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Distribution and Persistence of Chlorpyrifos and Diazinon Applied to Turf

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In recent years, as a result of restrictions on the use of chlorinated insecticides and the development of resistance, chlorpyrifos and diazinon have become the dominant insecticides for control of scarabaeid grubs in turf. Both compounds have several limitations for this purpose, the chief of these being inconsistencies in providing dependable control. In addition, their fixation in the thatch prevents penetration into soil where the grubs live (NIEMCZYK et al. 1977). Also, degradation may shorten their residual life to the extent that the grubs do not obtain a lethal dose. Practice has called for watering the turf after application of these two materials to move them down into the soil. This has been considered especially important in the case of liquid applications in order to wash residues off the foliage and into the ground.

There has been little actual work conducted to determine the fate of these applications to turf. During August 1976 we made an effort to examine the distribution and persistence of chlorpyrifos and diazinon to established turf. It was hoped that the results would help explain some of the performance inconsistencies.

MATERIALS AND METHODS

On August 30, 1976 we established 8 insecticide plots of 6.1 by 6.1 m and a single untreated plot of 6.1 by 12.2 m on a bluegrass lawn growing on Berrian fine sandy loam with 5.4% organic matter and pH of 5.6. There was essentially no thatch present. Each of the following formulations were applied to 2 plots: chlorpyrifos 2G and 2E and diazinon 5G and 2E. Rates of application in kg AI/ha were: chlorpyrifos 2.24 and diazinon 6.72. Granular formulations were applied with a hand shaker and liquid formulations were applied with a sprinkling can. Half of each total volume was applied in one direction and the remaining half at right angles to the first to obtain uniform distribution. Within 1.5 hr after start of applications, one plot of each treatment received 1.2 cm water via sprinkler.

Immediately after drainage of excess moisture off the foliage, 5 soil cores of 10.8 cm diameter and 5.1 cm deep were removed

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from each plot with a golf cup cutter. Thereafter soil cores were removed at the following intervals: 2, 4, 7, 14, 21, 28, and 44 days after application.

Weather conditions prevailing just prior to initiation of studies and during the sampling period were recorded. There was a 1.2 cm rainfall 2 days prior to treatment and the soil moisture was near field capacity on treatment date. During the 44-day test period, total precipitation equalled 10.7 cm and mean temperatures ranged from 11.5 to 17.7°C.

At each collection interval, the 5 cores from each plot were kept intact, held upright in a tray, and transported to the laboratory. These were then divided into the following categories: (1) surface vegetation including all green and dead upright foliage and dead tissues lying on the soil surface; (2) surface 1.3 cm soil, and (3) remaining soil to a depth of 5.1 cm. A single composite sample was made of each of 3 layers with the 5 cores and placed in storage at -23°C until needed for determination of insecticide residues. Subsamples of each layer from the untreated plot were spiked with 0.1, 1, and 10 ppm of each insecticide for recovery determinations.

At the time of extraction, all samples were weighed and thawed. The total vegetative layer for each treatment was divided into lots (never more than 2) of 100 g or less and each lot was homogenized for 2 min with 250 ml of acetonitrile in a Waring Blendor®. The homogenate was filtered through a fine-mesh nylon screen into a 1-liter separatory funnel and the remaining residue was reextracted with 200 ml of chloroform. The latter was filtered into the same funnel and the combined extracts were shaken for a few min before allowing the water and organic layers to separate. The solvent mixture containing the insecticide residue was drained through a glass-wool sodium sulfate plug into a bottle for storage at 5°C until analyzed by gas chromatography (usually within 3 weeks).

Soil residues were determined by taking two 100-g subsamples of each layer for all treatments. The subsamples were extracted with a 3 to 1 mixture of petroleum ether-isopropanol as previously described (DAVIS and KUHR 1976). Extracts were stored at 5°C until analyzed (within 3 weeks).

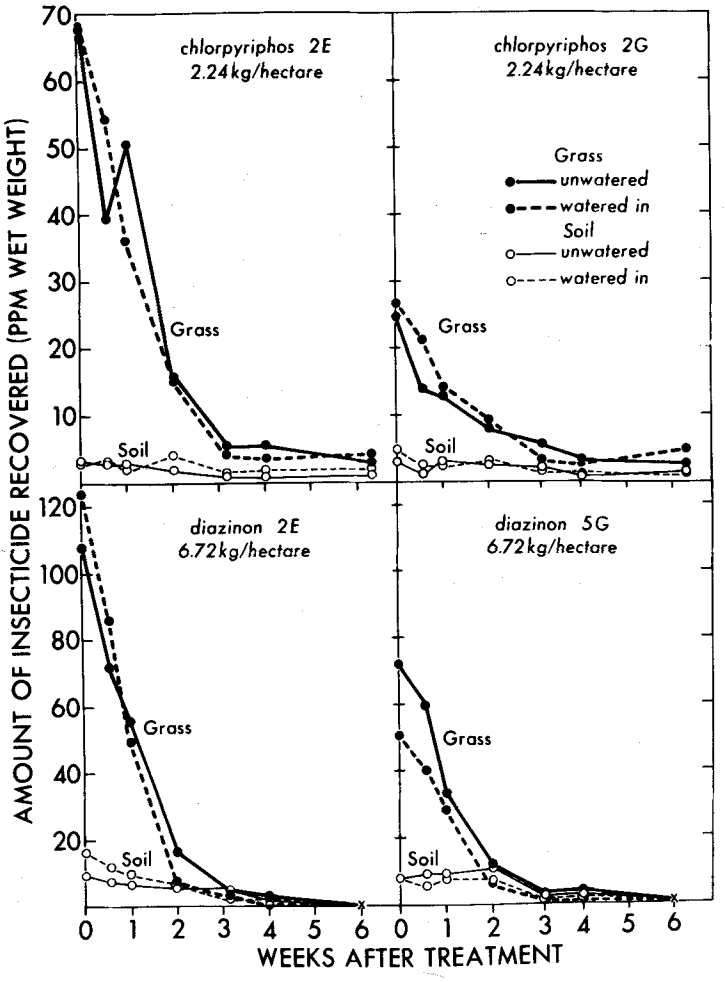
Portions of the grass and soil extracts were concentrated or assayed directly with a Tracor MT-220 gas chromatograph. For diazinon, quantitation was accomplished with a flame-photometric detector containing the phosphorus 525-nm filter. A Ni-63 detector was used for chlorpyrifos analysis. Both compounds were separated on 183 cm x 4 mm ID glass columns packed with 5% OV-1 on 80-100 mesh Gas Chrom-Q (Applied Science Laboratories, Inc., State College, PA). Temperatures in °C of injector block, column, and detector were 220, 200, and 165, respectively, for diazinon, and

225, 200, and 300 for chlorpyrifos. Each insecticide could be detected easily at the 0.01 ppm level, and recovery for spiked soil and grass samples averaged slightly more than 100%.

RESULTS AND DISCUSSION

All of the results are summarized in Fig. 1. Soil residues are expressed on a wet weight basis to allow direct comparison with grass residues. Soil moisture ranged from 14 to 27% by weight over the course of the experiment, and differences between plots were not significant. Thus, the shape of the soil curves in Fig. 1 would be very similar if expressed on a dry weight basis.

Fig. 1.-Distribution and dissipation of chlorpyrifos and diazinon residues following application to established turf; rates in kg AI/ha.



As expected, diazinon residues were higher than chlorpyrifos residues in both soil and grass, although the levels did not always reflect the 3-fold difference in application rate (Fig. 1). With each compound, larger residues were found on the grass with the liquid formulations than with granular.

The effect of watering on chlorpyrifos distribution between foliage and soil was minor, but diazinon appeared to move more readily from grass to soil when subjected to the water treatment, regardless of formulation (Fig. 1). This is even more apparent when the data in Table 1 are considered. In addition, the results show that more chlorpyrifos reached the soil when formulated as a granule, whereas the 5G and 2E diazinon products gave about the same distribution between grass and soil. However, the variation in the total insecticide recovered from the different plots may negate these differences.

TABLE 1

Zero-day distribution of residues between soil and grass after application of 2.24 kg/ha of chlorpyrifos or 6.72 kg/ha of diazinon.

Insecticide	Formulation	Watered	Total mg recovered		% of residue in soil
			Grass	Soil	
Chlorpyrifos	2G	No	1.42	2.98	68
"	2G	Yes	1.69	4.50	73
"	2E	No	3.71	2.78	43
"	2E	Yes	4.63	3.20	41
Diazinon	5G	No	9.08	7.39	45
"	5G	Yes	4.90	7.74	61
"	2E	No	8.37	7.54	47
"	2E	Yes	8.41	14.30	63

The dissipation rates for diazinon and chlorpyrifos from the grass were similar with half-lives of about 1 week (Fig. 1). How much of the loss was due to movement from the foliage into the soil is difficult to say. The fact that the soil residues appeared to remain level in most cases for about 2 weeks after treatment suggests that there may have been a transfer at a rate nearly equal to the dissipation rate in soil. Chlorpyrifos was shown to persist longer than diazinon with residues in soil and grass above 1 ppm even after 6 weeks. Diazinon residues at that time ranged from 0.17 to 0.65 ppm.

Analysis of the 1.3-5.1 cm soil samples indicated very little translocation of insecticide below the 1.3 cm level. For diazinon 5G treatments, there was no difference between watered and unwatered plots and only minor residues were detected (0-0.36 ppm).

Diazinon 2E yielded higher residues in watered plots, but none exceeded 1.44 ppm. Chlorpyrifos 2G appeared only occasionally in the deep soil layer at very low levels (0-0.09 ppm) with no differences between plots. Finally, the liquid formulation of chlorpyrifos appeared in higher amounts in watered plots (0.09-0.35 ppm) than in dry plots (0.02-0.10 ppm).

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REFERENCES CITED

DAVIS, A. C., and R. J. KUHR: J. Econ. Entomol. 69, 665 (1976).

NIEMCZYK, H.D., H. R. KRUEGER, and K. O. LAWRENCE: Ohio Report 62, 26 (1977).