

Nitrogen Rate Trials for 2021

John A. Lamb¹, David Mettler², and Mark Bloomquist³

¹Professor Emeritus University of Minnesota, St. Paul, MN,

²Research Agronomist, and ³Research Director, SMBSC, Renville, MN

Introduction: Nitrogen management is a top priority for production of high-quality sugar beet. With the continued changes in sugar beet production practices, it is important to continue to update N fertilizer guidelines with new information.

Objective: Provide current N fertilizer guidelines for sugar beet production in the Southern Minnesota Beet Sugar Cooperative growing area.

Methods and Materials: In 2021, two locations in the Southern Minnesota Beet Sugar Cooperatives growing area had studies with a N fertilizer rate component to them. One location near Renville, MN and the other near Hector, MN. Fall soil samples were taken for each location prior to the study. The results are reported in Table 1. The soil nitrate-N to a depth of four feet was low at each location, 55 lb N/A and 45 lb N/A at Renville and Hector, respectively. The N fertilizer rates were 0, 30, 60, 90, 120, 150, 180, and 210 lb N/A. There were six replications of the N rates at the Renville location and eight replications of the N rates at the Hector location. The fertilizer N source was urea applied and incorporated prior to planting. Stand counts were taken after emergence. The locations were harvested by machine in October and quality samples were taken at that time. Quality was determined in the Southern Minnesota Beet Sugar Cooperative tare lab.

Table 1. Soil test results for Renville and Hector locations in 2021.

Soil test	Renville	Hector
Soil nitrate-N 0-4 ft. (lb N/A)	55	45
Olsen -P 0-6 in. (ppm)	3	7
K 0-6 in. (ppm)	166	125
pH 0-6 in. (unitless)	8.0	7.7
Organic matter 0-6 in. (%)	6.7	2.9

Results: The 2021 growing season was droughty up to mid-August and then significant precipitation occurred at each site. The average root yield was 43.4 tons/A and the average sucrose was 16.6 % at the Renville location and 40.0 tons/A and 14.8 % at the Hector location.

Renville Results: The addition of N fertilizer significantly affected root yield and extractable sucrose per acre at the Renville location in 2021, Table 2, Figures 1, 2, and 3. Extractable sucrose per ton was not significantly affected by N application. The response for root yield and extractable sucrose per acre was a quadratic plateau. Root yield was optimized at 191 lb soil test nitrate-N plus fertilizer N (0 to 4 feet) with a plateau at 44.4 tons/A, Figure 1. Extractable sucrose per ton was not affected by the addition of fertilizer N. Normally the application of N fertilizer reduces extractable sucrose per ton, Figure 2. Extractable sucrose per acre response at the Renville site was maximized at 117 lb soil test nitrate-N plus fertilizer N/A, Figure 3. The soil test nitrate-N was low and a positive response for root yield and extractable sucrose per acre was expected. The 117 lb/A is well within the current N suggestions for optimum extractable sucrose per acre.

Table 2. The effect of nitrogen on root yield, extractable sucrose per ton, and extractable sucrose per acre at the Renville location in 2021.

Soil test nitrate-N plus fertilizer N	N rate	Root yield	Extractable sucrose per ton	Extractable sucrose per acre
lb N/A	lb N/A	ton/A	lb/ton	lb/A
55	0	38.4	275	10599
85	30	41.7	286	11950
115	60	44.1	284	12495
145	90	44.0	280	12311
175	120	43.4	276	11944
205	150	45.7	281	12891
235	180	46.0	278	12813
265	210	43.9	271	12120
Statistics	N rate	0.02	0.68	0.03
	C.V.	7.9	4.7	9.0
	Mean	43.4	279	12141

Hector Results: The addition of N fertilizer at the Hector location did significantly affect the root yield, extractable sucrose per ton, and the extractable sucrose per acre, Table 3, Figures 1, 2, and 3. This was expected as the soil test nitrate-N to a depth of four feet was 45 lb N/A. Root yield was optimized at 40.4 tons/A with 145 lb soil test nitrate-N plus fertilizer N/A, Figure 1, while the optimum extractable sucrose per acre was with 93 lb soil test nitrate-N plus fertilizer N/A, Figure 3. Extractable sucrose per ton was reduced with the addition of fertilizer N, Figure 2. The reduction was linear with the greatest extractable sucrose at 250 lb/ton with 0 lb N/A applied and reducing to 236 lb/ton with the 210 lb N/A application.

Table 3. The effect of nitrogen on root yield, extractable sucrose per ton, and extractable sucrose per acre at the Hector location in 2021. (Data provided by Dan Kaiser U of MN)

Soil test nitrate-N plus fertilizer N	N rate	Root yield	Extractable sucrose per ton	Extractable sucrose per acre
lb N/A	lb N/A	ton/A	lb/ton	lb/A
45	0	33.1	250	8282
75	30	39.5	247	9723
105	60	38.2	249	9520
135	90	43.0	249	10677
165	120	40.2	244	9789
195	150	41.2	231	9516
225	180	43.0	237	10019
255	210	42.9	236	10253
Statistics	N rate	0.0001	0.0009	0.0001
	C.V.	7.4	4.0	7.0
	Mean	40.0	243	9704

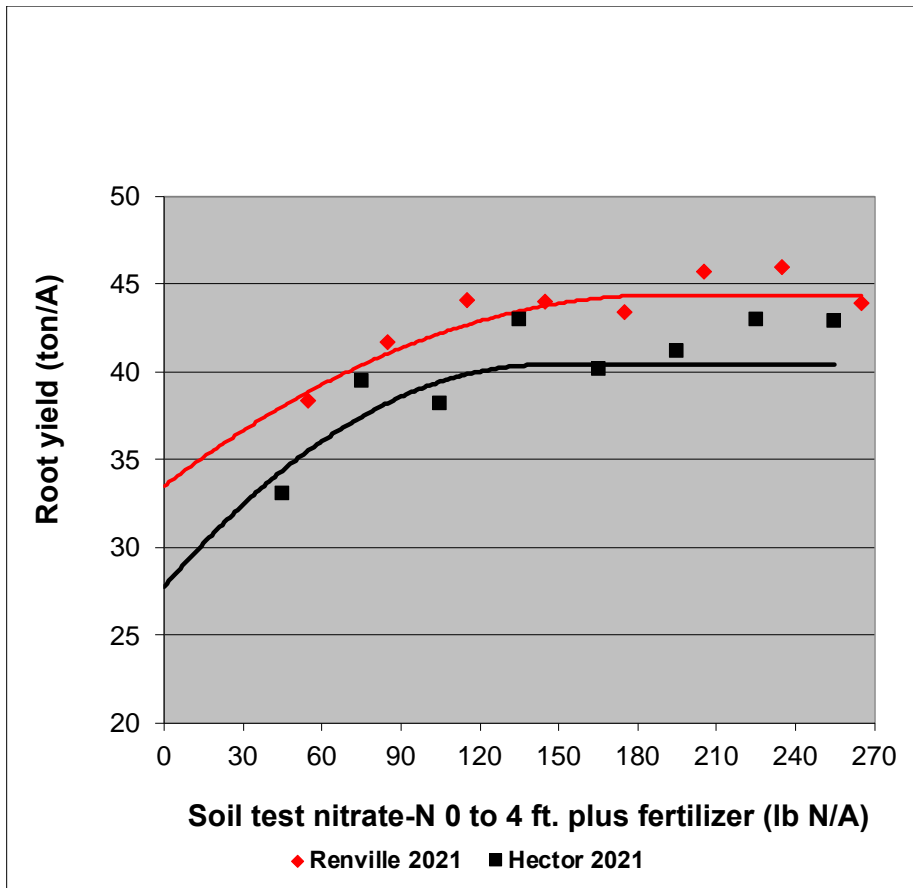


Figure 1. Root yield at Renville and Hector as affected by soil test nitrate-N (0-4 feet) plus fertilizer N in 2021.

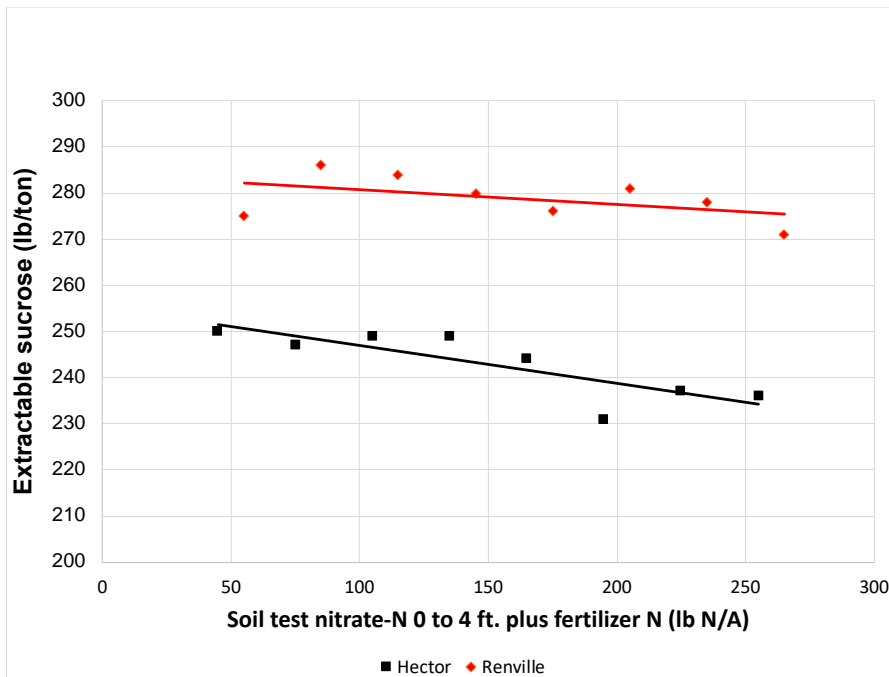


Figure 2. Extractable sucrose per ton at Renville and Hector as affected by soil test nitrate-N (0-4 feet) plus fertilizer N in 2021.

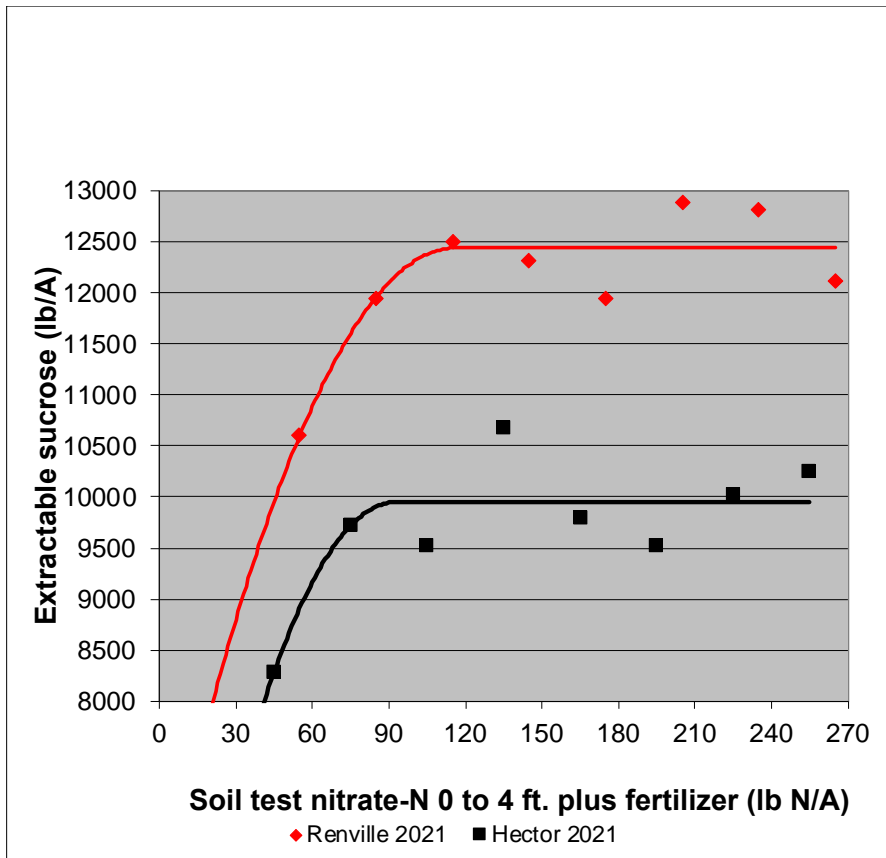


Figure 3. Extractable sucrose per acre at Renville and Hector as affected by soil test nitrate-N (0-4 feet) plus fertilizer N in 2021.

Conclusion: The responses to N application occurred for root yield and extractable sucrose per acre at both locations in 2021. The optimum soil test nitrate-N plus fertilizer N level was 191 lb N/A for root yield and 117 lb N/A for extractable sucrose per acre at the Renville location. The optimum soil test nitrate-N plus fertilizer N was 145 lb N/A for root yield and 93 lb N/A for extractable sucrose per acre at the Hector location in 2021. Extractable sucrose per ton was reduced by N application at the Hector site and not affected at Renville.

What does this mean for the N fertilizer guideline currently used? This guideline is based on many locations of data over the years. Because the information for both sites in 2021 was a positive and significant response to added N fertilizer, the data from these sites will be added to the database. Current guidelines based on research from 2010 to 2021 indicate that the optimum extractable sucrose per acre can be achieved with 117 lb N/A as soil test nitrate-N to a depth of four feet plus fertilizer N with N fertilizer cost of \$0.75 per lb N and sugar price at \$0.17 per lb.