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Liquid Swine Manure Impact on First-Year Soybeans and Subsequent-Year Corn

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Abstract
Liquid swine manure is a valuable crop nutrient source in Iowa. Producers may lack confidence in manure nutrient availability and ability to maintain high crop yields, and therefore may apply additional fertilizer or high manure rates to ensure adequate soil fertility levels. This results in over-application, reduced profits, and potential environmental impacts. Objectives of this project include learning more about liquid swine manure nitrogen (N) and phosphorus (P) as nutrient sources for first-year soybean and subsequent (second)-year corn production, evaluating crop yield with manure compared with commercial fertilizer, monitoring soil P test change with manure application, and helping crop and livestock producers improve manure nutrient management practices. This site was one of 46 on-farm demonstration sites established on various soils throughout 13 Iowa counties in 2000–03. Soil at this location was Kenyon loam.

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Introduction

Liquid swine manure is a valuable crop nutrient source in Iowa. Producers may lack confidence in manure nutrient availability and ability to maintain high crop yields, and therefore may apply additional fertilizer or high manure rates to ensure adequate soil fertility levels. This results in over-application, reduced profits, and potential environmental impacts. Objectives of this project include learning more about liquid swine manure nitrogen (N) and phosphorus (P) as nutrient sources for first-year soybean and subsequent (second)-year corn production, evaluating crop yield with manure compared with commercial fertilizer, monitoring soil P test change with manure application, and helping crop and livestock producers improve manure nutrient management practices. This site was one of 46 on-farm demonstration sites established on various soils throughout 13 Iowa counties in 2000–03. Soil at this location was Kenyon loam.

Materials and Methods

After corn harvest in 2001, soil samples (0–6 inch depth) were collected from the demonstration site for routine soil test analyses before manure application. A pre-application liquid manure sample testing 26 lb P_2O_5/1,000 gallons was collected from under-building pit storage at a local swine finishing facility. On November 9, 2001, three 10-row (25 ft) wide, field-length manure application rate strips were applied and replicated three times: check – no manure, fertilizer N, P, or K; low – manure to supply 60 lb P_2O_5/acre (2,340 gal/acre); and high – manure to supply 120 lb P_2O_5/acre (4,300 gal/acre). Target rates were one- and two-year crop removal rates of P_2O_5, with application rates based on pre-sample P_2O_5 analysis. Manure samples collected at application tested 63 lb N, 44 lb P_2O_5, and 48 lb K_2O/1,000 gallons (see Table 1 for calculated nutrient application rates).

Crop response to supplemental P beyond that supplied by manure was evaluated by incorporating fertilizer P (0-46-0) to small plots within each manure application strip (0, 20, 40, and 60 lb P_2O_5/acre). Fertilizer K (60 lb K_2O/acre) was applied in the small-plot area to mask manure K effects. NK Brand S24-K4 RR soybean variety was planted in 30-in. rows on May 16 and machine-harvested on October 11, 2002. First-year soybean grain yields and post-harvest soil test P results are summarized in Table 1.

The subsequent-year corn response to liquid swine manure was evaluated in 2003. The original field-length replicated manure application strips were left with no additional manure or fertilizer N, P, or K applied. Fertilizer P rates were re-applied on top of identical 2002 treatments, with K (60 lb K_2O/acre) and N fertilizer (150 lb N/acre) blanket-applied to the small P plots and incorporated before planting. Fertilizer N response was evaluated in separate, similar-sized small plots, (0, 40, 80, and 120 lb N/acre as ammonium nitrate applied soon after planting), with blanket P (60 lb P_2O_5/acre) and K (60 lb K_2O/acre) fertilizer applied. Pioneer 36B09 Bt corn hybrid was planted in 30-in. rows on May 13, 2003. To evaluate second-year crop-available manure N, late-spring nitrate (LSNT) soil samples (0–12 inch depth) were collected from small N plots in mid-June, and

corn ear leaf greenness, an indicator of chlorophyll and nitrogen deficiency, was measured with a Minolta SPAD meter at the R1 (silking) growth stage. Corn was machine-harvested on October 5, 2003. Corn grain yields are summarized in Table 2. Post-corn harvest soil test P results were not available for this report.

Results and Discussion

Soybean grain yield was unaffected by liquid swine manure and P fertilizer treatments in 2002 (Table 1). Small soybean yield increases have been demonstrated in some fields; however, the response typically is not large enough to offset the cost of manure-N that could be used for corn production. Initial soil-test P (19 ppm) and potassium (K) levels were Optimum and Low, respectively, at this site. The low-rate manure application produced little change in post-soybean harvest soil-test P, but the high rate increased soil-test P into the High range.

Corn ear leaf greenness and LSNT (data not shown) were similar for all prior-year manure rates, indicating little to no second-year crop-available manure N supply. Corn grain yield responded to the prior-year manure application (Table 2), but yield differences may have been a response to manure K (initial soil-test K was low), other manure nutrients, or other manure-related factors. There was no difference in response to fertilizer N, and there was similar yield increase to fertilizer N within each prior-year manure rate. This indicates no second-year N from the swine manure. Corn grain yield was unaffected by P fertilizer treatments.

Table 1. First-year soybean grain yield and soil test-P response to liquid swine manure and P fertilizer rate, Northeast Research Farm, 2002.

Manure	Estimated Total Nutrients Applied in Manure			Manure Impact on Soybean	Small-Plot Soybean Yield Fertilizer P Rate, lb P_2O_5/acre				Post-Harvest Soil Test P Fertilizer P Rate, lb P_2O_5/acre			
Strip Trt.	N	P_2O_5	K_2O	Strip Yield[1]	0	20	40	60	0	20	40	60
	----------(lb/acre)----------			(bu/acre)	----------(bu/acre)----------				----------(Bray P_1, ppm)----------			
Check	0	0	0	60 a	60	60	59	60	17	13	19	15
Low	147	103	112	60 a	58	59	59	62	18	24	22	26
High	271	189	207	61 a	58	59	60	62	28	28	29	33

[1] Manure treatment mean yields followed by the same letter are statistically similar at the 0.05 probability level.

Table 2. Subsequent (second)-year corn grain yield response to liquid swine manure and P and N fertilizer rates, Northeast Research Farm, 2003.

Manure Strip Treatments Applied Before 2002 Soybean Crop	Second-year Manure Effect on Corn Strip Yield[1]	Small-Plot Corn Yield Fertilizer P Rate, lb P_2O_5/acre				Small-Plot Corn Yield Fertilizer N Rate, lb N/acre			
		0	20	40	60	0	40	80	120
	(bu/acre)	----------(bu/acre)----------							
Check	125 a	174	178	177	169	142	160	169	172
Low	142 ab	179	175	176	178	153	174	178	183
High	148 b	178	185	185	181	156	173	191	183

[1] Manure treatment mean yields followed by different letters are statistically different at the 0.05 probability level.