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Fenvalerate Residues in Nontarget Organisms from Treated Cotton Fields*

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The use of fenvalerate [Pydrin®, cyano(3-phenoxybenzyl)-methyl 4-chloro-α-(1-methylethyl)benzeneacetate] on cotton for the control of bollworm (Heliothis zea) and tobacco budworm (H. virescens) has rapidly increased in recent years. Fenvalerate maintains sufficient photostability for agricultural use (OHKAWA et al. 1978), and is an effective broad spectrum insecticide (OHNO et al. 1976, JAIN et al. 1980, PLAPP 1981, BROWN et al. 1982), with proposed application rates of 0.055-0.224 kg/ha. It is also characterized as possessing moderate mammalian toxicity (SHELL DEVELOPMENT COMPANY 1975, NAKAYAMA et al. 1979), but it is extremely toxic to fish and aquatic invertebrates (MIURA and TAKAHASHI 1976, MIURA et al. 1977, COATS and O'DONNELL-JEFFERY 1979).

Fenvalerate residues on cotton foliage decline rapidly following application, with 56 to 96% lost during 17-day intervals between sprays (JAIN et al. 1980). HOLMSTEAD et al. (1978) reported a half-life on cotton of about 2 days. However, little is known about the concentrations of fenvalerate occurring in nontarget vertebrate and invertebrate species following application to a cotton field. Residues in samples collected less than 1 week after a fenvalerate application are reported.

MATERIALS AND METHODS

Samples of vertebrate and invertebrate species were collected on July 25-26, 1979, in and around cotton fields near Garland, Arkansas. Fenvalerate had been aerially applied at the rate of 0.112 kg active ingredient (AI)/ha (0.1 lb/acre) 5 days before collection. Several fenvalerate applications had also been made to these fields during the previous 2 years.

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Small mammals were captured at night with snap traps set along the edges of the cotton fields. Birds were collected with shotguns and mist nets in and around sprayed fields. Most other animals were collected by hand. Snails and fish were collected from standing water in field drainage ditches.

Samples were stored on dry ice in the field. Wet weight, capture location, and collection date were recorded for each sample. Birds and mammals were wrapped in aluminum foil for storage. Before analysis the skin and gastrointestinal tract were removed. All other samples were stored in glass bottles.

Forty samples were analyzed for fenvalerate at the Patuxent Wildlife Research Center, Laurel, Maryland. All samples were soxhlet-extracted with hexane and cleaned by gel permeation chromatography. Residues were analyzed by gas-liquid chromatography with an electron capture detector and confirmed by mass spectrometry. Twelve samples were cleaned by gel permeation chromatography using toluene-ethyl acetate (1+3, v/v). To improve cleanup and obtain mass spectrometry confirmation, the remaining 28 and 2 of the previous samples were cleaned by gel permeation chromatography using methylene chloride-cyclohexane (15+85, v/v) and an in-line alumina column as described by REICHEL et al. (1981). The method had an average recovery of 96% for fortified material. The lower limit of reportable residue was 0.01 ppm.

Samples of all mammals, birds, and snakes consisted of 1 individual each. Numbers of samples analyzed for each species were 3 house mice (Mus musculus) samples, 1 white-footed mouse (Peromyscus leucopus), 1 deer mouse (P. maniculatus), 2 hispid cotton rats (Sigmodon hispidus), 4 dickcissels (Spiza americana), 2 cardinals (Richmondena cardinalis), 2 red-winged blackbirds (Agelaius phoeniceus), 2 meadowlarks (Sturnella magna), 1 brown-headed cowbird (Molothrus ater), 3 purple martins (Progne subis subis), 1 horned lark (Eremophila alpestris), 1 little blue heron (Florida coerulea coerulea), 1 green heron (Butorides virescens virescens), and 1 western ribbon snake (Thamnophis proximus proximus).

Each sample of amphibians, fish, and invertebrates consisted of a pool of several individuals. Numbers of samples analyzed for each species or group were as follows: 2 of southern leopard frogs (Rana utricularia), 1 of green frogs (R. clamitans), 2 of Fowler's toads (Bufo fowleri), 1 of green treefrogs (Hyla cinerea), 1 of golden shiners (Notemigonus crysoleucus), 1 of mosquitofish (Gambusia sp.), 1 of

snails, 1 of cicadas (Cicadidae), 1 of ground beetles (Calosoma sp.), and 3 of short-horned grasshoppers (Acrididae).

RESULTS AND DISCUSSION

Fenvalerate residues were detected in 10 samples (Table 1). Terrestrial vertebrates contained the lowest residue concentrations. Only 1 of 17 avian and 1 of 8 mammalian samples contained detectable residues. The 1 avian sample, a male dickcissel, had a breeding territory established within a sprayed cotton field. The absence of residues in birds and mammals may not reflect the level of exposure, since they rapidly metabolize fenvalerate in their systems (SODERLUND and CASIDA 1977, BRADBURY 1981). Residues were also found in the ribbon snake and 1 of 6 amphibian samples.

The highest residue concentrations were found in fish and invertebrates. Residues in golden shiners, mosquitofish, and snails, collected from a small pool in a field drainage ditch, contained from 0.32 to 0.53 ppm fenvalerate. This compares with 0.92 ppm found in carp after 7 days of exposure to 0.8 ppb fenvalerate in

TABLE 1
Ten samples collected from cotton fields containing detectable levels of fenvalerate, which had been aerially applied at 0.112 kg AI/ha 5 days prior to collection.

Species	Wet weight (g)	% Lipid	Fenvalerate residues (ppm, wet wt.)
House mouse	12.18[1]	2.3	0.01
Dickcissel	17.78[1]	3.1	0.02
Ribbon snake	2.60	ND[2]	0.12
Fowler's toad	17.76	2.0	0.02
Golden shiner	5.14	3.1	0.47
Mosquitofish	1.30	ND[2]	0.32
Snail	8.26	0.5	0.53
Ground beetle	16.86	4.6	0.55[3]
Short-horned grasshopper	21.57	0.6	0.18[3]
Short-horned grasshopper	17.71	1.8	0.24[3]

[1] Wet weight represents carcass with skin and gastro-intestinal tract removed.
[2] ND = not determined.
[3] Residues confirmed by mass spectrometry.

aquarium tanks (OHKAWA et al. 1980). Carnivorous ground beetles, found trembling on the ground when captured, contained the highest residue levels (0.55 ppm). Approximately 0.2 ppm fenvalerate was found in 2 samples of grasshoppers captured near cotton fields. A third sample collected from an unsprayed soybean field, which had fenvalerate-treated cotton planted the previous 2 years, contained no detectable residues.

Large numbers of dead insects were found in the fields during collection. Considering the high insecticidal activity of fenvalerate, and the poisoning symptoms observed in the ground beetles, it is probable that residue concentrations higher than those reported here are lethal to many insect species. BENNETT (1983) found that even though short-horned grasshopper populations had been significantly reduced by fenvalerate in old-field vegetation, residues in the remaining grasshoppers were $\leq$0.33 ppm. All other invertebrate samples contained <0.5 ppm.

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