CAN WE INCREASE SUGAR BEET YIELD AND QUALITY WITH LIME, CULTIVAR SELECTION, AND FERTILIZER APPLICATIONS?

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In the Red River Valley (RRV) of Minnesota and North Dakota, some areas with coarse textured soils and with low soil organic matter content have experienced poor sugar beet (*Beta vulgaris L.*) growth, popularly known as 'sand-syndrome'. These soils have generous yields of other crops, including corn, wheat, and potatoes. Symptoms were appeared in large patches and visible differences in growth between 'normal' and 'poor' growing beet were appeared at the 6-8 leaf stage (Franzen et al., 2003). Within affected area, seedlings were shorter in height and lower in weight than of the normal sugar beet at the same growth stage. Seedling leaves are usually curled inward more prominently than normal, with a purple tom at the leaf edge. Later, rows might fill in but final yields were lower than normal of the same field. Sometimes, researchers have linked this symptom with inherent low nutrient availability in sandy soils and suggested spent lime (a sugar beet industry by product) and supplementary nutrient applications to overcome this condition (Sims, 2008; Overstreet et al., 2008).

On-farm trials were conducted on fields with previous history of sand syndrome but no prior history of spent lime application to determine the effect of spent lime application, cultivar selection (susceptible vs. resistant) and fertilizer application in addition to recommended fertilizers on sugar beet yield and quality during 2015-2016 growing seasons in the RRV. Each year, trials were conducted at two sites and laid out in split-split plot randomized block design with four replications. Main plot factor was spent lime application at two levels, control (no lime) and spent lime broadcasted at the rate of 10 ton/ac in spring prior to planting; sub-plot factor was roundup ready cultivar with lower (susceptible) and higher (resistant) performance ratings based on trials conducted by American Crystal Sugar Company; and sub-sub plot factor was fertilizer application in addition to recommended fertilizers, (i) control (only recommended NPK), (ii) muriate of potash or MOP broadcasted at the rate of 60 lb K_2O/ac, and in furrow applications of liquid starters, (iii) 3-18-18, (iv) 6-24-6, and (v) 9-18-9 at the rate of 3 gallons/ac.

Table 1. Basic site information and soil properties of experimental sites during 2015 and 2016 growing season

	2015		2016	
Site	**Ada, MN**	**Sabin, MN**	**Ada, MN**	**Downer, MN**
Location	N 47°18'50" W 96°23'07"	N 46°50'36.942" W 96°30'19.78"	N 47°18'54.432" W 96°24'35.28"	N 46°48'3.92" W 96°31'42.959"
Previous Crop	Spring Wheat	Soybean	Spring Wheat	Spring Wheat
Soil Series	Glyndon	Wyndmere	Wheatville	Elmville
Textural Class	Loam	Sandy loam	Loam	Fine Sandy Loam
Soil OM%	2.4	2.8	3.1	1.8
Soil pH	8.2	5.8	8.2	8.2
NO_3-N (lb/ac) of 2'	47	47	24	58
Olsen-P (ppm) of 0-6"	22	10	3	7
K (ppm) of 0-6"	100	113	68	50
Planting Date	April 27	April 23	May 3	April 28
Harvesting Date	September 21	September 15	September 22	September 23

All plots received recommended NPK fertilizers, determined based on initial soil test values (Table 1). Prior to planting, spent lime and dry fertilizers were broadcasted and incorporated within surface soil with a tiller and attached rotary basket. Sugar beet was planted with a John Deere Max Emerge II planter and individual plot dimension was 11 ft wide and 30 ft long. Sugar beet seed was placed 1.25 inches deep with 5 inch row spacing. Stand count data was recorded on May 27 in 2015 and June 1 in 2016. Roundup® herbicide was applied twice for weed control and Quadris® was applied at the 4-6 leaf stage and again three weeks later to control rhizoctonia root rot. Three fungicides, Inspire®, Topsin® and Headline®, were applied for Cercospora leaf control. Middle two rows of the plot were mechanically harvested for yield determination and sub samples were analyzed for sugar content. Statistical analysis was conducted in SAS 9.4 software (SAS Institute, 2015) using PROC MIXED procedure and mean separation was done using Fisher's Least Significant Difference method at 95% significance level.

For both site-years, sand syndrome symptom was not observed. Lime and cultivar selection effects were not significant for all parameters (Table 2). However, fertilizer treatment had significant effect. Starter fertilizers application significantly reduced the stand count for both sites in 2016 and the lowest stand count was observed with 9-18-9. Dissolved salts might reduce the seed germination particularly due to low soil moisture during the planting (Franzen, 2003). Supplemental applications of MOP and liquid starters did not significantly increase sugar beet yield and sugar content over control treatment. In 2015, application of 6-24-6 had the highest beet yield and significantly different from 9-18-9; whereas, in 2016 highest yield was observed with control and significantly higher than 9-18-9 application for both sites. Among liquid starters, 3-18-18 had the highest yield at Downer but lowest yield at Ada in 2016. Sugar content also did not show significant increase with supplemental addition. Moreover, additional application of potassium significantly reduced sugar content over control and 6-24-6 applications at Ada in 2015. All three factors, lime, cultivar and supplemental fertilizer addition did not improve sugar beet yield and quality under field sites with history of sand syndrome.

Table 1. Effect of Sugarbeet Plant Populations on Yield, Quality and Recoverable Sucrose at Foxhome, MN in 2016

Treatment – Plants per 100 ft row	Mean root weight (lb)	Root yield (t/A)	Sucrose concen-tration(%)	Recoverable sucrose (lb/t)	Recoverable sucrose (lb/A)
50	3.3	20.8	16.0	294	6,098
100	2.3	27.5	17.0	319	8,741
150	1.6	29.3	17.2	324	9,485
175	1.4	29.3	17.3	325	9,499
200	1.3	29.7	17.0	320	9,461
250	1.1	30.3	17.4	327	9,897
300	1.0	31.0	16.9	316	9,773
LSD (P=0.05)	0.2	3.1	0.70	15.6	939