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Drainage water quality impacts of current and future agricultural management practices

Abstract:
Researchers examined how crop tillage, rotation or crop residue removal can affect the chemical composition of water draining from farm fields.

Principal Investigators:

Matt Helmers

Ramesh Kanwar
Agricultural and Biosystems Engineering

Antonio Mallarino
Agronomy
Iowa State University

Budget:
$18,442 for year one

Q How do nutrient management practices influence nitrate-N loss in subsurface drainage?

A A multi-year, replicated plot subsurface drainage study monitored drainage water and crop yield. Cover crops have the potential to reduce nitrate loss and increased application of nitrogen in a corn-soybean or continuous corn system has the potential to increase nitrate loss.

Background

There is growing concern about nutrient export related to subsurface drainage and surface water runoff to surface water systems in Iowa and the Gulf of Mexico with nitrate loss through subsurface drainage systems of primary concern. As a result, new management practices that have the potential to significantly reduce nitrate losses at minimal cost are needed. One potential management practice is use of winter cover crops, but the effects on water quality are unclear. In addition, there is a need to better understand how crop rotation (corn-soybean or continuous corn), tillage, or crop residue removal may impact nutrient loss through drainage systems. Also, with the intensive use of liquid swine manure in Iowa, there is a need for evaluating NO_3-N losses when manure is applied to both corn and soybean in a corn-soybean rotation. The systems need to be studied to evaluate dissolved nutrient loss from drainage systems from these new or slightly different management practices.

The overall objectives of this study are to evaluate the drainage water quality impacts of various cropping and nutrient management systems. The treatments allowed for varied comparisons (see Table 1):

- Cropping practices through the use of a winter cover crop (treatment 1 vs. 5)
- Use of swine manure before corn and soybeans or just corn (treatments 2 vs. 3)
- Continuous corn systems with and without stover removal compared to a corn-soybean system (treatments 2 vs. 4)
- Use of a no-till corn-soybean system (treatments 2 vs. 6)

Approach and methods

These tasks were performed as part of this project:

- Apply fertilizer and manure and perform manure nutrient analysis (all treatments).
- Harvest and collect grain yields (all treatments)
- Sample and perform chemical analysis of harvested plant parts to measure nutrient removal (grain for all treatments and removed stover for treatment 4b).
- Sample and perform total nitrogen analysis of above-ground rye biomass in the spring of the year (treatment 5).
- Sample and analyze tile drainage water for nitrate and dissolved-reactive

phosphorus. Installed automatic samplers collect flow-proportional water samples from tile flow during the year (all treatments).
- Collect profile soil samples (from depths of 0-15, 15-30, 30-60, and 60-90 cm) and analyze them each year for total carbon and routine soil-test methods that will include P by methods supported by ISU, pH, and exchangeable cations (all treatments).
- Dissemination of project findings through peer-reviewed journal articles, Extension fact sheets, and Extension presentations.

Experimental data was collected at the Iowa State University Northeast Iowa Research and Demonstration Farm near Nashua. This study site has 36, 0.4 ha plots, with state-of-the-art surface and subsurface water quality monitoring system.

Results and discussion

Results from the study indicated tillage had little impact on nitrate-N concentrations in drainage water, but cover crops showed the potential to reduce nitrate-N concentrations. The addition of liquid swine manure prior to both corn and soybeans production increased nitrate-N concentrations when compared to liquid swine manure application only before corn in a corn-soybean rotation. A continuous corn system had increased nitrate-N concentration in drainage compared to a corn-soybean rotation, but residue removal had little impact on nitrate-N concentration. These results have had an impact in improving our understanding of how nutrient management impacts nutrient loss through drainage systems. These findings should be relevant to millions of tile-drained acres in , at least, Iowa.

Conclusions

Multiple management practices affected the export of nitrates in tile water. (See Table 1) The effect of spring urea ammonium nitrate (UAN) application combined with cover crops resulted in the lowest NO_3-N concentrations in tile water. Spring-applied UAN showed the next lowest concentration. Fall-applied manure to no-till showed a lower combined nitrate concentration than a conventional fall manure application with tillage, but the overall NO_3-N losses were greater from the no-till treatment.

When comparing the cover crop treatment to the treatment most similar but without a rye cover crop (systems 1 vs. 5), there was an approximately 26 percent reduction in NO_3-N concentrations, which was significant. The highest NO_3-N concentrations in tile water occurred in the treatments that received nitrogen every year from manure application. The corn-soybean rotation had a combined concentration at 17.7 mg/l NO_3-N with an average two-year application rate of 140 kg N/ha. Annual manure application at 224 kg N/ha in continuous corn treatments had 20.4 mg/l and 20.2 mg/l NO_3-N concentrations in tile water for treatments 4.1 and 4.2, respectively. When comparing the continuous corn treatments to the corn-soybean treatment with the most similar tillage and nitrogen management (systems 2 vs. 4.1 and 4.2), there was an approximately 37 percent increase in NO_3-N concentrations with the continuous corn treatment. However, this includes a 56 kg-N/ha increase in nitrogen application rate in in the continuous corn system.

The overall yield results highlighted the need for additional research documenting the

impact of cover crops on corn and soybean yield, and specifically examining ways to reduce potential yield risk to the following cash crop.

Impact of results

The results from this study have increased understanding about the potential for cover crops to reduce NO_3-N export from row-cropped lands. The work documented the increased risk of NO_3-N export when liquid swine manure is applied before both corn and soybeans. In addition, continuous corn showed some potential to increase NO_3-N export when compared to a corn-soybean system. The work on NO_3-N concentrations and loss from a system where liquid swine manure is applied before both corn and soybeans was reported to the Iowa Environmental Protection Commission (EPC) in fall 2012 when the EPC considered this practice.

Education and outreach

Results from this project have been shared at ISU Extension meetings held at the Northeast Research and Demonstration Farm in Nashua. In addition, an annual report for the Northeast Research and Demonstration Farm with a description of the project is available on the Research and Demonstration Farm website. (See www.ag.iastate.edu/farms/11reports/Northeast/ImpactManure.pdf) This report also is shared with regular attendees at events at the Research and Demonstration Farm. Information about the water quality benefits of cover crops provided by this project has been relayed to participants at Iowa Learning Farms field days throughout Iowa. .

Leveraged funds

Michelle Soupir is continuing the project efforts and has added bacteria monitoring to the work. Funding for this effort is being provided by the Leopold Center for Sustainable Agriculture and the Iowa Pork Board.

For more information, contact:
Matt Helmers, Agricultural and Biosystems Engineering, 219B Davidson, Iowa State University, Ames, IA 5001; (515) 294-6717, e-mail mhelmers@iastate.edu

Table 1. Treatments for Nashua manure management and water quality study beginning 2007

System	Application timings and source of N	Crop	Tillage	Application method	Application rate, kg-N/ha
1	Spring (UAN) -	Corn Soybean	Chisel Plow Field Cultivate	Spoke inject -	168 -
2	Fall (manure) -	Corn Soybean	Chisel Plow Field Cultivate	Inject -	168 -
3 3	Fall (manure) Fall (manure)	Corn Soybean	Chisel Plow Field Cultivate	Inject Inject	168 112
4a 4b	Fall (manure) Fall (manure)	Cont. Corn Cont. Corn Round Bale Removal	Chisel Plow Chisel Plow	Inject Inject	224 224
5	Spring (UAN) -	Corn/Rye cover Soybean/ Rye cover	No Till No Till	Spoke Inject -	168 -
6	Fall (manure)	Corn Soybean	No Till No Till	Inject -	168 -