Persistence of the Insecticide, Akton, in Soil

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Akton® [O-(2-chloro-1-(2,5-dichlorophenyl)vinyl)O,O-diethyl phosphorothioate] is effective as a residual soil surface treatment for cinch bugs and sod webworms (REINHART 1972, 1973) and is registered for use against these pests on turf in southeastern United States. Laboratory studies have shown that Akton has a chemical half life exceeding 32 weeks in soil (unpublished) and as such is certainly one of the most persistent organophosphorus insecticides known. Since Akton is unusually stable in soil under laboratory conditions and because persistent compounds are of environmental concern a study was initiated to determine its persistence in the field.

MATERIALS AND METHODS

The experiment was conducted on a University farm near Puyallup, Washington. The soil (Sultan silt loam, pH 6.3) contained 3.4% organic matter and 20% clay. Triplicate 35 x 15-ft plots were treated with 1% granular Akton at 2 lbs AI/A and with 4E emulsifiable concentrate sprays at 2 and 10 lbs AI/A on June 10, 1968. Granules were applied to the soil surface with large aluminum salt shakers and spray applications were made with a 3-gal. knapsack sprayer using 50 gal. of finished spray/A. Insecticides were mixed in the upper 3 to 4 in. of soil by rototilling within 1 h after application. Soil in the treated plots and in untreated controls was compacted with a heavy roller and seeded to corn. Corn was also planted in the 2nd and 3rd years after treatment. The plots remained fallow during the 4th and 5th years. Normal land preparation and cultivation practices were employed throughout the study with the exception that tillage was restricted to the top 4 in. of soil to minimize mechanical transfer of treated soil below the sampling zone.

Soil samples were taken for residue analysis at irregular intervals over a five-year period. A sample consisted of 50 random cores, each 6 in. deep x 1 in. in diameter. Each sample was

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screened through a 2-mm sieve and mixed in a Twin Shell blendor for 5 min. After the moisture content was determined, 20-cc air-dried equivalents of moist soil from each sample were placed in a 250 ml plastic centrifuge bottle with ca. 25 g of anhydrous sodium sulfate and 100 ml of hexane:acetone (2:1 v/v). After shaking the sample for 1 h on a reciprocal shaker, 10 ml of extract were removed and stored in a 25-ml screw cap centrifuge tube at -10°C for subsequent analysis.

Akton residues were measured with a Hewlett Packard Model 5750 gas chromatograph equipped with a phosphorus selective thermionic flame detector and a 4-mm x 4 ft glass column packed with 5% SE-30 on 60-80 mesh Gas Chrom Q. Helium (40 ml/min flow rate) was used for the carrier gas. Temperatures of the injection chamber, oven and detector were 275°, 250° and 375°C, respectively. Under these conditions analytical grade Akton (80% cis and 20% trans isomer) eluted as a single peak after a retention time of 2.1 min.

Four moist 20-cc samples of untreated Sultan silt loam were fortified with 4, 20 and 100 μg of analytical grade Akton to determine the recovery efficiency of the method. Average recoveries and standard deviations for the 3 levels of Akton were 102 ± 4, 98.7 ± 4 and 98.4 ± 4%, respectively. The sensitivity of the method was ca. .05 μg/cc of soil.

RESULTS AND DISCUSSION

Logarithm decay curves for the Akton soil treatments are shown in Figure 1. Akton was quite persistent in Sultan silt loam. Unlike most organophosphorus insecticides, Akton followed a 1st order degradation rate in soil throughout the 5-year test period. Computed half lives for the 2-lb granular treatment, 2-lb spray treatment and 10-lb spray treatment were 57.4, 62.1 and 84.3 weeks, respectively. Coefficients of correlation exceeded 0.97 for all 3 curves. Decay rates were similar for both 2-lb/A insecticide treatments. However, the regression coefficients or slopes of decay curves for the 2- and 10-lb application rates were significantly different at the 95% confidence limits. These data agree with those obtained for many other pesticides which generally show that disappearance rates tend to be greater for smaller application doses (EDWARDS 1964).

The calculated application doses derived from the general straight-line equation $Y = a + bX$, were about 25% lower than the theoretical application doses (1.5 and 6.5 μg/cc of soil for the 2- and 10-lb rates, respectively) which should have been recovered at the 0-day interval. The actual amounts found at the 0-time interval for the 2 lbs of granules, 2 lbs of spray and 10 lbs of spray were 2.03, 1.58 and 8.17 lbs AI/A, respectively. Only the recovery from the granular treatment approached the theoretical application rate, while the residues from the spray treatments were about 27% lower than expected. Two possible explanations exist for the lower than expected 0-day residue levels. One likely possibility is that volatilization occurred during application and

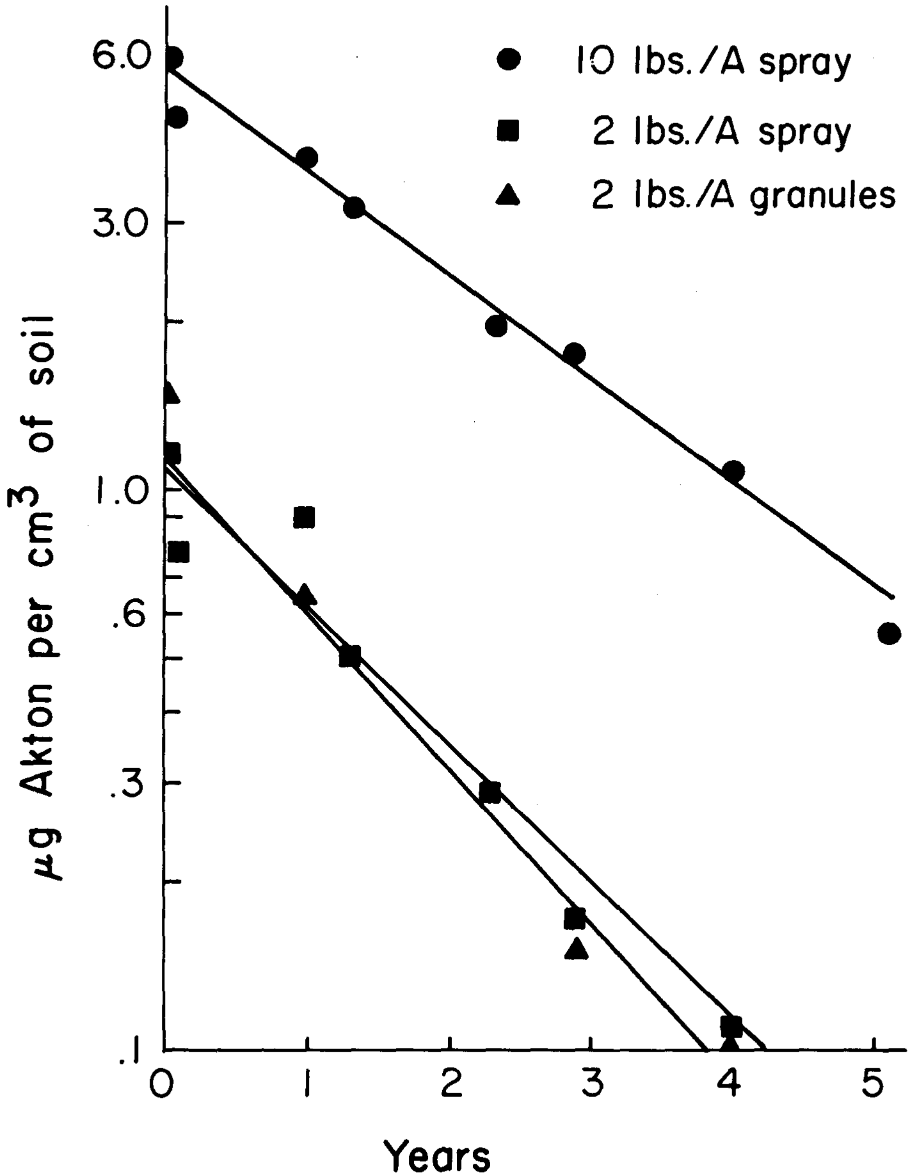

Fig. 1. - Decay curves for Akton in Sultan silt loam.

prior to incorporation and sampling. If volatilization is a valid explanation one would expect greater losses from the spray applications than from the granular applications and this was the case. Irreversible adsorption and/or degradation during the period between application and extraction could also account for the lower than expected 0-day residues. However, this is unlikely because recovery efficiencies from the spiked samples approached 100% and the demonstrated stability of this compound in soil would suggest that initial degradation was not a factor.

The linear decay curves depict 1st order rate reactions and suggest that a single mechanism is primarily responsible for the degradation of Akton in soil. Unpublished laboratory data indicate Akton is not readily attacked by soil microorganisms and that nonbiological degradation is largely responsible for its disappearance. The degradation behavior pattern of Akton under field conditions is consistent with the laboratory findings. In this respect Akton follows a decay pattern that is characteristic of most persistent chlorinated hydrocarbons.

Compared to other organophosphorus insecticides Akton has a much longer residual persistence in soil under field conditions. Most organophosphorus insecticides degrade quite rapidly in soil and significant concentrations of the toxicant seldom remain beyond the year of application. Akton exhibits a greater stability and is, without a doubt, one of the most persistent organophosphorus insecticides that has been studied to date.

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