Drainage Water Quality Impacts of Agricultural Management Practices: Effect of Manure Application Timing and Cover Crops on Yields in 2016–2018

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Introduction

The primary objective of this study is to evaluate the impact of various cropping and nutrient management systems on drainage water quality and crop yields. Treatment comparisons evaluate the impact of liquid swine manure application timing, nitrification inhibitor with late fall swine manure application, cereal rye cover crop, and gypsum application. These comparisons will be conducted for multiple years and used to develop appropriate manure and nutrient management practices in order to minimize water contamination potential and enhance the use of swine manure as a nutrient resource.

Materials and Methods

Table 1 lists the treatments established on 36 one-acre plots in the fall of 2015 at the Northeast Research Farm drainage water quality research site. Early fall manure, early fall manure with cereal rye cover crop, and late fall manure applications prior to corn are compared in a corn-soybean rotation. The cover crop also is included in the soybean phase of the rotation. In continuous corn, late fall manure with and without a nitrification inhibitor, late fall manure with a gypsum application of one ton/acre in the fall of 2015 and 2017, and spring manure are compared. The early fall manure with and without cover crop and late fall manure treatments are no-till and the rest of the treatments receive tillage. No manure or commercial N is applied prior to soybeans in any of the treatments. The cereal rye cover crop is seeded with a no-till drill in the fall after harvest and manure injection. Spring termination of the cover crop is done with glyphosate approximately 10 days prior to corn planting and ± 2 days of soybean planting.

Results and Discussion

Table 2 gives the monthly precipitation for the 2016 through 2018 growing seasons. Precipitation was much greater than the 30-yr average in 2016, with June and September being unusually wet. Total April through November precipitation for 2017 was very close to the 30-yr average, with July and October being wetter than normal and August and November being drier than normal. Growing season precipitation in 2018 was the wettest since recordkeeping began in 1976 and exceeded rainfall totals from the National Weather Service station in Charles City, Iowa, going back to 1951. August and September 2018 were much wetter than the historical average.

Yields. Table 3 gives the treatment effects on grain yield of corn in corn-soybean rotation for 2016 through 2018. In 2016, plots receiving late fall manure had a statistically greater corn yield than those receiving early fall manure. The highest average corn yield was achieved with spring urea-ammonium nitrate (UAN) application and conventional tillage. Early fall manure plots had a significantly higher yield than early fall manure plots with a rye cover crop. It should be noted the fall of 2015 was wetter than average, as was June, so the early fall manure application may have had more of a corn yield issue in 2016 than in years with normal rainfall.

In 2017, plots receiving late fall manure had a significantly higher (+64 bu/ac) yield than those receiving early fall manure. The highest average corn yield was achieved with spring UAN application and conventional tillage. The yield in early fall manure plots with a cover crop was not statistically different than the no cover crop treatment.

In 2018, plots receiving late fall manure averaged 29 bushels/acre higher yield than those receiving early fall manure. The yield in early fall manure plots with a cover crop was significantly higher than the no cover crop treatment. This was the first time the cover crop treatment out-yielded the no cover crop treatment on these plots. The highest average corn yield was again achieved with spring UAN application and conventional tillage.

Table 4 gives the yield results for continuous corn in 2016 through 2018. In 2016, spring manure application resulted in a statistically significant increase in corn yield compared with late fall manure application. There was no difference in corn yield with the one ton/acre gypsum application compared with no gypsum.

In 2017, spring manure application resulted in a significantly higher yield than late fall manure. Late fall manure with Instinct nitrification inhibitor had a 12 bushels/acre greater yield than late fall manure with no inhibitor. There was no difference in corn yield with the one ton/acre gypsum application compared with no gypsum.

In 2018, spring manure application again resulted in a significantly higher (+48 bu/ac) yield compared with late fall manure. Late fall manure with Instinct nitrification inhibitor had a 21 bushels/acre greater yield than late fall manure with no inhibitor. Yields with and without gypsum application did not differ significantly.

Table 5 shows the treatment effects on soybean yield in corn-soybean rotation for 2017 and 2018. Soybean yields in 2016 are not reported due to 2016 being a transition year to different nitrogen management practices. In 2017, Systems 1 and 2 had statistically greater yields than Systems 5 and 6, for an unknown reason. The cover crop treatment had a slightly lower yield than the comparable no cover crop treatment. In 2018, System 1 had a significantly greater soybean yield relative to the other treatments. There were no significant differences between Systems 2, 5, and 6. Yields will continue to be monitored in 2019 to get a better estimate of treatment differences over a range of weather conditions.

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Table 1. Experimental treatments for Nashua manure management and water quality study beginning fall of 2015.

System*	Application timing and nitrogen source	Crop	Tillage	N application rate (lb/ac)
1	Spring UAN	Corn	Chisel plow	150
	-	Soybean	Field cultivate	-
2	Early fall manure	Corn	No-till	150
	-	Soybean	No-till	-
3a	Late fall manure + Instinct	Continuous corn	Chisel plow	200
3b	Spring manure	Continuous corn	Chisel plow	200
4a	Late fall manure	Continuous corn	Chisel plow	200
4b	Late fall manure + gypsum	Continuous corn	Chisel plow	200
5	Early fall manure	Corn + rye cover	No-till	150
	-	Soybean + rye cover	No-till	-
6	Late fall manure	Corn	No-till	150
	-	Soybean	No-till	-

*Phosphorus fertilizer is applied as needed according to soil testing to Systems 1, 2, 5, and 6. Potassium is applied as needed according to soil testing to all systems.

Table 2. Precipitation (in) during the 2016 through 2018 growing seasons.

	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Total
2016	2.34	3.04	11.62	6.05	7.32	14.91	2.32	1.32	48.92
2017	4.31	4.79	5.15	8.35	1.75	2.25	4.86	0.37	31.83
2018	2.81	6.26	9.73	2.9	10.2	14.58	3.78	2.03	52.29
1986-2015 avg.	3.88	4.44	5.40	4.75	4.37	2.64	2.47	1.75	29.70

Table 3. Yield data for the 2016 through 2018 crop years for corn in corn-soybean rotation (C-S).*

System	1	2	5	6
Crop	C-S	C-S	C-S	C-S
N management	Spring UAN	Early fall manure	Early fall manure + cover crop	Late fall manure
2016 yield, bu/ac	228a	168c	142d	194b
2017 yield, bu/ac	239a	158c	162c	221b
2018 yield, bu/ac	242a	159d	175c	188b

*Yields with the same letter within year are not significantly different at $P \leq 0.05$.

Table 4. Yield data for the 2016 through 2018 crop years for continuous corn (C-C).

System	3a	3b	4a	4b
Crop	C-C	C-C	C-C	C-C
N management	Late fall manure + Instinct	Spring manure	Late fall manure	Late fall manure + gypsum
2016 yield, bu/ac	211*	224a	187b	179b
2017 yield, bu/ac	222b	238a	210c	209c
2018 yield, bu/ac	188b	215a	167bc	158c

*Treatment 3a was planted to soybean in 2015 so it was not included in the statistical analysis due to possible rotation effects. Yields with the same letter within year are not significantly different at the $P \leq 0.05$.

Table 5. Yield data for the 2017 and 2018 crop years for soybeans in corn-soybean rotation (S-C).*

System	1	2	5	6
Crop	S-C	S-C	S-C	S-C
N management	-	-	-	-
2017 yield, bu/ac	66.9a	66.4a	63.6b	64.5b
2018 yield, bu/ac	70.1a	65.9b	66.4b	67.1b

*Yields with the same letter within year are not significantly different at $P \leq 0.05$.