 (0.246)
12.0 h	0.098 (0.128)	0.180 (0.245)
1 d	0.085 (0.108)	0.126 (0.157)
2 d	0.078 (0.098)	0.110 (0.141)
3 d	0.074 (0.094)	0.098 (0.138)
4 d	0.069 (0.086)	0.081 (0.108)
5 d	0.061 (0.077)	0.074 (0.101)
6 d		0.061 (0.084)
8 d		0.049 (0.068)
10 d		0.035 (0.046)
12 d		0.029 (0.037)
21 d		0.013 (0.017)

See footnotes in Table 6

TABLE 9
Aminocarb Residues in Forest Soil from Plot I

Time after spraying	Aminocarb concentration (ppm)	
	1st application	2nd application
0.25 h	0.004 (0.007)	T
0.50 h	0.008 (0.013)	0.003 (0.005)
1.0 h	0.006 (0.011)	T
2.0 h	0.005 (0.008)	N.D.
3.0 h	0.006 (0.009)	N.D.
5.0 h	T	N.D.
12.0 h	N.D.	-
1 d	N.D.	-
2 d	-	-
3 d	N.D.	N.D.
4 d	-	-
5 d	N.D.	N.D.
6 d		
8 d		
10 d		
12 d		
21 d		

T = Trace < 0.003 ppm based on wet mass of soil

N.D. = Not detectable; detection limit 0.001 ppm
based on wet mass of soil

Values in parentheses are for oven-dry soil samples

TABLE 10
Aminocarb Residues in Forest Soil from Plot III

Time after spraying	Aminocarb concentration (ppm)	
	1st application	2nd application
0.25 h	0.008 (0.013)	0.004 (0.007)
0.50 h	0.014 (0.024)	0.005 (0.008)
1.0 h	0.018 (0.029)	0.010 (0.017)
2.0 h	0.016 (0.025)	0.005 (0.009)
3.0 h	0.010 (0.016)	0.004 (0.007)
5.0 h	0.011 (0.018)	T
12.0 h	0.007 (0.011)	N.D.
1 d	0.004 (0.006)	N.D.
2 d	N.D.	N.D.
3 d	N.D.	N.D.
4 d	-	-
5 d	N.D.	N.D.
6 d		
8 d		
10 d		
12 d		
21 d		

See footnotes in Table 9

TABLE 11
Aminocarb Residues in Forest Soil from Plot V

Time after spraying	Aminocarb concentration (ppm)	
	1st application	2nd application
0.25 h	0.024 (0.039)	0.008 (0.014)
0.50 h	0.032 (0.053)	0.016 (0.028)
1.0 h	0.050 (0.086)	0.034 (0.057)
2.0 h	0.051 (0.089)	0.044 (0.076)
3.0 h	0.046 (0.075)	0.038 (0.064)
5.0 h	0.037 (0.063)	0.030 (0.052)
12.0 h	0.024 (0.039)	0.022 (0.036)
1 d	0.011 (0.019)	0.017 (0.027)
2 d	0.007 (0.011)	0.011 (0.018)
3 d	0.004 (0.007)	0.006 (0.010)
4 d	T	0.004 (0.007)
5 d	T	T
6 d		T
8 d		N.D.
10 d		N.D.
12 d		N.D.
21 d		-

See footnotes in Table 9

TABLE 12
Aminocarb Concentration (ppb) in Stream Water at Different Stations
After Spraying the Stream with Three of its Formulations

Time after spraying	Formulation 180 FE				Formulation 180 FO				Formulation 180 D			
	Sampling station from application (m)				Sampling station from application (m)				Sampling station from application (m)			
	5	50	100	150	5	50	100	150	5	50	100	150
Prespray	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1 min.	0.1	N.D.	N.D.	N.D.	301.9	N.D.	N.D.	N.D.	380.4	N.D.	N.D.	N.D.
3 min.	799.8	N.D.	N.D.	N.D.	3823.2	N.D.	N.D.	N.D.	1862.3	0.4	N.D.	N.D.
5 min.	1306.5	N.D.	N.D.	N.D.	15000.0	1.2	N.D.	N.D.	30.1	74.9	0.9	N.D.
10 min.	959.3	T	N.D.	N.D.	481.4	3.0	N.D.	N.D.	8.4	17.5	6.4	N.D.
15 min.	451.3	0.5	N.D.	N.D.	136.0	195.6	N.D.	N.D.	3.7	12.4	35.4	N.D.
20 min.	163.9	122.1	N.D.	N.D.	21.7	273.7	0.1	0.2	0.8	2.8	34.0	7.7
30 min.	28.5	363.0	N.D.	N.D.	3.3	13.8	127.2	0.2	0.1	0.3	2.4	25.0
1.0 h	2.2	15.9	256.1	0.3	0.6	3.9	29.1	109.5	N.D.	0.1	0.1	0.4
1.5 h	1.1	3.2	162.1	100.1	0.2	0.9	3.8	48.7	N.D.	N.D.	N.D.	0.1
2.0 h	0.5	1.0	33.5	109.7	0.2	0.3	1.5	15.9	N.D.	N.D.	N.D.	N.D.
3.0 h	0.3	0.4	3.6	38.6	T	0.2	0.1	0.4	N.D.	N.D.	N.D.	N.D.
4.0 h	0.2	0.2	1.3	4.7	N.D.	0.1	0.1	0.3	N.D.	N.D.	N.D.	N.D.
5.0 h	0.2	0.2	0.6	1.3	N.D.	N.D.	0.1	0.1	-	-	-	-
6.0 h	0.1	0.1	0.2	0.6	N.D.	N.D.	N.D.	0.1	-	-	-	-
9.0 h	N.D.	N.D.	0.1	0.1	N.D.	N.D.	N.D.	N.D.	-	-	-	-
25 h	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-	-	-	-
50 h	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-	-	-	-

T = Trace <0.1 ppb.

N.D. = Not detectable; detection limit 0.05 ppb.

TABLE 13

Aminocarb Concentration (ppb) in Stream Sediments

Time after spraying	Formulation 180 FE		Formulation 180 FO		Formulation 180 D	
	Sampling station from spray site		Sampling station from spray site		Sampling station from spray site	
	5 m	50 m	5 m	50 m	5 m	50 m
Prespray	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1 min.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
3 min.	3.5 (3.9)	N.D.	3.2 (4.0)	N.D.	T	N.D.
5 min.	20.2 (23.8)	N.D.	7.6 (8.6)	N.D.	T	N.D.
10 min.	9.4 (10.9)	N.D.	T	N.D.	N.D.	N.D.
15 min.	6.8 (7.9)	T	N.D.	N.D.	N.D.	N.D.
20 min.	3.5 (4.1)	T	N.D.	N.D.	N.D.	-
30 min.	T	T	N.D.	N.D.	N.D.	-
1.0 h	T	T	N.D.	-	-	-
1.5 h	N.D.	N.D.	N.D.	-	-	-
2.0 h	N.D.	N.D.	-	-	-	-
3.0 h	N.D.	N.D.	-	-	-	-

Residues in parenthesis were based on dry weight of sediment

T = Trace, <3 ppb based on wet weight of sediment

N.D. = Not detectable; detection limit 1.5 ppb based on wet weight of sediment

TABLE 14

Residues of Aminocarb (ppb)* in Rainbow Trout Fingerlings**
Kept in Cages on Stream-bed at Different Stations From
Site of Application of the Aminocarb Formulations

Time after spraying (hr)	Formulation and sampling station		
	180 FE (150 m)	180 FO (100 m)	180 D (100 m)
Prespray	N.D.	N.D.	N.D.
0.5	N.D.	T	17.1 \pm 6.1
1.0	4.4 \pm 3.2	4.6 \pm 2.9	3.8 \pm 2.8
1.5	85.1 \pm 7.9	18.0 \pm 4.9	T
2.0	106.6 \pm 7.4	31.6 \pm 6.7	N.D.
3.0	127.4 \pm 8.8	T	N.D.
6.0	T	N.D.	N.D.

* Values are the mean of four determinations

** Average number of fish per cage (61 x 61 x 41 cm) = 25

Average mass of fish = 23.2 \pm 6.4 g

Average length of fish = 13.3 \pm 1.3 cm

T = Trace, <3.0 ppb based on wet weight of fish

N.D. = Not detectable; detection limit 1.5 ppb based
on wet weight of fish