

# Influence of soil aggregate size on atrazine sorption

J. M. Novak, T. B. Moorman, and D. L. Karlen

The effects of numerous soil properties including texture (7); pH (1); mineralogy (5); and organic matter content (4) on atrazine [6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine] sorption have received considerable attention. However, information on the effects of soil aggregate size on the sorption and movement of atrazine is relatively limited. More research is needed to evaluate aggregate size effects on atrazine sorption since these interactions are considered to be an important factor in solute sorption and movement (2). Our objective was to examine the sorption of atrazine to a suite of whole and crushed aggregates obtained from an Iowa glacial till soil.

## Materials and methods

**Isolation of Soil Aggregates.** Six sizes (0 to 0.5, 0.5 to 1, 1 to 2, 2 to 3, 3 to 4, and 4 to 5 mm) of whole soil aggregates were obtained by sieving the Ap horizons (0 to 15 cm) of Wisconsin-age glacial till (Clarion loam; Fine-loamy, mixed, mesic Typic Hapludolls) soil. Soil location, cropping history, aggregate extraction and physio-chemical properties have been described by Collado and Karlen (3). The sorption of atrazine to crushed aggregates (< 0.4 mm) was also determined to remove the effects of intra-aggregate porosity on sorptive processes.

**Sorption.** Batch sorption of atrazine was performed by equilibrating 4g air-dried whole (all isolated sizes) and crushed aggregates with 20 mL of 2 mg L<sup>-1</sup> atrazine dissolved in 0.01M CaCl<sub>2</sub>. Replicate centrifuge tubes along with controls (atrazine without soil) were agitated for 72 h. Atrazine in the equilibrium solution was determined by HPLC. The difference between initial atrazine concentration (mg L<sup>-1</sup>) and in the equilibrium solution was attributed to sorption by soil aggregates. The sorption  $K_d$  (L kg<sup>-1</sup>) was calculated as:

$$K_d = \text{mg atrazine kg}^{-1} \text{ soil} / \text{mg atrazine L}^{-1} \text{ eq. soln.} \quad [1]$$

**Kinetics.** Batch techniques were used to measure atrazine sorption kinetics on 0 to 0.5, 1 to 2, and 3 to 4 mm whole soil aggregates from both soil types using similar methods. Kinetic data was analyzed using nonlinear least squares procedures (6) using the regression equation:

$$S_T = S_i(1 - e^{-k_1 t}) + k_2 t \quad [2]$$

where  $S_T$  is total atrazine sorbed to soil (mg Kg<sup>-1</sup>),  $S_i$  is the initial atrazine sorbed (mg Kg<sup>-1</sup>),  $k_1$  is a first-order rate constant (h<sup>-1</sup>), and  $k_2$  (mg h<sup>-1</sup>) is a zero-order rate constant describing the increase in atrazine sorption above  $S_i$ .

## Results and discussion

Atrazine  $K_d$  values for both whole and crushed ranged between 3.02 and 3.63 (Figure 1). Comparing the whole aggregate atrazine  $K_d$  values within soil type, the smallest aggregate size (0-0.5 mm) had significantly different values (1-way ANOVA,  $P < 0.05$ ). Although, these differences are statistically significant, we believe that the magnitude of the aggregate effects on atrazine  $K_d$  are minor. Crushing the aggregates to a common size (0.4 mm) did produce some significant atrazine  $K_d$  differences for the 1 to 2 and 3 to 4 mm aggregate sizes (1-way ANOVA,  $P < 0.05$ ). These differences were also significant, however we believe that the magnitude of the atrazine  $K_d$  differences are small enough to be ignored. Aggregate size had little effect on atrazine sorption kinetics (Table 1). Values of  $S_i$  increased and  $k_1$  decreased in the 3-4 mm diameter aggregates compared to the 0-0.5 mm aggregates. Values of  $k_2$  were significantly different from zero for all regressions (Table 1). However, the  $k_2$  values are quite small in magnitude. In the initial 24 h first-order sorption reactions were rapid, but in some aggregate size classes slower, zero-order reactions were evident later in the time-course (Figure 2).

## References cited

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J. M. Novak, T. B. Moorman, and D. L. Karlen are with the U.S. Department of Agriculture- Agricultural Research Service, the National Soil Tilth Laboratory, Ames, Iowa.

Table 1. Kinetic parameters describing atrazine sorption to soil aggregates during batch equilibrium experiments. Values in parentheses are standard errors of the parameter estimates.

Soil	Size mm	$S_j$	Parameters	
			$k_1$	$k_2$
Clarion	0-0.5	2.22(0.06)	3.11(1.09)	0.0048(0.0016)
	1-2	2.40(0.05)	2.37(0.36)	0.0054(0.0012)
	3-4	2.49(0.04)	1.65(0.14)	0.0067(0.0010)

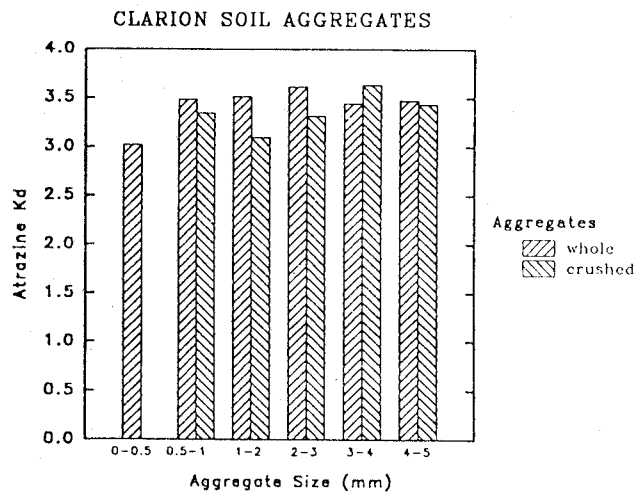


Figure 1. Atrazine  $K_d$  values for whole and crushed Clarion soil aggregates.

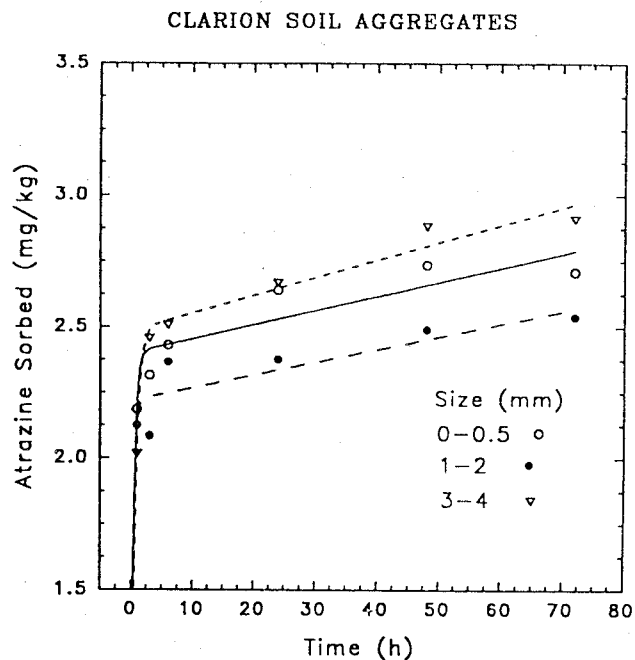


Figure 2. Atrazine sorption kinetics for 3 sizes of whole Clarion soil aggregates. Symbols represent means and the lines represent predicted quantities of sorbed atrazine. ( $S_t$ ).