2012

Impact of Liquid Swine Manure Application and Cover Crops on Ground Water Quality

Carl H. Pederson
Iowa State University, carl@iastate.edu

Rameshwar S. Kanwar
Iowa State University, rskanwar@iastate.edu

Matthew J. Helmers
Iowa State University, mhelmers@iastate.edu

Antonio P. Mallarino
Iowa State University, apmallar@iastate.edu

Impact of Liquid Swine Manure Application and Cover Crops on Ground Water Quality

Abstract
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 the water contamination potential and enhance the use of swine manure as inorganic 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 ground water.

Keywords
RFR A11117, Agricultural and Biosystems Engineering, Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Bioresource and Agricultural Engineering

Impact of Liquid Swine Manure Application and Cover Crops on Ground Water Quality

RFR-A11117

Carl Pederson, ag specialist
Ramesh Kanwar, professor
Matt Helmers, associate 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 the water contamination potential and enhance the use of swine manure as inorganic 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 ground water.

Materials and Methods

Table 1 identifies the treatments established in 2007 on 36, one-acre plots. Five treatments compare the effect of timing and source of N on subsurface drain water quality and crop yields in a corn-soybean rotation, and two treatments compare the effect of manure use on water quality under continuous corn rotation with and without stover removal. The spring applied urea-ammonium nitrate (UAN) with cover crop and fall applied manure are the only treatments using no-till. The rest of the treatments use fall chisel plow 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. 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 highest in comparison with other treatments/systems. Systems 2 and 3, which received fall swine manure for corn, gave the highest NO_3-N concentrations in tile water in comparison with other systems under corn-soybean rotation (systems 1, 5 and 6). The fall-applied manure to soybean rotation in treatment 3 had consistently higher NO_3-N concentrations in tile water when compared with all other soybean rotations. Two systems (systems 1 and 5) receiving UAN resulted in the lowest NO_3-N concentrations in tile water. Overall, 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 production system.

The effects of source and timing of nitrogen application on corn and soybean yields for 2007 through 2011 are shown in Figure 1. The spring UAN application at 150 lb N/acre resulted in the highest average corn yield of 207 bushels/acre compared with other systems. Treatments 2 and 3 had higher crop yield than Treatment 5. When receiving higher nitrogen rates, the continuous corn treatments did show lower corn yields than the rotation treatments. Soybean yields from systems 2 and 3 receiving swine manure resulted in the highest average soybean yield of 66.9 and 67.5 bushels/acre, respectively.

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	Fall (manure)	Cont. corn	Chisel plow	Inject	200	-
4	Fall (manure)	Cont. corn Stover removal	Chisel plow	Inject	200	-
5	Spring (UAN)	Corn/rye cover	No-till	Spoke Inject	150	-
	-	Soybean/rye cover	No-till	-	-	If needed
6	Fall (manure)	Corn	No-till	Inject	150	-
		Soybean	No-till	-	-	If needed

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

	2007		2008		2009		2010		2011		2007-2011	
Experimental Treatments	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**
1. Spring UAN 150 lb N/ac	10.1	11.7	15.1	8.0	12.1	9.5	12.3	8.0	17.8	13.8	13.5	10.2
2. Fall manure 150 lb N/ac	15.9	11.8	17.7	8.3	19.9	10.3	12.8	8.4	29.4	12.4	19.1	10.3
3. Fall manure 150 lbN corn & 100 lbN soybean	13.4	12.8	20.3	14.2	20.3	11.1	16.1	14.0	27.7	18.2	19.6	14.1
4.1 Fall manure 200 lb N/ac	26.2		23.1		20.1		15.1		22.3		21.5	
4.2. Fall manure 200 lb N/ac + Stover removal	27.1		23.0		17.6		16.0		24.2		21.6	
5. Spring UAN 150 lb N/ac + Rye removal	9.6	11.5	12.3	8.6	8.9	8.3	10.4	4.4	9.2	8.9	10.1	8.4
6. Fall manure 150 lb N/ac	14.8	7.9	15.3	8.9	15.8	8.3	12.8	8.0	20.9	9.5	15.9	8.5

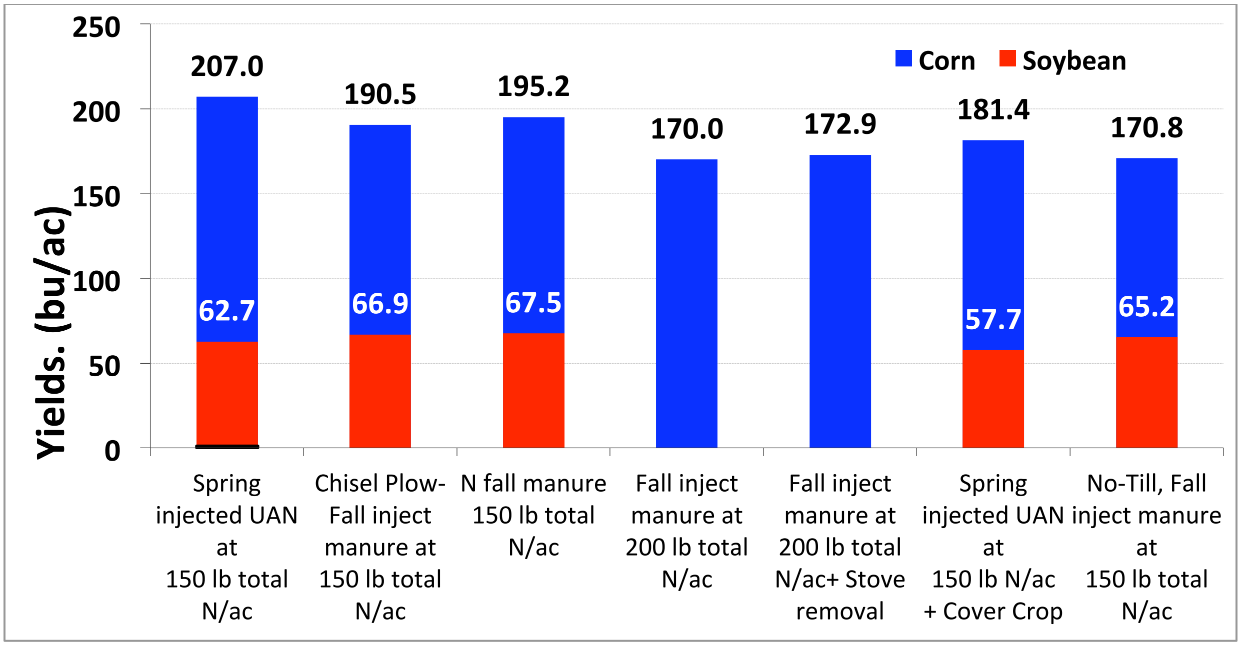

Figure 1. Corn and soybean crop yields for years 2007–2011.