

# Impact of 4R Management on Crop Production and Nitrate-Nitrogen Loss in Tile Drainage

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### Introduction

Corn belt corn and soybean producers increasingly are challenged to maximize crop production while addressing the contributions farm practices make to the Gulf of Mexico hypoxia. Based on the need for nitrate-N reductions to meet water quality goals, new management practices are needed to reduce nitrate-N losses at minimal cost and maximum economic benefits. This three-year field research and demonstration project evaluates various promising N management methods and technologies by documenting the nitrate-N export and crop yield.

### Materials and Methods

Funds provided by the Iowa State University Department of Agronomy Endowment helped to instrument the site for replicated studies of drainage water quality in 2013. In 2014, the site was uniformly cropped with treatments implemented for the 2015 growing season and each year thereafter (Table 1).

The site has 32 individual subsurface drained plots for subsurface drainage water quality evaluation. Drainage lines from individual plots are directed to separate sumps within culverts where drainage is diverted for sampling. Each treatment is replicated four times. Treatments consist of corn-soybean rotation with each phase of the rotation

present each year. Flow-proportional drainage samples are collected to quantify nitrate-N loss. Additionally, the project is documenting crop yield for each treatment.

### Results and Discussion

Except for the early fall 2014 freezing conditions, which prevented fall anhydrous ammonia application (completed early spring 2015), agronomic operations were completed in a timely manner in 2015, 2016, and 2017. The 2015 year was characterized by greater-than-normal precipitation in late summer and fall for this geographic area and overall greater yearly precipitation than the 30-yr average precipitation (Cherokee, Iowa, weather station is about 10 miles south of the project site). The 2016 crop year also was wetter than the 30-yr average precipitation with noticeably greater precipitation in April and September. The April precipitation delayed planting in 2016. The 2017 crop year had near normal precipitation in April and May, but much less than normal precipitation for the rest of the year.

In 2015, there was a 40 bushels/acre corn yield increase with the use of N in Treatments 1–3 as compared with Treatment 4 where no N was applied (Table 2). In 2016, the corn yield increase with nitrogen application was greater than 50 bushels/acre. During both 2015 and 2016, no statistically significant corn yield impacts were observed between the treatments where nitrogen was applied. In 2017, corn yield increase with Treatments 1 and 2 over no N application was greater than 75 bushels/acre. Also, in 2017, there was less of a yield increase with the split application, which may have been due to a dry summer after N application. There were no statistical differences among the soybean yields in 2015,

which would be expected based on the uniform previous site history, no treatments applied to soybean, and no prior-year N applications to corn. Soybean yields in 2016 were greater than 70 bushels/acre for all treatments and greater than 60 bushels/acre in 2017.

There were no statistically significant differences in flow-weighted nitrate-N concentrations between treatments where soybean was grown in 2015, which would be expected due to no nitrogen treatment application in the prior year (Table 3). In the corn phase in 2015, the treatment where no N was applied had statistically lower nitrate-N concentration than treatments where N was applied to corn. For 2016 and 2017, in the corn phase, lower nitrate-N concentration with the no nitrogen treatment did not occur as in 2015 (no significant difference between with and without nitrogen application). In 2016, within the soybean phase, the treatment where no nitrogen was applied to the 2015 corn crop

had statistically significant lower nitrate-N concentration than fall N treatment or the spring N preplant treatment. For all years in the corn phase, and in 2016 and 2017 in the soybean phase, the nitrate-N concentration was the same for the control and the split N application. Additional years of water quality data will provide important information in order to evaluate treatment effects over a longer time period with different weather conditions. Of note is the drainage in 2017 was much lower than in previous years, with average drainage of about 3.5 inches compared with 10 inches in 2015 and 17 inches in 2016.

We are continuing to summarize the crop sensing, stalk nitrate, grain N, and soil nitrate-N data collected in 2015, 2016, and 2017.

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**Table 1. Treatments at the northwest Iowa tile drain water quality study site.**

Treatment number	Tillage	Nitrogen application time	Nitrogen application rate (lb N/acre)*
1	Conventional tillage**	Fall (anhydrous ammonia with nitrapyrin)	135
2	Conventional tillage	Spring (anhydrous ammonia)	135
3	Conventional tillage	Split N, with 40 lb/acre of urea 2 x 2 starter at planting plus remainder Agrotain treated urea surface banded at V-10	135
4	Conventional tillage	None	0

\*For corn plots only. The 135 lb N/acre rate is based on the Corn Nitrogen Rate Calculator output for corn following soybean in Iowa at a 0.10 price ratio (<http://cnrc.agron.iastate.edu/>).

\*\*Fall chisel-plow corn stalks with spring disk/field cultivate, and spring disk/field cultivate soybean stubble.

**Table 2. Crop yields for 2015, 2016, and 2017.**

Trt	Nitrogen management for corn	Corn			Soybean		
		2015	2016	2017	2015	2016	2017
1	Fall NH <sub>3</sub> with inhibitor	221 a	198 a	203 a	62 a	74 ab	62 b
2	Spring NH <sub>3</sub> (no inhibitor)	223 a	200 a	203 a	64 a	75 a	67 a
3	Split N rate (40 lb N/acre UAN at planting + 95 lb N/acre mid-vegetative)	224 a	196 a	181 b	64 a	72 b	66 a
4	None	183 b	141 b	125 c	61 a	74 ab	64 ab

\*Means with the same letter in the same column are not significantly different, P = 0.05.

**Table 3. Flow-weighted nitrate-N concentrations (mg/L).**

Trt	Nitrogen management for corn	2015		2016		2017	
		Corn	Soybean	Corn	Soybean	Corn	Soybean
1	Fall NH <sub>3</sub> (with inhibitor)	16.2 a*	12.7 a	12.7 a	13.2 a	9.7 a	9.5 a
2	Spring NH <sub>3</sub> (no inhibitor)	15.7 a	13.4 a	12.1 a	13.7 a	10.1 a	9.5 a
3	Split N	12.0 ab	12.1 a	10.1 a	11.1 ab	7.1 a	8.8 a
4	None	9.1 b	12.5 a	9.7 a	7.6 b	7.4 a	10.1 a

\*Means with the same letter in the same column are not significantly different, P = 0.05.