

Deposition and Persistence of Aerially-Applied Fenthion in a Florida Estuary

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Fenthion [0,0-dimethyl 0-3-methyl-4-(methylthio)phenyl phosphorothioate] is one of most commonly used mosquito insecticides in the state of Florida. Although not sprayed on water intentionally, aerially applied insecticides may accidentally drift into estuarine waters and affect fish eggs and larvae and other organisms (Johnson and Finley 1980; Kenaga 1979; Patterson and Von Windeguth 1964; Ray and Stevens 1970). For mosquito control in Florida, the usual aerial application rate for fenthion is 0.029 lb/acre (32.5 g/ha). The pesticide is often applied as a thermal fog by C-47 aircraft. The thermal fog mixture contains 1.5% fenthion, 33.5% fog oil and 65% no. 2 diesel fuel (*Lee County Mosquito Control District, 1985*). This paper describes the occurrence and persistence of fenthion after aerial spraying over saltmarsh water.

MATERIALS AND METHODS

The field study area was in St. Lucie Mosquito Impoundment No. 23, located on the west side of North Hutchinson Island, in northern St. Lucie County (Figure 1). Two test platforms were built by St. Lucie County Mosquito Control District in the perimeter ditch adjacent to the upland fringe of the impoundment. The fringe consisted of a revegetating black mangrove-saltwort-glasswort marsh. The ditch opened into, and had continuous water exchange with the Indian River. Lee County Mosquito Control District performed the aerial spraying for the field tests. The plane flew approximately 30 meters (100 ft) above the ground and sprayed the fog mixture at a rate of 75.7 l/min (20 gallons/min) or 1.87 l/ha. Spray duration was one to two minutes as the plane made its swath directly over the test site. Sprays were conducted at the downwind test site to minimize the chance of drift to the other area.

Two No. 44 Whatman filter papers, 24 cm in diameter, were placed on a raft and another two filter papers were placed on the dock. Filter papers spaced 3 meters (10 feet) apart at the north and

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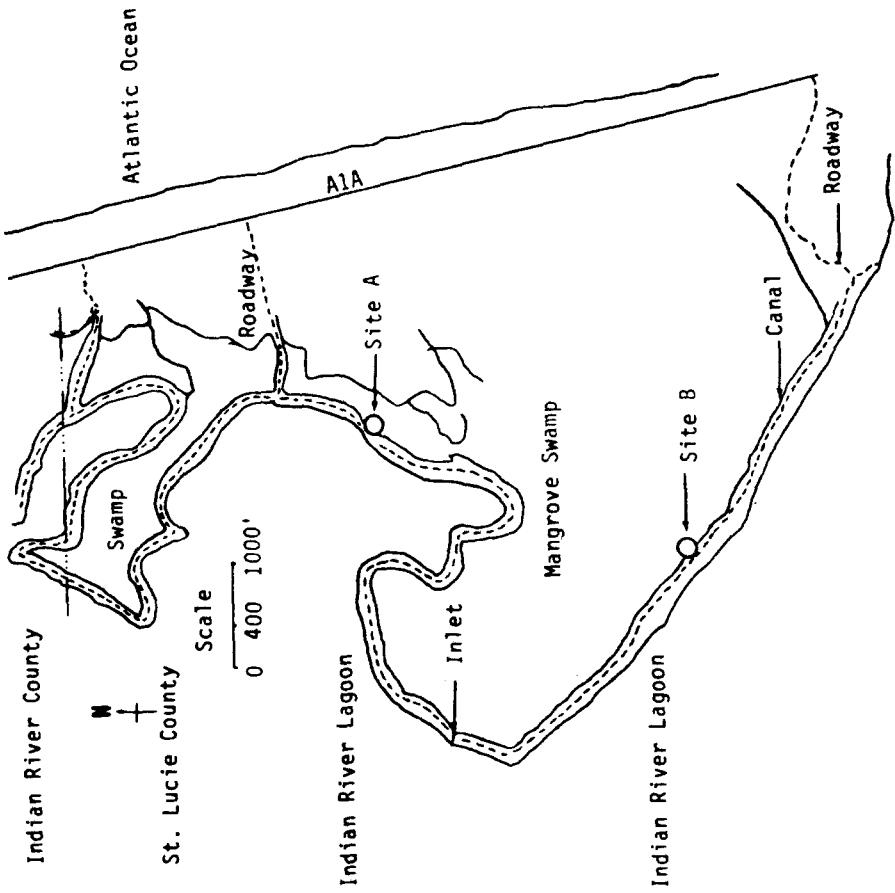
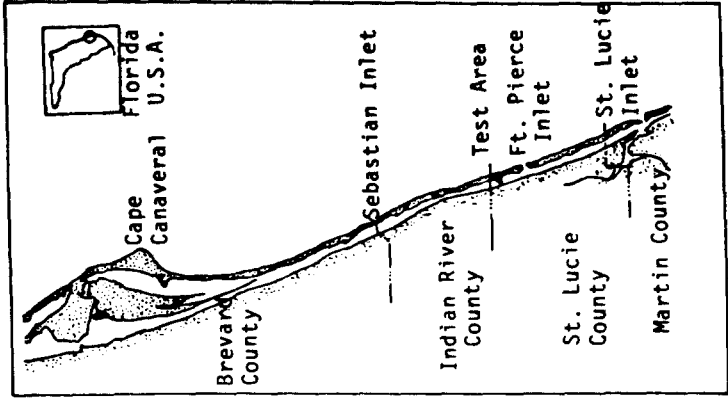


Figure 1. Location of Spray Test Sites

south ends of the test dock. Culture dishes (100 mm i.d.) holding approximately 200 ml of water were also placed on the dock to determine the amount of fenthion deposited on the water surface. To determine fenthion concentration in water, thirteen samples were collected, from before each spray up to 48 hours. Water samples were collected in one-liter amber glass bottles. The bottles and other glassware had been pre-cleaned with "Liquinox", followed by chromic acid, acetone and distilled water. The glassware was then placed in an oven at 200°C overnight before sampling. A 900 ml sample was collected 2.5 cm below the water surface. After collection each sample was acidified with 0.15 ml concentrated hydrochloric acid, reducing pH to 6.0 (Dale and Miles 1969). The sample was immediately extracted with 50 ml methylene chloride and given three one-minute shakes. Samples were immediately placed on ice and taken to the laboratory for further extraction. In the laboratory each sample was transferred to a one liter separatory funnel for separation of solvent and water phases. The solvent phase was then drained through a 19 mm (0.75-inch) Na₂SO₄ column and placed in a K-D concentrator with a 5 ml ampule (Wang 1983). A second extraction was performed in a similar manner. Samples were reduced to approximately 3 ml on a water bath and the concentrators were rinsed with 10 ml hexane. The sample was then concentrated to 0.5 ml with a gentle nitrogen stream. In some instances, sample extracts were further cleaned up with a silica gel column (Law and Goerlitz, 1970). A micro-column, 2140 mm x 5 mm i.d., was packed with 100-200 mesh deactivated silica gel. Sample extracts were eluted with 6 ml of 20% + 80% (V/V) of ethyl ether-hexane. After rinsing the ampule with 4 ml of hexane and reducing the volume to 0.5 ml, 3 µl of extract was injected to the gas chromatograph. A Hewlett-Packard 5730A gas chromatograph equipped with a nitrogen-phosphorous detector and 6' x 1/4" of 5% SP2401 on 100/120 Supelcoport column was used for sample analysis. The column temperature was 200°C isothermal and helium carrier gas flow was maintained at 30 ml/min. Fenthion retention time was 3.3 min.

Because fenthion might be adsorbed by particulate matter, an effort was made to determine particulate concentration and fenthion residue in test one. A 3.8 liter water sample was collected from the test sites at 0, 12 and 24 hours. Each was filtered through a 0.4 µm glass fiber filter and weighed to measure particulate concentration. Particles were then extracted with methylene chloride and analyzed.

Fenthion standard of 98% purity was obtained from Ultra Scientific. The primary standard stock solution was prepared in acetone, and the working standards were prepared in hexane. Water samples of 900 ml from the test site were spiked with a known concentration of fenthion during the test and were analyzed periodically for a routine quality control check. Recovery efficiency ranged between 90 and 110%. The minimum detectable concentration for fenthion was 0.01 µg/l. Except where noted, mean concentrations from duplicate samples are reported.

RESULTS AND DISCUSSION

Four aerial sprays were conducted between September 21, 1984, and June 28, 1985. Amounts of fenthion deposited on the filter paper and water in dishes are shown in Table 1. The highest amount of fenthion collected, 18.6 ng/cm², was during spray one. Mean amounts deposited for the filter papers of tests two to four ranged between 0.39 ng/cm² and 1.25 ng/cm². The decrease resulted partly from a reduction in nozzle size. The amount found in the dish water ranged between 1.01 ng/cm² and 4.33 ng/cm². Amounts in the dishes were generally higher than on the filter papers. This could have resulted from the different exposure times for sample collection after each spray. Filter papers were normally collected 15 minutes after the spray and dish samples were collected after 25 minutes. Deposition may have varied with time and some evaporative loss from the filter papers may have occurred also. Figure 2 shows the concentration profiles in the receiving water after each spray. Fenthion was not detected in the sample taken before each spray. The concentration normally increased and peaked at 45 minutes and then gradually decreased. After 24 hours, only a trace of fenthion ($\leq 0.01 \mu\text{g}/\ell$) was found. The peak concentration was 1.69, 0.16, and 0.16 $\mu\text{g}/\ell$ for tests one, three and four. In test two, 0.87 ng/cm² of fenthion was found on the filter papers and only trace amounts of fenthion were found in the early water samples.

Table 1. Fenthion Deposition on Filter Papers and in Dishes of Water during Field Tests with Thermal Fog

Sample Type	Fenthion Concentration			
	Test 1 9-21-84	Test 2 3-1-85	Test 3 6-12-85	Test 4 6-28-85
North Test Site Filter	15.9	0.88	1.13	0.36
South Test Site Filter	21.3	0.87	1.36	0.42
Mean Filter (ng/cm ²)	18.6	0.87	1.25	0.39
Dish No. 1 Water Medium	---	1.24	2.83	3.96
Dish No. 2 Water Medium	---	0.77	2.94	4.70
Mean Water Medium (ng/cm ³)	---	1.01	2.74	4.33

Tidal changes had a tendency to move water back and forth at the test site. This movement could change the observed fenthion concentration. When low tide occurred, water moved away from the test site and thus reduced the concentration observed. As the tide rose, some of the contaminated water moved back to the test site and a higher concentration was detected. The concentration of particulate matter was between 8.34 and 16.6 mg/ ℓ , and fenthion was not detected in it. Fenthion has a density of 1.245 g/ml, and fenthion droplets would tend to sink gradually through water. Bottom water samples were collected in test three at 0.42, 0.80, 2.25 and 12.25 hours after the spray. The samples were analyzed and only a trace ($\leq 0.01 \mu\text{g}/\ell$) of fenthion was detected.

Concentration (ppb) in Water

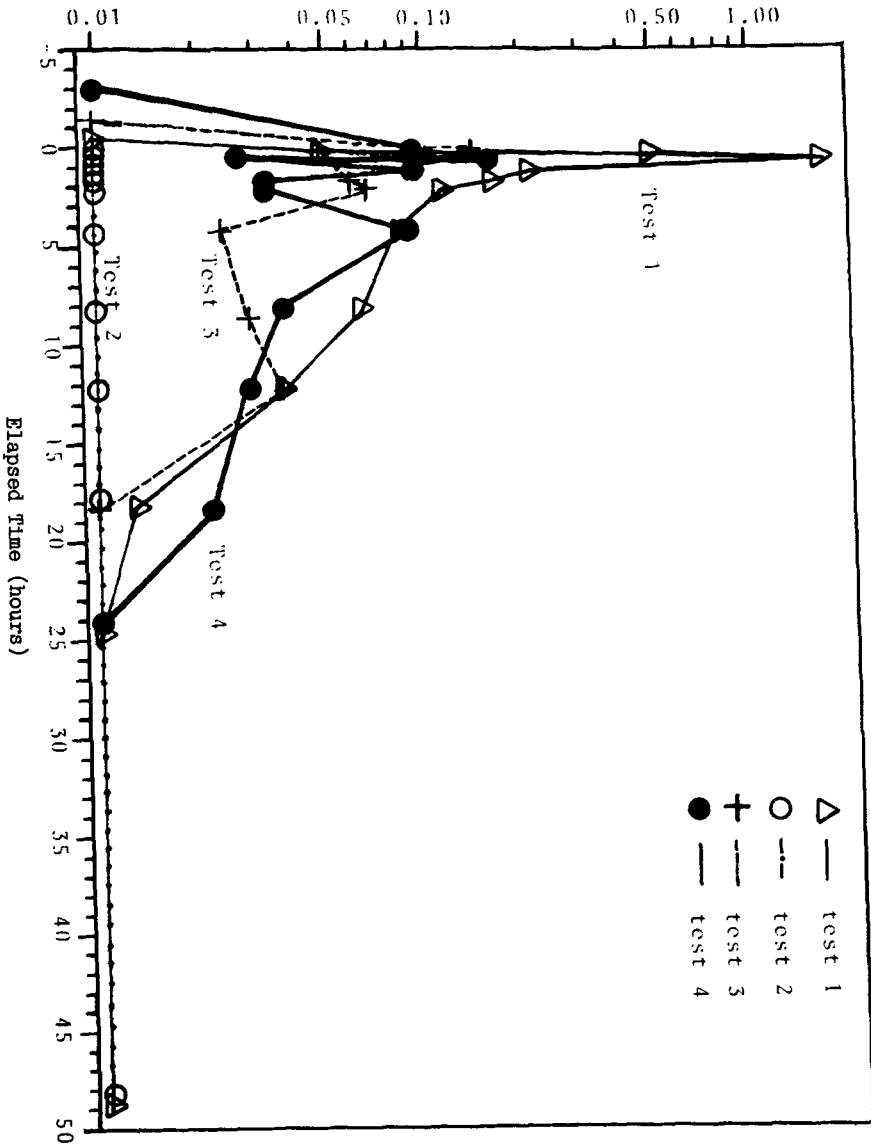


Figure 2. Fenthion Concentration in Ditch Water

This study shows that the highest peak concentration was 1.69 µg/l fenthion at 45 minutes after the spray. The concentration then gradually decreased to a non-detectable level after 24 hours. Fenthion droplets once deposited on the water surface were immediately dispersed and diluted in the water. Tidal flushing moved and transported the insecticide in the water, playing an important role in the disappearance of fenthion. The maximum amount of fenthion deposited on the water surface occurred in test one and was determined to be 18.6 ng/cm². This represents only 5.5% of the application rate. The remaining fenthion could have undergone volatilization or degradation during the aerial spray.

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