# Fertilizing Sugar Beet in Minnesota and North Dakota

*John A. Lamb, Albert L. Sims, Larry J. Smith, and George W. Rehm*

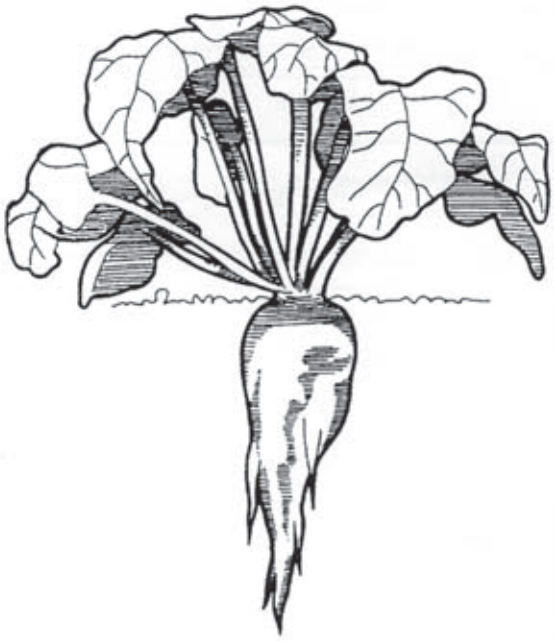
## Fertility Needs of Sugar Beet

The three grower-owned cooperatives in Minnesota and North Dakota vary in their payment programs. Some programs pay strictly on net sucrose quality, which is determined by sugar beet root quantity and quality. Other programs give financial incentives for delivering higher quality sugar beet roots to the factory. In both cases quality is determined by the concentration of sucrose and impurities in the root that need to be separated during the refining process.

Optimum sugar beet production in Minnesota and North Dakota relies on a sound soil fertility program. A sound fertilizer program can enhance the quality of the sugar beet. The recommendations suggested in this publication for the supplemental application of nitrogen (N), phosphorus (P), and potassium (K) are based on thirty years of scientific research in the sugar beet growing areas of Minnesota and North Dakota.

## Nitrogen:

Nitrogen is the single most important nutrient for optimum sugar beet production. Nitrogen status of the plant affects early growth or time to full canopy closure and the quality of the sugar beet at harvest. Optimum nitrogen management promotes vigorous early season plant growth reducing the number of days to canopy closure, which allows the sugar beet to utilize the sunlight's energy more efficiently to make sucrose. Excess N at or near the end of the growing season reduces sugar beet quality by reducing sucrose concentration and increasing impurity concentration. Research has indicated that the greatest sugar beet quality occurs when the plants undergo N deficiencies late in the growing season starting about six weeks prior to harvest. However, the development of severe N deficiencies too early in the growing season, while enhancing quality, will reduce sugar beet root yield. Minnesota and North Dakota soils, where most of the



sugar beets are grown, can mineralize sufficient N from their organic matter to reduce the severity of N deficiency later in the growing season. Therefore, a good fertility program needs only to provide N during the early and mid parts of the growing season.

## Soil Testing For Nitrate

The amount of nitrogen fertilizer application to a sugar beet crop should be based on a total N recommendation minus the nitrate-N from a soil test. The depth to which to take the required soil test depends

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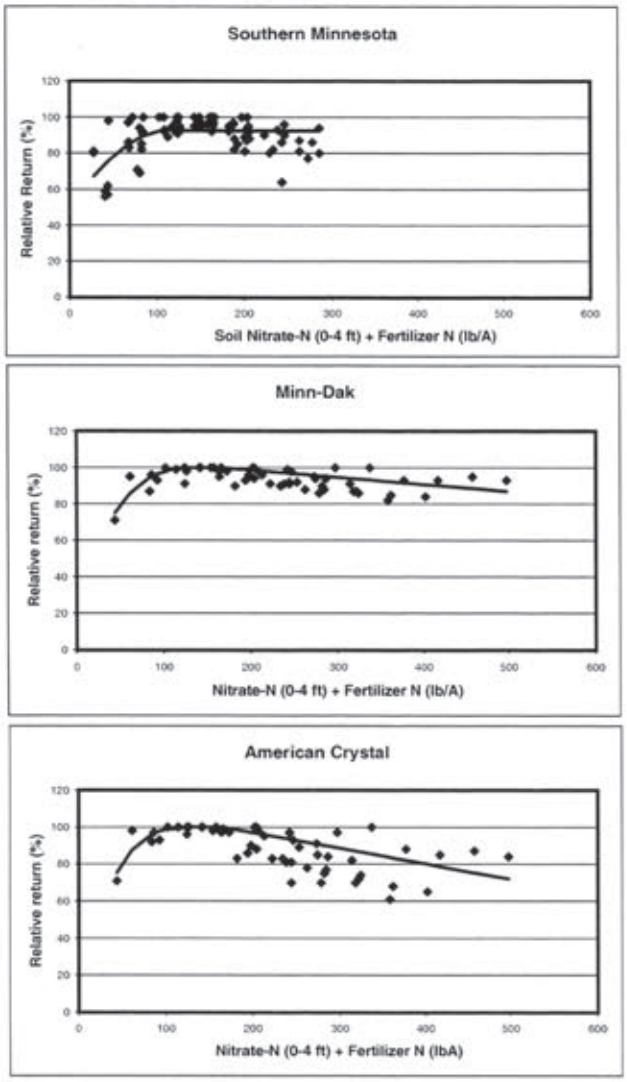


**Figure 1. Relative return for soil nitrate-nitrogen in a 4-foot soil sample plus fertilizer nitrogen applied from research studies conducted in the Southern Minnesota Beet Sugar Cooperative, Minn-Dak Farmers Cooperative, and American Crystal Sugar Cooperative growing areas.**

on the previous history of nitrogen management and the policy of the Sugar Cooperative. It is recommended that a soil sample to a depth of 4 feet be taken if little knowledge exists on levels of nitrate-N below 2 feet. The recommendation based on a sample taken to 4 feet is 130 pounds N per acre (Table 1 and Figure 1). This recommendation includes the amount of nitrate-N in the soil sample and the amount added as fertilizer. If for some reason you can only sample to a depth of 2 feet, then the recommendation is 100 pounds N per acre. In some cases where previous management and soil conditions occur that would cause a large amount of residual nitrate-N to be in the soil, a sample to a depth of 6 feet may be needed. In all cases, it is suggested that a minimum of 65 pounds N per acre in the 0- to 2-foot depth should be present no matter how much nitrate-N occurs in the 2- to 4-foot depth.

## Nitrogen Sources:

The summary of several research trials indicate all N sources will perform similarly if applied appropriately to minimize losses. For environmental and N loss concerns, fall applications of nitrate forms of fertilizers such as urea ammonium nitrate solution (UAN) or ammonium nitrate are strongly discouraged. Anhydrous ammonia and urea N sources can be used either as preplant applications in the spring or the previous fall after soil temperatures fall below 50° F.

## Split Applications:

Split applications of N fertilizer may be wise for sugar beets grown on sandy soils. The split applications should be scheduled so the last application is done before July 1 to minimize the possible reduction in root quality at harvest. Research conducted in the 1980's and 1990's on heavier textured soils indicates that split applications did not perform better than a preplant application and actually decreased root quality in recent trials conducted in the Red River Valley.

## Previous Crop and Rotation Management

The above recommendations must be modified based on crop rotation and previous input management. The soil nitrate test is not accurate in situations where the previous crop is a legume such as soybean or alfalfa or where manure applications have been made. It is strongly recommended not to grow sugar beets following soybeans and alfalfa, or where manure has been applied the previous year because of the increased nitrogen mineralized from organic N sources during the growing season. Research data and Sugar Cooperative Grower records indicate a reduction in sugar beet root yield and quality when grown in a field previously planted to soybean. Research with sugar beet growth following alfalfa and manure application indicates that while root yield was not affected, the use of nitrogen fertilizer reduced sucrose concentrations and recoverable sucrose yields.

**Table 1. Nitrogen, phosphate, and potash recommendations for sugar beet.**

| Soil nitrate-N plus fertilizer N required | | Soil Test Phosphorus, ppm | | | | | Soil Test Potassium, ppm | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VL | L | M | H | VH | VL | L | M | H | VH |
| | Bray P1 | 0-5 | 6-10 | 11-15 | 16-20 | 21+ | | | | | |
| | Olsen P | 0-3 | 4-7 | 8-11 | 12-15 | 16+ | 0-40 | 41-80 | 81-120 | 121-160 | 161+ |
| lb/acre-2' | lb/acre-4' | lb $P_2O_5$/acre | | | | | lb $K_2O$/acre | | | | |
| 100 | 130 | 80 | 55 | 35 | 10 | 0 | 110 | 80 | 50 | 0 | 0 |

**Table 2. Common starter phosphorus fertilizer sources and maximum amounts suggested for seed application.**

| Source | Name | Dry or Liquid | Maximum amount to apply | Phosphate supplied (lb/acre) |
|---|---|---|---|---|
| 10-34-0 | Ammonium polyphosphate | liquid | 4 gallons/acre | 16 |
| 18-46-0 | Diammonium phosphate | dry | 28 pounds/acre | 13 |
| 11-52-0 | Monoammonium phosphate | dry | 45 pounds/acre | 24 |
| 0-44-0 | Triple Super phosphate | dry | no limit | NA |

## Yield Goals

In the past, nutrient recommendations for sugar beet have utilized a yield goal. This was to account for differences in the grower's management, soil, and production potential. **The use of yield goals to make fertilizer recommendations has been discontinued** because sugar beets require a high level of management and are grown on the more productive soils. With nitrogen, growing seasons that have potential for greater than normal yields also have conditions that are favorable for greater mineralization of nitrogen from the organic matter. In recent years, 30-ton per acre root yields were obtained in fields that were fertilized at a rate recommended for a 20-ton per acre yield goal. With nutrients such as phosphorus, the amount needed for a 20-ton/acre crop is very similar to the amount needed for a 16-ton/acre sugar beet crop.

## Phosphorus

Phosphorus is used by the plant for energy compounds. Phosphorus has been documented to increase root yields in soils that are low in phosphorus while not affecting quality. Since phosphorus is immobile in the soil, recommendations are based on a soil sample to a depth of 6 to 8 inches. The phosphorus soil test does not measure the chemical form utilized by the plant as is the case with the nitrate test. The P soil test is only an index that has been correlated to the crop response to P fertilizers in field trials.

The availability index (soil test) used for recommendations is dependent on the soil's pH. If the pH is less than 7.4, a Bray P1 soil test can be used. When the pH is 7.4 or greater, the Olsen P soil test should be used. At this time, the University of Minnesota and North Dakota State University do not support the Mehlich III soil test. The recommendations suggested in Table 1 are based on broadcast applications of P fertilizer.

## P Fertilizer Placement

Recent research at the University of Minnesota's Northwest Research and Outreach Center indicates that the use of a starter placement of fertilizer phosphorus with the sugar beet seed is more efficient than a broadcast application. Phosphate application rates can be reduced up to one-half of the broadcast application rates and still produce similar yields.

Greenhouse work in Minnesota and Nebraska indicates that early sugar beet growth is enhanced with starter placement of phosphorus, but there is a difference in the placement of the starter band. Placement with the seed or 2 inches below the seed was superior to the more conventional placement of 2 inches to the side and 2 inches below the seed. If you choose to use the seed placement option, there are cautions on the amount which can be applied. **Applying greater than 5 pounds per acre of N + $K_2O$ in contact with the seed can reduce plant stand emergence.** The amount of P in contact with the seed has not been detrimental to plant stands. The occurrence of stand reduction increases with decreasing soil moisture condition at the time of planting.

The source of starter fertilizer is not a factor in getting a yield response. Dry and liquid starter fertilizer sources will perform similarly. The only difference is the amount that can be applied in contact with the sugar beet seed. Common phosphorus fertilizer sources that can be used and their maximum recommended application amounts are listed in Table 2.

## Potassium

At this time, the use of a starter fertilizer with potassium is not recommended because there is little research on the effect these sources have on sugar beet growth, and only a small amount of the sugar beet growing areas need potassium fertilization. Potassium is essential to sugar beet production and is not mobile in the soil. The soil test is based on an ammonium acetate extraction on a surface 6- to 8-inch deep soil sample. If the soil test is in the responsive range, placement can be similar to phosphorus except extreme caution should be exercised when placing potassium-containing fertilizers in contact with the seed. Potassium is not a large concern in Minnesota and North Dakota because the majority of the soils where sugar beet is grown are natively high in potassium.

## Other Nutrients

There have been no documented yield or quality responses to other nutrients such as sulfur, zinc, magnesium, calcium, boron, or sodium in the Minnesota and North Dakota sugar beet growing areas.

## Nutrient Concerns for Crops Following Sugar Beet

Recent work from North Dakota State and the University of Minnesota's Northwest Research and Outreach Center indicate that nitrogen credits should be given for nitrogen in the sugar beet tops for crops such as small grains and corn grown after the sugar beet crop in rotation. If sugar beet top growth is lush and green, the credit could be as great as 70 pounds N per acre.

If you are growing corn following sugar beet in the rotation, you should consider using a starter application of 40 pounds phosphate per acre. If the EDTA zinc soil test is low, also include 2 pounds of zinc in the starter.

*Authors:*
***John A. Lamb*** *is an Extension soil scientist in the Department of Soil, Water, and Climate.*
***Albert L. Sims*** *is a soil scientist at the Northwest Research and Outreach Center.*
***Larry J. Smith*** *is Head at Northwest Research and Outreach Center.*
***George W. Rehm*** *is an Extension soil scientist in the Department of Soil, Water, and Climate.*

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