Effect of Manure Application Timing and Cover Crops on Yields 2016–2020

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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. 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 were compared in a corn-soybean rotation. The cover crop also was included in the soybean phase of the rotation. In continuous corn, late fall manure with and without Instinct II® nitrification inhibitor, late fall manure with a gypsum application of 1 ton/acre in the fall of 2015 and 2017, and spring manure were compared. The early fall manure with and without cover crop and late fall manure treatments were no-till and the rest of the treatments received tillage. Spring UAN was applied as a sidedress approximately four weeks after planting in System 1. No manure or commercial N was applied prior to soybean. The cereal rye cover crop was seeded with a no-till drill in the fall after manure injection. Spring termination of the cover crop was 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 2020 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. The 2020 crop year was drier than average, with drought conditions in July and August.

Rotated corn yields 2016-2018, 2020. Table 3 gives the treatment effects on corn yield in corn-soybean rotation for 2016, 2017, 2018, and 2020. The late fall manure treatment had a statistically greater corn yield in all years compared with early fall manure, with a 4-yr average yield advantage of 38 bushels/acre. There were substantial year-to-year differences in yield advantage when comparing early fall manure with and without a cereal rye cover crop. The cover crop significantly reduced yield in 2016, possibly due to transition year effects from the prior treatment where those plots received spring UAN sidedress. The cover crop significantly out-yielded the no cover treatment in 2018. There was no

statistical difference in 2017 or 2020. The 4-yr average showed no statistical yield difference when comparing the cover and no cover crop treatments. The highest 4-yr average corn yield was achieved with spring UAN sidedress application and tillage. This is likely due to the timing advantage of a spring sidedress relative to fall applied manure.

Continuous corn yields 2016-2018, 2020. Table 4 gives the yield results for continuous corn in 2016, 2017, 2018, and 2020. Spring manure resulted in a statistically significant increase in 2016, 2017, and 2018 compared with late fall manure application. There was no statistical difference in 2020, possibly due to dry weather conditions. Spring manure had a 4-yr average yield advantage of 27 bushels/acre relative to late fall manure.

Late fall manure with Instinct II® nitrification inhibitor had a 12 bushels/acre greater yield compared with late fall manure with no inhibitor averaged over 3 years (2016 data excluded). There was no difference in 4-yr average corn yield in the gypsum treatment compared with no gypsum application.

Corn yields in 2019. Corn yield comparisons for 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 14 bushels/acre higher yield compared with no cover crop. Delaying manure application from late fall to spring resulted in an 18 bushels/acre yield advantage. There was no yield difference when comparing spring UAN sidedress and spring-applied manure in 2019, suggesting that timing of application is the main driver of yield difference between UAN and manured plots, rather than N source.

All continuous corn plots received manure in the spring of 2019 and there were no significant yield differences between treatments and no yield effect from the Instinct II® treatment applied with spring manure.

Soybean yields 2017-2020. Table 7 shows the treatment effects on soybean yield in corn-soybean rotation for 2017 through 2020. 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. In 2018, System 1 had a significantly greater soybean yield relative to the other treatments. The trend reversed in 2019, with System 1 having a significantly lower yield than the other treatments. In 2020, System 6 had the highest yield. Overall, 4-yr average yield differences were minimal and the only significant difference was between Systems 5 and 6. The causes of this year-to-year soybean yield variability between systems are unknown, but could relate to plot-to-plot variation in growing conditions.

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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 sidedress	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 2020 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
2020	1.53	5.36	6.95	1.96	1.48	5.41	1.64	1.47	25.80
1986-2015 avg.	3.88	4.44	5.40	4.75	4.37	2.64	2.47	1.75	29.70

Table 3. Corn yield in corn-soybean rotations for the 2016, 2017, 2018, and 2020 crop years.[1]

System	1	2	5	6
N management	Spring UAN sidedress	Early fall manure	Early fall manure + cover crop	Late fall manure
	Corn yield in corn-soybean rotation (bu/ac)			
2016	228a	168c	142d	194b
2017	239a	158c	162c	221b
2018	242a	159d	175c	188b
2020	211a	173b	169b	203a
4-yr avg.	230a	164c	162c	202b

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

Table 4. Continuous corn yield for the 2016, 2017, 2018, and 2020 crop years.

System	3a	3b	4a	4b
N management	Late fall manure + Instinct	Spring manure	Late fall manure	Late fall manure + gypsum
	Continuous corn yield, bu/ac			
2016	211*	224a	187b	179b
2017	222b	238a	210c	209c
2018	188b	215a	167bc	158c
2020	203a	193ab	199a	185b
4-yr avg.	204b^	217a	190c	183c

*Treatment 3a was planted to soybean in 2015 so 2016 yield 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 $P \leq 0.05$.
^3-yr average is reported, with 2016 data excluded.

Table 5. Corn yield in corn-soybean rotations for the 2019 crop year.[1]

System	1	2	5	6
N management	Spring UAN sidedress	Late fall manure	Late fall manure + cover crop	Spring manure
	Corn yield in corn-soybean rotation (bu/ac)			
2019	228a	210b	224a	228a

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

Table 6. Continuous corn yield for the 2019 crop year.[1]

System	3a	3b	4a	4b
N management	Spring manure + Instinct	Spring manure	Spring manure	Spring manure + gypsum
	Continuous corn yield (bu/ac)			
2019	214a	212a	214a	213a

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

Table 7. Soybean yield for the 2017 through 2020 crop years.[1]

System	1	2	5	6
N management	-	-	-	-
	Soybean in corn-soybean rotation (bu/ac)			
2017	66.9a	66.4a	63.6b	64.5b
2018	70.1a	65.9b	66.4b	67.1b
2019	63.6b	69.0a	67.0a	68.6a
2020	61.4ab	59.0b	58.7b	63.3a
4-yr Avg	65.5ab	65.1ab	63.9b	65.9a

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