MANAGEMENT OF TURKEY AND SWINE MANURE DERIVED NITROGEN IN SUGAR BEET CROPPING SYSTEM

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Justification of Research:

Livestock operations, mainly poultry and swine, are increasing in size and impact in the Southern Minnesota sugar beet growing area. Many sugar beet producers own or have interest in these operations; thus have manure available to use on their fields. Manure research data concludes that manure has a positive effect on crop production from its effects on soil nutrient availability and soil physical properties. A concern has been raised about the effect of late season nitrogen mineralized from the manure on sugar beet quality. Grower observations indicate better growth in manured fields. With the large amount of manure available the question has changed from whether to use manure but when in the sugar beet crop rotation should manure be applied to minimize quality concerns and realize benefits. The answer to this question maybe different depending on the type of manure. Poultry manure has a considerable amount of litter in it compared to swine manure, thus slowing initial release of poultry manure-N.

Little recent information is available on the effect of manure on sugar beet root yield and quality. Halvorson and Hartman (1974) reported that sucrose concentration and recoverable sugar per acre were reduced with the addition of beef manure while root yield was increased. Schmitt et al. (1996) reported that swine manure mineralization occurs several years after application in a legume-corn rotation. Malzer and Graff (1995) reported that leached nitrate-N during second year after an application of turkey manure was greater than in the first year after application. This data suggests that poultry manure has a latter or more extended release of N when compared to liquid swine manure.

The implications of the manure-N release are critical, especially to sugar beet growers. Therefore, recommendations need to be evaluated with sugar beets. This research project has been designed to: 1) measure the effect of manure application effects on sugar beet root yield and quality compared to fertilizer N applications; 2) determine the effect of turkey and swine manure mineralization differences on sugar beet root yield and quality; and 3) develop management strategies for manure application in a sugar beet rotation.

Materials and Methods:

To address the objectives, two experiments were conducted in 1999 and 2000 at locations near Renville and Raymond, Minnesota. Experiment 1 was established after soybean was grown in a soybean-corn-sugar beet rotation at Renville in 1999 while the experiment was established after corn was grown at the Raymond site in 2000. The treatments listed in Table 1 were designed to evaluate the effect of manure applied one cropping year before sugar beet is grown and compare its nitrogen contribution to fertilizer applied the year of sugar beet production. In the corn year (1999 at Renville and 2000 at Raymond), the plots used for the N rate evaluation in the sugar beet year were fertilized with a recommended rate of fertilizer for optimum corn production. Deep nitrate-N soil samples were taken from the check plots Fall 1998 at Renville and Fall 1999 at Raymond before manure and fertilizer application, April 1999 at Renville and early May 2000 at Raymond before corn planting. Nitrate-N and ammonium-N soil samples were taken monthly to a depth of one foot to characterize the N dynamics during the growing season. Basal stalk samples for nitrate concentration were taken at physiological maturity (black layer). Corn grain was hand harvested from each plot. After corn and sugar beet harvest, soil samples to a 4 foot depth were taken and analyzed for residual nitrate-N from every plot.

Table 1. Treatments for Experiment 1.

Treatment number	reatment Year 1 (corn)	Year 2 (sugar beet)
1	120 lb N/A	0 lb N/A (check)
2	120 lb N/A	40 lb N/A
3	120 lb N/A	80 lb N/A
4	120 lb N/A	120 lb N/A
5	120 lb N/A	160 lb N/A
6	120 lb N/A	200 lb N/A
7	Swine manure 2500 gal/A	Residual
8	Swine manure 5000 gal/A	Residual
9	Turkey manure 5 tons/A	Residual
10	Turkey manure 10 tons/A	Residual
11	Check (no fertilizer or manure)	Check (no fertilizer or manure)

The second experiment was established at the same locations near Renville, Minnesota in 1999 and Raymond in 2000. The objective of this experiment was to measure the effect of manure application directly before sugar beet production. The treatments include fertilizer nitrogen, turkey manure, and swine manure (Table 2). The treatments were applied early November 1998 at the Renville site and November 1999 at Raymond. Fertilizer nitrogen was applied in a series of rates to determine the equivalent of the N supplied by manure. Soil samples were taken to a depth of four feet for nitrate-N from the check plots Fall 1998, and April 1999 at the Renville site and Fall 1999 and early May 2000 at the Raymond site. This is similar to Experiment 1. Soil samples to one foot for nitrate-N and ammonium-N were taken monthly to estimate the mineralization of N from manure during the growing season. Soil samples were taken to a depth of 4 foot in all plots at both sites after sugar beet harvest.

Table 2. Treatments for Experiment 2.

Treatment number	Treatment
1	0 lb N/A (check)
2	40 lb N/A
3	80 lb N/A
4	120 lb N/A
5	160 lb N/A
6	200 lb N/A
7	Swine manure 2500 gal/A
8	Swine manure 5000 gal/A
9	Turkey manure 2.5 tons/A
10	Turkey manure 5.0 tons/A

Sugar beet top growth and N content, root yield, and root quality were measured at harvest. Quality samples were taken at harvest and analyzed by the Southern Minnesota Beet Sugar Cooperative Quality Laboratory.

Results and Discussion:

Experiment 1 - The initial soil nitrate-N measured Fall 1998 was 30 pounds per acre for the 0 to 2 foot depth and 11 pounds per acre for the 2 to 4 foot depth. Corn grain yield for the Renville site in 1999 is reported in (Table 3). There was a significant increase in grain yield when compared to the check with the application of fertilizer and manure. There were no significant differences in grain yield between the fertilizer treatment and the manure treatments. The only significant difference was between the grain yields for the two rates of swine manure (155 vs 169 bushels per acre**).**

Soil ammonium-N and nitrate-N were measured each month in 1999, Table 4. Soil ammonium-N concentrations in the surface foot of soil (not shown) were similar for soil from all treatments and at all sampling dates, approximately 40 pounds N per acre. Soil nitrate-N concentrations in the surface foot of soil, did change during the growing season. Nitrate concentrations were greatest at the June sampling date and decreased to a low value in August. The use of fertilizer and manure increased soil nitrate-N concentrations over the check which received no fertilizer or manure. The soil treated with a 120 pounds of fertilizer N per acre had similar nitrate concentrations to the soil treated with 5000 gallons per acre of liquid swine manure. The soil treated with turkey manure had the greatest nitrate-N concentration in June and the soil treated with 10 tons per acre of turkey manure had elevated nitrate concentration at the

November sampling date. The first year of this experiment was the set up year to investigate the effects of manure on sugar beet production two years after application. Sugar beet was grown at this site in 2000.

Table 3. Corn grain yields at 15.5% moisture or Experiment 1 at Renville in 1999.

Treatment	Corn grain yield - - - - bu/A - - - -
Check	126
Fertilizer - 120 lb. N/A	158
Swine Manure 2500 gallon/A	155
Swine Manure 5000 gallon/A	169
Turkey Manure 5 tons/A	166
Turkey Manure 10 tons/A	167
LSD 0.05	12

Table 4. Soil nitrate-N for top 1 foot during corn year (Experiment 1) at Renville, MN in 1999.

Treatment	Fall 98	June	July	Aug.	Sept.	Nov.
	- - - - - - - - - - - - - - - - - - lb N/A - - - - - - - - - - - - - - - - - -					
Check 0 lb N/A	22	71	45	14	16	15
Fertilizer 120 lb N/A	22	146	72	28	28	32
Swine manure 2500 gal/A	22	109	60	18	20	21
Swine manure 5000 gal/A	22	148	85	33	27	33
Turkey manure 5 ton/A	22	177	93	33	37	36
Turkey manure 10 ton/A	22	288	176	111	87	136

Sugar beet yield, sucrose concentration, loss to molasses, recoverable sucrose per, and recoverable sucrose per acre for 2000 at the Renville site are reported in Table 5. The root yield for the treated plots, manure and 120 pounds fertilizer N per acre applied in 1999, were greater than the check plot which was not treated in 1999 or 2000. This reflects the difference in the soil nitrate-N contents between the check treatment and the 120 pounds N per acre fall 1999, 25 verses 48 pounds N per acre in the 0 to 2 foot depth. The use of fertilizer in 2000 did not affect root yield. Swine manure applied at 5000 gallons per acre and turkey manure applied at 5 and 10 tons per acre fall 1998 increased root yields over the 2000 fertilize N treatments and the checks. Recoverable sucrose per acre was affected similar to root yield by the treatments. Only the use of 200 pounds of fertilizer N per acre reduced sucrose concentration significantly in 2000. The manure treatments applied fall 1998 did not affect sucrose concentrations. This was unexpected. The lack of reduction in sucrose concentration could have been caused by the lack of N uptake during the last part of the 2000 growing season. There were dry moisture which caused the plant to slow growth and N uptake during this time. The soil information which is not available at the time of this report may help determine if this occurred.

Table 5. Sugar beet root yield, sucrose, loss to molasses, recoverable sucrose per ton, and recoverable sucrose per acre for Experiment 1 at Renville, MN 2000.

Treatment 1999	Treatment 2000	Root Yield	Sucrose Concentration	Loss to Molasses	Recoverable Sucrose	
		ton/A	- - - - % - - - -	- - % - -	lb/ton	lb/A
Check	Check	15.1	17.4	1.05	328	4948
120 lb N/A	0 lb N/A	18.4	17.2	1.07	322	5921
120 lb N/A	40 lb N/A	17.1	17.0	1.08	318	5429
120 lb N/A	80 lb N/A	18.5	17.1	1.08	320	5927
120 lb N/A	120 lb N/A	17.6	16.6	1.11	311	5476
120 lb N/A	160 lb N/A	17.9	16.5	1.12	309	5524
120 lb N/A	200 lb N/A	18.1	15.7	1.19	290	5276
Swine manure 2500 gal/A	0 lb N/A	17.6	17.2	1.08	321	5643
Swine manure 5000 gal/A	0 lb N/A	24.1	18.3	0.99	345	8314
Turkey manure 5 ton/A	0 lb N/A	22.3	18.0	1.01	344	7608
Turkey manure 10 ton/A	0 lb N/A	21.9	16.4	1.12	366	6727
$LSD_{0.05}$		2.4	1.5	0.11	32	1139

Experiment 2 - Renville 1999 site - The objective of this experiment was to determine the effect of manure application the fall before sugar beet production on sugar beet yield and quality. The soil nitrate-N content was 27 pounds per acre in the 0 to 2 foot depth and 18 pounds per acre in the 2 to 4 foot depth in the fall of 1998 at the Renville site. Root yield was not significantly affected by the nitrogen fertilizer applications (Table 6). Only the root yields of the 5 ton per acre turkey manure and 5000 gallons per acre swine manure applications were significantly greater than the root yield of the check. The loss to molasses for the 5 ton per acre turkey manure application was significantly greater than the check. No significant differences occurred for sucrose concentration, recoverable sucrose per ton, and recoverable sucrose per acre.

Table 6. Root yield, sucrose concentration, loss to molasses, recoverable sucrose per ton, and recoverable sucrose per acre for Experiment 2 at Renville in 1999.

Treatment	Root Yield	Sucrose Concentration	Loss to Molasses	Recoverable Sucrose	
	ton/A	%	%	lb/ton	lb/A
Check	23.9	18.3	0.93	348	8301
Fertilizer 40 lb N/A	24.9	18.2	1.01	345	8570
Fertilizer 80 lb N/A	25.3	18.1	0.94	342	8634
Fertilizer 120 lb N/A	25.7	17.5	0.86	332	8546
Fertilizer 160 lb N/A	26.1	17.4	0.98	329	8492
Fertilizer 200 lb N/A	24.2	17.6	1.03	331	8033
Swine Manure 2500 gal/A	25.3	17.5	1.00	329	8353
Swine Manure 5000 gal/A	28.0	17.5	0.94	330	9371
Turkey Manure 2.5 ton/A	26.2	17.8	0.93	337	8849
Turkey Manure 5.0 ton/A	27.3	17.3	1.10	323	8819
LSD 0.05	2.6	NS	0.10	NS	NS

Soil nitrate-N contents in the top 1 foot at Renville in 1999 are reported in Table 7. During the June, and July soil sampling dates soil nitrate-N was greater in the soil's treated with 160 pounds fertilizer N per acre, 200 pounds fertilizer N per acre, 5000 gallons of liquid swine manure per acre, and 5 tons of turkey manure per acre than the check. By August this difference was not measured. This is different than the soil nitrate information reported for corn in Table 4. Sugar beet roots is very efficient at utilizing nitrate-N from the soil and leaves little nitrate-N in soil compared to corn.

Table 7. Soil nitrate-N for top 1 foot during sugar beet year (Experiment 2) at Renville, MN in 1999.

Treatment	Fall 98	June	July	Aug.	Sept.	Nov.
	---------- lb N/A ----------					
Check 0 lb N/A	18	61	34	15	17	16
Fertilizer 40 lb N/A	18	76	40	16	16	22
Fertilizer 80 lb N/A	18	90	36	15	19	16
Fertilizer 120 lb N/A	18	101	40	14	18	17
Fertilizer 160 lb N/A	18	122	64	17	20	18
Fertilizer 200 lb N/A	18	126	63	28	19	25
Swine manure 2500 gal/A	18	62	36	13	18	16
Swine manure 5000 gal/A	18	132	54	18	21	18
Turkey manure 2.5 ton/A	18	99	37	17	19	20
Turkey manure 5.0 ton/A	18	160	74	22	20	19

Experiment 2 - Raymond, Minnesota site in 2000. The soil nitrate-N for this site was 50 pounds per acre in the 0 to 2 foot depth and 25 pounds per acre in the 2 to 4 foot depth. The maximum root yield occurred with 120 pounds fertilizer N per acre, 5000 gallons of swine manure per acre, 2.5 tons turkey manure per acre, and 5 tons turkey manure per acre. The sucrose concentration for the manure treatments and the 160 and 200 pounds of fertilizer N per acre treatments were decreased. Recoverable sucrose per acre was the greatest, approximately 10,000 pounds per acre, with the 120 pounds fertilizer N per acre, 5000 gallons of swine manure per acre, 2.5 tons turkey manure per acre, and 5 tons turkey manure per acre.

Table 8. Root yield, sucrose, loss to molasses, recoverable sucrose per ton, and recoverable sucrose per acre for Experiment 2 at Raymond, MN in 2000.

Treatment	Root Yield	Sucrose Concentration	Loss to Molasses	Recoverable Sucrose	
	Ton/A	- - - % - - - -	- - % - -	lb/ton	lb/A
Check 0 lb N/A	18.5	18.8	0.99	356	6593
Fertilizer 40 lb N/A	24.1	18.9	0.98	359	5632
Fertilizer 80 lb N/A	27.5	18.5	1.01	349	9644
Fertilizer 120 lb N/A	28.5	18.9	0.99	358	10206
Fertilizer 160 lb N/A	26.7	18.4	1.00	348	9300
Fertilizer 200 lb N/A	26.0	17.8	1.03	335	8701
Swine manure 2500 gal/A	23.5	18.1	1.02	342	8026
Swine manure 5000 gal/A	29.9	18.0	1.02	339	10135
Turkey manure 2.5 ton/A	31.4	18.2	1.02	344	10819
Turkey manure 5.0 ton/A	26.4	19.3	0.88	366	9643
$LSD_{0.05}$	3.4	1.3	0.06	28	1419

The results from the first two years of this study indicate that the use of manure may not be as detrimental to sugar beet production was original thought. Concern about effect of long term manure use in the sugar beet rotation still remain. The above results are from fields with no prior manure history. Also the 2000 growing season had a long period during August and September in which the sugar beet plant was under moisture stress and may not have been able to take up the nitrate-N that was mineralized from the manure late in the season.

Literature Cited:

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