Impact of Liquid Swine Manure Application and Cover Crops on Groundwater Quality

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Carl Pederson, ag specialist
Matt Helmers, associate professor
Ramesh Kanwar, professor
Department of Agricultural and Biosystems Engineering
Antonio Mallarino, professor
Department of Agronomy

Introduction

The primary objective of this project was to determine the impact of appropriate rates of swine manure applications to corn and soybeans based on nitrogen and phosphorus requirements of crops, soil phosphorus accumulation, and the potential of nitrate and phosphorus leaching to groundwater. Another purpose of this long-term experimental study was to develop and recommend appropriate manure and nutrient management practices to producers to minimize water contamination potential and enhance the use of swine manure as fertilizer. A third component of this study was to determine the potential effects of rye as a cover crop to reduce nitrate loss to shallow groundwater.

Materials and Methods

Table 1 identifies the treatments first established in 2007 on 36, 1-acre plots. Five treatments compared the effect of timing and source of N on subsurface drain water quality and crop yields in a corn-soybean rotation and two treatments compared the effect of manure use on water quality under continuous corn with and without stover removal. The spring-applied UAN (urea-ammonium nitrate) with cover crop and fall-applied manure are the only treatments using no-till management, whereas the rest of the treatments used fall chisel plow and spring field cultivation as method of tillage.

Results and Discussion

The effects of nutrient management treatments on NO_3-N concentrations in subsurface drain (tile) water are summarized in Table 2. The tile water from Treatment 3 had the highest five-year average NO_3-N concentration at 23.3 mg/l for the manure applied to the corn year of the corn-soybean rotation. Five-year average NO_3-N concentrations in tile water from plots under continuous corn and receiving swine manure every year (System 4) were the next highest in comparison with other treatment systems. The fall-applied manure to soybean in Treatment 3 had consistently higher NO_3-N concentrations in tile water when compared with soybean of other rotations. Two systems (Systems 1 and 5) receiving UAN after corn emergence resulted in the lowest NO_3-N concentrations in tile water. The five year experimental data from this study show that average NO_3-N concentrations in tile water from Treatment 5, with a cover crop, was the lowest in the corn and soybean phases of the corn-soybean rotations. When comparing Treatments 2 and 5, where the only difference is the tillage, overall there is little difference in the NO_3-N concentrations, but the no-till has slightly lower NO_3-N concentration.

The impacts of the treatments on end of season soil nitrate are shown in Table 3. As expected, the highest concentrations of soil nitrate are in the 0-6 in. and 6-12 in. soil depth. Overall, the concentrations are very similar for the different treatments. In addition, there is relatively little difference in the residual soil nitrate after corn or after soybean.

Table 1: Experimental treatments for Nashua water quality study.

System	Timings and Source of N	Crop	Tillage	Application method	Rate, lb/ac N-based	Rate, lb/ac P-based
1	Spring (UAN)	Corn	Chisel plow	Spoke inject	150	If needed
	-	Soybean	Field Cultivate	-	-	If needed
2	Fall (manure)	Corn	Chisel plow	Inject	150	-
	-	Soybean	Field Cultivate	-	-	If needed
3	Fall (manure)	Corn	Chisel plow	Inject	150	-
	Fall (manure)	Soybean	Field Cultivate	Inject	100	-
4.1	Fall (manure)	Cont. Corn	Chisel plow	Inject	200	-
4.2	Fall (manure)	Cont. Corn Stover removal	Chisel plow	Inject	200	-
5	Spring (UAN)	Corn/rye cover	NT	Spoke inject	150	-
	-	Soybean/rye cover	NT	-	-	If needed
6	Fall (manure)	Corn	NT	Inject	150	-
		Soybean	NT	-	-	If needed

Table 2. Effects of experimental treatments on flow weighted average NO_3-N concentrations in drainage water (mg/l).

	2008		2009		2010		2011		2012		2008-2012	
Experimental treatments	**Corn**	**Soy**	**Corn**	**Soy**	**Corn**	**Soy**	**Corn**	**Soy**	**Corn**	**Soy**	**Corn**	**Soy**
1. Spring UAN 150 lb N/ac (C-S)	15.1	8	12.1	9.5	12.3	8	17.8	13.8	14	19.5	14.3	11.8
2. Fall manure 150 lb N/ac (C-S)	17.7	8.3	19.9	10.3	12.8	8.4	29.4	12.4	22.3	15.7	20.4	11
3. Fall manure 150 lb N corn & 100 lb N Soybean (C-S)	20.3	14.2	20.3	11.1	16.1	14	27.7	18.2	32.1	20.1	23.3	15.5
4.1 Fall manure 200 lb N/ac (C-C)	23.1		20.1		15.1		22.3		21.9		20.7	
4.2. Fall manure 200 lb N/ac + Stover removal (C-C)	23		17.6		16		24.2		19.4		20.0	
5. Spring UAN 150 lb N/ac + Rye removal	12.3	8.6	8.9	8.3	10.4	4.4	9.2	8.9	8.4	7.4	9.8	7.5
6. Fall manure 150 lb N/ac (C-S)	15.3	8.9	15.8	8.3	12.8	8	20.9	9.5	23.4	13.4	17.7	9.6

C-C, continuous corn; C-S, corn-soybean rotation.

Table 3. Average effects of experimental treatments on average NO_3-N concentrations in the soil profile from years 2008-2012 (ppm).

Depth	0-6 in.		6-12 in.		12-24 in.		24-36 in.		36-48 in.	
Experimental treatments	**Corn**	**Soy**	**Corn**	**Soy**	**Corn**	**Soy**	**Corn**	**Soy**	**Corn**	**Soy**
1. Spring UAN 150 lb N/ac (C-S)	13.3	11.4	9.1	6.1	4.7	3.1	1.7	2.6	1.3	2.2
2. Fall manure 150 lb N/ac (C-S)	13.5	13.1	5.8	6.9	3.5	4.1	2.6	1.8	1.3	2.0
3. Fall manure 150 lb N corn & 100 lb N Soybean (C-S)	12.0	11.1	5.7	7.3	3.4	4.1	1.9	2.3	1.3	1.5
4.1 Fall manure 200 lb N/ac	12.5		7.0		3.2		1.9		1.6	
4.2. Fall manure 200 lb N/ac + Stover removal (C-C)	10.4		5.8		2.8		1.4		1.0	
5. Spring UAN 150 lb N/ac + Rye removal (C-S)	15.3	12.3	9.3	7.8	5.0	4.1	1.7	2.2	1.3	1.1
6. Fall manure 150 lb N/ac (C-S)	12.6	14.9	5.5	7.0	3.3	3.7	1.9	1.9	1.7	1.3

C-C, continuous corn; C-S, corn-soybean rotation.