Dissipation of

ATRAZINE RESIDUES

In North Dakota Soils

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Atrazine is an excellent herbicide for season-long weed control in corn. Corn displays an extremely high tolerance to this chemical. One of the main problems confronting farmers who apply atrazine, however, is its long soil residual which occasionally damages crops that follow atrazine-treated corn the next year in a rotation. Because residues vary from year to year, an understanding of the method of dissipation (breakdown and/or movement out of soil) would help farmers to predict approximately the amount of residue for the following year. Burnside (2) reported that in Nebraska the dissipation of atrazine from the soil was mainly by leaching. However, Bick and Roadhouse (1) in Ontario reported very little leaching of atrazine and that dissipation was increased by fallow. In Alabama, Sikka and Davis (3) reported that atrazine soil residues were lower following corn than fallow because of corn's ability to metabolize atrazine to nonphytotoxic products. This study was conducted to determine the dissipation of atrazine from various soils in North Dakota.

Procedure

In spring, 1964, atrazine residue plots were established on the Dalrymple experimental plots at the Agronomy Seed Farm, Casselton, in Fargo silty clay soil; at the Carrington Irrigation Station in Heimdahl loam; and at the Minot Experiment Station in Williams loam. At all three stations, the atrazine was applied at 2, 4, and 8 pounds per acre to plots containing corn and to plots kept fallow. Each treatment was replicated twice at Carrington and Minot and three times at Casselton. In the fall of 1964 and again in 1965, three soil cores were obtained with a hydraulic powered sampling core from each plot. The intact cores were cut into segments beginning at the surface 0-4, 4-8, 8-12, 12-18, and 18-24 inches.

The three core segments of corresponding depth were composited and placed in plastic bags. The soil from Carrington and Minot was frozen and stored until analyzed, while the soil from Casselton was processed immediately for atrazine residue, using Russell oats as a bioassay crop in the greenhouse. Besides the soil samples from the treated plots, soil of the various depths was obtained from plots without atrazine at each location. This soil was used to obtain a standard curve for Russell oats growth when various amounts of atrazine were added to the soil. The atrazine residue in the soil from the corn and fallow plots was determined as the amount that was added to untreated soil of a corresponding depth to give an equal reduction in Russell oats growth.

In 1965, corn was seeded again to the plots containing corn in 1964 without plowing the experiment area, and the non-corn plots were again maintained fallow. Atrazine was not applied in 1965. The corn was kept weed-free where atrazine did not give complete weed control. However, at Casselton in 1965, one-half of each fallow and corn plot was seeded to wheat and allowed to grow wheat and weeds. These plots were harvested in the fall with reductions in dry matter production used as a measure of atrazine residue. In 1966 at

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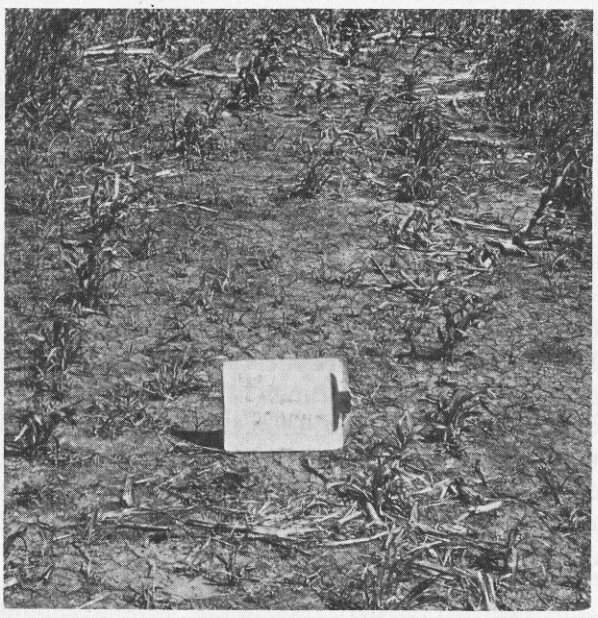
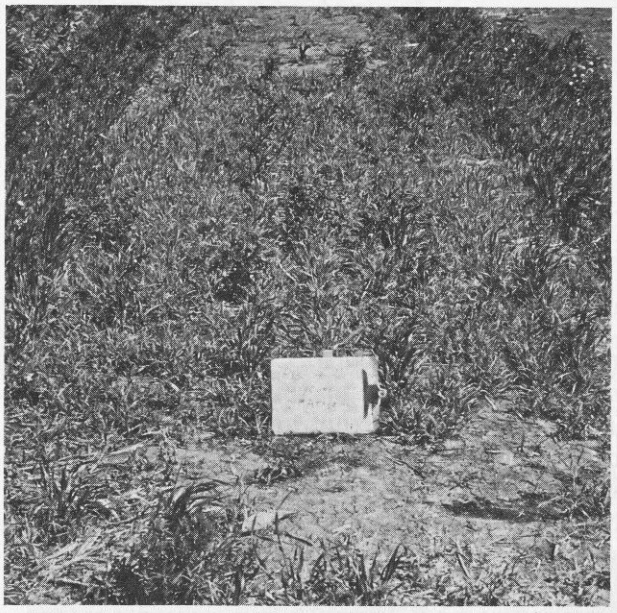
Figure 1. Growth of wheat the year following corn and fallow under two different atrazine application rates.

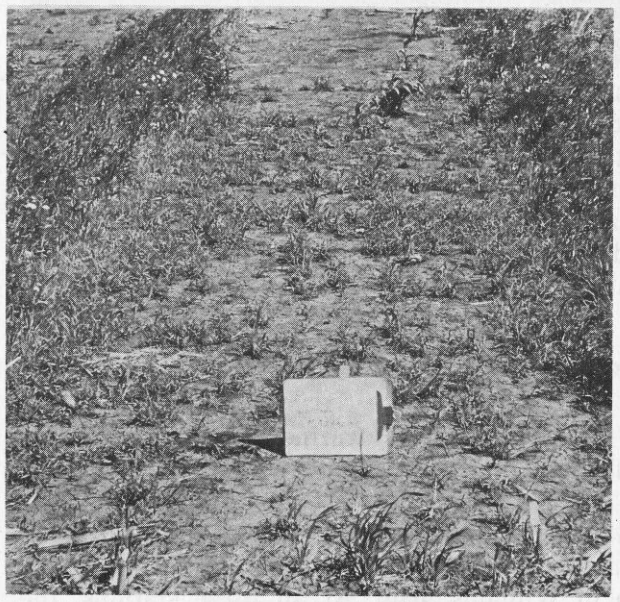


Two pounds per acre of atrazine applied to corn.



Two pounds per acre of atrazine applied to fallow.

Four pounds per acre of atrazine applied to corn.



Four pounds per acre of atrazine applied to fallow.

Casselton and Minot, wheat was seeded over the atrazine residue corn and fallow plots, and dry weights were determined at harvest.

Results and Discussion

Residue from atrazine remained primarily in the upper four inches of soil and dissipation was increased by keeping the soil fallow. The bioassay results of the 0-4 inch soil depth for 1964 and 1965 are presented in Table 1. Residues were not found

Table 1. Pounds per acre of atrazine remaining in the surface four inches of soil in the fall of 1964 and 1965 after a 1964 spring application.

Crop	Atrazine applied lb/A	Casselton 1964	Casselton 1965	Carrington 1964	Carrington 1965	Minot 1964	Minot 1965
Corn	2	0.2	.17	0.1	0.0	0.0	0
Corn	4	1.4	.28	0.6	0.1	0.7	0
Corn	8	3.6	.70	1.2	0.4	1.2	0
Fallow	2	0.4	.13	0.0	0.0	0.0	0
Fallow	4	1.6	.45	0.0	0.0	0.0	0
Fallow	8	1.5	.49	1.0	0.1	1.3	0

below the four-inch level except for 0.2 pounds per acre of atrazine in the 4-8 inch zone at Minot from the eight pounds per acre application in corn.

Presence of the residue in the upper soil surface was not from a lack of moisture for percolation. Precipitation between atrazine application and soil sampling in 1964 was 15 inches at all three locations, and from sampling in 1964 to sampling in 1965, 23, 18 and 24 inches of rainfall at Casselton, Minot and Carrington, respectively. In both years the residues were higher at Casselton than at Carrington or Minot, and the plots containing corn generally had more residue than the fallow plots. In 1965, the bioassays indicated that the residue had dissipated at Minot. However, the 1966 wheat dry weight yields indicated that a residue was still present in the plot growing corn treated with eight pounds per acre of atrazine. All bioassay results may be low since one week was required to process the soil for bioassay and this may have allowed some decomposition of the atrazine. The atrazine used in the standard curve was mixed with the soil just prior to seeding the oats used for bioassay.

The more rapid decomposition of atrazine on fallow is further demonstrated from the Casselton weed dry weights harvested in the fall of 1965 and the wheat dry weights of Casselton and Minot from 1966 (Table 2). Weed or wheat dry matter produced was always less on the corn plots than on the fallow plots. The reduced stands of wheat following corn as compared to fallow (Figure 1) indicated

Table 2. Dry matter production in grams per square yard following various applications of atrazine in the spring of 1964.

Atrazine applied lb/A	1964 and 1965 Crop	Casselton 1965 Wheat and Weeds[1]	Casselton 1966 Wheat	Minot 1966 Wheat
2	Corn	139	732	1730
4	Corn	40	555	1820
8	Corn	0	152	1315
2	Fallow	350	1075	1872
4	Fallow	234	810	2130
8	Fallow	56	515	1842
0	Fallow	0	1212	0
0	Corn	762	895	1700

[1]Wheat and weed dry matter yields from the half of the plot that was over-seeded with wheat in the spring.

that the reductions in dry matter were from an atrazine residue and not from a nutrient depletion caused by continuous corn cropping.

Since fallow apparently increases the dissipation of atrazine from North Dakota soils, a microbial or a chemical process apparently is involved. Fallow soils are warmer and moister than cropped soils, facilitating either method of dissipation. In North Dakota, the moisture and higher temperature of the soils with fallow apparently were more important factors than the amount of decomposition of atrazine through metabolism by the corn plant roots. Leaching was not a factor in the dissipation of atrazine, as nearly all the residue remained in the upper four inches of soil over the two years. In 1965, cores were taken down to 48 inches in the soil from certain plots to check if the atrazine had leached below our standard 24-inch sampling depth. Atrazine residues were not detected at these lower depths.

Summary

Under North Dakota conditions, leaching is not important in the removal of atrazine residues from the upper root zone of the soil. Fallow soils dissipate atrazine more rapidly than soils growing corn.

In a wet and hot year, one could expect less atrazine residue than in dry cool years, as experienced in 1967. Therefore, farmers are urged to be cautious when seeding crops to soil that was treated with atrazine in 1967 which was a dry cool year.

LITERATURE CITED

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