Methoxychlor and 2,4,5-T in Lysimeter Percolation and Runoff Water

WILLIAM M. EDWARDS and BOBBY L. GLASS, USDA, ARS, SWC,
North Appalachian Experimental Watershed, Coshocton, Ohio and U. S. Soils Laboratory, Beltsville, Maryland in cooperation with Ohio Agricultural Research and Development Center, Wooster, Ohio

This report describes the transport of a chlorinated hydrocarbon insecticide, methoxychlor, and a water-soluble herbicide, 2,4,5-T, in runoff and percolation from a field lysimeter. Runoff and percolation resulting from natural rainfall were monitored for 14 months following the March 30, 1967 surface application of 11.2 and 22.4 kg per ha of 2,4,5-T and methoxychlor, respectively.

Runoff in this period carried over 5.5 g/ha or 0.05 percent of the applied 2,4,5-T. As evident in Table 1 and Figure 1, the bulk of the 2,4,5-T removal in the runoff took place within the first 4 months after application, and more than half of the loss took place within 32 days. Over 25 percent of the entire loss was associated with one storm event occurring 21 days after application, when the concentration in the runoff reached a maximum of 380 µg/l. It is noteworthy that the amount of runoff water during this event was relatively small.

In contrast, the methoxychlor concentration was generally low for the first 3 months after application, April - June, when 18 percent of the period's runoff carried only 8 percent of the insecticide removed. Somewhat higher concentrations prevailed through January 1968, when a single event, which occurred when the surface soil was frozen, removed more methoxychlor than all other events combined. Although the methoxychlor concentration in the runoff was no higher than that of several earlier events, the removal was high because of the relatively large volume of runoff (see Table 1). Only because the topsoil was frozen, was the event significant. The rain which produced this runoff fell at low intensities and would have infiltrated had the soil not been frozen.

Total methoxychlor removed by runoff during the 14-month period was 0.8 g/ha -- 0.004 percent of the application.

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TABLE 1

Methoxychlor and 2,4,5-T in Lysimeter Runoff in the 14-Month Period Following March 30, 1967 Application

Sample Date	Concentration (µg/liter) 2,4,5-T	Methoxychlor	Runoff (liter)
1967			
4-5	105	0.1	2.2
4-17	197	8.8	6.6
4-21	380	1.3	4.4
5-2	170	1.0	2.2
5-7	52	1.0	4.4
5-15	59	0.8	8.8
5-29	82	0.2	6.6
7-2	68	2.2	4.4
7-19	30	7.8	8.8
7-24	(25)	4.7	4.4
8-20	13	(5.5)	11.1
9-9	10	(5.5)	2.2
9-28	2	6.3	13.6
11-1	3	0.6	8.8
1968			
1-27	(3)	5.3	86.2
3-22	2	1.1	11.1
3-27	1	2.0	4.4
3-31	1	2.0	2.2
4-14	3	3.4	6.6
5-24	1	1.3	22.1
			221.1

Data in parentheses are estimates

Runoff for the study period totaled 274 mm, about the same as the 20-year average.

Percolate, water intercepted below the rooting depth at 2.44 m, contained no methoxychlor and only trace amounts of 2,4,5-T. The first indication that the chemical had moved down through the soil material to the lysimeter bottom was a concentration of 0.5 ppb of 2,4,5-T on December 6, 1967, 9 months after application. Samples taken on March 25 and 28, 1968, 1 year after application, contained 0.1 ppb, although none was detected in most of the samples taken during this period.

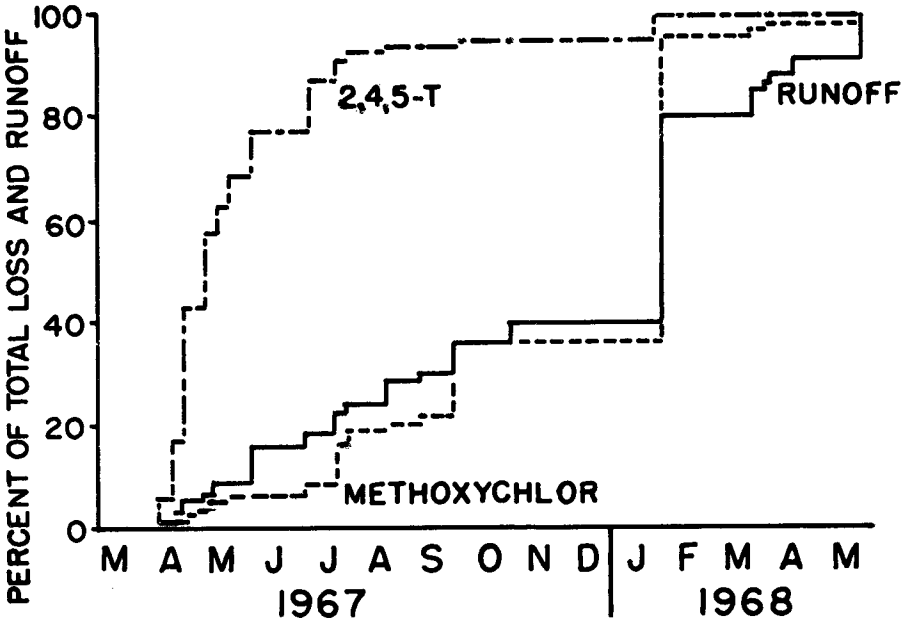

Figure 1. Cumulative runoff and removal of 2,4,5-T and methoxychlor in runoff in the 14-month period after surface application, March 30, 1967.

Percolation for the study period totaled 265 mm, about 100 mm less than the 20-year average.

The total amount of 2,4,5-T found in the percolate was so small that it did not indicate significant contribution to groundwater contamination. The rapid degradation rate, earlier indicated by Trichell et al. (3), explains why this soluble herbicide did not persist long enough in the soil water system to move freely to the sampling depth. Only by rapid flow through large channels and deep soil cracks can 2,4,5-T move out of agricultural soils into deep ground water supplies.

Treatment was applied to the 8.07 m^2 surface of lysimeter No. 101B at the North Appalachian Experimental Watershed at Coshocton, Ohio. Poverty grass and broadleaf weeds were the predominate cover crops of this poorly fertilized surface. The soil is Muskingum silt loam, well drained over sandstone bedrock.

Percolating water was intercepted at a depth of 2.44 m, well below the rooting depth. The lysimeter and soil are fully described elsewhere (2).

The methoxychlor (18.16 g) and 2,4,5-T (1.08 g) were dispersed in 8 l of water and spread evenly over the lysimeter surface. KCl was also applied to provide a readily detectable tracer (Cl^-) to indicate when the chemical-containing water reached the 2.44-m depth. As soon as the chloride was detected in the percolate, more complex analyses for the pesticides were initiated.

All analyses were performed at the U. S. Soils Laboratory at Beltsville, Maryland. Samples of percolate and runoff water were extracted with n-hexane to partition the methoxychlor as described by Barry et al. (1). After concentration of the hexane solution with a Kuderna-Danish concentrator, the methoxychlor content was determined directly in a gas chromatograph using an electron-capture detector. Where necessary, the hexane solutions were cleaned by elution on a chromatographic column containing Florisil P.R. The 2,4,5-T was isolated from the water by addition of 25 ml of 10 percent H_2SO_4 to 500 ml of sample after the initial hexane extraction and partitioning into 5:1 ether-hexane solution. After concentration, the 2,4,5-T was converted to the ethyl ester by acid esterification, partitioned into ether, evaporated, and taken up in hexane for assay on the gas chromatograph.

2,4,5-T (Trichlorophenoxyacetic acid) is a biodegradable, chlorinated hydrocarbon herbicide, commonly used to control many woody plants. A low volatility amine form was used.

Methoxychlor (2, 2-bis (p-methoxyphenyl)-1, 1, 1-trichloroethane) is an insecticide widely used because of its long residual action against many species of insects and its low toxicity to humans and other warm-blooded animals. It is commonly used in the preparation of household insecticides and in many cases is used as a replacement for DDT.

Literature Cited

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