Effect of composted cattle manure on sugar beet production

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Introduction and Objectives

Sugar beets grown on land treated with high rates of cattle manure often exhibit decreased extractable sugar content due to excessive levels of added nitrogen. Composting cattle manure reduces the total nitrogen content and offers other benefits such as reduced weed seed viability and reduced product volume. Compost is a source of slow release nutrients, and contains a number of macro and micronutrients. Composts may reduce certain soil diseases to below critical threshold levels (Hoitink and Changa, 2004). As with manure, compost should improve soil structure and tilth.

In southern Alberta, composted cattle manure is being applied commercially at rates of 2 to 4 metric tonnes per acre as a soil amendment and nutrient source. Our objective was to evaluate extractable sugar content and beet yield of sugar beets treated with composted cattle manure plus inorganic fertilizer.

Materials and Methods

From 2001 to 2004, research trials were conducted at the sugar beet research farm near Taber, Alberta. Plots were treated with 2, 4 or 8 metric tonnes (2.2, 4.4 and 8.8 tons) of compost per acre prior to the production of sugar beets each year. The compost contained 1.6-1.7% total nitrogen (dry matter basis), of which 25% (6-7 lbs N/tonne) was estimated to be available in the year after application. However, recent research determined that only 5-10% of N is available for crop growth in the year of application (Helgason et al, 2005). Table 1 lists the analysis from the composted cattle manure applied in 2004. Compost applied in previous years was obtained from the same supplier and was analyzed for N, P and K, but not for micronutrients.

Table 1. Analysis of composted cattle manure applied to sugar beet plots in 2004

	Dry matter basis (%)[a]		Dry matter basis (ppm)
Aluminum	1.24	Boron	10
Calcium	3.22	Copper	47
Carbon (total)	14.16	Manganese	390
Iron	1.27	Molybdenum	3
Nitrogen	1.67	Zinc	285
Magnesium	1.27		
Phosphorus	0.87		
Sodium	0.71		

[a] Moisture content 27.4%

All compost treatments were amended with urea fertilizer as necessary to achieve recommended levels of nitrogen fertility (Table 2), except for one compost treatment that was not supplemented with urea in 2003. Fertilizer-only treatments were applied at recommended N rates and at rates below and above the recommended rates. Compost and inorganic fertilizer treatments were hand-applied in the spring for the tests conducted in 2001 and 2004, and in the previous fall for the tests conducted in 2002 and 2003. All treatments were incorporated immediately following application. The plots were ridged in each year of testing. Each test contained six replications; in the 2002 test, two replications had to be abandoned following heavy rains and flooding in June.

Soil tests indicated low soil phosphorus levels in each year. All plots were treated with ammonium phosphate fertilizer applied under the ridge in every year (Table 2), except for one compost treatment in 2004 that was not supplemented with ammonium phosphate fertilizer. Potassium fertilizer was not applied, except as a maintenance application in 2001, as the soil tests indicated high soil potassium levels in all years.

Table 2. Previous fall soil nitrogen levels, recommended fertilizer nitrogen, and ammonium phosphate fertilizer applied in each test year

Year of test	Fall soil N (0-4ft) lbs N/ac	Recommended N [a] lbs N/ac	P_2O_5 applied lbs /ac
2001	105	70	60
2002	120	70	40
2003	120	100	50
2004	140	80	50

[a] Recommended N was determined from soil fall N levels, previous fertilizer applied and crop history

Results

In 2001, extractable sugar per acre (ESA) and beet yield were significantly higher for all compost-containing treatments and the 120 lbs N/ac urea treatment than for the control treatment (Table 3). Within the compost treatments, ESA and beet yield did not vary. Extractable sugar per ton (EST) and sugar content did not vary among treatments. Within the 70 lbs N/ac treatments, potassium was significantly higher for the 8 mt/ac treatment than for the fertilizer-only and 2 mt/ac treatments.

In 2002, ESA, EST and sugar content did not vary among treatments (Table 4). Compared to the control treatment, beet yield was significantly higher for all three compost treatments and for the 35 and 105 lbs N/ac urea treatments. Within the 70 lbs N/ac treatments, potassium was significantly higher for the 8 mt/ac treatment than for the urea-only treatment.

Table 3. Sugar beet harvest results - 2001

Treatment			Extractable sugar		Sugar	Beet yield	K
Compost mt/ac	Added N lbs/ac	N source[a]	lbs/ac	lbs/ton	%	ton/ac	ppm
Control	20	AP	9377	339.8	18.90	27.6	1849
	70	U+AP	9985	339.4	18.87	29.4	1742
2	70	C+U+AP	10578	336.1	18.63	31.5	1757
4	70	C+U+AP	10333	336.4	18.79	30.7	1894
8	70	C+U	10624	340.0	19.02	31.2	1978
	120	U+AP	10325	334.3	18.59	30.9	1760
	170	U+AP	9990	339.3	18.83	29.4	1764
LSD (0.05)			671	NS	NS	2.0	153

[a] C = compost, U = urea fertilizer, AP = ammonium phosphate fertilizer

Table 4. Sugar beet harvest results - 2002

Treatment			Extractable sugar		Sugar	Beet yield	K
Compost mt/ac	Added N lbs/ac	N source[a]	lbs/ac	lbs/ton	%	ton/ac	ppm
Control	10	AP	6851	321.5	18.12	21.3	1751
	35	U+AP	7616	325.7	18.13	23.4	1559
	70	U+AP	7248	321.2	17.94	22.6	1511
2	70	C+U+AP	7647	314.8	17.89	24.3	1659
4	70	C+U+AP	7738	319.9	18.19	24.2	1728
8	70	C+U+AP	7498	310.6	17.84	24.1	1882
	105	U+AP	7379	321.2	17.75	23.0	1384
LSD (0.05)			NS	NS	NS	1.3	246

[a] C = compost, U = urea fertilizer, AP = ammonium phosphate fertilizer

In 2003, ESA was significantly higher for all three compost treatments supplemented with urea relative to the control treatment (Table 5). EST was lower for all treatments receiving at least 100 lbs N/ac compared to the control treatment. Sugar content was significantly affected for the 100 and 150 lbs N/ac urea treatments, and for the 4 mt/ac 100 lbs N/ac treatment. Beet yield was significantly higher for all compost treatments compared to the control treatment. Within the 100 lbs N/ac treatments, potassium was significantly higher for the 4 and 8 mt/ac treatments than for the urea-only treatment.

Table 5. Sugar beet harvest results - 2003

Treatment			Extractable sugar		Sugar	Beet yield	K
Compost mt/ac	Added N lbs/ac	N source[a]	lbs/ac	lbs/ton	%	ton/ac	ppm
Control	10	AP	11222	347.5	18.81	32.3	1299
4	35	C+AP	11618	341.4	18.76	34.0	1496
	50	U+AP	11280	345.2	18.81	32.7	1353
	100	U+AP	11061	335.9	18.42	32.9	1300
2	100	C+U+AP	11705	338.2	18.49	34.6	1358
4	100	C+U+AP	12211	334.4	18.44	36.5	1454
8	100	C+U+AP	12117	335.5	18.49	36.1	1496
	150	U+AP	11037	332.1	18.20	33.2	1290
LSD (0.05)			460	8.6	0.32	1.4	145

[a] C = compost, U = urea fertilizer, AP = ammonium phosphate fertilizer

In 2004, the 8 mt/ac rate of compost was not tested, as the previous three years of data suggested no additional benefit from this high rate of compost compared to the 4 mt/ac rate. To determine if the yield benefit from compost was related to the ability of compost to supply phosphorus, a 2 mt/ac compost treatment was applied in 2004 without any supplemental phosphate fertilizer.

Compared to the control treatment, ESA was significantly higher for the 2 mt/ac 40 lbs/N compost treatment in 2004 (Table 6). EST did not vary among treatments; however, sugar content was significantly lower for the 40 lbs N/ac urea treatment and all 80 lbs N/ac treatments compared to the control treatment. Compared to the control treatment, beet yield was significantly higher for all compost treatments that received phosphate fertilizer. Within the 80 lbs N/ac treatments, potassium was significantly higher for both the 2 and 4 mt/ac compost treatments compared to the fertilizer-only treatment.

Table 6. Sugar beet harvest results - 2004

Treatment			Extractable sugar		Sugar	Beet yield	K
Compost mt/ac	Added N lbs/ac	N source[a]	lbs/ac	lbs/ton	%	ton/ac	ppm
Control	10	AP	7339	296.9	16.81	24.7	1353
	40	U+AP	7172	285.5	16.35	25.1	1384
2	40	C (no AP)	7815	289.2	16.58	27.0	1429
2	40	C+U+AP	8292	294.6	16.76	28.2	1438
4	40	C+AP	7982	287.8	16.56	27.7	1511
	80	U+AP	7187	287.4	16.36	25.0	1279
2	80	C+U+AP	7829	287.2	16.47	27.3	1444
4	80	C+U+AP	7897	281.4	16.31	28.1	1512
LSD (0.05)			729	NS	0.32	2.5	115

[a] C = compost, U = urea fertilizer, AP = ammonium phosphate fertilizer

Summary

- In each of the four study years, beet yield was significantly higher for sugar beets amended with compost compared to the control treatments. The only exception was the compost treatment not amended with ammonium phosphate fertilizer in 2004, which did not exhibit a statistically significant yield increase over the control treatment.

- At the recommended nitrogen level, fertilizer-only treatments increased yield over the control treatments an average of 1.0 t/ac, whereas 2 and 4 mt/ac of fertilizer-amended compost, respectively, increased yield an average of 2.9 and 3.4 t/ac.

- The reason for the yield response was not determined in these trials, but nitrogen does not appear to be the cause of this yield increase, as the fertilizer-only treatments did not consistently statistically improve yields over the control treatments. Plant stand did not vary significantly among treatments in any of the study years.

- In three of the four study years, extractable sugar per ton (EST) did not differ between the control treatments and any of the compost treatments.

- In 2003, EST values were significantly lower for the compost treatments than for the control treatments, but were comparable to EST values for fertilizer-only treatments.

- In each year, extractable sugar per acre (ESA) was always highest for the compost-amended treatments. In statistically significant responses, ESA was improved by 4-13% by applying compost compared to the control treatments.

- Potassium levels were significantly increased by the addition of 8 mt/ac compost in each year, and occasionally increased by the addition of 2 or 4 mt/ac compost, over fertilizer alone.

Literature Cited

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