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Carry-over of Dinitramine, Triallate, and Trifluralin to the Following Spring in Soils Treated at Different Times During the Fall

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In Saskatchewan, soil applications of emulsifiable concentrate formulations of the herbicides dinitramine (N,N-diethyl-α, α, α-trifluoro-3,5-dinitrotoluene-2,4-diamine), triallate (S-2,3,3-trichloroallyldiisopropylthiocarbamate) and trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) are incorporated during the fall so that residues may be carried over in the soil to the following spring for the control of germinating grassy weed seedlings in a variety of crops (ANON 1981). All 3 herbicides are volatile and soil treatments are usually made during October, before November freeze-up, to reduce volatility losses.

Field persistence studies conducted with small field plots at different sites in Saskatchewan have indicated (SMITH 1975) that between 23% and 75% of the original dinitramine, triallate and trifluralin can remain in the soil in May after October treatments.

All 3 herbicides are lost from treated soils by biological degradation and by volatilization (BANTING 1967, HELLING 1976). Both these processes are favoured by moist conditions and are inhibited by dry soil conditions. On the Canadian prairies, the months of September, October and early November tend to be very dry with the moisture contents of field soils being less than their wilting point values. Consequently, losses of all 3 herbicides should be minimal, and it could be possible to apply such fall treatments earlier than October without undue extra loss of the chemicals.

The present work was undertaken to investigate the carry-over of dinitramine, triallate and trifluralin residues from fall treatments to the subsequent May to ascertain whether the application dates of the herbicidal treatments are critical in determining the amounts of chemical being carried-over to the following spring. Treatments were made during the first weeks of September, October and November and all soils were sampled and analyzed the following May. The experiment was repeated for 3 successive years at 2 locations for dinitramine and triallate, and for 6 consecutive years at both sites for trifluralin.

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MATERIALS AND METHODS

Soils. The physical characteristics and composition of the heavy clay and sandy loam field soils used in this study have already been reported (SMITH 1978a).

Chemicals. Commercial formulations containing dinitramine, triallate and trifluralin were diluted with methanol to give individual solutions with herbicide contents of 2.5 mg/mL.

Field persistence studies. Separate field plots (20 X 20 cm, 400 cm^2) at Regina (heavy clay) and White City (sandy loam), Saskatchewan were treated with the methanolic solutions (2 mL, or 5 mg of herbicide equivalent to a rate of 1.25 kg/ha) and incorporated to a 5 cm depth using a small fork, exactly as described (SMITH 1972, 1975). Three replicate plots were treated at both sites with trifluralin during the first week of September, October and November each of the 6 years 1976 to 1981, while similar treatments with dinitramine and triallate were made the 3 years of 1979 to 1981. During the second week of May following the fall treatments, the soil from the 0 to 5 and 5 to 10 cm levels of all plots was removed as described (SMITH 1972, 1975). After air-drying at laboratory temperatures the samples were weighed (approximately 2 kg), ground, and mixed in a laboratory mixer for 20 minutes. Sub-samples (20 g) were then solvent extracted and analyzed gas chromatographically for herbicide remaining.

Herbicide extraction and analysis. All 3 chemicals were extracted from the soils using 30% aqueous acetronitrile containing 2.5% glacial acetic acid, since this solvent system is good for recovering triallate and dintroaniline herbicides from weathered field soils (SMITH 1978b, 1981). Following extraction, the various herbicides were partitioned into *n*-hexane. Full details are as described (SMITH 1979). The Hewlett-Packard 5713A gas chromatograph was equipped with a radioactive nickel detector operated at 300°C. The glass column (1.5 m X 4 mm i.d) was packed with 5% Dexsil-300, on Chromosorb W, HP (80-100 mesh). Carrier gas was argon containing 5% methane, at a flow rate of 40 mL/min. All samples and standards were injected directly onto the column packing. With a column temperature of 195°C trifluralin and triallate had retention times of 2.75 and 5.10 minutes respectively, while at a temperature of 200°C, dinitramine had a retention time of 3.93 minutes.

RESULTS AND DISCUSSION

The results of the study are summarized in Table 1. At all sampling times, all of the chemical residues were in the top 5 cm soil levels and less than 2% of the applied herbicides were detected in the 5 to 10 cm depths at any site. Data are not available for the Regina location for the treatments made during 1980, since flooding in spring of 1981 resulted in extensive soil erosion of all plots.

TABLE 1

Percentage recovery of dinitramine, triallate and trifluralin from the top 5 cm of field plots at two locations during the second week of May, following applications of 1.25 kg/ha at different times during the preceding fall.

	Herbicide recovered the following May (%)*					
Applic.	Heavy clay			Sandy loam		
Yr./Mo.	Sep.	Oct.	Nov.	Sep.	Oct.	Nov.
			Dinitramine			
1979	68 a	71 a	76 a	68 a	57 a	68 a
1980	- **	-	-	39 b	52 a	63 a
1981	47 a	49 a	47 a	60 a	57 a	62 a
			Triallate			
1979	53 a	64 a	50 a	56 a	62 a	61 a
1980	-	-	-	23 a	27 a	29 a
1981	22 a	22 a	23 a	23 a	20 a	21 a
			Trifluralin			
1976	57 a	54 a	53 a	33 ab	17 b	43 a
1977	32 a	34 a	38 a	30 a	35 a	35 a
1978	32 a	40 a	38 a	33 a	41 a	36 a
1979	44 a	46 a	42 a	49 a	51 a	37 a
1980	-	-	-	22 a	28 a	32 a
1981	20 a	19 a	22 a	20 a	28 a	23 a

* Average from triplicate plots; for each herbicide and site, means within each horizontal column followed by a common letter are not significantly different at the 0.01 level according to Duncan's multiple range test.

** Data not available.

It can be noted (Table 1), that following fall applications, dinitramine is more persistent in both soil types than either triallate or trifluralin. It can also be noted (Table 1) that the amounts of triallate and trifluralin remaining in the soil each May were more variable than for dinitramine. Thus, for triallate and trifluralin treatments made during 1979, carry-over was considerably greater than from applications made in the fall of 1981. These differences no doubt reflect differences in soil moisture and temperature following soil treatment. In general, losses of all 3 chemicals after fall treatments were similar to those previously reported (SMITH 1975).

For all the years studied, the amounts of the 3 herbicides remaining in the heavy clay the spring following application were not significantly different (at P = 0.01) regardless of whether the treatments were made during the preceding September, October or November (Table 1). On the sandy loam, significant differences (at P = 0.01) were noted only for dinitramine applied during September of 1980 when compared to treatments made during October and November of that year, and for trifluralin applied in 1976 (Table 1). For all other years the herbicide residues remaining in the soil in May were similar regardless of application month.

The present study, therefore, indicates that in Western Canada the timing of fall treatments of dinitramine, triallate and trifluralin does not appear to be critical in determining the amounts of the chemicals being carried over in the soil to the subsequent spring, so that these chemical treatments can be made as early as September or as late as November.

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