

SOIL/WATER RESEARCH
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Comparing Crop Nutrient Management using Manure and Fertilizer (33008 and 33108)

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Introduction:

The rapid growth of the ethanol industry in South Dakota has a benefit of producing large amounts of a feedstuff in the form of distillers' grain. Utilization of the wet distillers grain (WDG) may lead to concentrated animal feeding operations (CAFOs) near the ethanol plants. Feeding of dry distillers grain (DDG) could lead to more feeding operations (especially ruminants) through out the state.

Manure has been shown to be an excellent source of plant nutrients. However, over application of manure near some CAFOs can lead to ground water (nitrate-N) and surface water (P) contamination. South Dakota has regulated land application of manure from CAFOs for a number of years based on crop nitrogen needs. Since the ratio of N to P in manure is much narrower than in grain, this can lead to over application of P because more P will be applied than is needed by the crop. In December, 2002 the EPA directed states to also consider P management in land application of manure.

There is a need to agronomically evaluate the SD Department of Environment and Natural Resources (DENR) rules (February, 2003) pertaining to manure application rates that are based on nitrogen and phosphorus. The producer needs to be assured that these rates will not limit yields when compared to commercial fertilizer application. In addition, buildup of soil nitrate-N and soil test P needs to be monitored.

Purpose- To agronomically evaluate rates of manure based on nitrogen and phosphorus crop needs.

Objectives:

- 1) To determine if manure rates applied according to rules set by the SD DENR for

CAFOs meet crop nutrient needs (grain yield and crop growth) as compared to commercial fertilizer.

- 2) To compare P buildup rates when manure is applied according to either the N or P needs of the crop.

- 3) To compare nitrate-N carryover from manure and commercial fertilizer.

Methods:

Two field sites were established to evaluate the study objectives. A site is located on an Egan soil just south of the office building at the SE Farm near Beresford on which beef feedlot manure was applied. The other site is located on the east Agronomy Farm at Brookings on Vienna-Lamoure soils (Range D-1) on which daily-scrape solid dairy cow manure was applied. In 2008, a new site at Brookings was established which is located 3 miles north and 0.38 miles west of Brookings on a Brookings soil.

Beginning soil tests for 2007 can be found in Table 1. The P soil test from the P manure treatment was used to calculate the manure needed for that treatment. If the P soil test is high enough where no P recommendation would be made, the average crop P removal was used to calculate manure P rate. Similarly, the nitrate-N soil test from the N manure treatment was used to calculate the manure needed for that treatment. Both the P and nitrate-N soil tests were used from the fertilizer treatment to make the phosphate and N recommendations for the fertilizer treatment.

The manure was applied on October 28, 2007 and incorporated with a disc three days later at the Beresford site and applied on September 19, 2007 and was incorporated with a chisel plow two days later at Brookings. The analysis of the beef feedlot manure and the dairy barn manure are given in Table 2. The treatments established and nutrients applied are listed in Table 3. Treatments were arranged in a randomized complete block design with four replications.

At Beresford, Asgrow 2653 RR STS soybeans were planted on May 28 in 30 inch rows. Harvest was completed with a plot combine on October 1. At Brookings, DKC 46-60 VT3 corn was

planted in 30 inch rows at 30,100 seeds/a on May 20. Harvest was completed with a plot combine on Nov 4.

Results:

Previous manure applications for the N and 2N treatments have increased most soil tests over the other treatments (Tables 1 and 4). Soybean yields at Beresford were very good. Treatment soybean yields were not significantly different from each other (Table 3). Corn grain yields were significantly influenced by the applied treatments at the Brookings site (Table 3). All treatments had significantly higher yields when compared to the check. The manure P treatment had significantly lower yield when compared to the fertilizer treatments, no explanation is given for this effect. The manure N treatments were not significantly lower when compared to the fertilizer treatments.

Post-harvest soil tests at both sites indicate increases in plant nutrient levels especially with the higher two rates of applied manure and the high fertilizer treatment (Table 4).

Five Year Summary

The first six years of this experiment has been summarized and results are given here. The total manure and nutrients applied are shown in Table 5 for the Beresford site only. The N values are available N and not total N in the manure. More N is applied for the manure N treatment compared to the fertilizer treatment because the manure treatment is applied each year including for

soybean while N is only applied on corn years for the fertilizer treatment.

Brookings soil data is for the new site. Soil test increases for N, P and Zn from both fertilizer and manure are clear (Table 4).

Five year total yields are not significant for the Beresford site probably because two dry years (2005 and 2007) severely affected corn yields (Table 6). Five year total yields are significantly different for the previous Brookings site (Table 7). Manure treatments based on crop N needs were the highest.

Phosphorus soil tests have increased over six years at Beresford and five years at Brookings (old site), with the manure N and manure 2N treatments (Figures 1 and 2). Phosphorus soil tests are also increasing at the new Brookings site from manure and fertilizer applications (Figure 3). In general the phosphorus applied with manure or fertilizer increased soil test P values similarly.

Conclusions

- Manured treatments produced grain yields similar or better than fertilized treatments.
- Soil test P from manure is changing soil test P similarly to fertilizer P.

Acknowledgements

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Table 1. Soil tests¹ after fifth year at Beresford and before first year at the new Brookings site for manure studies, 2008

Treatment	O.M.	NO ₃ -N	SO ₄ -S	Olsen P	K	Zinc	pH	salts
----- Beresford site -----								
	%	-lb/a in 2 feet-		----- ppm -----				mmho/cm
Check	3.4	48	44	8	282	0.87	6.5	0.3
Fert	3.4	60	54	13	267	0.78	6.3	0.4
P	3.8	84	90	30	583	2.60	6.5	0.5
N	4.0	108	130	50	730	3.75	6.8	0.5
2N	4.5	224	194	100	1208	5.05	7.0	0.6
High Fert	3.7	112	56	20	311	7.15	6.6	0.7
----- Brookings site -----								
Site								
Composite	3.5	81	31	10	118	0.59	6.9	0.3

¹ Samples taken fall of 2007.

High Fert = high fertilizer rates started in 2007 at Beresford

Table 2. Manure nutrient analysis for manure studies for 2008.

Analysis	units	Manure ¹	
		Beef (from apron)	Dairy (daily scrape with straw bedding)
Total N	lb/ton	19.2	12.5
Organic-N	lb/ton	18.8	11.2
Ammonium-N	lb/ton	0.4	1.3
Total Available-N	lb/ton	9.8	6.8
P ₂ O ₅	lb/ton	13.0	4.7
K ₂ O	lb/ton	12.3	8.3
Moisture	%	43.5	77.2

¹ Manure collected and analyzed in November, 2007, as received basis.

Table 3. Treatments, nutrients applied and influence on grain yields, 2008.

Treatment	Manure applied ¹ ton/a	Manure N-P ₂ O ₅ -K ₂ O applied lb/a	Fertilizer N-P ₂ O ₅ -K ₂ O applied lb/a	Grain Yield bu/a
----- Beresford site (soybean) -----				
check	0	0	0	44.2
Fertilizer (Rec) ²	0	0	0	47.1
Manure – P ³	3.5	35-45-43	0	44.5
Manure – N ⁴	14.1	138-183-173	0	45.8
Manure - 2N ⁵	28.2	276-366-346	0	46.5
Fertilizer (High) ⁶	0	0	200-70-60-5Zn-25S	47.2
LSD				NS
Pr>F				0.37
C.V.%				5.3
----- Brookings site (corn) -----				
check	0	0	0	154.4 c
Fertilizer (Rec) ²	0	0	99-39-60-5Zn	184.6 a
Manure – P ³	13	66-61-107	40-0-0	171.1 b
Manure – N ⁴	22	112-103-182	0	181.4 ab
Manure - 2N	44	224-206-364	0	185.2 a
Fertilizer (High) ⁵	0	0	200-80-90-10Zn-25S	181.1 ab
LSD _(0.05)				13.1
Pr>F				0.006
C.V.%				6.0

¹ Applied fall 2007

² Recommended fertilizer rate determined from soil test and yield goal.

³ P manure rate based on P recommendation from soil test or on P removal from crop, which ever is greater.

⁴ N manure rate is based on N requirement of 1.2 lb/bu for corn or 3.8 lb/bu for beans minus soil test nitrate-N and legume credit.

⁵ High fertilizer rate to determine maximum yield from fertilizer.

* Yields followed by different letters are significantly different at the 0.05 level.

Table 4. Soil tests¹ after sixth year at Beresford and the first year at Brookings for manure studies, 2008.

Treatment	O.M.	NO ₃ -N	SO ₄ -S	Olsen P	K	Zinc	pH	salts
----- Beresford site -----								
	%	-lb/a in 2 feet-		----- ppm -----				mmho/cm
Check	3.3	38	54	4	224	0.97	6.5	0.3
Fert	3.4	38	30	16	204	0.72	5.9	0.3
P	3.7	68	114	33	221	2.40	6.3	0.3
N	4.1	102	116	64	156	3.25	6.7	0.4
2N	4.6	170	156	144	129	5.45	7.1	0.4
High Fert.	3.7	50	74	25	286	3.35	6.2	0.3
----- Brookings site -----								
Check	3.5	20	92	10	118	0.71	7.0	0.4
Fert	3.5	120	104	19	115	1.17	6.8	0.5
P	3.5	36	102	15	131	3.35	6.8	0.5
N	3.6	40	92	16	124	4.05	6.9	0.4
2N	3.8	44	52	22	168	5.40	7.0	0.5
High Fert.	3.6	228	90	17	123	0.63	6.8	0.6

¹ Samples taken fall 2008.

Table 5. Manure and nutrients applied, Beresford (2003 – 2008) and Brookings (2008).

Treatment	----- Beresford -----				----- Brookings -----			
	manure	N	P ₂ O ₅	K ₂ O	manure	N	P ₂ O ₅	K ₂ O
	ton/a	----- lb/a -----			- ton/a -	----- lb/a -----		
Fert	0	305	175	0	0	99	36	60
Man P	25.2	335 + 105 ¹	415	604	13	66 +40 ¹	61	107
Man N	69.0	773	993	1303	22	112	103	182
Man 2N	138	1546	1986	2599	44	224	206	364

¹ Fertilizer N added to supplement manure

Table 6. Yields from manure study, Beresford, 2003-2008.

Treatment	2003	2004	2005	2006	2007	2008	6 year
	corn	soybean	corn	soybean	corn	soybean	Total
	----- bu/a -----						
Check	143	41	88	44	74.6 a	44.2	435
Fert.	139	45	109	48	77.9 a	47.1	466
Man. P	151	44	102	47	56.3 b	44.5	446
Man. N	152	47	121	50	73.9 a	45.8	490
Man. 2N	142	48	105	48	49.2 b	46.5	438
High Fert.					74.5 a	47.2	not used
Pr>F	0.30	0.14	0.003	0.71	0.02	0.37	0.10
L.S.D.	NS	NS	12	NS	18	NS	NS

Table 7. Yields from manure study, Brookings, 2003-2008.

Treatment	Old Site						New Site
	2003 soybean	2004 corn	2005 soybean	2006 corn	2007 soybeans	5 year Total	2008 corn
	----- bu/a -----						
Check	32	147	59	109	57.3	403 c	154.4 c
Fert.	30	151	59	120	56.2	417 bc	184.6 a
Man. P	33	152	60	117	57.1	419 bc	171.1 b
Man. N	32	166	61	125	59.4	442 ab	181.4 ab
Man. 2N	32	172	61	132	60.3	457 a	185.2 a
High Fert.							181.1 ab
Pr>F	0.30	0.04	0.34	0.14	0.09	0.02	0.006
L.S.D.	NS	18.2	NS	NS	3.6	31	13.1

Figure 1. Influence of seven years of manure or fertilizer additions on soil test P, Beresford SD.

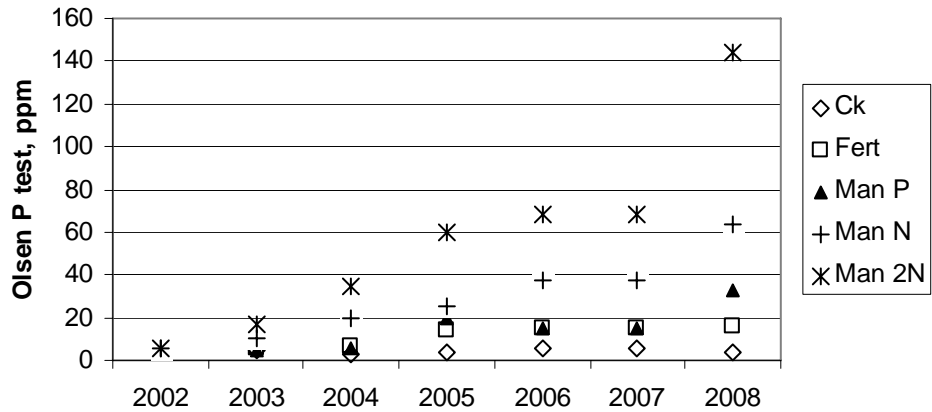


Figure 2. Influence of six years of manure or fertilizer additions on soil test P, Old Site, Brookings SD.

