Phosphorus by Nitrogen Rate Trial

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Nitrogen management is a priority for production of high-quality sugar beets. However, many other nutrients also play a role in plant growth. It is important to understand how the availability of other major nutrients may be impacted by varying levels of nitrogen.

Research Objective

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

Methodology

This trial was conducted as a 3 x 5 factorial with four replications following field corn west of Redwood Falls, MN. Soil samples were taken in the spring prior to treatment application (Table 1). The nitrogen fertilizer rates were 0, 63, and 133 lb N/A. The phosphorus fertilizer rates were 0, 15, 30, 45, and 60 lb P/A. The phosphorus and nitrogen treatments were applied broadcast in the spring and incorporated using a small field cultivator. The nitrogen source was urea, and the phosphorus source was triple super phosphate (TSP). The site was planted on June 3rd using Crystal M089. Dual Magnum and ethofumesate were applied as a pre emerge and Sequence as a layby application with Roundup Powermax to keep the site weed free. The center two rows of each six-row plot were harvested on October 6th 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 a sample of those beets were used for a 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 Redwood Falls location from fall soil sample in 2021.

Soil test	Redwood Falls
Soil nitrate-N 0-2 ft. (lb N/A)	77
Olsen P 0-6 in. (ppm)	14
K 0-6 in. (ppm)	228
pH 0-6 in. (unitless)	7.7
Organic matter 0-6 in. (%)	5.6

Figure 1. Drone images from July 1st and July 15th.

Results

The application of phosphorus had no impact on the yield or quality of sugar beets regardless of the amount of nitrogen applied (Table 2). The increased rate of nitrogen applied had a positive impact on extractable sugar per acre (Table 3). Drone images taken during in July do not show drastic differences in canopy color or size between treatments (Figure 1).

Table 2. The effect of fertilizer P on root yield and quality averaged across N rates.

Phosphorus Rates	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
0	17.0	33.3	13.9	277.4	9224.2	88.3
15	17.1	32.4	14.0	279.1	9037.2	88.3
30	17.1	33.0	14.0	279.7	9214.9	88.4
45	17.1	33.6	14.0	280.6	9414.9	88.6
60	16.8	33.4	13.7	273.4	9133.0	88.1
Mean	17.0	33.1	13.9	278.0	9204.9	88.3
CV%	2.0	4.7	2.7	2.7	4.4	0.6
Pr>F	0.1991	0.3882	0.1543	0.1543	0.2465	0.2832
lsd (0.05)	ns	ns	ns	ns	ns	ns

Table 3. The effect of fertilizer N on root yield and quality averaged across P rates.

Nitrogen Rates	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
0	16.94 b	31.9 b	13.8	276.4	8814.8 b	88.3
63	16.96 b	33.9 a	13.8	276.3	9373.7 a	88.2
133	17.21 a	33.5 a	14.1	281.5	9426.1 a	88.4
Mean	17.0	33.1	13.9	278.0	9204.9	88.3
CV%	2.0	4.7	2.7	2.7	4.4	0.6
Pr>F	0.033	0.0004	0.0512	0.0512	<.0001	0.5104
lsd (0.05)	0.2	1.0	ns	ns	259.6	ns

Conclusions

No response was seen to increasing the rate of phosphorus applied with any rate of nitrogen. It was speculated that as nitrogen rates increase that the rates of other nutrients, such as phosphorus, would also need to be increased. Based upon the results of this study increasing phosphorus rates as nitrogen rates increase does not have any impact.