# EFFECT OF MANURE COMPOST ON SUGAR BEET YIELD AND QUALITY

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## Introduction:

Before the advent of commercial fertilizer, manure application was the only means of supplying additional N other than plowing down previous legume crops for sugar beets. The benefits of manure as a fertilizer for grain crops are well known, but there has been limited information in the US recently (Brown *et al*., 2006). More research has been done in Europe and the middle-east. Teleghani *et al.* (2006) in a wheat sugar beet rotation compared no manure application and 30 t/ha (13.4 t/a) manure. The application of manure before planting wheat increased wheat yield by 23% and the following sugar beet crop showed a 17% increase in sugar yield. Javaheri et al. (2005) conducted a study on the effects of farm yard manure and other nutrients on quality and quantity of sugar beet. The research found that 20t/ha (9 t/a) of manure increased sugar yield 10% with no significant effect on sugar loss to molasses. Research results show that manure could be a valuable source of nutrients for sugar beet, however, composted manure has different properties then non-composted manure. Manure mineralizes slowly over the summer and into the fall which can affect sugar content and impurities. Composted manure is lower in total N content than feedlot manure and composting reduces the mineralization rate of the N. Due to significant fertilizer cost increases in 2008, producers were interested in using low rates of compost to supply both P and N for sugar beets. With that background, the objective of this research was to compare composted manure rates of 0, 4, 8 and 16 tons per acre versus broadcast inorganic N at 60 and 120 lbs N/acre and to determine effects on stand, yield, sugar and sugar loss to molasses (SLM).

## Procedure:

A sprinkler-irrigated field previously in corn at the PHREC Mitchell station was selected during spring 2009 for the experiment. The soil is a Tripp fine sandy loam (*Coarse-silty, mixed, superactive, mesic Aridic Haplustolls*). Soil analyses are listed in Table 1. N rates for 26 and 30 tons per acre are shown as a reference based on the UNL algorithm for sugar beets. Soils were sampled to a five foot depth in increments of 0 to 8, 8 to 24, 24 to 36, 36 to 48, and 48 to 60 inches. Samples were analyzed for pH, organic matter, Olsen P, K, DTPA-Zn and nitrate-N.

Table 1. Soil test values and N recommendations.

| Soil test parameter | | | | | UNL N recommendation for | |
|---|---|---|---|---|---|---|
| Year | pH | Organic Matter | Olsen P | Nitrate-N Lbs in 4 feet | 26 T beets | 30T beets |
| 2009 | 8.2 | 1.98% | 25 ppm | 73 | 80 lbs N/ac | 120 lbs N/ac |
| 2010 | 7.9 | 1.73% | 13 ppm | 100 | 50 lbs N/ac | 85 lbs N/ac |

The experimental design was a randomized complete block with 5 replications in 6-row plots by 35 feet long in 22” rows. Corn stalks were shredded in March. Composted manure and urea were broadcast in mid-April then the area was disked once. The area was strip-tilled with no N applied in late April. Sugar beet variety Beta 66RR70 was planted at 56,000 seeds per acre on May 6, 2009 and April 27, 2010. Plant population was taken June 25, 2009 and May 25 and June 30, 2010.

**Results and Discussion:**

The composted manure analysis is shown in Table 2. The product was quite dry (11% moisture 2009, 8.6% moisture 2010) but was a consistent size grade resembling crumbled sawdust. The total N level is somewhat lower than comparable feedlot manure from the PHREC feedlot while the P in the compost is higher. Levels of other plant nutrients are shown in Table 2.

Table 2. Composted manure analysis used in the experiment.

| Content | Analysis – dry basis 2009 | Analysis – dry basis 2010 | #/T as-is basis 2009 | #/T as-is basis 2010 |
|---|---|---|---|---|
| Moisture | 11.4% | 8.6% | --- | --- |
| Organic N | 0.92% | 0.96% | 14.8 | 16.4 |
| Ammonium-N | 0.02% | 0.02% | 0.3 | 0.2 |
| Nitrate-N | 0.14% | 0.13% | 2.2 | 2.2 |
| Total N | 1.08% | 1.10% | 17.3 | 18.9 |
| P as $P_2O_5$ | 1.51% | 1.66% | 24.3 | 28.5 |
| K as $K_2O$ | 1.59% | 1.55% | 25.6 | 26.6 |
| S | 0.30% | 0.30% | 4.8 | 5.1 |
| Zn | 314ppm | 332ppm | 0.5 | 0.6 |
| Fe | 0.68% | 0.70% | 11.0 | 12.1 |

Soil moisture conditions at planting were good with moderate soil moisture both years. Limited rainfall occurred after planting, so the plot received a light irrigation about one week after planting to facilitate germination. Severe hail occurred June 10, 2009. No major hail occurred in 2010. Treatment effect on stand are shown in Table 3, however, there was no statistically significant effect of any treatment versus the check on final stand. Plant stand averaged 62% of seed drop in 2009 and 68% in 2010.

Table 3. Treatment effects on sugar beet stand.

| Treatment | 1000 plants/ac 6/25/09 | 1000 plants/ac 5/25/10 | 1000 plants/ac 6/30/10 |
|---|---|---|---|
| Check | 35.9 | 38.7 | 34.7 |
| 4T compost | 33.0 | 42.3 | 38.5 |
| 8T compost | 33.3 | 38.7 | 35.6 |
| 16T compost | 35.4 | 40.4 | 37.1 |
| 60 lbs N - urea | 36.4 | 41.6 | 38.1 |
| 120 lbs N- urea | 34.7 | 40.2 | 38.7 |

The analysis of variance (SAS PROC GLM) did not show any statistically significant treatment effects in 2009, however, there were interesting trends (Table 4). Single degree of freedom tests showed that the check versus 120 lbs of N was significantly greater for tonnage and total sucrose at the 0.1 probability level. There was not a consistent trend for SLM. 2009 was not a good year for sugar accumulation (hail, cool temperatures), although yields were maximized near 29 T/ac. The highest yields were from the 120 lb N rate. The 8T/acre compost rate produced near maximum yield and sugar but with somewhat higher SLM. The low rate of compost did improve yield but did not maximize yield or sugar and had a higher SLM than inorganic N.

Table 4. Treatment effects on selected sugar beet yield parameters.

| Treatment | 2009 T/ac | 2010 T/ac | 2009 %Sugar | 2010 %Sugar | 2009 SLM | 2010 SLM | 2009 # Sucrose | 2010 # Sucrose |
|---|---|---|---|---|---|---|---|---|
| Check | 24.4 | 19.6 c | 14.7 | 17.46a | 1.39 | 1.12a | 7152 | 6,847b |
| 4T cmpst | 26.4 | 24.4 b | 14.5 | 17.93a | 1.43 | 1.05a | 7644 | 8,778a |
| 8T cmpst | 28.7 | 26.6ab | 14.4 | 17.15a | 1.44 | 1.05a | 8244 | 9,155a |
| 16T cmpst | 28.4 | 27.2ab | 14.2 | 17.63a | 1.45 | 1.11a | 8056 | 9,577a |
| 60# N | 27.7 | 25.5ab | 14.6 | 17.30a | 1.34 | 1.13a | 8096 | 8,831a |
| 120# N | 28.9 | 28.3 a | 14.5 | 17.95a | 1.34 | 1.00a | 8429 | 10,169a |
| Pr > F | 0.46 | 0.01 | 0.83 | 0.46 | 0.57 | 0.66 | 0.58 | 0.02 |
| CV | 14% | 13% | 4% | 4% | 9% | 13% | 15% | 15% |

In 2010 there were several statistically significant treatment effects (Table 4). Single degree of freedom tests showed that the check versus all treatments except the 4 T compost rate were significantly greater for tonnage and total sucrose. There was no trend for SLM to be higher for compost rates versus mineral N. SLM was significantly lower in 2010 than 2009. Since the same variety was used and soil residual nitrate levels were higher in 2010 than 2009, a major effect on SLM is growing season conditions. Producers can manage SLM with proper N rates, but SLM is somewhat out of their control. 2010 was an excellent year for sugar accumulation and yields. The highest yields were again from the 120 lb N rate. The 16T/acre compost rate produced near maximum yield and sugar with acceptable SLM. The 4T compost rate did improve yield but did not maximize yield or sugar.

After harvest in 2010, treatments were sampled for soil test parameters (0 – 8 inch depth) and for residual nitrate-N to a depth of five feet. Data are shown in Table 5.

Table 5. Treatment effects on selected soil properties following 2010 harvest.

| Treatment | pH | %OM | OlsenP ppm | Salts - dS/m | #$NO_3$-N in 5 ft |
|---|---|---|---|---|---|
| Check | 7.5 | 1.6 | 16 | 0.42 | 30 |
| 4T compost | 7.6 | 1.6 | 22 | 0.46 | 38 |
| 8T compost | 7.6 | 1.7 | 36 | 0.49 | 38 |
| 16T compost | 7.6 | 1.7 | 43 | 0.51 | 41 |
| 60# N | 7.5 | 1.6 | 17 | 0.49 | 37 |
| 120# N | 7.5 | 1.5 | 16 | 0.42 | 35 |

The only significant effect was on soil P level. The additional P supplied by the compost was clearly reflected in soil test P values. Other parameters were not significantly different. The data show no increased salinity due to even the highest manure level. The data also show that sugar beets are an excellent crop at scavenging residual nitrate. Residual soil nitrate-N levels were generally less than 1 ppm to a depth of five feet for all treatments.

During the first two years of this study, even the highest rate of compost (well above what most producers would use) did not produce a disaster. The rates farmers are currently using (4 to 6 T/acre at $18-$20/T) will not produce maximum yield or sugar. A 10 to 12T composed manure rate may be needed but may be cost prohibitive while still not providing as good a yield as the proper rate of mineral N. In this work, the 120# N cost $70/acre at current fertilizer prices. There is significant phosphorus added with the compost plus other nutrients including S and micronutrients that could benefit crops following sugar beets. Residual studies will be needed to determine the compost value for those crops compared to a conventional fertilizer program if farmers plan to use compost for their sugar beet crop.

**References:**

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