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.

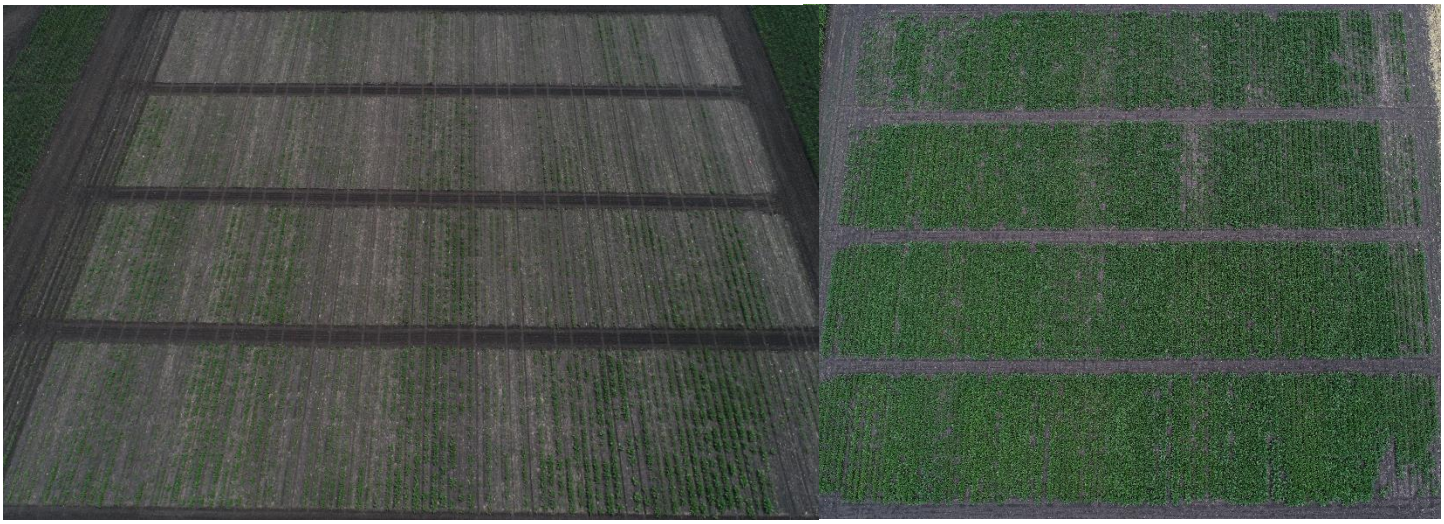
Methodology

This trial was conducted as a 3 x 5 factorial with four replications following soybean northeast of Renville, MN. Soil samples were taken in the fall prior to treatment application (Table 1). The applied nitrogen fertilizer rates were 0, 70, and 140 lb N/A. The phosphorus fertilizer rates were 0, 15, 30, 45, and 60 lb P_2O_5/A. The phosphorus and nitrogen treatments were applied broadcast in the spring and incorporated using a small field cultivator. The nitrogen source was urea (46-0-0), and the phosphorus source was triple super phosphate (0-46-0). The site was planted on May 4th using Crystal M089. Dual Magnum was applied preemergence and other standard practices were used post emergence to keep the site weed free. The center two rows of each six-row plot were harvested on September 18th 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 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 Renville location from fall soil sample in 2022.

Soil test	Renville
Soil nitrate-N 0-4 ft. (lb N/A)	33
Olsen P 0-6 in. (ppm)	3
K 0-6 in. (ppm)	224
pH 0-6 in. (unitless)	8.0
Organic matter 0-6 in. (%)	5.3

Figure 1. Drone images from June 15th and July 20th showing reduced foliage in plots that were deficient in phosphorus, nitrogen, or both.



Results

The application of phosphorus and nitrogen had an interaction that significantly impacted root yield and ESA (Figure 2). The application of phosphorus did not impact any quality parameters. The application of nitrogen did however have an impact on quality with percent sugar, ES, and EST being negatively impacted by the highest rate of nitrogen (Table 2).

Figure 2. Impact on root yield of increasing nitrogen across P_2O_5 rates and increasing phosphorus across nitrogen rates.

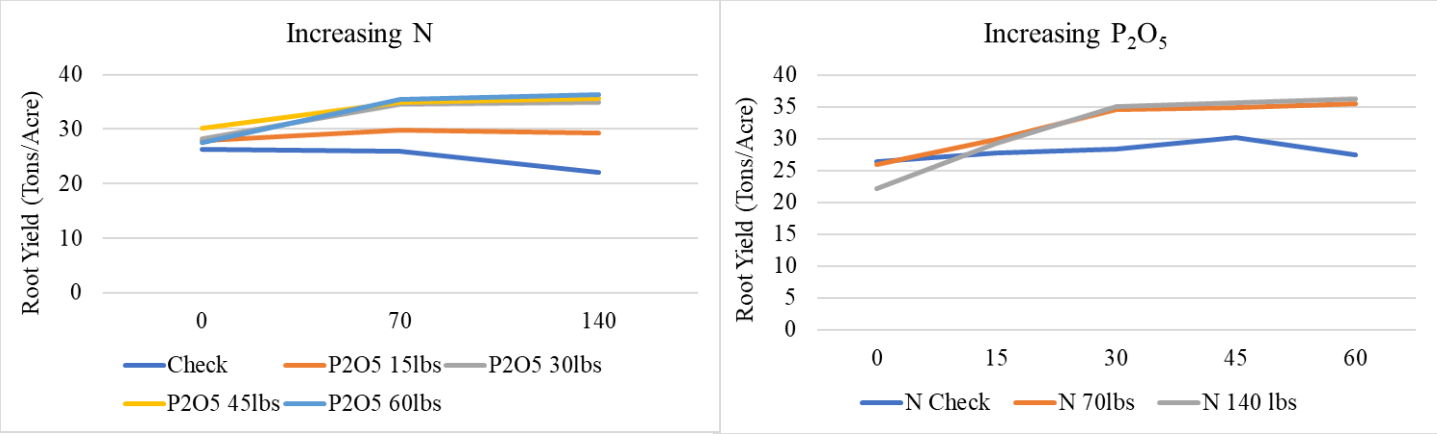


Table 2. The effect of fertilizer N on quality averaged across P_2O_5 rates.

Applied Nitrogen Rates	Total Nitrogen	Percent Sugar	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Percent Purity
0	33	17.2 a	14.4 a	288.8 a	90.1
70	103	17.2 a	14.4 a	288.1 a	89.9
140	173	16.9 b	14.1 b	283.0 b	90.0
Mean		17.1	14.3	286.6	90.0
CV%		1.7	1.7	1.7	0.4
Pr>F		0.0011	0.0008	0.0008	0.2451
lsd (0.05)		0.18	0.16	3.11	ns

Conclusions

Phosphorus having a significant impact on root yield was not surprising as the soil sample results indicated very low soil test levels of phosphorus (Table 1). The response to additional nitrogen over the control was expected and consistent with previous studies when conducted on a site with low residual nitrogen. There was a deficiency in both nutrients being tested. This resulted in an interaction between the two nutrients. Increasing the rate of nitrogen without increasing the rate of phosphorus did not result in a root yield increase (Figure 2). Similarly, increasing the rate of phosphorus without increasing the rate of nitrogen also did not result in a root yield increase. Increasing the rate of phosphorus improved root yield up to 30lbs of additional phosphate with no further increase in root yield after that rate. Root yield increased with the addition of 70lbs nitrogen per acre but did not increase any further with 140lbs per acre of additional nitrogen. After sufficiency levels were met there does not appear to be any benefit to increasing the rate of phosphorus if the rate of nitrogen is increased. Increasing the rate of nitrogen outside the recommended range did not improve the root yield in this study and had a negative impact on the quality.