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Persistence of Fenitrothion Insecticide in Poplar *Populus tremuloides* and Gray Birch *Betula populifolia*

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Fenitrothion, O, O-dimethyl O-(4 nitro-m-tolyl) phosphorothioate, has been used since 1969 to control spruce budworm Choristoneura fumiferama (Clemens) in the forest of the Canaan Game Reserve, New Brunswick, Canada. Various workers (Shishido et al 1972, Miyamoto 1969) have previously shown a short persistence of fenitrothion in a natural environment. In contrast, Yule and Duffy 1972 and Sundaram (1974) demonstrated that fenitrothion can persist within a coniferous forest in concentrations ranging from 0.14 to 0.80 ppm over a 5-year period.

This project evaluated residual concentrations of fenitrothion and its oxygen analogue in Poplar Populus tremuloides and gray birch Betula populifolia. Previous studies by Brenner (1962), Hodgson (1966), and Novakowski (1967) all indicate that poplar is the preferred food of the beaver. Barber et al. (1971) indicated that a high concentration of dietary fenitrothion might have a negative effect on the rumen flora; hence the energy requirements of the beaver might be affected during the winter period.

MATERIALS AND METHODS

The field experiments were located in the Canaan Game Reserve area 34 km northwest of Moncton within longitude 65°30' and latitude 46°20'. The experimental plot within the sprayed area was located 5 km from Alward Brook within spray block 279 of the 1979 spray program. The control plot was located along the south side of the Canaan River approximately 27 km south from the sprayed plots. The control plot has not been sprayed since 1972.

The sampling plots within both the sprayed and unsprayed areas were located within areas where poplar Populus tremuloides (Michx.) and grey birch Betula populifolia (Marsl.) were the predominant species. Red spruce Picea mariana (L.) has been extensively logged within this

area during the past 17 years. A growth of red maple Acer rubrum (L.) and beaked hazelnut Corylus cornuta (Marsl.) varying from 1.5 to 3 m in height formed the major, lower vegetation within the plots. All sampling plots were located in areas where beaver browsing had been observed. The sprayed plots were treated with two aerial applications of 100 g active ingredient/hectare of fenitrothion in an oil emulsion between May 26th and June 5th 1980.

The sampling plots measured ten square meters. Samples were collected from the 15th of May through the 15th of November 1980. A total of 400 samples were collected and processed. Five samples were collected for each weekly monitoring cycle. The samples were analysed individually and the average obtained for each reading. The samples were clipped with pole and hand pruners. About 10 cm lengths were cut at random from terminal twigs ensuring a representative sampling of the entire tree. Thirty grams were cut into small pieces and placed in 110 ml glass bottles. While in the field, the bottles were filled with pesticide-grade ethyl acetate and covered with plastic snap lids which had previously been lined with aluminum foil. Within 2 hours these bottles were refrigerated at $2^{o}C$ until extraction.

Extraction of the insecticide and its derivatives from 20 g samples of wet foliage was accomplished within 15 days following the collection date. The macerated samples were placed in a Waring blender with enough ethyl acetate to bring the volume to 150 ml. Using an external rheostat, the sample was blended at gradually increasing speeds until it formed a pulp. A Buckner funnel (Reeve Angel) filter paper, and 2 cm pad of anhydrous Na_2SO_4 were used to separate solid plant residues from the extract. Plant solids remaining in the funnel were rinsed with ethyl acetate to ensure total recovery of the residue. The resulting solution was evaporated to about 10 ml in a 500 ml boiling flask on a Buchi roto evaporator. This residue was dissolved in 50 ml of pesticide-grade acetonitrie, and was partitioned twice wih 25 ml of pesticide-grade hexanes. The polar layers were evaporated to about 20 ml and placed on an activated charcoal column previously rinsed with 50 ml pesticide-grade benzene. A 20 mm Id column was used with the following packing: glass wool; 10 g Na_2SO_4 mixture of 9 g activated charcoal (BDH), 6 g Celite 503 and 10 g Na_2SO_4. An electrical vacuum pump providing 270 mm H_9 suction was used for elution using 100 ml benzene ethyl acetate (25:75, following by 10 ml benzene. The eluate was reduced to a 10 ml for analysis; and was refrigerated until analysis. Fenitrothion in the extract was analyzed by gas-liquid chromatography done on a gas chromatograph Tractor

(Model MT 270) equipped with an automatic sampler, Hewlett-Packard Model 7671A, and an automatic calculator Spectro physics auto Lab 1. The detector was a F.P.D. (Flame photometric detector). Operating conditions of the chromotograph were: glass column 1.83 mx0.64 cm, Id column packing chromasorb W 80/100 Mesh, liquid phase 3.6% OV 101. The carrier gas was helium with a flow rate of 13 kg.

Table 1. Fenitrothion residues (ppm) in Poplar Populus tremuloides and Gray birch Betula populifolia following the 1979 aerial budworm spray program.

Time relative to application	Sprayed Plots (1) X Poplar (5)* (2) X Birch (5)*		Control Plots (1) X Poplar (5) (2) X Birch (5)	
	(1)	(2)	(1)	(2)
- 15 days	0.02	0.01	0.00	0.00
- 5 days	0.01	0.00	0.00	0.00
- 1 day	0.01	0.02	0.00	0.00
1st spray				
+ 15 min.	22.41	18.37	0.01	0.01
+ 12 hrs.	18.71	16.21	0.00	0.01
+ 1 day	12.64	9.21	0.01	0.01
+ 2 days	7.86	8.31	0.01	0.02
+ 3 days	6.31	5.30	0.00	0.00
+ 5 days	3.08	2.36	0.00	0.01
+ 6 days	0.96	3.13	0.00	0.00
+ 10 days	0.83	1.22	0.00	0.00
2nd spray				
+ 11 days	24.16	17.96	0.03	0.01
+ 12 days	16.31	13.32	0.00	0.01
+ 14 days	9.20	6.54	0.01	0.03
+ 15 days	2.14	4.63	0.00	0.00
+ 30 days	0.98	0.80	0.00	0.00
+ 60 days	0.14	0.08	0.00	0.00
+ 90 days	0.09	0.18	0.00	0.00
+120 days	0.08	0.06	0.00	0.00
+150 days	0.06	0.05	0.00	0.00

* Number of samples analysed

RESULTS AND DISCUSSION

The concentration of fenitrothion varied from 22.4 ppm in poplar to 18.37 ppm in gray birch, immediately following the spray. the concentration within both species diminished rapidly following the spray applications, and 30 days following the initial application, all concentrations were below 1 ppm.

The control plots were relatively free of contamination from the pesticide. The light concentration which was detected following the spray program is more than likely due to aerial drift. The oxygen analogue of fenitrothion, fenitrooxon, was not detected in any sample. Results from both species sampled indicate a persistence of the pesticide throughout the entire sampling period within the sprayed plots. However, the concentrations available to beaver during the browse period which extended from mid August to late November varied between 0.14 and 0.05 for both species sampled.

Oral administration of ^{14}C fenitrothion at a dose level of 0.5 Mg/Kg results in absorption of the pesticide and its appearance into the blood and internal organs of rats. After 4 days, the concentration in the blood was less than .001 ppm (Miyamoto 1969). Hollingworth et al (1967) have indicated that the greater part of ^{32}P and ^{14}C fenitrothion is excreted in the urine of mice within 24 hours and that excretion is virtually complete within 96 hours. Barber et al. (1971) studied the influence of several pesticides on rumen bacteria of deer. With concentrations of 1, 10, 100 and 1000 ppm of malathion, cellulose digestion was respectively 83%, 63%, 25% and 12.6% of the control. After a period of 72 hours, all inhibition had ceased. Production of volatile fatty acids was little affected at 1 ppm or 10 ppm of the pesticide. At 100 ppm, fenitrothion caused a slight decrease in fatty acid concentrations. Schwartz et al. (1973) studied the effects of certain pesticides on rumen function; the concluded that fenitrothion did not affect the digestion of dry matter and cell wall constituents. Novakowski (1967) and Hodgson (1966) indicated that beavers consume between 400 and 700 grams of plant material as a daily diet intake.

In relating the concentrations of 0.14 and 0.05 ppm of fenitrothion for both species sampled to the daily diet requirements of the beaver and the results obtained by Barber and Nagy (1971) and Hollingworth (1967), the results from this study do not support the hypothesis that the concentration of residual fenitrothion presently found in beaver browse could directly affect the cellulose digestion of the beaver during its winter feeding activities.

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REFERENCES

Barber TA, Nagy JG (1971) Effects of pesticides on mule deer rumen bacteria. NA Wildlife Nat Res Conf Trans 36:153-162

Brenner FJ (1962) Food consumed by the beaver. J Wildl Mgmt 26(1):104-107

Hodgson KW, Hunt JH (1966) Beaver Management in Maine. Game Division Bulletin No 3,pp 102

Hollingworth RM, Metcalf RL, Fukuto TR (1967) The selectivity of sumithion compared with methyl parathion metabolism in the white mouse. J Agr Food Chem 15:242-249

Miyamoto J (1969) Studies on the mode of action of organophosphorus componds. Part III. Activation and degradation of sumithion and methyl parathion in vivo. Agr Biol Chem 28:411-421

Nigam PC (1971) Summary of laboratory evaluation of insecticides against forest insect pests during 1971. Chem Control Res Instit Inf Rep cc-x-12 14p

Novakowski NS (1967) The winter bioenergetics of a beaver population in Northern latitudes. Can J Zool 45:1107-1118

Schwartz CC, Nagy JG, Streefer CI (1973) Pesticide effect on rumen microbial function. J Animal Sci 37:821-826

Shishido TK, Vsui M, Sato, Fukami J (1972) Engymatic conjugation of diazion with glytathion in rat and american cockroach. Pestic Biochem Physiol 2:51-63

Sundaram KMS (1974) Distribution and persistence of fenitrothion residues in foliage, soil and water in Larose Forest. Chem Control Res Instit Inf Rep cc-x-64 43p

Yule WN, Duffy JR (1972) The persistence and fate of fenitrothion insecticide in a Forest environment. Bull Environ Contam Toxicol 8:10-18

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