SUGAR BEET PRODUCTION ON SANDY SOILS: THE NEED FOR NON-TRADITIONAL NUTRIENTS

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Most fertilizer programs in sugar beet production in Minnesota and North Dakota focus on nitrogen and phosphorus, and, in some cases, potassium. In recent years, sugar beet grown on sandy soils along the beach ridges in NW Minnesota has shown a variety of visual symptoms that resemble nutrient deficiencies. Soil test and plant tissue analysis suggest deficiencies in one or more of the following nutrients; sulfur (S), sodium (Na), boron (B), manganese (Mn), iron (Fe) or a variety of other possibilities. Reports suggest about 15,000 acres are potentially affected by these symptoms (verbal communication with Al Cattanach)

Sulfur and Na are considered macronutrients and B, Mn, and Fe are considered micronutrients because of the relative quantities in which these nutrients are absorbed by the sugar beet crop. Under typical sugar beet growing conditions there is little emphasis on these nutrients because their release from the soil organic matter and naturally occurring minerals is sufficient to meet the sugar beet needs. However, on sandy soils with low organic matter (< 2%) this may not always be the case and deficiencies may appear. Draycott and Christenson (2003) reported that sugar beet can become deficient in several micronutrients, but is most responsive to the application of B, Mn, and Fe fertilizers when the soil availability of these nutrients is low. Boron and Mn deficiencies are probably most frequent and subsequently are the most studied of all the micronutrient important to the sugar beet crop.

It is difficult to predict where and when deficiencies of these nutrients will occur, especially for the micronutrients. Soil tests methods are available for some of these nutrients and, under some situations, are valuable in predicting the likelihood the sugar beet crop will respond to the application of fertilizer. Since availability of these nutrients is dependent on their release from soil organic matter and minerals and are taken up in small quantities, especially micronutrients, the likelihood of a deficiency occurring can be dependent on weather conditions. Deficiencies are more frequent when the weather is cold, excessively wet, or dry.

Materials and Methods

Originally two field sites were to be selected for this experiment, one north of the Northwest Research and Outreach Center near Crookston, Minnesota and one south. The north site was preselected in the fall of 2005, but by spring the grower had changed his mind and was not growing sugar beet any longer, or at least in that field. By the time we found out, it was too late to find another site. A southern site was located between Twin Valley and Mahnomen, Minnesota in Norman County on a field managed by John Habedank. The soil at this site was a Flaming loamy fine sand (Flaming sandy, mixed, frigid oxyaquic hapludoll). An area large enough to accommodate this trial was located in this field between the normal headlands and a drainage cut. The area looked to be very uniform in both topography (gently sloping towards the drainage cut) and soil texture.

The experimental design used in this experiment was a randomized complete block with four blocks or replications. The entire field had been fertilized for nitrogen, phosphorus and potassium by the cooperator. Seven treatments were imposed that included a Control (no added fertilizer), B, Copper (Cu), Fe, Mn, Na, and Zn. No S treatment was imposed because this site tested high for sulfate-S. The actual fertilizer treatments were made up of 2 lbs B A^{-1} (granualar borate-15%B) and 10 lbs A^{-1} each of Mn ($MnSO_4$), Fe ($FeSO_4$), Zn ($ZnSO_4$), and Cu ($CuSO_4$), and 100 lbs Na A^{-1} (NaCl). Fertilizer was weighed into individual bags and hand spread on the appropriate plots. On May 8th, the fertilizer was spread and incorporated with a field cultivator and sugar beet (variety Seedex Alpine) was planted in plots 11 ft wide (6 rows) and 35 ft long. Sugar beet was over seeded and thinned to at 150 beets per 100 ft of row population after all seedlings were emerged and reasonably assured of survival. Herbicides, insecticides and fungicides were applied as needed.

On September 29, the middle two rows of each plot were harvested with a plot beet lifter. Harvested beets were weighed and 10 randomly selected beets were placed in a tare bag and sent to the American Crystal Sugar Quality Laboratory in East Grand Forks for determination of tare and sugar and impurity concentrations. Data were used to calculate root yield, root quality (lbs of sucrose ton^{-1}), and Loss to Molasses (LTM). Concentrations of Na, potassium and amino nitrogen were used to calculate LTM.

Data were analyzed using Proc GLM in SAS 9.1 and Fishers protected LSDs used to determine mean separation. Alpha levels of both 0.05 and 0.10 were used to determine significance if the main ANOVA showed main treatment significance.

Results and Discussion

This site did not receive any rain from Memorial Day in May until August 25 when it received approximately 0.75 inches of rainfall. While this rainfall was greatly needed, it was only enough to see beet recovery for a few days. Prior to the rain and again 10 days after the rain, the sugar beet plants were severely wilted and in some cases the canopy was lying nearly flat on the soil. The entire forth replication was abandoned due to a severe infestation of Rhyzoctonia, which killed more than 75% of 5 plots and about 33% of the remaining two plots. Rhyzoctonia was apparent in other replications as well, but not to the extent as was in the forth replication.

What was disappointing however, was a streak that angled through the remaining three replications. On one side of this streak the sugar beets, though suffering from moisture stress, looked reasonably healthy. On the other side of the streak, the beets had died by harvest time. The streak left 5 plots reasonably healthy in replication 1, 4 plots in replication 2, and 2 plots in replication 3. This creates a lack of confidence in the data that was collected. Table 1 shows the results from the three replications that were harvested.

Soil test analysis of the surface 6 inches of soil from this experimental area indicated very low or low plant availability for B (0.3 ppm), Cu (0.2 ppm), Mn (2.0 ppm), Zn (0.41 ppm), and Na (15 ppm). Iron was in the very high range (14.8 ppm). There was a range sugar beet root yields (14.5 to 20.5 tons A-1) and quality (247 to 292 lbs sucrose ton^{-1}), but there was no significant difference among the treatments. The only variable that was significantly different among treatments was Na concentration. Applying NaCl significantly increased Na concentration in the roots compared to the other treatments.

Due to the extreme drought at this location the value of the data is very questionable. It appears B resulted in the greatest sugar beet yield, root quality, and recoverable sucrose. But, this advantage was not significantly different from the control or other nutrient treatments. The lowest production resulted from Na application, but again not significantly different from other treatments.

References

Draycott, A.P. and D.R. Christenson. 2003. Nutrients for Sugar Beet Production. CABI Publishing, Cambridge, MA.

Table 1. 2006 Sugar beet root yield and quality parameter responses to various micronutrient and non-traditional fertilizer treatments near Twin Valley.

Treatment	**Root Yield**	**Root Quality**	**Revcoverable Sucrose**	**Loss to Molasses**	**Na**	**K**	**Amino N**
	Ton/A	**lbs sucrose/ton**	**lbs. A^{-1}**	**%**	**ppm**	**ppm**	**ppm**
Control	14.6	264	3855	1.4	138	1759	602
B	20.6	292	6009	1.3	110	1650	511
Cu	18.7	262	4921	1.5	98	1776	688
Fe	19.4	265	5115	1.4	118	1738	533
Mn	19.5	265	5277	1.5	95	1799	660
Na	14.7	247	3627	1.6	205	1914	695
Zn	19.4	262	5108	1.5	110	1874	624
$LSD_{(0.05)}$	ns	ns	ns	ns	53	ns	ns
$LSD_{(0.10)}$	ns	ns	ns	ns	44	ns	ns