NITROGEN MANAGEMENT TO OPTIMIZE SUGAR BEET PRODUCTION IN THE RED RIVER VALLEY

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Fertilizer nitrogen (N) is a critical component of sugar beet (*Beta vulgaris* L.) production. Root yield, extractable sucrose- and purity percentage are greatly impacted by fertilizer N application rate. Optimum fertilizer N management promotes vigorous early season vegetative growth, canopy closure, which allows sugar beet for efficient use of solar energy to increase yield. The current fertilizer N recommendation for sugar beet (after considering residual N of 4 ft soil depth) is 130 lb N ac^{-1} to achieve the yield goal of 20 t ac^{-1}. This multi-location on-farm fertilizer N rate trial was conducted to determine whether current fertilizer N recommendation still holds the promise to achieve the maximum yield and quality across the Red River Valley (RRV).

Table 1. Initial soil nutrient availability of experimental sites

Site	Previous crop	Soil N (lb/ac) of 4 ft	Olsen-P (ppm) 0-6”	K (ppm) 0-6”
Ada	Wheat	24	3	68
Downer	Wheat	58	7	50
Crookston	Wheat	42	5	122
Foxhome	Wheat	80	11	157
St. Thomas	Potato	43	20	156

During 2016 growing season, on-farm fertilizer N trials were conducted at five locations across the Red River Valley. At each location, plots with six fertilizer N rates (0, 70, 100, 130, 160 and 190 lb N/ac) were laid out in randomized block design with four replications. Initial soil nutrient availability was presented in Table 1. At Foxhome, residual soil N was 80 lb N ac/, so fertilizer N treatment at 70 lb N/ac was not included. Before planting, soil samples were collected and analyzed for residual soil nitrate-N with depth increments of 0-6”, 6-12”, 12-24”, 24-36”. Fertilizer N rate were adjusted for residual soil N and fertilizer N in the form of urea was broadcasted and mixed within 0-6” depth. Each plot was 30 ft long and 11 ft wide with 22-inch row spacing. Sugar beet (cultivar Crystal 093) was planted at the end of the April. Mid-season soil and plant tissue samples were collected for all sites. St. Thomas and Foxhome sites were significantly affected by sugar beet-root maggot (*Tetanops myopaeformis* (Röder)) and –cercospora leafspot (*Cercospora beticola*) . Plot level mechanical harvester was used to harvest middle two-rows of each plot and subsample from each plot was send to American Crystal Quality Lab at East Grand Forks, to determine quality parameters like percentage of sugar and sugar loss to molasses.

Table 2. Sugar beet yield (ton/ac) and sugar content (%) in response fertilizer N application rate at four experimental sites

Fertilizer-N (lb/ac)	Ada			Crookston			Downer			St. Thomas			Foxhome		
	Yield (ton/ac)	Sugar (%)	$/ac	Yield (ton/ac)	Sugar (%)	$/ac	Yield (ton/ac)	Sugar (%)	$/ac	Yield (ton/ac)	Sugar (%)	$/ac	Yield (ton/ac)	Sugar (%)	$/ac
Control	36.4^{AB}	16.0^{A}	1171^{B}	43.4^{A}	16.7^{A}	1546^{AB}	37.1^{A}	16.6^{AB}	1333^{AB}	29.6^{ABC}	13.3^{AB}	438^{AB}	25.3^{A}	15.1^{A}	883^{A}
70	41.2^{A}	16.0^{A}	1338^{AB}	45.8^{A}	16.9^{A}	1672^{A}	33.0^{B}	16.2^{AB}	1113^{C}	24.9^{C}	13.3^{AB}	365^{B}	-	-	-
100	41.7^{A}	16.0^{A}	1355^{AB}	45.1^{A}	15.9^{B}	1366^{BC}	36.4^{AB}	16.9^{A}	1368^{A}	27.1^{BC}	13.2^{AB}	393^{B}	29.4^{A}	15.3^{A}	1021^{A}
130	34.5^{B}	16.3^{A}	1185^{B}	45.6^{A}	16.1^{AB}	1498^{ABC}	37.0^{A}	16.4^{AB}	1270^{ABC}	30.3^{ABC}	12.9^{B}	347^{B}	30.0^{A}	14.8^{A}	955^{A}
160	33.6^{B}	16.5^{A}	1210^{AB}	43.3^{A}	16.1^{AB}	1420^{ABC}	36.3^{AB}	16.7^{AB}	1301^{ABC}	32.5^{AB}	13.2^{AB}	477^{AB}	29.7^{A}	14.5^{A}	893^{A}
190	38.7^{AB}	16.5^{A}	1386^{A}	43.6^{A}	15.5^{B}	1267^{C}	36.8^{AB}	15.8^{B}	1137^{BC}	34.5^{A}	13.6^{A}	568^{A}	28.4^{A}	15.2^{A}	960^{A}
LSD($p<0.05$)	5.55	0.78	191	4.03	0.80	265	3.85	1.04	207	6.52	0.66	152	5.74	2.03	417

Sugar beet yield, sugar content and economic return showed significant variation in responses to six fertilizer N application rates at five on-farm sites (Table 2). At Ada, highest yield was observed with 100 lb N /ac but the highest sugar content was observed at 160 and 190 lb N/ac, Finally, economic return was highest at 190 lb N/ac, however, return was not significantly different than 70 and 100 lb N/ac. At Crookston, Downer, St. Thomas and Foxhome, fertilizer N application did not significantly increase yield and quality over control. Outcomes indicate that under favorable condition, supply of N through mineralization of soil organic matter is sufficient for sugar beet production. It is important to quantify the potential soil N mineralization of different soil types to optimize the fertilizer N use efficiency.