The Persistence and Fate of Fenitrothion Insecticide in a Forest Environment. II. Accumulation of Residues in Balsam Fir Foliage

by

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It was shown by YULE and DUFFY (1972) that, although 70-85 per cent of the initial dosage (<4 ppm.) of fenitrothion (O, O - dimethyl O - (4-nitro - m - tolyl) phosphorothioate) deposited by aircraft on coniferous forest trees (mixed spruce spp. and balsam fir) for spruce budworm control was lost by the foliage within two weeks after spraying, approximately 10 per cent of the initial dose persisted there for at least a further 10 months. Soil residues of fenitrothion were smaller and less persistent than those in foliage, and only trace amounts (<0.02 ppm.) of known breakdown products were found at any time in these environmental components under operational conditions of insect control YULE and DUFFY, 1972).

Large-scale use of fenitrothion for budworm control began in 1968, and several million acres of New Brunswick's (N.B.) forests have been sprayed for a number of years with applied dosages up to 5 ounces of fenitrothion per acre per year (Table 1). In view of the unexpected persistence of fenitrothion in spruce and fir foliage over the 1970-71 season (YULE and DUFFY, 1972), and because of possible ecological implications of such persistence, a survey was made in the Spring of 1973 to check for accumulation of fenitrothion residues by coniferous foliage in areas of N.B. which had been sprayed up to 5 consecutive years.

Methods and Materials

Large areas with spray histories ranging from 5 consecutive years' fenitrothion spraying (1968-72), to a single application in 1972, were selected for soil and foliage sampling from records and maps of the N.B. spray operation (Table 1). Field sampling was done just before the start of the 1973 spray programme (early May).

Balsam fir (Abies balsamea (L.) Mill.) was chosen as indicator species for coniferous trees, and foliage and soil samples were taken from each site using the same general techniques as YULE and DUFFY (1972). Soil sampling was carried out using a toothed auger to a depth of

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6 inches, but evergreen foliage sampling posed the problem of age classification and sorting of exposure to sprays, so it was done in two ways. A general cross-section sample of balsam fir branches (as used by YULE and DUFFY, 1972) was taken at all the selected sites, and physical separation of discrete year classes of foliage within each branch sample was made with foliage up to 4 years old (Table 2).

Because of the hurried nature of this extensive field work (between thaw and spray), immediate solvent extraction of foliage samples was not possible (cf. YULE and DUFFY, 1972). Instead, air-dried foliage samples (100g.) were placed in 1 quart Mason jars at the sampling site with 100 ml. re-distilled methanol, and on return to this laboratory, 200 ml. re-distilled chloroform was added to each jar, and the contents were extracted using a jar adaptor with a Sorvall Omni-Mixer. Soil cores (8 per site) were collected and transported to the laboratory in plastic bags, deep-frozen, and extracted there. Extraction, clean-up, and analysis using chromatographic techniques, were as described in YULE and DUFFY (1972), except that a 2/1 chloroform/methanol final mixture was used for extraction in this case.

Results and Discussion

Local names of sites sampled in N.B., together with their spray histories between 1968 and 1972 are given in Table 1. Fenitrothion residues found in the Spring of 1973 for single year age classes of balsam fir foliage, and/or mixed-age foliage sample, and soil, are given in Table 2 for each site.

No measurable amounts(< 0.005 ppm.) of fenitrothion or known breakdown products (YULE and DUFFY, 1972) were found in any of the soils sampled, whatever their spray history. The foliage of balsam fir did contain measurable year-end residues of fenitrothion, but no major breakdown products, and residues appear to have accumulated in the foliage approximately in proportion to number of years sprayed and dosage applied. Although spray years and emitted annual dosages are accurately recorded for each area, the history of actual insecticide deposit at each sampling site is unknown; thus the interaction between spray history and residue data is open to interpretation rather than precise arithmetic correlation.

The conclusion of this work is that residues of fenitrothion appear to have persisted and accumulated in coniferous tree foliage over a number of years with repeated annual applications. The maximum accumulated residue found under any operational spray circumstance to date (Spring 1973) in New Brunswick was approximately one part per million fenitrothion in fresh balsam fir foliage, but no build-up was found in forest soil (cf. DDT; YULE, 1973). Ecological implications of these properties of persistence and accumulation of fenitrothion residues in coniferous foliage over large areas of sprayed forest are virtually unknown at present . However, current research programmes dealing with the ecological impact of fenitrothion in the forest environment have not demonstrated measurable effects of

TABLE 1

Location and spray history of sites in New Brunswick sampled for balsam fir foliage and soil in May 1973.

Location of sampling site	Spray history of area						
	Fenitrothion applied (ounces/acre) per year 19--					No. of years sprayed	Total emitted dosage (oz./acre)
	68	69	70	71	72		
Renous - Catamaran Bk.	2	4	3	2	3	5	14
Priceville	0	4	4	3	3	4	14
Fundy	0	0	4	5	3	3	12
Tracy	0	0	0	4	3	2	7
Lepreau	0	0	0	0	3	1(a)	3
Calhoun	0	0	0	0	3	1(b)	3
Tormentine	not sprayed					0	0

(a) Water emulsion formulation of fenitrothion

(b) Oil solution of fenitrothion

TABLE 2

Fenitrothion residues found in May 1973 in balsam fir foliage and soil from various locations (Table 1).

Location of sampling site	Fenitrothion (ppm. fresh weight)						
	Foliage of year 19--					Mixed-age foliage sample	Soil
	68	69	70	71	72		
Renous-Catamaran Bk.	-	-	-	-	-	0.80	ND
Priceville	-	0.80	0.80	0.49	0.28	0.52	ND
Fundy	-	-	0.86	1.15	0.61	0.34	ND
Tracy	-	-	-	0.70	0.41	0.40	ND
Lepreau	-	-	-	-	0.04	0.02	ND
Calhoun	-	-	-	-	0.04	0.06	ND
Tormentine	-	-	-	-	-	ND	ND

ND - none detected (< 0.005 ppm.)

fenitrothion residues at this level on forest fauna (BUCKNER, VARTY; personal communications), and further chemical and toxicological research with plants, animals, water and soil should help to elucidate the situation.

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