Effect of Manure Application Timing and Cover Crops on Yields in 2016–2019

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Introduction

The primary objective of this study was 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. This information can be used to develop appropriate manure and nutrient management practices 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 soybean 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

Precipitation. Table 2 gives the monthly precipitation for the 2016 through 2019 growing seasons. Precipitation was much greater than the 30-yr average for both 2016 and 2018. Growing season precipitation in 2018 was the wettest since recordkeeping began at the farm in 1976. Total precipitation in both 2017 and 2019 was close to the 30-yr average.

Rotated corn yields 2016-2018. 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. Early fall manure plots had a significantly higher yield than early fall manure plots with a rye cover crop. It should be noted that 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 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. In all three years, the highest average corn yield was achieved with spring UAN application and conventional tillage.

Continuous corn yields 2016-2018. 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. 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.

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. There was no difference in corn yield with the 1 ton/acre gypsum application compared with no gypsum in any of the three years.

Corn yields in 2019. Corn yield comparisons among treatments in 2019 differ from other years due to delayed manure application in the fall of 2018. Manure was applied to the 'early fall' plots October 25 when soils were about 42°F, which would be considered a 'late fall' manure application. Manure application to all 'late fall' plots was delayed until the spring of 2019. Tables 5 and 6 show 2019 yields for rotated corn and continuous corn, respectively. In rotated corn, the cover crop treatment had a significantly higher yield (+14 bu/ac) compared with no cover crop. Delaying manure application from late fall to spring resulted in an 18 bushels/acre yield advantage. All continuous corn plots received manure in the spring of 2019. There were no significant yield differences between treatments and no yield effect from the Instinct treatment applied with spring manure.

Soybean yields 2017-2019. Table 7 shows the treatment effects on soybean yield in corn-soybean rotation for 2017 through 2019. 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. 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. The trend reversed in 2019, with System 1 having a significantly lower yield than the other treatments. The causes of this variability in soybean are unknown but could relate to plot-to-plot variation in growing conditions. There was no significant difference between treatments when looking at 3-yr average yields.

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

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	-

[1]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 2019 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
2019	3.77	6.32	2.89	3.46	2.50	3.94	5.20	2.15	30.23
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).[1]

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

[1]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 2019 crop year for corn in corn-soybean rotation (C-S).[1]

System	1	2	5	6
Crop	C-S	C-S	C-S	C-S
N management	Spring UAN	~~Early~~ Late fall manure	~~Early~~ Late fall manure + cover crop	~~Late fall~~ Spring manure
2019 yield, bu/ac	228a	210b	224a	228a

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

Table 6. Yield data for the 2019 crop year for continuous corn (C-C).[1]

System	3a	3b	4a	4b
Crop	C-C	C-C	C-C	C-C
N management	~~Late fall~~ Spring manure + Instinct	Spring manure	~~Late fall~~ Spring manure	~~Late fall~~ Spring manure + gypsum
2019 yield, bu/ac	214a	212a	214a	213a

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

Table 7. Yield data for the 2017 and 2019 crop years for soybean in corn-soybean rotation (S-C).[1]

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
2019 yield, bu/ac	63.6b	69.0a	67.0a	68.6a
3-yr avg, bu/ac	66.9a	67.1a	65.7a	66.7a

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