Mirex Incorporation in the Environment: Uptake and Distribution in Crop Seedlings[1]

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The persistence of certain organochlorine pesticides in agricultural crops as observed by LICHTENSTEIN (1959, 1960) and NASH (1968) reflects the ready incorporation of residues in plant tissues. BEALL and NASH (1969) reported the uptake of various amounts of DDT, dieldrin, endrin, and heptachlor residues from soil by soybean, wheat, corn, alfalfa, bromegrass and cucumber seedlings under greenhouse experimental conditions. There was indication that the degree of accumulation of pesticide residue in plants is a function of soil type and taxonomic differences (HARRIS and SANS 1967). The widespread use of mirex-impregnated bait to control the fire ant (Solenopsis saevisima Forel, Formicidae) in Southeastern United States led us to conduct investigations on the movement of mirex in the environment. One of these studies is the uptake of mirex residues by crop seedlings which are commonly cultivated in areas that receive aerial treatment of mirex.

Preliminary works on a number of biological samples show that plants contain extremely low concentrations of mirex (ALLEY 1973). MARKIN et al. (1972) reported that bahiagrass (Paspalum notatum Flugge) contained 0.0003 to 0.017 ppm residues when grown in soil containing 0.001 to 0.002 ppm mirex. In this study, we found that soybean, garden bean, sorghum, and wheat seedlings take up and accumulate varying amounts of mirex residue when grown in substrates containing 0.3 to 3.5 ppm mirex.

MATERIALS AND METHODS

Two planting substrates were used in this study, field soil and loamy sand. The soil was collected from the Mississippi

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State University Agricultural Experiment Station research fields where no mirex was detected by the gas-liquid chromatographic technique described in this report. However, the soil has traces of DDT and toxaphene residues. Analytical data for the soil include: pH 6.6, organic matter 0.87%, sand 42.80%, silt 43.30%, and clay 13.03%. The loamy sand contains 86.5% fine sand, 9.6% silt, 3.8% clay, and organic matter 0.04%. Calculated quantities of recrystallized mirex dissolved in 100 ml acetone to establish the final experimental concentrations was applied to a 0.5 kg sample of sand or soil from each of the 5 kg lots. After solvent evaporation at room temperature, the 0.5 kg subsamples were mixed thoroughly and then blended with the rest of the respective 5 kg lot in a rotary mixer. Five replicates of each test concentration were prepared.

Seeds of soybean (Glycine max (L.) Merr. Var: Lee-68), garden bean (Phaseolus vulgaris), sorghum (Sorghum vulgare Pers. Var: 'BR-64', hybrid grain sorghum ('DeKalb') and wheat (Triticum vulgare Vill. (Aestivum L.) var: 'Cooker 68-15') were grown in the experimental substrates held in large greenhouse emergence trays. Two hundred seeds were planted in each of the five replicates for each test concentration. Each crop was grown for 4 weeks in the greenhouse and then harvested and analyzed for mirex residue. Contamination of above ground plant parts was prevented by careful and cautious handling of the experimental plants during the growth period. All above ground parts were clipped first and then the root portions carefully retrieved. Plant parts were thoroughly washed with water and rinsed briefly in hexane. Plant samples were air-dried overnight and divided into different parts. Soybean and garden bean plants were divided into: growing tips, leaves, upper half stems, lower half stems, and roots; sorghum and wheat plants into leaves, stems, and roots. The various plant parts were labelled and allowed to dry completely at room temperature. Approximately 20 grams of each dried plant parts were individually ground to a uniform size (about 0.5 mm) in a Wiley Mill and stored in glass vials.

Residue analyses were carried out according to the procedures outlined by WHEELER et al. (1967) and MILLS et al. (1963). When the method was tested with 20 ppm of mirex in plant tissue, the recovery of mirex residue was better than 90%. The residue from soil was extracted with benzene using the method outlined by MARKIN et al. (1972). All residue analyses were done by electron capture gas chromatography with a Barber Colman Model 5360 Pesticide Analyzer. A preliminary determination of extracts from control plant parts revealed no interfering peaks, which might be confused with mirex.

RESULTS AND DISCUSSION

The final mirex concentrations in the soil are 0.3, 0.8, and 3.5 ppm and in the sand 0.31, 0.8, and 3.4 ppm. Results of mirex uptake by roots and shoots grown in field soil are shown in Table 1 and the uptake by plants grown in loamy sand are summarized in Table 2.

TABLE 1

Concentrations of mirex residues (ppm dry weight) detected by GLC in different parts of 4-week old crop seedlings grown in field soil

	Concentration (ppm) of mirex in the experimental field soil		
Plant parts	3.5	0.8	0.3
Garden Beans			
Growing tip	0.12	0.06	0.02
Leaves	0.20	0.11	0.01
Upper half stem	0.31	0.22	0.10
Lower half stem	0.63	0.25	0.02
Root	1.18	0.49	0.21
Soybean			
Growing tip	0.09	0.06	0.01
Leaves	0.21	0.12	0.10
Upper half stem	0.35	0.18	0.11
Lower half stem	0.76	0.27	0.12
Root	1.25	0.49	0.17
Sorghum			
Leaves	0.22	0.20	0.11
Stem	0.51	0.31	0.17
Root	0.81	0.44	0.20
Wheat			
Leaves	0.17	0.18	0.09
Stem	0.56	0.20	0.20
Root	1.17	0.27	0.23

Varying amounts of mirex residues were taken up by the different parts of the plants grown in soil and sand. In general, roots had the highest quantity of mirex residue.

Regardless of differences in species, all plants grown on loamy sand accumulated generally higher amounts of mirex than those grown in field soil.

TABLE 2

Concentrations of mirex residues (ppm dry weight) detected by GLC in different parts of 4-week old crop seedlings grown in loamy sand

	Concentration (ppm) of mirex in the experimental loamy sand		
Plant parts	3.4	0.8	0.31
Garden Beans			
Growing tip	0.27	0.09	0.04
Leaves	0.40	0.19	0.01
Upper half stem	0.31	0.28	0.17
Lower half stem	0.79	0.38	0.20
Root	1.68	0.69	0.23
Soybean			
Growing tip	0.31	0.08	0.05
Leaves	0.36	0.18	0.03
Upper half stem	0.73	0.29	0.13
Lower half stem	0.92	0.31	0.27
Root	1.47	0.49	0.32
Sorghum			
Leaves	0.40	0.33	0.18
Stem	1.60	0.46	0.21
Root	1.71	0.67	0.28
Wheat			
Leaves	0.21	0.19	0.04
Stem	0.95	0.32	0.21
Root	1.33	0.55	0.36

HARRIS and SANS (1967) reported that residues detected in crops grown on muck soil with higher initial concentration of insecticide were lower than those found in crops grown on mineral soil with lesser initial concentration of insecticide. The results of the soil/sand analysis for presence of mirex residues after termination of the experiments indicated that field soil retained higher levels of mirex than sand (Table 3).

TABLE 3

Per cent mirex residues remaining in the planting media 6 months after application

Planting Medium	Theoretical initial concentration (ppm)		
	0.5	1.0	5.0
	Per cent residue		
Soil	37	68	71
Sand	26	41	59

Our results show that crop seedlings take up and accumulate mirex when available in the soil, and the rate and amount depends on insecticide concentration and plant species. Data on the amount of mirex present in the soil under varying soil conditions are rare. While the mirex concentrations used in this study were higher than what is found in nature, these concentrations were used since our primary objective was to determine mirex uptake by and accumulation in crop plants. To date, no evidence is available on the biochemical fate of mirex once it enters the plant body. It is not known how long mirex persists in plant tissues beyond four weeks.

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