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Effects of Tillage Systems and Nitrogen Source on Corn Yield

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Abstract
Corn producers in Iowa adopt different tillage systems for commercial fertilizer or liquid swine manure. The cost of commercial nitrogen fertilizers continues to rise due to the increasing cost of natural gas, which is the raw product of commercial nitrogen fertilizers. Liquid swine manure is a good source of nitrogen, phosphorus, and potassium and can be a potentially viable substitute for the more expensive commercial fertilizers. The effects of tillage systems on crop yield are functions of several factors including soil and climatic conditions. Determining the most appropriate combination of tillage systems and nitrogen rates for corn production leads to profitability for corn producers. The objective of this study was to evaluate the responses of corn to three tillage systems and four nitrogen rates of swine manure and commercial nitrogen.

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Introduction

Corn producers in Iowa adopt different tillage systems for commercial fertilizer or liquid swine manure. The cost of commercial nitrogen fertilizers continues to rise due to the increasing cost of natural gas, which is the raw product of commercial nitrogen fertilizers. Liquid swine manure is a good source of nitrogen, phosphorus, and potassium and can be a potentially viable substitute for the more expensive commercial fertilizers. The effects of tillage systems on crop yield are functions of several factors including soil and climatic conditions. Determining the most appropriate combination of tillage systems and nitrogen rates for corn production leads to profitability for corn producers. The objective of this study was to evaluate the responses of corn to three tillage systems and four nitrogen rates of swine manure and commercial nitrogen.

Materials and Methods

This study was conducted at the Northeast Research and Demonstration Farm near Nashua, Iowa, from 2002 to 2004. The experiment was on a 40-acre site and was divided into two 20-acre plots for a corn-soybean rotation. The 20-acre plot for corn was further divided into two 10-acre plots for application of either liquid swine manure or commercial nitrogen fertilizer. The experiment had a completely randomized split-plot design with three replications. Three tillage systems—no-tillage, strip-tillage, and chisel plow—were adopted as main plot treatments and the four nitrogen rates (0, 75, 150 and 225 lb N/acre) were imposed on each tillage treatment as subplot treatments for each corn experiment. Each tillage treatment measured 215 ft × 184 ft. Prior to applying the nitrogen each year, liquid swine manure was analyzed for total nitrogen (TN), phosphorous (P_2O_5), potassium (K_2O), and organic matter (OM) content. Initial and postharvest soil profile sampling was done prior to and after each corn experiment in 12-in. increments. The 0–12 in. soil depth was analyzed for total nitrogen, total carbon, phosphorous, nitrate, electrical conductivity, and pH. Soil samples from the 12–48 in. depth were analyzed for nitrate only.

Results and Discussion

The manure nutrient analyses for 2002, 2003, and 2004 are presented in Table 1. Over the three years, total nitrogen, phosphorus, and potassium were not significantly different.

In 2002, 2003, and 2004 tillage systems were significantly different for swine manure or commercial nitrogen (Table 2). Average corn grain yields at the 150 lb N/acre rate were 190, 130, 185 bushels/acre for 2002, 2003, and 2004, respectively.

In 2002 and 2004, corn grain yields increased with the addition of nitrogen from 0–75 lb N/acre regardless of the nitrogen source (Table 2). However, in 2003 swine manure nitrogen yields increased with nitrogen application from 0 to 150 lb N/acre for both no-tillage and strip tillage. Under chisel plowing, corn grain yield increased from 0 to 225 lb N/acre. With commercial nitrogen, maximum corn grain yields were realized at the 0 lb N/acre rate for strip tillage and chisel plowing, while the 75, 150, and 225 lb N/acre rates were not significantly different for no-tillage.

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Table.1. Nutrient analysis of liquid swine manure‡

Liquid swine manure content	2002	2003	2004
	- - - - - - - lb/1000gal - - - - - - -		
Total nitrogen	56	57	57
Phosphorus (P_2O_5)	41	42	40
Potassium (K_2O)	42	37	36

‡ Minnesota Valley Testing Laboratories, Inc., Nevada, Iowa.

Table 2. Grain yield of three tillage systems (chisel plow, no-tillage and strip tillage) and four nitrogen rates of liquid swine manure and commercial nitrogen at Nashua from 2002 through 2004.

		Liquid Swine Manure N Rate (lb acre^{-1})				Commercial N Fertilizer Rate (lb acre^{-1})			
Year	Tillage	0	75	150	225	0	75	150	225
2002	NT	128 Ab	186 Aa	195 Aa	188 Aa	128 Ab	181 Aa	192 Aa	188 Aa
	ST	132 Ab	181 Aa	189 Aa	190 Aa	163 Aa	187 Aa	183 Aa	184Aa
	CP	142 Ab	190 Aa	193 Aa	188 Aa	142 Ab	174 Aa	189 Aa	184 Aa
2003	NT	84 Ab	117 Aab	128 Aa	136 Aa	99 Ab	130 Aa	132 Aa	128 Aa
	ST	93 Ab	119 Aab	132 Aa	137 Aa	112 Aa	134 Aa	128 Aa	127 Aa
	CP	103 Ab	133 Aab	136 Aab	140 Aa	118 Aa	128 Aa	122 Aa	126 Aa
2004	NT	107 Ab	142 Aa	177 Aa	189 Aa	85 Ab	171 Aa	185 Aa	185 Aa
	ST	111 Ab	161 Aa	177 Aa	188 Aa	140 Ab	164 Aa	180 Aa	184 Aa
	CP	136 Ab	187 Aa	198 Aa	210 Aa	120 Ab	178 Aa	190 Aa	196 Aa

Uppercase letters compare means across tillage systems. Means with the same uppercase letter are not significantly different according to the Tukey's studentized range (HSD) test.
Lowercase letters compare means across nitrogen rates. Means with the same lowercase letter are not significantly different according to the Tukey's studentized range (HSD) test.