Effect of Frequency of Swine Manure Application on the Yield of Corn and Soybean

Randy Killorn, professor of soil fertility,
Department of Agronomy

ASL-R1593

Summary and Implications

This study was conducted to find the effect of the frequency of liquid swine manure application on the yield of corn and soybean grown in rotation. The results suggest that all the nitrogen (N) in the swine manure is available for plant uptake the year that it is applied. This is new information that will be incorporated into new recommendations for animal manure management. Soybean yields responded to manure application even though the field tested high in both phosphorus (P) and potassium (K). The reason for the response cannot be determined from these data. Further research is warranted into this question. These data strongly suggest that soybean is a good crop to receive animal manure applications.

Introduction

The nutrients contained in animal manure can be used to produce crops. Efficient use of these nutrients, however, is difficult because part of the total nutrient content of animal manure is in organic compounds. The nutrients in these compounds must be converted to inorganic forms before they can be used by crops. The rate that this occurs has never been established precisely. The purpose of this study was to find the effect of the frequency of liquid swine manure application to a corn-soybean rotation on the availability of nitrogen (N).

Materials and Methods

The experiment is located in north central Iowa and is a split-plot in a randomized, complete-block design with three replications. The main-plots are frequency of liquid swine manure application: every year, every other year to corn, every fourth year to corn, and no manure. Manure is applied at one rate estimated to supply 150 lb of total N per acre.

The subplots are rates of N fertilizer (0, 50, 100, and 150 lb/acre) when corn is the crop planted. The treatments are applied to a corn-soybean rotation with only one crop planted each year. The manure and the liquid N fertilizer are injected to a depth of 4-6 inches.

Table 1 lists planting dates and rates, crop hybrid or variety, and harvest dates for 1994-1997. These cultural practices have been timely and typical for north central Iowa. Pesticides were applied as required.

Results and Discussion

Initial soil tests showed that pH (6.3), P (24 ppm), and K (162 ppm) were all adequate for crop production. Table 2 illustrates the variability in the nutrient content in the manure among years. Table 3 shows the actual amounts of nutrients applied. The amount of N, P, and K applied varied considerably over the 4 years. In fact, the N rate applied with the manure in 1996 was half what was intended.

Average grain yields for 1994 -1997 are shown in Table 4. Corn yields in 1994 were high but were not affected by rates of N fertilizer. The main-plots that received manure yielded more than 10 bu/acre more than the main-plot that received N fertilizer only (P=0.04). This observation is interesting because the area tested high in both P and K and there was not a response to N.

Soybean yields in 1995 averaged about 35 bu/acre. The yields were not affected by direct application of liquid swine manure nor residual effects from the application made in 1994. However, the experiment was only in its second year so it was not possible to evaluate the entire range of manure treatments.

Corn yields in 1996 were lower than in 1994 but were typical of north central Iowa. Plots that received manure (every year and every other year) did not respond to

Table 1. Cultural practices by year for the frequency of manure application study at Kanawha, Iowa.

Year	Treatments Applied	Crop	Planting Date	Hybrid	Seeding Rate seeds/acre	Harvest Date
1994	early May	Corn	May 16	NK[a] 4242	29,000	October 26
1995	May 26	Soybean	May 31	Latham 440		October 10
1996	April 26	Corn	May 6	Pioneer 3563	28,800	October 25
1997	April 24	Soybean	May 14	Latham 522		September 30

[a]Northrup King

application of N fertilizer and averaged about 150 bu/a. The plots that receive manure every fourth year (no application in 1996) and the no manure plots responded to N fertilizer ($P<0.01$). Yields were maximized at the 100 lb N/acre rate at about 135 bu./acre.

As in 1994, the yield of corn in manure treated plots was higher than in plots that received only N fertilizer. The magnitude of the difference is, in part, an artifact of the experimental design. The plots that received manure had high yields in both the 0 and 50 lb N/acre treatments. In the fertilizer only plots the 0 and 50 lb N/acre treatments did not maximize yields leading to a higher average yield in the manure treated plots when averaging over N fertilizer rates. The average yield of the manure treated plots is about 130 bu/a if the average yield for the fertilizer only plots for the 0 and 50 lb N/acre plots is substituted for the high yields. Still, the manure treated plots averaged about 10 bu/a higher yields than the fertilizer only plots.

Soybean yields averaged about 45 bu/a in 1997. Yields were five to seven bu/a higher in plots to which manure had been applied in 1997 and 1996 ($P<0.01$). The response of the soybean was not expected because N fertilization is not considered to be necessary for legumes. This deserves more study because if soybean yields can be increased by applying animal manure then farmers have more acres for profitable manure application.

Table 2. Concentration of N, P, K, and percentage of solids in liquid swine manure used in the experiment.

Year	Total N	Total P	Total K	Solids
	----------ppm----------			%
1994	7,095	2,523	2,950	7.98
1995	8,250	1,050	2,040	3.04
1996	5,970	1,430	2,860	6.30
1997	6,822	2,213	2,720	6.21

Table 3. Amount of N, P_2O_5, and K_2O applied to the experiment, 1994-1997.

Nutrient	1994	1995	1996	1997
	----------lb/acre----------			
N	160	159	87	182
P_2O_5	127	46	45	130
K_2O	80	46	47	88

There is no evidence of residual N due to prior manure application in the corn yields of the plots treated every 4th year with manure. The yields are no different from the fertilizer only plots suggesting that we need to reevaluate the assumption of slow mineralization of organic N. It may be that, at least for liquid swine manure stored in pits, it is possible to take credit for the total N concentration.

Acknowledgments

I would like to thank Wayne Rietsema and Nick Verbrugge for furnishing the liquid swine manure used in this study and Dave Reuber for his help in taking care of the experiment.

Table 4. Effect of the frequency of animal manure application and N fertilizer rate on the yield of corn and soybean, 1994-1997.

		Grain Yields			
		Corn	Soybean	Corn	Soybean
Frequency	N Rate	1994	1995	1996	1997
	lb/acre	----------bu/a----------			
Every Year	0	191	35.7	163	49
	50	186	34.7	148	49
	100	186	35.3	151	49
	150	192	34.0	148	52
	Average	189	34.9	152	50
Every Other Year	0	198	36.7	149	47
	50	198	36.7	151	47
	100	192	36.0	146	50
	150	194	36.7	151	47
	Average	195	36.5	149	48
Every 4th Year	0	191	34.6	100	42
	50	201	35.3	123	44
	100	195	34.3	136	43
	150	187	37.7	130	43
	Average	194	35.5	122	43
No Manure	0	170	34.6	96	43
	50	173	34.3	120	43
	100	186	35.0	135	42
	150	186	35.3	130	43
	Average	179	34.8	120	43
	Statistics				
	Frequency (F)	0.04	0.15	<0.01	<0.01
	R Rate (R)	0.88	0.75	<0.01	0.80
	F*R	0.07	0.62	<0.01	0.87