FALL VS. SPRING NITROGEN APPLICATION ON SUGARBEET PRODUCTION

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Introduction: Sugarbeet growers apply fertilizer N either in fall or spring often dependent on workload, soil compaction concerns, and without knowledge of relative N use efficiency. A risk of leaching, denitrification and erosion loss is prolonged for fall-N, but fall-N can be readily available to seed during germination and produce early vigor. Spring-N application reduces the chance of N loss due to a narrow interval between N application and uptake. Further, it is also important to know the relative response from applications of fertilizer N split between fall and spring. For sugarbeet, soil N-availability plays a significant role in yield and quality. Estimation of soil N supply as influenced by relative proportion of fall and spring fertilizer N application has potential to increase sugarbeet N use efficiency. Main objectives were to (i) determine the sugarbeet yield and quality as influenced by N application rate and timing, (ii) determine the ratio of fall and spring N application to optimize yield and quality, and (iii) compare the N use efficiency of two soil types in response to fertilizer N application and timing.

Materials and Methods: This field experiment was conducted at Crookston and Downer sites. Treatments consisted of the two fertilizer-N application rates, 130 and 190 lb N/ac; each having 0, 40, 60, 80 and 100 percent of total N applied in fall, and the balance in the spring. Trials were laid out in randomized block design with four replicates. Each plot was 30 ft long and 11 ft wide. During fall 2016, soil samples were collected from 0-6", 6-24" and 24-48" and analyzed for soil nitrate-N. Required amount of urea-N after adjusting for soil residual N were broadcast. Recommended rates of P and K fertilizer were also applied. Spring fertilizer-N treatments were applied just before planting and incorporated. Standard Roundup Ready® cultivar was planted at 22 inch row spacing. Middle two rows of six row plots were harvested and quality traits were evaluated by American Crystal Lab, Grand Forks. Planting occurred on May 4 and April 29 and harvested on September 21st and September 19th, at Crookston and Downer, respectively. Economic return was calculated using the beet payment formula used by the American Crystal Sugar. Statistical analyses were conducted using PROC ANOVA in SAS 9.4 and significant mean separation identified using Fisher's LSD at 95% significance level.

Table 1. Initial soil parameters of Downer and Crookston field experimental sites in fall, 2016.

	NO_3-N (lb/ac)			Olsen-P (ppm)	K (ppm)	Soil OM%	Soil pH
Depth	0-6"	6-24"	24-48"	0-6"	0-6"		
Downer	19	21	30	10.5	97	3.1	8.6
Crookston	17	30	24	42	132	3.8	8.4

Table 2. Sugarbeet yield, quality and economic return in response to urea-N application rate and timing during the 2017 growing season

N Rate	---- Split% ----		Crookston				Downer			
lb N/ac	Fall	Spring	Tons/ac	Sugar %	RSA (lb ac^{-1})	Return ($ ac^{-1})	Tons/ac	Sugar %	RSA	Return ($ ac^{-1})
Check	0	0	32.7^{AB}	18.6	11437^{AB}	1570.91^{AB}	26.8^{B}	19.6^{A}	9998^{B}	1462.22^{B}
130	0	100	31.4^{AB}	19.0	11417^{AB}	1633.69^{AB}	34.5^{A}	19.2^{AB}	12549^{A}	1795.26^{A}
	40	60	32.1^{AB}	18.5	11260^{AB}	1554.28^{AB}	33.9^{A}	19.1^{ABC}	12310^{A}	1756.14^{A}
	60	40	30.1^{AB}	18.5	10356^{AB}	1401.82^{AB}	33.0^{A}	19.2^{AB}	12044^{A}	1727.25^{A}
	80	20	31.5^{AB}	19.1	11511^{AB}	1653.68^{AB}	32.8^{A}	19.1^{ABC}	11799^{A}	1670.05^{AB}
	100	0	31.7^{AB}	18.8	11374^{AB}	1605.44^{AB}	31.6^{A}	19.0^{ABCD}	11268^{AB}	1577.73^{AB}
190	0	100	35.0^{A}	18.4	12209^{A}	1674.65^{A}	34.7^{A}	18.7^{BCD}	12171^{A}	1680.61^{AB}
	40	60	29.4^{AB}	18.6	10328^{AB}	1428.95^{AB}	34.9^{A}	18.9^{ABCD}	12367^{A}	1725.19^{A}
	60	40	35.4^{A}	18.6	12403^{A}	1706.51^{A}	32.2^{A}	18.8^{BCD}	11301^{AB}	1558.64^{AB}
	80	20	33.0^{AB}	18.5	11674^{AB}	1621.62^{AB}	34.1^{A}	18.5^{CD}	11785^{A}	1599.93^{AB}
	100	0	26.3^{B}	18.8	9417^{B}	1326.25^{B}	34.1^{A}	18.3^{D}	11682^{A}	1569.19^{AB}
LSD			8.09	0.68	2717	377.9	4.31	0.73	1588	258
Significance (P<0.05)			*	NS	*	*	*	*	*	*

At Crookston, the lowest observed yield was associated with the high fertilizer N rate (190 lb N/ac), 100 % applied in the fall. This application scheme yielded significantly less than 100% and 40% spring application of 190 lb N/ac. Spring application of 100% and 40% of 190 lb N/ac also resulted in the higher recoverable sugar per acre (RSA) and economic return; RSA and return calculations involve yield and percent sugar. At Downer, all the N fertilizer treatments resulted in significantly higher yield than the check, irrespective of N rate and application time. Sugar percent was lowest with 100% fall application of 190 lb N/ac. RSA and economic return was lowest for the check plot, although not significantly different from several other N application patterns. These results show that high N application rate in fall might reduce sugarbeet yield and percent sugar while reducing economic return.