The Persistence and Fate of Fenitrothion Insecticide In A Forest Environment. III. Deposit and Residue Studies with Black Spruce and Red Maple

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The fate of fenitrothion (0,0-dimethyl-0(4-nitro-m-tolyl) phosphorothioate) in a forest environment has been studied so far in several of the main economic species of New Brunswick's mixed pulpwood forests, namely red spruce, white spruce, and balsam fir (YULE and DUFFY, 1972), and in forest soils. It was found that an operationally-applied dosage of 4 ounces/acres fenitrothion produced maximum deposits on coniferous foliage of <4 ppm., which decreased by 70-85 per cent within two weeks. However, the small terminal residue (10 per cent) persisted throughout the year, and accumulated in balsam fir foliage with further annual spray treatments (YULE, in press). Few breakdown products of fenitrothion were found in coniferous foliage, and the insecticide did not persist for long in forest soil (YULE and DUFFY, 1972).

Further sutides have now been made using black spruce (Picea mariana (Mill.) B.S.P.) and red maple (Acer rubrum L.) as additional indicator species for Eastern Canadian forests. Black spruce is a major pulpwood tree in Eastern Canada, and is of ecological significance because of its peculiar habitat selection (bog), physiological adaptations (late development, budworm resistance) and distinctive faunal associations (e.g. high populations of parasitic Hymenoptera). Red maple is of frequent occurrence in Eastern Canada, and is of increasing economic importance as a fibre resource. Since hardwood species in general may comprise about one third of the wood fibre in pulpwood forests, and frequently support and shelter a large number and variety of animal species, they are important to the integrity of the spruce-fir ecosystem and to the forest environment at large. Spray operations for spruce budworm control inevitably subject the hardwood component to insecticidal strees, but we have little knowledge of the responses of the arthropod communities thus exposed.

The purpose of this work was to determine the persistence and fate of fenitrothion in associated species of trees when a mixed spruce-fir forest was sprayed operationally for budworm control, to understand further the ecological implications of such pest control practices on the general forest environment.

Materials and Methods

An area of mixed forest near Fredericton, N.B., that was scheduled for operational spraying of fenitrothion in the 1973 spruce budworm control program, was selected for this study. Sampling of black spruce foliage (developing buds and shoots, and

1972 needles), and of red maple foliage, were made before and at intervals after the operational application on 30th May; the spray dosage was 3 ounces/acre fenitrothion in an aqueous emulsion formulation. Samples were cut with pole pruners in the upper crowns of fully exposed trees.

Wherever practicable, 100g samples were taken on each sampling occasion (IWV), weighed fresh and sealed in a screw-top mason jar together with 100 ml pesticide-analysis grade methanol (Fisher Scientific, New Jersey) and transported to Ottawa for analysis (YULE, in press). Two hundred ml of pesticide-analysis grade chloroform (Caledon Laboratories, Georgetown, Ontario) were added to the sample jar, and extraction, clean-up, and analysis procedures used thereafter were as described in YULE and DUFFY (1972). An aliquot of the original sample was oven-dried (A.O.A.C., 1955) so that residues could be presented both in terms of "ppm. fresh weight" for ecological interpretation, and "ppm. oven-dry weight" for more standardized comparison of residues between species and sampling times.

Results and Discussion

It is apparent from the analysis (Table 1) that fenitrothion residues in black spruce were very similar in quantity and rate of decrease to those reported previously in red and white spruces and in balsam fir (YULE and DUFFY, 1972). The 1973 foliage, which was in the form of tightly closed buds at the time of spraying and for about 3 weeks afterwards, showed no evidence of systemic carry-over of fenitrothion residue from previous sprayings. With the 1972 foliage of black spruce, however, a trace of fenitrothion residue persisted from treatment in previous years, as has been found with balsam fir (YULE, in press).

The rate of decrease of fenitrothion residue was greater with the foliage of 1973 black spruce and red maple due to a large biomass dilution factor (seasonal leaf growth) operating together with the real rate of loss of fenitrothion. In the case of black spruce, the current year's buds flared into shoots about 3 weeks after spraying (Table 1). With maple, spraying took place at the crumpled leaflet stage, and leaflets expanded with growth into larger flat leaves, whose mass further increased as the season progressed by the growth of new leaves at the shoot apex. By comparison, the mass, surface area, and water content of the 1972 black spruce foliage remained relatively constant throughout the season.

The comparatively heavy initial deposit of fenitrothion on red maple foliage (3-4 times that on black spruce, Table 1) may be of ecological significance regarding exposure of hardwood fauna in a mixed forest. The difference in deposit between tree species may be associated with growth habit. Black spruce trees tend to grow in dense clumps with tall raking tops exposed to the sun. Red maple, on the other hand, tend to occur in more open woodland and form a hollow ball-shaped canopy of foliage, with most new leaves seeking the sun on the periphery, where they would be more exposed to spray. Research on the ecological impact of fenitrothion on the arthropod community associated with red maple has been initiated (VARTY, I.W., unpublished).

TABLE 1

Fenitrothion deposits and residues on black spruce and red maple foliage in relation to time of application

Sampling days relative to spray day	Fenitrothion Deposit/Residue (ppm.)					
	Black Spruce				Red Maple	
	1973 foliage		1972 foliage		1973 foliage	
	f.w.	o.d.w.	f.w.	o.d.w.	f.w.	o.d.w.
-1	ND	ND	0.01	0.02	ND	ND
0	2.27	6.25	2.33	4.19	5.39	18.91
+2	1.52	4.63	4.50	7.85	2.08	7.63
4	0.84	2.36	2.00	3.35	0.63	2.10
8	0.29	0.94	1.89	3.43	0.14	0.53
16	0.03	0.12	0.71	1.31	0.02	0.04
32	T	T	0.34	0.72	0.06	0.15
64	T	T	0.19	0.42	0.01	0.02
128	T	T	0.02	0.03	T	T

Buds: 1973 foliage, f.w. and o.d.w.; 1972 foliage, f.w. and o.d.w.

Shoots: 1973 foliage, f.w. and o.d.w.

f.w. = ppm. fresh weight
o.d.w. = ppm. oven-dry weight

T = < 0.01 ppm.
ND = < 0.004 ppm.

To check if, in the case of deciduous trees, foliar residues might be passed on to the soil stratum of the forest environment, several samples of red maple leaves and soil were taken before and after leaf fall (August and October). Only traces of fenitrothion were found in either of these substrates at these times (< 0.01 ppm.), indicating that there was no significant transfer of residues upon leaf fall.

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