Long-Term Poultry Manure Study

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Introduction

Iowa is the number one egg producing state in the nation, with nearly 16 billion eggs produced in 2017 (USDA-NASS, 2018), and an estimated 2 million tons of fresh manure generated from these facilities annually. Although poultry manure can be a valuable resource for crop fertilization and soil amendment, these benefits need to be weighed against potential negative environmental impacts. Poultry manure applied to meet crop nitrogen requirements may result in other nutrients, such as phosphorus, applied at rates that do not match crop needs, as well as introducing potential pathogens that may be associated with manure application. The transport and movement of excess nutrients and other contaminants from fields may be exacerbated by tile drainage.

Materials and Methods

The long-term poultry manure fertilizer study was initiated in 1998 with a corn-soybean (CS) rotation at each plot (1998–2009). To match changing landscape trends, the plots were changed to continuous corn (CC) from 2010 to 2017. Manure was applied on a nitrogen (N) basis at two rates during each phase: one at the agronomic recommended application rate for either corn-soybean (CS) or corn-corn (CC) rotation, with 150 lb N/acre (CS phase) or 200 lb N/acre (CC phase); and either at double application rate of 300 lb N/acre (CS phase) or at half application rate of 100 lb N/acre (CC phase). UAN was applied as a control at the agronomic recommended application rates of 150 lb N/acre during the corn-soybean rotation, and 200 lb N/acre for continuous corn. The overall goal of this study was to define the long-term effect of poultry manure application on tile water quality, soil quality and nutrients, and crop yields under corn-soybean and corn-corn cropping systems.

Throughout the study period, environmental soil and drainage samples were collected from the field plots.

Results and Discussion

A comprehensive 20-year assessment suggests many positive outcomes associated with poultry manure application. Table 1 highlights the crop yields throughout the study. Similar corn yields were achieved with poultry manure and UAN applied at the same rate, and higher soybean yields associated with poultry manure application during the CS phase. Corn yields with poultry manure at both the low rate and the agronomic rate exceeded UAN yields during the CC phase. The highest monthly average drainage NO_3-N concentrations were typically measured with UAN application during the CS and CC phases (Figure 1) compared with poultry manure applied at or below the recommended agronomic rate. Drainage PO_4-P concentrations also were typically not elevated with poultry manure application, with average concentrations well below the EPA recommended TP limit of 0.05 mg P L^{-1} for streams discharging into lakes.

Results of soil testing showed increasing PO_4-P concentrations in the topsoil (0-30 cm), but indicated virtually no movement of phosphorus below the topsoil. While soil P levels were elevated, PO_4-P concentrations in drainage water remained low throughout the study period. Elevated soil P levels indicate potential risk to water quality through surface

runoff, which was not monitored in this study. New questions are emerging regarding the relationship between soil health and water quality.

This study site provided a unique opportunity to assess differences in soil health after 20 years of poultry manure application, when compared with plots only receiving UAN. The economic aspect also was evaluated among the treatments through technoeconomic analysis (TEA). Details of the soil health and TEA analysis and results will be available in a future publication.

Table 1. Summary of crop yields during the CS phase, CC phase, and the long-term average.

	Corn yield (bu/ac)			Soybean yield (bu/ac)		
	Low PM	**High PM**	**UAN**	**Low PM**	**High PM**	**UAN**
CS phase (1998-2009)	159	177	162	50	51	45
CC phase (2010-2017)	144	159	128	---	---	---
Long-term (1998-2017)	154	170	149	---	---	---

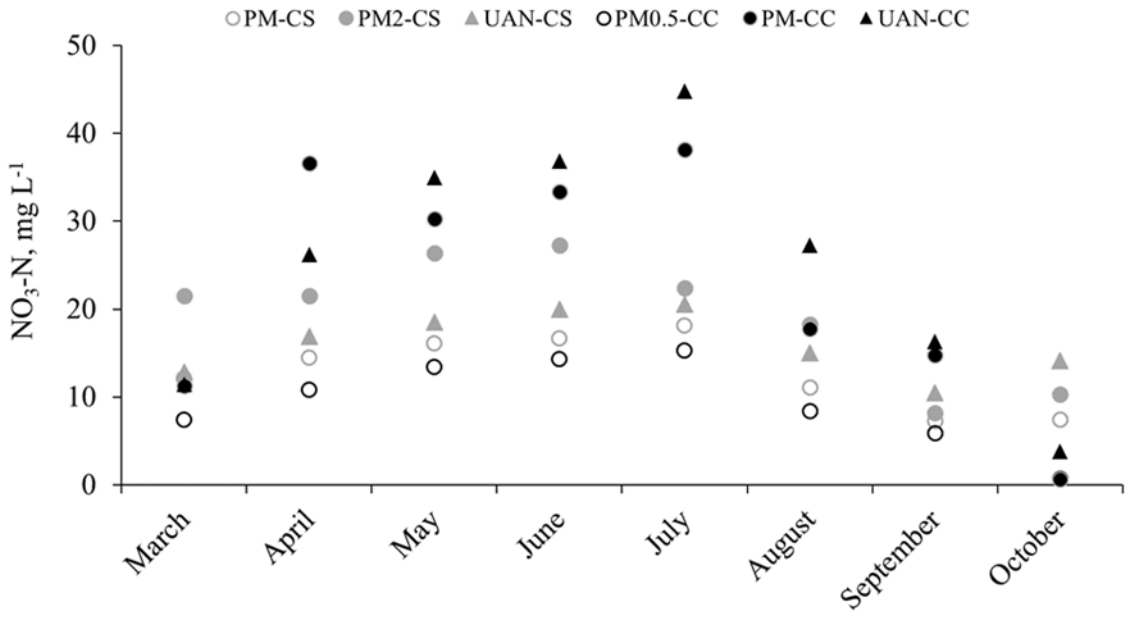

Figure 1. 20-year average monthly drainage NO3-N concentrations. The grey markers indicate the CS phase data, and the black markers indicate the CC phase data.