2007 Micronutrient Studies on Sugarbeet

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Introduction

Partially due to the difficulties encountered when growing sugarbeet on heavy clay soils with a history of drainage issues and disease, sugarbeet growers in the Red River Valley of Minnesota and North Dakota continue to push acres west and east into the beach ridge areas of the region. These soils are typically coarse textured sandy loams and loamy sands, with organic matter levels sometimes below 2%, compared to more traditional silty clay loams and clays with 4-5% organic matter. A variety of micronutrient deficiencies are more likely on coarser textured, low organic matter soils than have been seen on heavier, higher organic matter soils. Symptoms resembling sulfur (S) deficiency and boron (B) deficiency have been observed since 2005 in these soils. The objective of this study is to examine the effects of B, iron (Fe), manganese (Mn), sodium (Na), and S rate and source on sugarbeet yield and quality in low organic matter, coarse textured soils.

Methods

Four sites were examined in 2007: St. Thomas, ND; Ada, MN, Glyndon, MN and Downer, MN. At each site, the experimental design was a randomized complete block with 8 treatments and 4 replications. Two additional treatments were included at the Ada and Downer locations. All preplant treatments were applied in the spring prior to field preparation and seeding. Foliar treatments were applied while the beets were in the 6-leaf stage. During the statistical analysis the profit parameters of gross return per ton (GRT) and gross return per acre (GRA) were analyzed separately from other parameters using a spatial correction factor and were not analyzed for outlier removal, as were the other treatments. This may result in some discrepancy between profit analysis and production factors.

Treatments at St. Thomas and Glyndon were as follows-

Treatment no.	Treatment description	Abbreviation
1	Check-no added micronutrients or S	ck
2	Sulfur as gypsum, 20 lb S/a	S/gyp
3	Mn as manganese sulfate, 10 lb Mn/a	Mn
4	Na as NaCl (rock salt), 100 lb Na/a	Na
5	Fe as ferrous sulfate, 10 lb Fe/a	Fesul
6	B as 14% sodium borate, 2 lb B/a preplant	Bpp
7	Sulfur as Tiger 90CR, 20 lb S/a	St90
8	B as Solubor, 2 lb B/a, foliar	Bf

Treatments at Ada and Downer were as follows-

Treatment no.	Treatment description	Abbreviation
1	Check-no added micronutrients or S	ck
2	Sulfur as gypsum, 20 lb S/a	s/gyp
3	Mn as manganese sulfate, 10 lb Mn/a	Mn
4	Na as NaCl (rock salt), 100 lb Na/a	Na
5	Fe as ferrous sulfate, 10 lb Fe/a	Fesul
6	B as 14% sodium borate, 2 lb B/a preplant	Bpp
7	Sulfur as Tiger 90CR, 20 lb S/a	St90
8	Fe as Soygreen, 2 lb/a in-furrow	Fesoy2
9	Fe as Soygreen, 1 lb/a in-furrow	Fesoy1
10	B as Solubor, 2 lb B/a, foliar	Bf

Each plot was 30 ft long and six 22-in rows wide. At St. Thomas, herbicide and fungicide applications were performed by the cooperator. At the other three sites, pest control operations were performed by the researchers.

The St. Thomas trial was harvested 9/17 by hand, taking 5 ft of row from the middle two rows. The other three sites were harvested with a 2-row sugarbeet lifter, removing the middle two rows of each plot and filling a tare bag for quality analysis at the East Grand Forks Quality Laboratory.

Results

St. Thomas

Treatments were applied at St. Thomas May 2. The field was seeded May 7. Foliar B treatment was applied 6/11.

There were no differences between treatments in net sugar, tons/a, or recoverable sugar per acre (RSA). Plant stand was greatest for the check, which was significantly greater than for the sulfur (S/gyp) treatment. The Fe (iron sulfate) and Na (sodium) treatments yielded significantly less recoverable sugar per ton (RST) compared to the check. In this study, the Fe treatment (ferrous sulfate) tended to depress several harvest factors, including recoverable sugar per acre (RSA), Gross revenue per ton (GRT) and Gross revenue per acre (GRA). Tiger 90 also tended to depress GRA. Yield and quality figures are presented in Table 1.

Table 1. Sugarbeet yield and quality from St. Thomas, ND due to micronutrient/S treatments, 2007.

Treatment	Net Sugar, %	Tons t/a	Beets/ 100 ft	RSA lb/a	RST lb/t	GRT $/t	GRA $/a
1 ck	12.82 a	20.12 a	170 a	5161 a	256 b	22.57 ab	473.81 ab
2 S/gyp	12.62 a	21.63 a	138 b	5455 a	252 ab	21.63 ab	428.54 ab
3 Mn	12.60 a	19.93 a	150 ab	5036 a	252 ab	21.53 ab	449.34 ab
4 Na	12.33 a	20.51 a	150 ab	5045 a	247 a	20.30 ab	412.59 ab
5 Fesul	12.13 a	20.57 a	140 ab	4642 a	243 a	19.33 a	400.06 a
6 Bpp	12.43 a	22.45 a	158 ab	5563 a	249 ab	20.77 ab	476.60 ab
7 St90	12.46 a	21.63 a	168 ab	5217 a	249 ab	20.90 ab	401.59 a
8 Bf	12.92 a	21.18 a	138 ab	5449 a	268 b	23.03 b	515.30 b

Glyndon

Treatments were applied and plots worked and seeded April 26. The variety Beta 4554 was used, planting at 5 inch spacing. Four applications of micro-rate herbicides were applied for weed control. Two applications of a tank-mix of Eminent and Headline were applied mid-late season. Foliar B was applied 6/26. Harvest was conducted September 12.

Glyndon suffered from heavy rains early in the growing season and the experiment site was flooded during the time that seedlings were germinating and emerging; the result was low stand, increased disease pressure, and lower sugar for most plots in this treatment. Outlier data has been removed from Table 2. Yield among treatments was greatest for the check and lowest for Mn, S/gyp, and Tigersulf90. This was due to the greater stand establishment (See Table 2, Beets/100 ft) in the check relative to other treatments and was probably a random effect and not representative of reduced stand caused by any of the treatments. There were no treatments that significantly affected the sucrose content, RSA, or RST. The B preplant treatment produced the highest GRT, while the Na produced the lowest. The highest GRA was produced by the Na treatment, while the lowest was produced by the Tiger 90 treatment. There was an interaction between the high tonnage and high slm values for Na, resulting in that treatment displaying a relatively high GRA but a relatively low GRT.

Table 2. Sugarbeet yield and quality from Glyndon, MN due to micronutrient/S treatments, 2007.

Treatment	Net Sugar, %	Tons t/a	Beets/ 100 ft	RSA lb/a	RST lb/t	GRT $/t	GRA $/a
1 ck	13.97 a	21.37 a	141 a	4842 a	279 a	30.44 ab	478 ab
2 S/gyp	12.36 a	15.44 b	106 a	4290 a	247 a	30.12 ab	504 b
3 Mn	14.33 a	15.14 b	111 a	4230 a	287 a	35.26 b	499 ab
4 Na	13.73 a	18.47 ab	124 a	4708 a	256 a	28.82 a	506 b
5 Fesul	13.34 a	18.91 ab	134 a	5024 a	267 a	31.65 ab	481 ab
6 Bpp	14.06 a	17.26 ab	113 a	4530 a	244 a	31.97 ab	466 ab
7 St90	14.09 a	15.51 b	105 b	4335 a	282 a	31.04 a	391 a
8 Bf	13.77 a	20.05 b	138 a	5184 a	243 a	30.10 a	432 ab

Downer

The treatments and seeding in this study were conducted April 26. The variety used was Seedex Alpine. The initial seed spacing was 3.5 inches, which was later hand-thinned to 154 plants/100 ft row. Counter was applied at seeding at 10 lb/a. Four applications of micro-rate herbicides and two applications of mid-late season Eminent/Headline fungicide applications were made. The foliar B treatment was applied June 8. There was disease in the plot at that time and some plant dying was noted. Plots were harvested September 12.

The highest net sugar was obtained with Tiger 90CR. Treatments with higher net sugar than the check were Soygreen at 1 lb/a, Na, B preplant, ferrous sulfate, and Tiger 90CR. The greatest tonnage was produced by the foliar B treatment; the Soygreen at 1 lb/a also gave greater tonnage than the check. Highest RSA was produced by the foliar B treatment. Other treatments with RSA higher than the check were B preplant, Tiger 90, and Soygreen at 1 lb/a. The highest RST was produced by the Na treatment. Other treatments with RST higher than the check were Fe (ferrous sulfate), Tiger 90, and foliar B. Treatments with greater stand at harvest than the check were S (gypsum), Tiger 90, and Soygreen at 2 lb/a (highest). The highest GRT was produced by the B foliar treatment. Other treatments that had higher GRT than the check were S (gypsum), Mn, Na, Fe (ferrous sulfate), Tiger 90, and Soygreen at 2 lb/a. Highest GRA was produced by the B foliar treatment. The yield and quality data summaries for Downer are presented in Table 3. It is not clear whether the yield and quality advantages seen in the ferrous sulfate treatment at this location were primarily the result of the iron or sulfur component, or some combination. Na appears to have improved the net sugar content at this site. The foliar B treatment performed very well at this location.

Table 3. Sugarbeet yield and quality from Downer, MN due to micronutrient/S treatments, 2007.

Treatment	Net Sugar, %	Tons t/a	Beets/ 100 ft	RSA lb/a	RST lb/t	GRT $/t	GRA $/a
1 ck	13.3 a	19.3 a	118 a	5213 a	266 a	24.84 a	565 a
2 S/gyp	14.1 ab	22.2 ab	147 b	6268 ab	282 ab	29.05 b	710 b
3 Mn	14.1 ab	23.7 ab	121 ab	6616 ab	281 ab	29.26 b	724 b
4 Na	14.5 bc	21.6 a	116 a	6255 ab	290 b	29.15 b	657 ab
5 Fesul	14.4 bc	19.6 ab	135 ab	5734 ab	288 b	28.94 b	743 b
6 Bpp	14.5 bc	23.9 ab	145 ab	6744 b	281 ab	27.89 ab	702 b
7 St90	15.3 c	21.1 ab	147 b	6574 b	285 b	30.43 b	754 b
8 Fesoy2	14.0 a	23.1 ab	151 b	6480 ab	280 ab	28.84 b	685 ab
9 Fesoy1	14.5 bc	24.4 b	123 ab	6769 b	277 ab	28.44 b	650 ab
10 Bf	14.3 b	26.6 b	138 ab	7627 b	286 b	30.59 b	767 b

Ada

The Ada treatments were applied and the plots were seeded April 25. Variety used was Seedex Alpine mini pellets. The stand was seeded to 3.5 inches and later hand-thinned to 180 plants/100 ft row. Counter 15G was applied at seeding at 10 lb/a. Micro-rates of herbicides were applied three times for weed control. An Eminent/Headline tank-mix was applied twice in mid-late season for Cercospora control. Foliar B treatment was applied June 8. The plot was harvested September 19.

The highest net sugar was produced with the Na treatment (Table 4). Other treatments with higher net sugar than the check were S (gypsum), Mn, Na, Tiger 90, and Soygreen at the 1 and 2 lb/a rates. The lowest tons/a of sugarbeets was produced by the check treatment. The highest tonnage was produced by the B foliar treatment. The B foliar treatment was the only treatment that was significantly different than the check at the 10% probability level. The Soygreen at 2 lb/a resulted in significantly less slm relative to the check. The B pre-plant treatment was the only treatment to demonstrate significantly greater stand establishment than the check. The lowest RSA was produced by the check. The highest RSA was produced by the foliar B treatment. Other treatments with higher RSA compared to the check were B preplant and Soygreen at 1 and 2 lb/a. The highest RST was produced by the foliar B and preplant B treatmetns. All treatments gave a higher RST than the check. The highest GRT was produced by S (gypsum). Other treatments with higher GRT compared to the check were Mn, B preplant, and B foliar. Lowest GRA was produced by the check. The highest GRA was produced by the B foliar treatment. Other treatments with higher GRA compared to the check were S (gypsum), Na, B preplant, Tiger 90CR, and Soygreen at 2 lb/a. As in the Downer location, Na increased the sucrose content of sugarbeet, but did not give as much of a yield advantage as the foliar B treatment. The preplant B and Soygreen application treatments also provided sugar production advantages.

Table 4. Sugarbeet yield and quality from Ada, MN due to micronutrient/S treatments, 2007.

Treatment	Net Sugar, %	Tons t/a	Beets/ 100 ft	RSA lb/a	RST lb/t	GRT $/t	GRA $/a
1 ck	12.9 a	14.2 a	165	3639 a	257 a	22.84 a	319.51 a
2 S/gyp	14.0 bc	16.8 ab	150	4723 ab	280 b	26.40 b	476.71 b
3 Mn	14.2 bc	14.4 a	163	4059 ab	283 b	25.39 b	412.48 a
4 Na	14.6 c	16.7 ab	132	4732 ab	282 b	24.78 a	481.43 b
5 Fesul	13.6 ab	17.9 ab	160	4923 ab	272 b	23.32 a	416.06 a
6 Bpp	14.2 bc	17.0 ab	157	4837 b	284 c	25.42 b	497.30 b
7 St90	13.9 bc	18.8 ab	152	4687 ab	278 b	23.92 a	467.25 b
8 Fesoy2	14.4 bc	17.5 ab	150	4877 b	279 b	24.17 a	487.06 b
9 Fesoy1	14.0 bc	19.7 b	139	5032 b	278 b	24.09 a	426.36 a
10 Bf	14.5 c	18.0 ab	159	5033 b	284 b	25.91 b	503.63 b

Summary-

Treatment differences in yield, quality and/or revenue were seen at all four sites. Generally, the B treatments, particularly the foliar B treatment, were most often superior to other treatments. However, the Fe treatments, most often the Soygreen at 2 lb/a treatment, was also effective in improving yield, quality and revenue. The S treatments, most often gypsum, but also at some sites the Tiger 90CR and ferrous sulfate, were also effective, producing positive results. Future research may include combinations of the most effective treatments to determine whether even greater returns are possible in combination (e.g. Fe and S) compared to single treatments.