The Persistence of Fenitrothion Insecticide in Red Maple (*Acer rubrum* L.) and White Birch (*Betula papyfifera* (Marsh.)) Deer Browse

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Abstract

From May 15 to November 15, 1977, vegetation plots were monitered on a constant basis in order to obtain the concentration of fenitrothion in red maple and white birch deer browse. The data obtained indicates that the concentrations tend to be as high as 21.413 ppm for the red maple and 19.371 ppm for the white birch immediately following the spray application. However, the concentrations are below 0.010 ppm 120 days following the application. Fenitroxon was detected in two of the samples taken from the sprayed plots. None was detected within the control plots. There is no evidence in the literature that a concentration of fenitrothion of the magnitude detected would have obvious effects on deer populations during their winter yarding.

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, Nigam et al. 1971) have previously shown the short persistence and fate of fenitrothion in a natural environment. Furthermore Yule and Duffy (1972) and Sundaram (1974) demonstrated that fenitrothion can persist in a coniferous forest in concentration ranging from 0.80 to 0.14 ppm over a 5-year period.

This project evaluated residual concentrations of fenitrothion and its oxygen analogue in red maple *(Acer rubrum)* and white birch (*Betula papyrifera* (L.)). Previous studies by Crête (1976) and unpublished data obtained by the author from monitoring deer yards in southeastern New Brunswick indicate that red maple and white birch play an important role in the diet of the white-tailed deer (*Odocoileus virginianus* (Zimmerman)) during the winter yarding. It was anticipated that a high concentration of fenitrothion might have a negative effect on the intestinal rumen flora and consequently disrupt the energy requirements of the deer during their winter yarding.

Study Area and Methods

The field experiments were located in the Canann Game Reserve area 34 km northwest of Moncton within longitude 65° 30′ and latitude 46° 20′. The experimental spray plot was located 5 m from Alward Brook inside spray block 279 of the 1977 spray program. The control plot was located along the south side of the Canaan River approximately 17 km from the sprayed plot. The control plot was not sprayed during the 1975, 1976, and 1977 programs.

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The sampling plots were surrounded by forested aeas dominated by red spruce (*Picea rubens* (Moench)), and black spruce (*Picea mariana* (L.) (M.ll)). Logging of these species occurred 10 years ago in areas where the experimental plots were established. A young growth of red maple and white birch varying from 1.5 to 3 m in height formed the major, lower vegetation within the plots. The upper canopy was composed of mature red maples, grey birch (*Betula populifolia* (Marsl.)), and aspen *(Populus tremuloides* (Michx.)). Both habitats selected were identical in vegetation composition. All sampling plots were located in areas where deer browsing had been observed during the winters of 1975 and 1976. The sprayed plots were treated with two aerial applications of three ounces active ingredient/hectare of fenitrothion in an oil emulsion between May 26 and June 3, 1977.

The sampling plots measured 10 m^2. Samples were collected from the 15th of May through the 15th of November 1977. A total of 80 samples were collected and processed.

The browse samples were clipped with pole and hand pruners. About 10 cm were cut at random from terminal twigs ensuring a representative sampling of the entire tree. Twenty to 30 g 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 alumininum foil. Within 2 hr these bottles were refrigerated at 2° C until extraction.

Extraction of the insecticide and its derivatives from 20-g samples of foliage was accomplished within 15 days following the collection date. The macerated samples were placed in a Waring blender with enough ethyl acetate (pesticide grade) 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 dark-green solution was evaporated to about 10 ml in a 500 ml round bottom boiling flask on a Buchli Roto evaporator. This residue was dissolved in 50 ml of pesticide-grade acetonitrite, and was partitioned twice with 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 presticide-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 Hg suction was used for elution using 100 ml benzene ethyl acetate (25:75), followed by 10 ml benzene. The eluate was flushed to a small volume of about 10 ml for analysis. This sample was refrigerated until analysis.

Analysis

Fenitrothion in the extract was analyzed by gas-liquid chromatogrophy done on a gas Tracor Model MT 270 equipped with an automatic sampler; Hewlett-Packard Model 7671A with interface, and an automatic calculator Spectro physics auto Lab 1. The detector was a FPD system. Operating conditions of the gas chromatograph were: glass column 1.83 M × 0.64 cm, 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/cm^2.

Results

Results of the analysis as given in Table 1 are expressed in units of ppm as sampled. Due to insufficient time and funds, dried samples were not processed. The concentration of fenitrothion varied from 21.41 ppm in the red maple to 19.37 ppm in the white birch, immediately following the spray. The concentration within both species diminished rapidly following the spray application, 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 appeared following the spray programs is more than likely due to aerial drift. The oxygen analogue of fenitrothion, fenitroxon, was detected in only two samples taken from the sprayed plots at concentrations of 0.004 and 0.15 ppm; no detection was obtained from the control samples. Results from both samples of browse indicate a persistence of the pesticide throughout the entire sampling period within the sprayed plots. However the concentration available to the deer during the browse period is considered to be below 0.010 ppm.

Table 1. Fenitrothion residues in red maples *(Acer rubrum)* and white birch *(Betula papyrifera)* deer browse for the 1977 aerial budworm spray program.

Time relative to application	Fenitrothion (ppm)			
	Sprayed plots		Control plots	
	Maple	Birch	Maple	Birch
− 15 days	0.05	0.01	0.00	0.00
− 5 days	0.01	0.01	0.00	0.00
− 1day	0.01	0.01	0.00	0.00
1st Spray				
+ 15 min	21.41	19.37	0.01	0.01
+ 12 hr	16.72	14.20	0.01	0.01
+ 1 day	11.32	9.02	0.01	0.01
+ 2 days	8.76	7.79	0.01	0.01
+ 3 days	5.31	6.33	0.01	0.01
+ 5 days	1.82	2.44	0.00	0.02
+ 6 days	0.97	3.41	0.00	0.01
+ 10 days	0.79	1.22	0.00	0.00
2nd Spray				
+ 11 days	19.39	9.31	0.01	0.01
+ 12 days	12.03	3.21	0.00	0.01
+ 14 days	7.63	2.42	0.00	0.02
+ 15 days	3.28	1.02	0.00	0.00
+ 30 days	0.74	0.09	0.00	0.00
+ 60 days	0.06	0.07	0.00	0.00
+ 90 days	0.02	0.03	0.00	0.00
+ 120 days	0.02	0.01	0.00	0.00
+ 150 days	0.01	0.01	0.00	0.00

Discussion

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. However, 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 within 24 hr and that excretion is virtually complete with 96 hr. Barber and Nagy (1971) studied the influence of several pesticides on rumen bacteria of deer. With concentration of 1, 10, 100, and 1000 ppm of fenitrothion, cellulose digestion was respectively 83%, 63%, 25%, and 12.6% of the control. After a period of 72 hr, 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; they concluded that fenitrothion did not affect the digestion of dry matter and cell wall constituants.

In relating my findings to the work of the above authors, I can find no evidence to support the hypothesis that a concentration of fenitrothion of the magnitude, which I have detected in this study, would directly affect the white tail deer population of this area during winter yarding activities.

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