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Antibiotic Resistant Bacteria and Resistance Genes in Crop Fields

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Abstract
Antimicrobials are added to swine feed or water to boost the daily growth of pigs and reduce animal death rates at swine facilities, thereby enhancing overall production efficiency and increasing profitability. Tylosin is among the most widely used of the macrolide class of veterinary antibiotics by the swine industry. This study is being conducted over multiple years to examine the fate and transport of antibiotic resistant bacteria (ARB) from fieldsreceiving swine manure application to tile drainage systems.

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Antibiotic Resistant Bacteria and Resistance Genes in Crop Fields

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Introduction

Antimicrobials are added to swine feed or water to boost the daily growth of pigs and reduce animal death rates at swine facilities, thereby enhancing overall production efficiency and increasing profitability. Tylosin is among the most widely used of the macrolide class of veterinary antibiotics by the swine industry. This study is being conducted over multiple years to examine the fate and transport of antibiotic resistant bacteria (ARB) from fields receiving swine manure application to tile drainage systems.

Materials and Methods

Eight plots were sampled at the ISU Northeast Research Farm, Nashua, Iowa. These agricultural plots are instrumented with a subsurface water quality monitoring system operational since 1988. Each one-acre plot is drained separately with subsurface drain lines installed in the center of the plot. The plots encompass two tillage practices: chisel plow and no-till. Liquid swine manure was injected on one of each tillage type while the second of each type received urea ammonium nitrate (UAN) and served as a control for assessing background levels. A summary of the plots selected for sampling is presented in Table 1.

Following manure application, composite soil samples were collected from each manure plot, three from the manure band and three from area between the manure bands. Three samples also were collected from the control plots. A second set of soil samples was collected the following April from the same locations. Water samples were collected on a weekly basis and following major rainfall events while tile lines were flowing.

Results and Discussion

Entercocci were present in liquid swine manure, with average concentrations of 565,706 cfu/g and 89,336, cfu/g for year 1 (2010) and year 2 (2011), respectively. Of those, 396,529 cfu/g (70%) and 108,917 cfu/g (100%) were resistant to tylosin in 2010 and 2011, respectively. The concentrations of enterococci and tylosin-resistant enterococci were significantly lower ($P < 0.1$) in year two. In soil, enterococci concentrations were the greatest in the manure injection band and the lowest in the no-manure (control) plots.

Enterococci concentrations in tile water were highly variable relative to time after manure application (Figure 1) and drainage flow rate (data not shown). Enterococci concentrations were expected to be highest at the start of tile flow and decrease over the growing season. However, there was no correlation ($r < 0.5$) between enterococci concentrations relative to drainage flow or time after manure application. There was also no statistical difference in the concentration of enterococci in tile water due to manure application or study year (2010–2011 compared with 2011–2012 as shown in Figure 1).

Tylosin-resistant enterococci in the tile water were rarely detected, and when present, the maximum concentration was 1 cfu/100 mL. Tylosin-resistant enterococci were detected in

2 – 16 percent of the 132 tile water samples collected over the two-year period.

Conclusions

In two years of study, concentrations of enterococci in tile water are very low, and rarely exceeded the geometric mean for recreational waters. The true influence of soil management practices such as tillage on antibiotic losses is not well understood, and a longer period of study is recommended to assess the fate and transport of these contaminants over a larger range of climatic conditions as the results presented here are from a period of below average rainfall. Future work is recommended to capture the event hydrograph for better assessment of land management practices on contaminant transport during precipitation events.

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Table 1. ISU Northeast Research Farm plots selected for sample collection, including ID numbers, crop, tillage practice, and nutrient management history.

Plot No.	Tillage	Nitrogen management
23	CP	2010 Fall inject swine manure at 168 kg N ha^{-1}[a]
24	CP	Spring preplant spoke inject UAN at 168 kg N ha^{-1}
25	NT	2010 Fall inject swine manure at 168 kg N ha^{-1}
34	NT	Spring preplant spoke inject UAN at 168 kg N ha^{-1} with cover crop
29	CP	Spring preplant spoke inject UAN at 168 kg N ha^{-1}
30	CP	2011 Fall inject swine manure at 168 kg N ha^{-1}
19	NT	Spring preplant spoke inject UAN at 168 kg N $ha^{-1}$with cover crop
20	NT	2011 Fall inject swine manure at 168 kg N ha^{-1}

[a]150 lb N/acre.

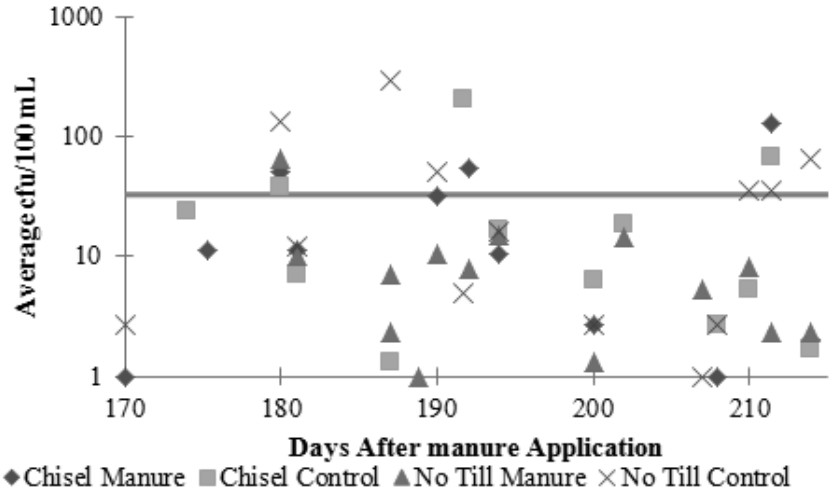

Figure 1. Enterococci in individual tile water samples in the first growing season after manure application in 2010 and 2011. The recreational water quality limit for Enterococcus (33 cfu/100 mL) is shown for reference.