Assessing Leaching of Agricultural Chemicals on Prairie Derived Silt Loam Soils in the Walworth County Farm

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by

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BACKGROUND / NEED

Water contamination represents one of our nation's most significant and long-term problems. Alleviating the undesirable tradeoff between agricultural production and deterioration of water quality has been a challenge for the past two decades. To meet this challenge, it is imperative to accurately sample and understand the leaching of agricultural chemicals to groundwater and to develop farming systems that cause less contamination of water resources.

OBJECTIVES

The objectives of this study were 1) to use tile drain sampling to compare nitrate leaching from two cropping systems, and 2) to determine the mechanisms that cause chemical leaching.

METHODS

The experimental site was located in Walworth County Wisconsin. The soils at the site are poorly drained Griswold and Pella silt loams which consist of wind blown silts over gravelly glacial till and outwash. The poor drainage results from a highly compacted glacial till layer between 80 and 130 cm in the profile.

Tile drainage water was sampled to compare nitrate leaching between two cropping systems: a corn-soybean rotation and a corn-soybeans-wheat/red clover rotation. In the corn-soybean system, half the plot was corn and half was soybean. In the corn-soybean-wheat/red clover system, one third of the plot was planted to each crop. The corn-soybean-wheat/red clover rotation minimizes the use of agricultural chemicals whereas the corn-soybean rotation depends heavily on agricultural chemicals.

Potassium bromide and penta-fluorobenzoic acid (PFBA) tracers were applied and used to study the mechanisms of chemical transport at the site. The bromide tracer was applied in conjunction with an irrigation rate of 3.1 mm/hr for 22 days and the PFBA was applied in conjunction with an irrigation rate of 0.89 mm/hr for 14 days.

RESULTS / DISCUSSION

From April to November 2001, the total nitrate mass recovered from the Corn-Soybean rotation was 127.9 kg/h and the total mass recovered from the corn-soybean-wheat/red clover rotation was 74.8 kg/h. Approximately 85% of the nitrate leaching occurred from April to early July for both rotations. Fall soil coring to 90 cm showed that there was more nitrogen available for leaching in the corn-soybean rotation (137.8 kg/h) than in the corn-soybean-wheat/red clover rotation (103.7 kg/h).

The initial arrival of bromide tracer was detected in tile drainage water 16 minutes after application. The bromide mass flux then quickly increased two orders of magnitude within 6 hours of application. The short bromide transit times and the rapid rise of the breakthrough curves indicate that bromide was being primarily transported through preferential flow pathways.

In contrast, the main breakthrough of PFBA tracer did not occur until 90 hours after application and peaked at 240 hours after application. The slower breakthrough of the PFBA tracer suggests that matrix flow through the smaller matrix pores of the soil was the dominant transport mechanism. The difference in the timing of the breakthrough curves and the mechanism of transport for the bromide and PFBA was due to the different rates of irrigation that were applied during the two tracer experiments.

CONCLUSIONS / IMPLICATIONS / RECOMMENDATIONS

The results indicate that the three-phase corn-soybean-wheat/red clover rotation was better at reducing nitrate leaching. The results also demonstrate that preferential flow paths were important in causing chemical transport in unsaturated soils. When preferential flow pathways become hydraulically active, contaminants can be quickly leached from a soil profile.

RELATED PUBLICATIONS

None.

FINAL REPORT

A final report containing more detailed information on this project is available at the Wisconsin Department of Agriculture, Trade and Consumer Protection. For more information: phone 608/224-4503, or email at jeff.postle@datcp.state.wi.us.