Title: **Effect of Soil Type, Selected Best Management Practices, and Tillage on Atrazine and Alachlor Movement through the Unsaturated Zone**

Project I.D.: DNR Project No. 66

Investigators: Birl Lowery, Professor, UW-Madison, Dept. of Soil Science
Kevin McSweeney, Assoc. Professor, UW-Madison, Dept. of Soil Science
Kevin Fermanich, Assoc. Researcher, UW-Madison, Dept. of Soil Science
Gary Hart, Dong Wang, and Cathy Seybold, Research Assistants, UW-Madison, Dept. of Soil Science

Period of Contract: August 18, 1989 through December 31, 1991

Background/Need: Groundwater monitoring results have revealed numerous cases of contamination by agricultural chemicals in areas with sandy soils. The amount of this contamination, however, has varied greatly between areas with similar landscapes and management practices. It appears that a particularly susceptible region was the intensively irrigated Lower Wisconsin River Valley (LWRV). Data from soil-column studies suggests that herbicide movement through the root zone of LWRV soils is much greater than through the similar soils from the Central Sands (CS) area of Wisconsin. A need exists to understand the link between groundwater contamination and field applied herbicides in the LWRV, as well as the differences between sandy soils from the LWRV and CS.

Objectives: 1) To document the rate and extent of water, atrazine and nitrate movement through the unsaturated zone to groundwater in the LWRV. 2) To evaluate the effects of soil type (LWRV vs. CS), irrigation scheduling and tillage on herbicide and nitrate movement. 3) To improve understanding of the relationships between herbicide behavior, inherent soil properties, and pesticide and irrigation application.

Methods: A field site representative of the intensively cropped and irrigated alluvial sands in the LWRV was divided into three irrigation blocks with each block containing no-tillage and moldboard plow tillage subplots. A linear move irrigation system was installed to permit controlled, uniform water application. Herbicides and nitrogen fertilizer were applied at recommended rates following corn planting each spring. Movement of surface applied agrichemicals to groundwater was monitored at various depths by soil-solution sampling, periodic soil coring, and groundwater monitoring. *In situ* hydrologic characterization of the site was performed by continuously measuring changes in soil-water content and soil-water potential under various rainfall/irrigation and drainage events. Soil type comparisons were made by long-term, large-scale soil-column leaching studies, atrazine adsorption studies, and detailed morphological, chemical, and mineralogical characterization of several Wisconsin sandy soils.

Results: Drainage through the soil profile at the field site is very rapid, with field moisture capacity being reached within 24 hours after rainfall. Unsaturated hydraulic conductivity was about one order of magnitude greater in the LWRV sand compared to previous measurements of CS sand. The LWRV sand demonstrated little water holding capacity below 30 cm.

Atrazine concentrations greater than 10 ppb were measured at a depth of 140 cm within 40 days after herbicide application in 1990. During late June, 16 cm of rainfall were received at the site, creating a "pulse" in the atrazine concentration during early July. We estimated that 1 to 2% (about 0.01 lb/a) of the applied atrazine was lost to deep percolation during that period.

The 1991 growing season was generally drier than 1990. Average peak concentrations were less in 1991 than in 1990. However, there was evidence of rapid movement of atrazine deep into the root and vadose zones. Generally, peak concentrations of atrazine were measured between 30 and 60 days after application and corresponded closely to major rain events during mid-June. Peak concentrations at the 250 cm depth were less than 4 μg/L. Differences in average atrazine concentrations between the three water management regimes were small. The range of atrazine concentrations measured in groundwater during 1991 were from <0.3 to 6.5 μg/L. The mean concentration was about 1.1 μg/L. Atrazine concentrations measured in the groundwater were reasonable given the levels of atrazine measured in soil-solution samples collected from the lower soil profile.

Conclusions: Laboratory/greenhouse studies indicate that differences in herbicide leaching between the LWRV and CS areas are due, at least in part, to uniform grain size distribution and lack of significant morphologic discontinuities, causing very rapid water percolation in LWRV soil, as well as a smaller water holding capacity and less atrazine adsorption in LWRV sand. The soil column study suggests that atrazine degradation may be faster in the CS.

LWRV soil is very susceptible to atrazine leaching. Under normal management practices atrazine can leach to groundwater within the season of application, even under nonirrigated situations. It appears that about 2% of applied atrazine reaches the groundwater as parent compound during the growing season.

Implications/Recommendations: To reduce the quantity of atrazine reaching the groundwater, the amount applied should be minimized through management practices such as band-application, reduced rates, and crop/herbicide rotation. Irrigation should be reduced particularly when rain is expected to prevent deep percolation.

Publications: Fermanich, K.J., B. Lowery, W.L. Bland, and K. McSweeney. 1993. Water, atrazine, and nitrate flux below the root zone of a sandy soil. p. 92-99. *In* Proc. Agricultural Research to Protect Water Quality Conf., 21-24 Feb., Minneapolis, MN. Soil Water Conserv. Soc., Ankeny, IA.

Fermanich, K.J., B. Lowery, K. McSweeney and S. Grant. 1991 Atrazine leaching at a field site in the Lower Wisconsin River Valley. *In* Proc. 1991 WI. Fert, Aglime and Pest Mgmt. Conf. 30:129-137.

Girard, B.D. 1991. Development of a modified flow-column technique for the determination of atrazine adsorption coefficients. M.S. thesis, UW-Madison.

Hart, G. L. 1992. Sparta sand: *in situ* hydraulic characterization, sampler evaluation, irrigation, and solute transport. M.S. thesis, UW-Madison.

Key words: atrazine, nitrate, Lower Wisconsin River Valley

Funding: DNR, DATCP, Nonpoint Source Pollution project (admin. by Dept. of Soil Science), USDA-CSRS, WI Fertilizer Research Council, UWS, CIBA GEIGY Corp.

Final Report: A final report containing more detailed information on this project is available for loan from Wisconsin’s Water Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.