Colorado State University
Extension

Fertilizing Sugar Beets

Fact Sheet No. 0.542 Crop Series|Soil

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Adequate soil fertility is one of the requirements for profitable sugar beet production. Nitrogen (N) is the most yield-limiting nutrient, and N management is critical to obtain optimum sugar beet yield and quality. Phosphorus (P) is the next most limiting nutrient, while levels of available potassium (K), sulfur (S), and micronutrients are adequate for sugar beet production in most Colorado soils.

Soil Sampling

The value of a soil test to predict nutrient availability during the growing season directly relates to how well the sample collected represents the area sampled. Take soil samples prior to planting to assess the fertility status of the soil to the depth of the tillage layer, usually 1 foot.

Take subsoil samples to the 4-foot depth (in 1-foot increments) to determine available NO_3-N. A good sample is a composite of 15 to 20 soil cores from an area uniform in soil type. Sample separately these areas with major differences in soil properties or management practices.

Thoroughly air-dry all soil samples within 12 hours after sampling by spreading the soil on any clean surface where the soil will not be contaminated. **Do not oven-dry the soil;** this can change the soil test results. Place the air-dried soil in a clean sample container for shipment to the soil test laboratory. Submit a carefully completed information form with the soil samples. This form provides information so fertilizer suggestions can be tailored to your specific situation. Take soil samples for NO_3-N every year for optimum N fertilization of crops. Soil analysis for other nutrients, pH, and organic matter content is sufficient every three to four years.

More detailed explanations of the importance of proper soil sampling are found at the Colorado State University Soil, Water, and Plant Testing Laboratory is located in Room A319 Natural and Environmental Sciences Building, Colorado State University, Fort Collins, CO 80523, (970) 491-5061, and at www.extsoilcrop.colostate.edu/SoilLab//soillab.html.

Nitrogen Suggestions

Base nitrogen rates for sugar beets on the expected yield for each field. Nearly all sugar beet crops require some N fertilizer, unless there is a substantial N carryover. Adequate N is needed to obtain maximum vegetative growth early in the growing season. However, adjust the N application rate so available N supply is at low levels by midseason to maximize sugar production. High N availability late in the season increases impurities in the beet.

Soil Nitrate-N Credit

Residual NO_3-N in soil is immediately available to plants, so decrease the fertilizer rate to allow for the amount of NO_3-N in the rooting zone. Sample soil to a depth of 4 feet in 1-foot increments and test for NO_3-N. When soil samples are taken from depths other than 4 feet, use a soil profile factor to estimate the NO_3-N for the 4-foot profile. This profile factor is for the average Colorado field. If your field is not average, accuracy of the suggested N rate is decreased. Multiply the sum of the NO_3-N values by the appropriate factor (see Table 1) before utilizing Table 2.

Quick Facts

- Nitrogen is the most limiting nutrient for sugar beet production. Proper N management during the season is critical.
- Apply nitrogen fertilizers at rates based on expected crop yields, minus credits for residual soil nitrates in the top 4 feet of soil and nitrogen mineralized from soil organic matter.
- Do not apply manure to fields prior to planting sugar beets.
- Apply phosphate fertilizers at rates based on soil test results.
- Most Colorado soils contain sufficient available potassium, sulfur, and micronutrients for sugar beet production.

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Table 1: Soil Profile Factors.

Sample Depth, Feet	Profile Factor
0 - 1	2.67
0 - 2	1.54
0 - 3	1.18

Soil Organic Matter Credit

Nitrogen in soil organic matter becomes available to plants through a mineralization process. Research results show that about 30 pounds of nitrogen per acre will become available during the growing season for each 1.0 percent of organic matter in the surface soil layer. When a soil test result for organic matter content is not available, a level of 1.5 percent organic matter can be assumed for Eastern Colorado soils.

Other Credits

Previous legume crop residues will release N to the succeeding crops after incorporation into the soil. Because the amount and timing of N release during the season varies, planting sugar beets after legumes, especially alfalfa, is not suggested. Manure applications also are **not** suggested for sugar beets. Much of the nitrogen in manure may be released as NO_3-N during the latter part of the season, at the time when the available N supply should be low. Excessive supplies of N during the late season decrease the sugar percentage and increase impurities in the beets.

Nitrogen Rates

The basis for suggested N rates is an algorithm (equation). This relates N needs for a 23-ton per acre expected yield of sugar beets to credits given for the available NO_3-N in a 4-foot depth of soil, as well as the expected amount of N available to the crop during the growing season. These suggested N rates optimize yield and sugar production. The suggested N rate is determined by using the following algorithm:

N rate (lb/A) = 200
– (3.6 x the sum of ppm NO_3-N in 1-foot sample depths to 4 feet)
– (30 x % OM)

where % OM = percent organic matter in the surface sample.

Table 2: Suggested N rates for sugar beets, as related to soil organic matter content and amount of soil nitrate-nitrogen at 4 feet (expected yield, 23 tons per acre).

ppm NO_3-N in Soil*	Soil Organic Matter, %		
	0 - 1.0	1.1 - 2.0	> 2.0
	Fertilizer Rate, Pounds N Per Acre		
0 - 6	170	140	120
7 - 12	150	120	100
13 - 18	130	100	80
19 - 24	110	80	60
25 - 30	90	60	40
31 - 36	70	40	20
> 36	50	0	0

*Sum of ppm NO_3-N in 1-foot sample depths to 4 feet.
Note: For sample depths other than 0-4 feet, add the ppm NO_3-N levels and multiply by the appropriate profile factor before using the table to obtain the suggested N rate.

Multiply the sum of the NO_3-N values by 3.6 (there are about 3.6 million pounds of soil per acre-foot) to estimate the pounds per acre of NO_3-N in the soil. For example, if your soil test results show NO_3-N values of 12, 6, 4, and 2 ppm in the 0- to 1-, 1- to 2-, 2- to 3-, and 3- to 4-foot samples, respectively, and the surface soil contains 1.5 percent organic matter, the suggested N rate for an expected yield of 23 tons per acre is:

N rate (lb/A) = 200 – (3.6 x 24) – (30 x 1.5) = 200 – 85 – 45 = 70 lb N/A

Table 2 suggests N rates for sugar beets at an expected yield of 23 tons per acre. Fertilizer N rates decrease with increasing amounts of NO_3-N in the top 4 feet of soil and increasing soil organic matter content in the surface soil sample. Rates are rounded to the nearest 5 pounds of nitrogen per acre. For more precise N rates, calculate the N rate for your field by the algorithm above, using the appropriate values for NO_3-N with soil depth to 4 feet, and soil organic matter content of the surface sample.

For expected yields higher or lower than 23 tons per acre, add or subtract 10 pounds of N per acre per ton per acre of beets. However, the maximum suggested N rate is 200 pounds per acre minus the N credits previously discussed, regardless of the expected yield.

Methods and Timing of N Applications

The most efficient use of soil-applied N fertilizers can be obtained by applying part of the N prior to planting and the remainder as side-dressed N. If the stand is poor, decrease the N rate for side-dressing. However, apply all of the fertilizer before July 15 to optimize beet yields and quality. Some N may be band-applied in combination with starter fertilizers, but the rate should be less than 20 pounds of N per acre.

Use of planter attachments with the standard 2-inch by 2-inch placement (2 inches below and beside the seed row) is preferred for starter fertilizers. Do not use popup fertilizer placement (directly with the seed) because seedling emergence may be decreased in dry soil.

All sources of N fertilizers are equally effective per unit of N if properly applied. Base your choice of N fertilizer on availability, equipment available, and cost per unit of N. Application of N fertilizers with surface-applied irrigation water is not suggested because it is difficult to obtain a uniform N application in the field.

Phosphorus (P) Suggestions

High P fertility generally is required by sugar beets to enhance sugar production. The main soil tests for extractable P in Colorado soils are the AB-DTPA and sodium bicarbonate ($NaHCO_3$; also known

Table 3: Suggested phosphorus rates for sugar beets (broadcast).

ppm P in Soil AB-DTPA	ppm P in Soil $NaHCO_3$	Relative Level	Fertilizer Rate, Pounds P_2O_5 Per Acre
0 - 4	0 - 7	low	100
5 - 7	8 - 14	medium	75
8 - 11	15 - 22	high	50
> 11	> 22	very high	0

Table 4: Suggested potassium rates for sugar beets.

ppm K in Soil AB-DTPA or NH_4OAc	Relative Level	Fertilizer Rate, Pounds K_2O Per Acre
0 - 60	low	80
61 - 120	medium	40
> 120	high	0

as Olsen) tests. Table 3 shows suggested P fertilizer rates for band or broadcast applications related to soil test levels measured by either test.

Placement of P fertilizers in the root zone is important because P is not mobile in soil. Incorporate broadcast applications of P fertilizers into the soil prior to planting. Band application at planting (starter fertilizer) is the most efficient placement method for P fertilizers. If the P fertilizer is band-applied, then reduce the P rate in Table 3 by 50 percent. Do not use popup placement (directly with the seed) for sugar beets because seedling emergence may be decreased due to salt effects of the fertilizer in dry soil and the inclusion of pesticides in starter fertilizers. Monoammonium phosphate (MAP, 11-52-0), diammonium phosphate (DAP, 18-46-0), and ammonium polyphosphate (10-34-0) are equally effective per unit of P if properly applied. Choose fertilizer based on availability, equipment available, and cost per unit of P.

Potassium Suggestions

Most Colorado soils are relatively high in extractable K, and few crop responses to potassium (K) fertilizers have been reported. Suggested K rates related to soil test values (AB-DTPA or NH_4OAc) are given in Table 4. The main K fertilizer is KCl (potash). Broadcast application incorporated into the soil prior to planting is the usual method. If K is included in a starter or popup fertilizer, the total N and K should not exceed 20 pounds N + K_20 per acre.

Other Nutrients

Most Colorado soils contain adequate levels of available sulfur (S); therefore, soil tests for available S are not routinely performed. However, some sandy soils may require S applications. Irrigation water from most surface waters and some wells often contains appreciable SO_4-S, so irrigated soils usually are adequately supplied with S.

There have been no confirmed deficiencies of boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), or zinc (Zn) in sugar beets in Colorado.