# POTASSIUM REQUIREMENT FOR SUGARBEET PRODUCTION

Laura Overstreet[1], Norman R. Cattanach[2], David W. Franzen[1], North Dakota State Univ., Fargo, ND

[1]Scientist; [2]Research Assistant – North Dakota State Univ.

## Introduction

In previous years, agronomists and growers have observed that potassium (K) soil test values on many of the sandier Red River Valley soils were low relative to other areas in the sugarbeet-producing areas of ND and MN. In 2006, a small 3-treatment study was implemented to examine effects of different K fertilizer rates. The results of this study were quite exciting, especially early in the growing season before the condition known as Sand Syndrome became evident in the study plots, masking the initial treatment effects observed (Cattanach and Overstreet, 2006). In this study, it was possible to visually differentiate between treatments simply by observing plant vigor and developmental stage of beet plants. The higher K rates were clearly adding vegetative growth and appeared more vigorous than lower K rates. Despite the negative effect of Sand Syndrome on harvest measurements for yield and quality, there were highly significant treatment effects for root yield, recoverable sugar per acre, and gross dollar return per acre between high and low K treatments.

Due to the obvious benefits observed and measured in the K study in 2006, the study was expanded in 2007 to include 4 treatment levels and 3 study locations. The treatments in 2007 were check (no K added), and 40, 80, 160, and 200 lbs K/a (33, 66, 133, and 166 lb $K_2O$/a, respectively). The objective of this study was to determine optimum rates of broadcast potassium fertilizer for maximizing yield, quality, and profitability of sugarbeet crops, especially on sandy soils low in soil organic matter.

## Materials and Methods

Field experiments were established at three sites: Location 1) near Downer, MN on an Elmville fine sandy loam (coarse-loamy over clayey, mixed over smectitic, superactive, frigid aeric calciaquoll); Location 2) near Glyndon MN on a Glyndon silt loam (Coarse-silty, mixed, superactive, frigid Aeric Calciaquolls ); and Location 3) near Ada, MN on Bearden silty clay loam(fine, silty mixed, superactive frigid aeric calciaquolls) . Initial soil test levels taken just prior to planting at each site indicated that potassium levels were 86, 67, and 69 for locations 1, 2, and 3, respectively. These levels range from a classification of low to medium for sugarbeet production. Potassium rate treatments were broadcast applied as KCl and then incorporated. Planting was arranged in a randomized complete block design with four replications. Individual treatment plots measured 11 feet wide and 30 feet long.

Sugarbeet variety Beta 4554 was seeded at Downer and Seedex Alpine was seeded at Glyndon and Ada. The Downer and Glyndon sites were planted on April 26 and the Ada site was planted on April 25. Seeds were placed at a depth of 1.25 inches with 3 inch in-row spacing and later thinned, except at the Glyndon location, where the cooperating grower planted the plots to stand**.** Counter was surface band applied at 11.9 lbs/a, and incorporated with drag chain at planting. Four post emergence micro-rate herbicides, two cultivations and hand labor was used as needed for weed control. Three fungicide applications, Eminent, Supertin and Headline were applied for Cercospora leafspot control.

Sugarbeet plots were harvested on September 12 for Downer and Glyndon and September 19 at Ada. The middle two rows of each 6-row plot were harvested. Stand establishment and vigor rating measurements were made at each site at least once during the growing season. Yield determinations were made and quality analysis was performed at the American Crystal Sugar Quality Tare Lab in East Grand Forks, MN.

## Results and Discussion

According to the current recommendations for K fertilization, location 1 (Downer) should have received 50 lb $K_2O$/a; location 2 (Glyndon) required 80 lb $K_2O$/a; and location 3 (Ada) required 80 lb $K_2O$/a. In general, yields were low at all locations due to flooding conditions occurring in early spring throughout the southern Red River Valley. Standing water for one to two weeks after planting made stand highly variable and introduced greater error into the data set. The result of flooding and resulting disease was reduced yield and percent sugar values (average of 16 ton/a and 14% sucrose across all treatments and locations).

The Downer location was not as negatively affected by flooding as the other locations, but it was strongly affected by Sand Syndrome in parts of the field where this study was established. Yield at the Downer location, was 20.7 ton/a, averaged across all treatments and net sucrose content was 13.7%, averaged across all treatments. Yield and sugar content were depressed by disease and Sand Syndrome at this site, so that any treatment effect resulting from different K application rates was not observed.

The Glyndon site (Table 2) was adversely affected by flooding and disease pressure in 2007, only yielding 16 ton/a and 15.7% net sucrose when averaged across all treatments. Percent net sucrose was significantly greater in the 200 lb K/a treatment compared to the check, giving a 0.7% sugar increase. The greater sugar content in the 200 lb K/a treatment resulted in a significantly greater RST value for the 200 lb K/a treatment relative to the check. This data suggests that higher K values can increase sugar content on sandy soils when other stressors, such as disease or flooding, are present.

At the Ada site, yield and net sucrose were reduced by flooding and disease as well, but the 160 and 200 lb K/a application rates yielded significantly greater recoverable sugar per ton. (Table 3). When averaged across all treatments, yield was only 11 ton/a and net sucrose content was 14% at the Ada location. There were no statistical differences between K application rates for yield, net sucrose content, recoverable sugar per acre, or stand.

**Table 1. Downer Harvest Data**

| Parameter | Check (0 lb K/a) | 40 lb K/a | 80 lb K/a | 160 lb K/a | 200 lb K/a |
|---|---|---|---|---|---|
| Yield | 18 a | 22 a | 24 a | 19 a | 21 a |
| Net Sugar | 13.48 a | 13.45 a | 13.81 a | 13.85 a | 13.98 a |
| RSA | 5453 a | 5982 a | 6748 a | 5187 a | 5884 a |
| RST | 270 a | 269 a | 276 a | 277 a | 280 a |
| Beets/100’ | 115 a | 128 a | 122 a | 107 a | 131 a |

Values are means averaged across reps. RSA = Recoverable Sugar per Acre (lb/a); RST = Recoverable Sugar per Ton (lb/ton); Yield = root yield (ton/a); sugar (% sucrose); Beet/100’ = # beets per 100 feet of row. Letters following values represent statistical differences determined by lsd. All statistical analysis is measured within the given parameter between K rates (across the rows, not down the columns).

**Table 2. Glyndon Harvest Data**

| Parameter | Check (0 lb K/a) | 40 lb K/a | 80 lb K/a | 160 lb K/a | 200 lb K/a |
|---|---|---|---|---|---|
| Yield | 15 a | 16 a | 17 a | 16 a | 16 a |
| % Sugar | 15.36 a | 15.59 a | 15.58 a | 15.69 a | 16.06 b |
| RSA | 4533 a | 4984 a | 5398 a | 5145 a | 5278 a |
| RST | 307 a | 312 a | 312 a | 314 a | 321 b |
| Beets/100’ | 120 a | 114 a | 105 a | 119 a | 122 a |

Values are means averaged across reps. RSA = Recoverable Sugar per Acre (lb/a); RST = Recoverable Sugar per Ton (lb/ton); Yield = root yield (ton/a); sugar (% sucrose); Beet/100’ = # beets per 100 feet of row. Letters following values represent statistical differences determined by lsd. All statistical analysis is measured within the given parameter between K rates (across the rows, not down the columns).

**Table 3. Ada Harvest Data**

| Parameter | Check (0 lb K/a) | 40 lb K/a | 80 lb K/a | 160 lb K/a | 200 lb K/a |
|---|---|---|---|---|---|
| Yield | 10 a | 11 a | 13 a | 11 a | 11 a |
| % Sugar | 14.05 a | 13.68 a | 13.85 a | 14.40 a | 14.05 a |
| RSA | 2668 a | 2898 a | 3474 a | 3262 a | 2992 a |
| RST | 266 a | 274 a | 277 a | 288 b | 281 b |
| Beets/100’ | 143 a | 137 a | 133 a | 119 a | 141 a |

Values are means averaged across reps. RSA = Recoverable Sugar per Acre (lb/a); RST = Recoverable Sugar per Ton (lb/ton); Yield = root yield (ton/a); sugar (% sucrose); Beet/100’ = # beets per 100 feet of row. Letters following values represent statistical differences determined by lsd. All statistical analysis is measured within the given parameter between K rates (across the rows, not down the columns).

**Conclusions**

Flooding conditions and disease at all locations where this study was established resulted in stand loss and low percent sugar relative to other areas of the Red River Valley that were not as strongly affected by flooding. Based on this data, application rates of K greater than 160 lb K/a can result in greater sucrose content and greater recoverable sugar per ton compared to the current recommendations. More research may be desirable to confirm these findings in years without flood and disease pressure.

**References**

Cattanach, N.R. and L.F. Overstreet. 2006. Effect of potassium fertilizer on sugar production. *In* 2006 Sugarbeet Research and Extension Reports. Vol. 37. Sugarbeet Res. and Ed. Bd. of MN and ND.