Nitrogen Rate and Placement Trials

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Nitrogen management is a priority for production of high-quality sugar beets. The use of nitrogen placement could offset the input cost of nitrogen and lower the overall use rate through more efficient use and availability.

Research Objective

- Provide nitrogen fertilizer guidelines for sugar beet production in the Southern Minnesota Beet Sugar Cooperative growing area.

Methodology

Two trials were established in 2023 using randomized complete block design. One trial was located near the Murdock piling site following soybean and the other trial was located near Clara City following field corn. Both sites were soil sampled in the fall of 2022 to develop treatment rates for the trials in 2023 (Table 1). The treatments for each site were identical with treatments including broadcast urea rates, placement of liquid 32% N (UAN), and use of nitrogen fixing biological products (Tables 2 and 3). The Murdock site was planted on May 9th, and the Clara City site was planted on May 24th. Both sites were planted using Crystal M089. Prior to planting, the urea treatments were broadcast by hand and incorporated with a small field cultivator. The liquid 32% N treatments were applied at planting using a 360 Bandit system with CO_2 as a propellant for the fertilizer. The 360 Bandit dribbled the liquid three inches either side of the row at a depth from the soil surface of 0.75 to one inch (Photo 2). For the surface applied UAN dribble treatment, the hoses were removed from the disc and allowed to drag along the soil surface (Photo 3). The Biopath, Generate, and Alpha Complete treatments were applied through the infurrow system on the planter with a 6gpa application volume. The Utrisha N treatments were applied with the bicycle sprayer on June 9th at the Murdock trial and June 15th at the Clara City trial. The bicycle sprayer was equipped with XR11002 nozzles with a spray volume of 17gpa. Standard sugar beet production practices were used to keep the trial weed and disease free. Each plot was 35ft long and 6 rows wide. The center two rows of each six-row plot were harvested on September 19th at Clara City and October 11th at Murdock using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and two samples of those beets from each plot were used for quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Table 1. Soil test results for the two trial locations from fall soil sample in 2022.

Soil test	Murdock	Clara City
Soil nitrate-N 0-4 ft. (lb N/A)	34	39
Olsen P 0-6 in. (ppm)	3	8
K 0-6 in. (ppm)	178	199
pH 0-6 in. (unitless)	8.1	7.9
Organic matter 0-6 in. (%)	5.5	5.8

Results

There were no significant differences between any of the treatments at the Murdock site (Table 3). The root yield data for this site had some variability caused by rhizoctonia root rot. There may be numerical differences, however, these differences are not statistically significant because of the variability caused by the rhizoctonia.

There was a significant increase in root yield at the Clara City site up to an additional 60lbs per acre of nitrogen (Table 2). Adding additional nitrogen over 60lbs did not result in greater root yield compared to the 60lbs N per acre (99lbs per acre Total N) nitrogen treatment. There were also some differences in quality parameters with the check (residual N only), and the highest two rates of additional N having lower quality than some of the other treatments with lower amounts of additional N applied.

Photos 2 & 3. The 360 Bandit system installed on the 6-row research planter. The dribble treatment visible on the soil surface after planting.

Conclusions

In the past decade of nitrogen research at SMBSC, many nitrogen trials have failed to generate a positive response to the addition of nitrogen over the residual nitrogen that's already present in the field. In the most recent years, trials following field corn have generally had a greater response to additional nitrogen compared to trials following soybean. Because of the lack of response to the addition of nitrogen following soybean, a comparison of the methods of application cannot be made at the site located north of the Murdock piling site. The Clara City site, which followed field corn, had a slight increase in root yield with the addition of nitrogen, however, there were no statistical differences between the application methods. These nitrogen placement trials will be conducted again in 2024 to complete a third year of evaluation into the methods of nitrogen application.

Table 2. Root yield and quality data for the Clara City trial following field corn. Trial harvested on September 19th.

Entry	Treatment	Applied N	Total N	Percent Sugar	Root Yield Tons/Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	Check	0	39	16.9	27.1 d	14.4 cdef	286.6 cde	7749.8	91.0 abcd
2	Broadcast Urea	30	69	17.3	29.3 bcd	14.8 ab	295.5 ab	8650.1	91.3 a
3	Broadcast Urea	60	99	17.4	29.9 abcd	14.9 a	297.1 a	8871.9	91.3 ab
4	Broadcast Urea	90	129	17.0	30.8 abc	14.4 cdef	287.5 cde	8858.2	90.7 d
5	Broadcast Urea	120	159	16.9	31.3 ab	14.3 def	286.0 cde	8946.4	90.8 bcd
6	Broadcast Urea	150	189	16.7	31.6 ab	14.1 f	282.2 e	8922.6	90.7 cd
7	Broadcast Urea	180	219	16.8	33.1 a	14.2 ef	284.1 de	9384.5	90.7 cd
8	3x1 32%	30	69	17.0	30.6 abc	14.4 bcdef	288.6 bcde	8819.0	91.0 abcd
9	3x1 32%	60	99	17.1	31.3 ab	14.5 abcde	290.7 abcd	9096.0	90.9 abcd
10	3x0 32%	30	69	17.2	27.9 cd	14.6 abcd	292.7 abc	8175.6	91.3 a
11	3x0 32%	60	99	17.2	29.5 bcd	14.6 abcd	292.6 abc	8626.3	91.1 abcd
12	Utrisha N	30	69	17.2	29.3 bcd	14.7 abc	293.9 abc	8609.9	91.3 ab
13	BioPath	30	69	17.2	29.9 abcd	14.6 abcd	292.1 abc	8725.6	91.0 abcd
14	Generate	30	69	17.1	27.6 cd	14.4 bcdef	289.0 bcde	7971.5	90.8 cd
15	Alpha Complete	30	69	17.1	27.6 cd	14.6 abcde	291.8 abcd	8031.9	91.2 abc
			Mean	17.1	29.8	14.5	290.0	8629.3	91.0
			CV%	1.7	6.6	1.6	1.6	6.4	0.3
			Pr>F	0.2042	0.0275	0.0191	0.0239	0.0536	0.0492
			lsd (0.05)	ns	3.3	0.4	7.9	ns	0.5

Table 3. Root yield and quality data for the Murdock trial following soybean. Trial harvested on October 11th.

Entry	Treatment	Applied N	Total N	Percent Sugar	Root Yield Tons/Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	Check	0	34	16.5	36.5	13.9	276.8	10079.2	90.3
2	Broadcast Urea	30	64	16.8	34.9	14.1	281.7	9816.5	90.1
3	Broadcast Urea	60	94	16.7	35.1	14.0	280.4	9870.7	90.4
4	Broadcast Urea	90	124	16.6	36.1	14.0	278.9	10149.8	90.4
5	Broadcast Urea	120	154	16.7	36.1	14.0	279.9	10108.3	90.5
6	Broadcast Urea	150	184	16.5	40.6	13.8	276.2	11116.9	89.9
7	Broadcast Urea	180	214	16.5	35.2	13.8	275.4	9682.1	90.1
8	3x1 32%	30	64	16.6	35.9	13.9	278.2	9927.6	90.3
9	3x1 32%	60	94	16.6	40.4	13.9	278.2	11265.0	90.2
10	3x0 32%	30	64	16.8	35.4	14.1	280.8	9925.6	90.1
11	3x0 32%	60	94	16.5	35.0	13.8	276.6	9664.3	90.3
12	Utrisha N	30	64	16.4	35.0	13.7	274.2	9743.3	90.1
13	BioPath	30	64	16.5	33.7	13.9	276.6	9372.7	90.3
14	Generate	30	64	16.8	33.1	14.1	281.9	9380.0	90.5
15	Alpha Complete	30	64	16.8	34.4	14.1	281.5	9671.9	90.2
			Mean	16.6	35.8	13.9	278.5	9987.4	90.2
			CV%	1.9	12.7	2.0	2.0	11.9	0.4
			Pr>F	0.75	0.89	0.70	0.65	0.90	0.57
			lsd (0.05)	ns	ns	ns	ns	ns	ns