COMPARISON OF STRIP TILLAGE VERSUS BROADCAST N APPLICATION FOR SUGAR BEETS

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Introduction:

Strip-till or zone placement of fertilizer is a fairly recent application option for sugar beet production. Producers may apply both nitrogen and phosphorus at one or two application depths (e.g., shallow and deeper), depending on the manufacturer's equipment design. Because of the root architecture of sugar beets, the question many producers have is whether strip-till placement of N might be more efficient than conventional broadcast application of N. Improved efficiency could mean less N or improved quality, however, limited data is available comparing conventional N placement versus deeper placed N. The importance of proper nitrogen nutrition in sugar beet production is well known. A lack of nitrogen results in reduced root yield while excess nitrogen causes a decrease in sucrose content and an increase in SLM (sugar loss to molasses).

Procedure:

A sprinkler-irrigated field at the PHREC Mitchell station was selected during spring 2006 for the experiment. The cropping sequence has been corn-corn-dry bean-wheat-sugar beet. 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 20 and 26 tons per acre are shown as a reference based on the University of Nebraska algorithm for sugar beets. Soils were sampled to a six foot depth in increments of 0 to 8, 8 to 24, 24 to 48, and 48 to 72 inches. Samples were analyzed for pH, organic matter, Olsen P, K, DTPA-Zn and nitrate-N.

The University of Nebraska algorithm for sugar beet N recommendations is:
***N Rate (lbs/a) = 9*expected yield {Tons} - 30*%OM - nitrate-N in 6 feet* - other credits**.

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 6 feet	20 T beets	26T beets
2006	8.1	1.45%	25 ppm	44	80 lbs N/ac	135 lbs N/ac
2007	8.1	1.67%	25 ppm	160	0 lbs N/ac	25 lbs N/ac
2008	8.0	1.63%	22 ppm	72	60 lbs N/ac	115 lbs N/ac

A strip-split-plot design was used to compare N application methods and N rates. N rates were 0, 35, 70, 105, 140, and 175 lbs in 2006. In 2007 and 2008 an additional N rate (210 lbs) was

added. Treatments were replicated five times. The strip-till implement was manufactured by Schlagel Manufacturing of Torrington, WY - http://www.schlagel.net/Till-N-Plant.htm.

To avoid confounding tillage or ripping effects with N application method, all plots were strip tilled. The strip-till N treatments were applied one or two days before planting (late April) using UAN (32-0-0). The shanks were set to a depth of 11 inches with two injection points at 4 and 10 inches below the soil surface with half of the N applied at each depth. The broadcast N treatments received 35 lbs N/acre before planting (except check) with remaining N applied in late June as urea (46-0-0) followed by a light irrigation. Sugar beets were replanted in 2006 and 2007 due to poor stand. Replant dates were May 19, 2006 and May 15, 2007 (Beta 7341). In 2008 (Beta 7341) stand was also low (32,200 plants per acre), but beets were left and not replanted.

Results and Discussion:

Nitrogen rates for sugar beets were set so the highest rate would be sufficiently high to provide excess N to determine effects on sugar and SLM. With the planting and replanting delays, inclusion of the lower rates turned out to be important as we fully expected a much lower yield level (nearer 20 tons per acre) due to the late replanting. Seedling counts a week after planting (2006 and 2007) showed stands as low as 24,000 to 28,000 plants per acre (seeding rate 56,000/a). Plant stands two weeks after replanting ranged from 38,000 to 45,000 plants per acre in 2006 and 2007 and there were no N rate or method treatment effects (data not shown

A condensed analysis of variance (SAS PROC MIXED) is shown in Table 2. N rate had a significant effect all three years. In 2008, there was a significant interaction, however, between method and N rate for sugar content, and SLM which make generalizing results more complex.

Table 2. Analysis of variance for strip-till N versus broadcast N for sugar beets.

Factor	Tons per acre			% Sugar		
	2006	2007	2008	2006	2007	2008
	---------- Pr > F----------					
N Method	0.91	0.14	0.02	0.82	0.65	0.01
N Rate	0.01	0.01	0.01	0.01	0.01	0.01
N*Method	0.61	0.06	0.55	0.29	0.68	0.01

Factor	% SLM			#Sucrose/acre		
	2006	2007	2008	2006	2007	2008
	---------- Pr > F----------					
N Method	0.23	0.65	0.01	0.99	0.13	0.14
N Rate	0.01	0.02	0.02	0.04	0.01	0.04
N*Method	0.80	0.56	0.03	0.54	0.15	0.21

Tables 3 and 4 show parameter averages as affected by N application method and N rate. As noted from Table 2, N application method had no significant effect in 2006 and 2007 but did in 2008. SLM tended to be somewhat lower with strip-till versus broadcast in 2006 and 2007 but was higher for strip till in 2008. Recoverable sugar was lower for strip till than broadcast in 2008. The averages do not tell the story. Data in Table 5 are required to explain what happened.

Table 3. Yield averages for N method effects on sugar beets.

Factor	Tons per acre			% Sugar		
	2006	2007	2008	2006	2007	2008
Broadcast	25.9	24.1	30.2	17.5	15.3	16.7
Strip Till	25.6	25.3	31.6	17.5	15.3	15.7

Factor	% SLM			# Sucrose/acre		
	2006	2007	2008	2006	2007	2008
Broadcast	1.39	1.55	1.20	9050	7350	10,116
Strip Till	1.35	1.52	1.41	9050	7755	9882

Because there was not a significant method effect in 2006 and 2007, N rate effects were averaged across application methods. N rate increased root yield up to a N rate of 105 pounds per acre in 2006 and 70 pounds per acre in 2007. Sugar content showed the usual decline with increasing N rate, but sucrose amount was maximized near the 105 lb N rate in 2006 and 35 lb N in 2007. Increasing N rate significantly increased SLM and decreased sugar content.

Table 4. Yield averages for N rate effects on sugar beets in 2006 and 2007.

N Rate	Tons/acre		% Sugar		% SLM		Lbs Sucrose/acre	
Lbs/acre	2006	2007	2006	2007	2006	2007	2006	2007
0	22.7	22.8	18.2	16.1	1.21	1.40	8265	7310
35	24.7	24.9	17.6	15.9	1.32	1.51	8700	7985
70	26.2	25.9	17.8	15.3	1.35	1.52	9335	7920
105	27.4	25.0	17.2	15.0	1.42	1.60	9425	7500
140	26.6	24.6	17.3	15.0	1.47	1.56	9240	7380
175	27.4	24.6	16.9	15.3	1.48	1.55	9320	7540
210	--	25.0	--	14.5	--	1.64	--	7240

In 2008, N from strip till was very effective (Table 5) whereas N from broadcast tended to show a very limited effect. The lack of effective N can be seen from the lack of root yield response, a slight increase in sugar content as N rate increased (usually decreases) and a lack of effect of N on SLM. The lack of effective N, however, did not hurt sugar production. At higher N levels, broadcast produced more sugar than strip till because the high N rates (175 & 210) for strip till significantly reduced sugar as expected.

Table 5. Yield averages for N rate effects on sugar beets in 2008.

N Rate	Tons/acre		% Sugar		% SLM		Lbs Sucrose/acre	
Lbs/acre	Bdcst	Strip	Bdcst	Strip	Bdcst	Strip	Bdcst	Strip
0	27.6	28.3	16.8	17.1	1.17	1.19	9,328	9,663
35	30.6	30.7	16.5	16.2	1.14	1.39	10,093	9,942
70	30.6	30.7	16.2	16.3	1.27	1.32	9,927	9,990
105	30.3	32.9	17.1	16.0	1.21	1.42	10,388	10,551
140	31.1	33.5	16.8	15.5	1.21	1.41	10,455	10,433
175	31.0	32.3	16.6	14.5	1.27	1.57	10,334	9,404
210	30.3	32.5	17.0	14.2	1.13	1.54	10,289	9,190

The three years were very different in terms of growing conditions. In 2006 beets matured and lower N rates showed the typical 'yellowing' that would be expected if N could be managed perfectly. In 2007, the growing season was long and warm. The checks and lowest N rates showed 'greenness' near the October harvest date. In 2008, there was marked N deficiency on checks and the lowest N rate throughout the year. This difference is reflected in SLM values which were highest in 2007 and lowest in 2008 and show that even with good N management, quality levels are not always controllable.

This experiment confirms much of our past N rate research: Increasing N rate increases tonnage up to a point, but with declining sugar content and increasing SLM, maximum recoverable sugar is still near optimum N. In this work, we began the project with the expectation of producing at least 26 ton beets. Replanting decreased the likelihood of that, but yields were still surprisingly good (33 T max in 2008, 27 T max in 2006 and 25 T max in 2007).

The current University of Nebraska N algorithm for 26 T beets would have recommended 135 lb N in 2006, 25 lb N in 2007 and 115 lb N in 2008. Response functions showed N rates of 105 'optimum' for 2006, 105 in 2007 and about 100 in 2008. The research shows that the UNL algorithm, although considered conservative, is still a good guide to N application and in this research was not that conservative. To work 'properly' a value of nitrate-N for a 6 foot depth must be used, otherwise the 'answer' will be incorrect. Shallower sampling values from 3, 4 or 5 foot depths can be used, but must be adjusted to a 6-foot basis. Doing a good job of soil sampling to estimate soil organic matter and residual nitrate and using a realistic yield expectation will produce the highest recoverable sugar per acre with an acceptable SLM.

There is some evidence that strip-till may have an advantage over broadcasting N (somewhat lower SLM, tare, higher sucrose in 2007, lower N rate in 2008). The perplexing results for broadcast in 2008 would suggest that more site years and locations be used to determine if that difference is truly significant. The data support strip-till applied N as a good option for sugar beet production requiring less energy than plowing and broadcasting N. The 'broadcast' application went on in late June to simulate a split application (all N rates except the check received 35 lbs of N preplant and the remaining amount later). There was no advantage to the later N and for some reason (N volatilization?) it had little effect in 2008.