NITROGEN RECOMMENDATION RESEARCH IN SOUTHERN MINNESOTA FOR 2002

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Intoduction

New nitrogen fertilizer recommendations have been developed for sugar beet production in Minnesota and North Dakota. A new study was established to confirm the recommendation and to determine the N contribution of sugar beet tops to a preceding corn crop. This study is also part of a larger research effort looking at fertilizer management during the whole rotation. In the past soybean has been grown after sugar beet in the rotation. Since soybean is a legume, little attention was given the nitrogen that was released from sugar beet tops grown the previous year. In the future sugar beet producers will be encouraged to increase the length of their crop rotation from the common three year sugar beet – soybean – corn rotation practiced now. Information on nutrient issues for corn grown after sugar beet is needed. One of the issues is how much N credit should be given for sugar beet tops. Work in the Red River Valley indicates sugar beet tops can provide a varying amount of N for a wheat crop. The amount depends on the nitrogen status of the sugar beet crop at harvest. Green tops are credited up to 70 pounds of N per acre while yellow N deficient tops are given 0 credit. This article reports the results of the sugar beet crop grown under differing N rates in the first year of this two year study.

Materials and Methods

To accomplish the objective of this study, two sites were established in 2002. The sites were located near Olivia and Maynard, Minnesota. The first year treatments were five nitrogen fertilizer rates of 0, 40, 80, 120, and 160 pounds N per acre at the Olivia site and 0, 50, 100, 150, and 200 pounds N per acre at the Maynard site. These sites had relatively low initial soil nitrate-N soil tests. These values plus the N recommendations are listed in Table 1. The initial nitrate-N soil samples were taken spring 2002 to a depth of seven feet in one foot increments.

Table 1. Initial soil nitrate-N and nitrogen fertilizer recommendations at the Olivia and Maynard, Minnesota sites in 2002.

	Initial soil nitrate (lb nitrate-N/A)			N recommendation (lb N/A)	
	0-2 ft.	0-4 ft.	0-7 ft.	0-2 ft.	0-4 ft.
Site	--- pounds nitrate-N per acre ---			- pounds N per acre -	
Maynard	32	49	90	68	81
Olivia	48	79	112	52	51

The fertilizer N treatments were applied early spring as urea to plots 44 ft X 44 ft in size. The cooperators provided the planting, weed control, and fungicide applications to the sites. The studies were hand harvested early October. Root yield and quality determined at the Southern Minnesota Beet Sugar Cooperative tare laboratory. Also at harvest, sugar beet top yield was determined and sub-samples were taken and analyzed for total N. After harvest, soil samples were taken to a depth of four feet in each plot and analyzed for soil nitrate.

Results and Discussion

Root yield, quality, and recoverable sucrose

Root yield was significantly increased with the first increment of fertilizer application (Table 2 and Table 3). The increase was 2.6 tons per acre with 50 pounds N per acre at the Maynard site (Table 2) and 5.4 tons per acre with 40 pounds N per acre at the Olivia site (Table 3). Root yields were not increased with additional N above the first increment of N application at either site.

Sucrose was reduced significantly by nitrogen fertilizer application at both sites. The average decrease was 0.38 % per 50 pounds of fertilizer N per acre at the Maynard site and 0.22 % per 50 pounds of fertilizer N per acre at the Olivia site. Loss to molasses was increased by nitrogen fertilizer application at both sites.

At Maynard, the recoverable sucrose per ton of sugar beet processed was reduced by 7.75 pounds per ton of processed sugar beet for every 50 pounds of N fertilizer applied per acre. The recoverable sucrose per acre increased with the first 50 pounds fertilizer N per acre applied. The increase was 622 pounds per acre.

Recoverable sucrose per ton of processed sugar beet was reduced 5 pounds per ton for every 50 pounds of fertilizer N per acre applied at the Olivia site. The recoverable sucrose per acre was increase by the first 40 pounds of fertilizer N per acre by 1533 pounds per acre. At both sites, the maximum recoverable sucrose per acre occurred at less amounts of soil nitrate-N plus fertilizer N than the current recommendations.

Table 2. Root yield, root quality, and recoverable sucrose for the Maynard site in 2002.

N rate	Root yield	Sucrose	Loss to molasses	Recoverable sucrose	
pounds N/A	tons/A	-------- % --------		pounds/ton	pounds/A
0	26.7	18.4	1.00	347	9276
50	29.3	17.9	1.02	338	9898
100	30.8	17.3	1.06	325	9959
150	27.5	17.2	1.06	323	8873
200	31.3	16.9	1.09	316	9827
Statistics					
N rate	0.03	0.0002	0.0005	0.0002	0.15
C.V. (%)	8.2	2.4	2.5	2.7	8.0

Table 3. Root yield, root quality, and recoverable sucrose for the Olivia site in 2002.

N rate	Root yield	Sucrose	Loss to molasses	Recoverable sucrose	
pounds N/A	tons/A	-------- % --------		pounds/ton	pounds/A
0	23.1	17.4	1.04	328	7693
40	28.5	17.3	1.05	324	9226
80	28.3	16.7	1.11	311	8789
120	28.4	16.7	1.09	313	8893
160	26.7	16.7	1.10	312	8332
Statistics					
N rate	0.02	0.02	0.02	0.02	0.03
C.V. (%)	9.3	2.4	2.8	2.7	8.4

Top Dry Matter, Top N Concentration, and Top N Content

The application of N fertilizer significantly increased top yield, N concentration, and N content at the Maynard site (Table 4). The top yield ranged from 4299 pounds per acre for the check sugar beet tops to 7104 pounds per acre for the 200 pounds N per acre treated sugar beets. The N concentrations ranged from 1.84 % for check sugar beet tops to 2.57 % for sugar beets grown with an extra 200 pounds N per acre. The resulting N contents of the sugar beet tops returned to the soil range from 79 pounds N per acre for the check beets to 184 pounds per acre for the beets grown with 200 pounds fertilizer N per acre.

Table 4. Top dry matter yield, nitrogen concentration, and nitrogen content for the Maynard site in 2002.

N rate	Top dry matter yield	N concentration	N content
pounds N/A	pounds dry matter/A	%	pounds N/A
0	4299	1.84	79
50	5046	2.05	104
100	5907	2.45	144
150	6410	2.43	154
200	7104	2.57	184
Statistics			
N rate	0.04	0.002	24.7
C.V. (%)	21.5	9.8	0.004

At Olivia, yield, N concentration, and N content of sugar beet tops were also increased by the addition of fertilizer N (Table 5). The top yield and N content at Olivia was considerably less than the top yield and N content at Maynard. The top yield increased from 2349 pounds per acre for the check sugar beet tops to 3205 pounds per acre for sugar beet tops treated with 160 pounds N per acre. The N content increased from 56 to 96 pounds N per acre from the check to 160 pound N treatments. The N concentrations at Olivia were greater than at Maynard. The N concentrations for the zero N plots were 2.37 % while the beets treated with 160 pounds N per acre had N concentrations of 3 %.

Table 5. Top dry matter yield, nitrogen concentration, and nitrogen content for the Olivia site in 2002.

N rate	Top dry matter yield	N concentration	N content
pounds N/A	pounds dry matter/A	%	pounds N/A
0	2349	2.37	56
40	2824	2.23	63
80	2754	2.61	72
120	3140	2.88	90
160	3205	3.00	96
Statistics			
N rate	0.07	0.002	0.002
C.V. (%)	15.2	8.2	16.2

Residual nitrate-N

Soil nitrate-N was measured from soil samples taken after sugar beet harvest late October 2002 at each site. At the Maynard and Olivia sites, there were no differences in residual soil nitrate caused by the fertilizer treatments applied Spring 2002, Table 6. At the Maynard site, the average soil nitrate-N in the 0-2 ft. depth was 32 pounds per acre while the average soil nitrate-N in the 0- 4 ft. was 46 pounds per acre. The average residual soil nitrate values at the Olivia site were 27 pounds per acre in the 0-2 ft. depth and 40 pounds per acre in the 0-4 ft. depth.

Table 6. Residual soil nitrate-N for 0-2 ft. and 0–4 ft. depths at the Maynard and Olivia sites in fall 2002.

Maynard site			Olivia site		
N rate	0-2 ft.	0-4 ft.	N rate	0-2 ft.	0-4 ft.
pounds N/A	- pounds nitrate-N/A -		pounds N/A	- pounds nitrate-N/A -	
0	31	43	0	28	42
50	28	40	40	23	35
100	30	42	80	27	39
150	41	62	120	29	41
200	32	45	160	29	42

Summary

The results from the two sites confirm the new N recommendations adopted in 2001. Excess nitrogen fertilizer reduces sugar beet root quality while root yield is not increased with applications above the optimum N rate. These sites have also set up conditions to test the effect of N credit from the sugar beet tops returned to the soil for the next corn crop in 2003. The fall 2002 soil nitrate-N test results indicate no differences in residual soil nitrate-N as a result of the spring 2002 N fertilizer treatment applications. There are different amounts of N in the sugar beet tops returned to the soil caused by the 2002 fertilizer treatments. The differences in 2003 corn yield response returned sugar beet top can be measured.