FINE-TUNING A NITROGEN BUDGET SYSTEM FOR SUGARBEETS PRODUCED UNDER SPRINKLER AND FLOOD IRRIGATION

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Objective: To fine-tune nitrogen recommendations for sugarbeets produced under sprinkler and flood irrigation

Procedure: Previous crops were malt barley in 2002, potatoes in 2001, and durum in 2000. Residual soil N to 4 feet was 95 lb/ac (including OM) under the flood site and 121 lb/ac (including OM) under the sprinkler site. Residual soil P to 6 inches was 28 ppm under the flood site and 27 ppm under the sprinkler site. Residual soil K to 6 inches was 458 ppm under the flood site and 500 ppm under the sprinkler site. Five rates of liquid 28-0-0 were applied October 4, 2002 (recommended rate for 25 T/ac crop, per Kerry Rasmussen, Holly Sugar, now Sidney Sugars). A check treatment with no applied N was included.

Table 1. Residual soil N and applied soil N on sugarbeets grown under sprinkler and flood irrigation.

SPRINKLER IRRIGATION				FLOOD IRRIGATION			
Treatment	Soil N*	Applied N	Available N	Treatment	Soil N*	Applied N	Available N
No applied N	121	0	121	No applied N	95	0	95
Recommended – 20%	121	47	168	Recommended – 20%	95	73	168
Recommended – 10%	121	68	189	Recommended – 10%	95	94	189
Recommended	121	89	210	Recommended	95	115	210
Recommended + 10%	121	110	231	Recommended + 10%	95	136	231
Recommended + 20%	121	131	252	Recommended + 20%	95	157	252

*residual soil N to 4 feet + 65 lb N/ac attributed to OM

Plots were planted to stand with the variety AC927 on April 28, 2003, with a commercial six-row planter. Alleys were trimmed soon after emergence to define the plots, which were 30 feet long and six rows (12 feet) wide. Ro-Neet 6E (3.5 lb AI/ac) and Counter (1 lb AI/ac) were applied in 7" bands at planting. Betamix (1.5 pt/ac) was applied on May 30, June10 and June 16. Stinger (0.4 pt/ac) was applied June 2. Headline (9.2 oz/ac) was applied by ground rig on July 11.

Soil moisture was monitored using ECH$_2$O soil probes that were placed under both irrigation regimes. The probes measured soil moisture at 12 and 24 inches. The initial probe in the sprinkler site was near the edge of the field, and during the growing season, it was determined that the soil moisture being measured was not representative of soil moisture in the rest of the field under the sprinkler, so a second probe was placed under the sprinkler that was farther from the edge of the field. Sprinkler plots were irrigated on July 1, July 12, July 17, July 24, July 31, August 12, and August 26. Flood irrigated plots were irrigated on June 30, July 16, July 24, August 5, and August 19. Growing season (April-August) precipitation was 8.82 inches. Plots were harvested on September 18 (flood) and September 19 (sprinkler).

Results: All treatments with applied N had significantly greater root yield than the treatment with no applied N under flood irrigation (Table 2). The greatest gross sucrose yield and extractable sucrose yields under flood irrigation were achieved with the recommended rate of available N, although these yields were not significantly different from the yields achieved with any applied N treatment. Yields under sprinkler irrigation were not significantly different from one another, but the treatment with 10% less than the recommended rate resulted in the greatest sucrose and extractable sucrose yield. When analyzed across treatments, sprinkler irrigated sugarbeets had greater root yield and sucrose yield.

Differences in impurities were not great among the N treatments (Table 3). Under flood irrigation, the three treatments with the most applied N had the greatest amino-N content. No significant differences were seen under sprinkler irrigation, although amino-N content continued to increase as applied N increased. When analyzed across treatments, sugarbeets under sprinkler irrigation had greater Na, K, and amino-N contents than sugarbeets under flood irrigation, resulting in greater sucrose loss to molasses and lower extraction.

Table 2. Yield of sugarbeets with six N-rates. Data analyzed using ANOVA.

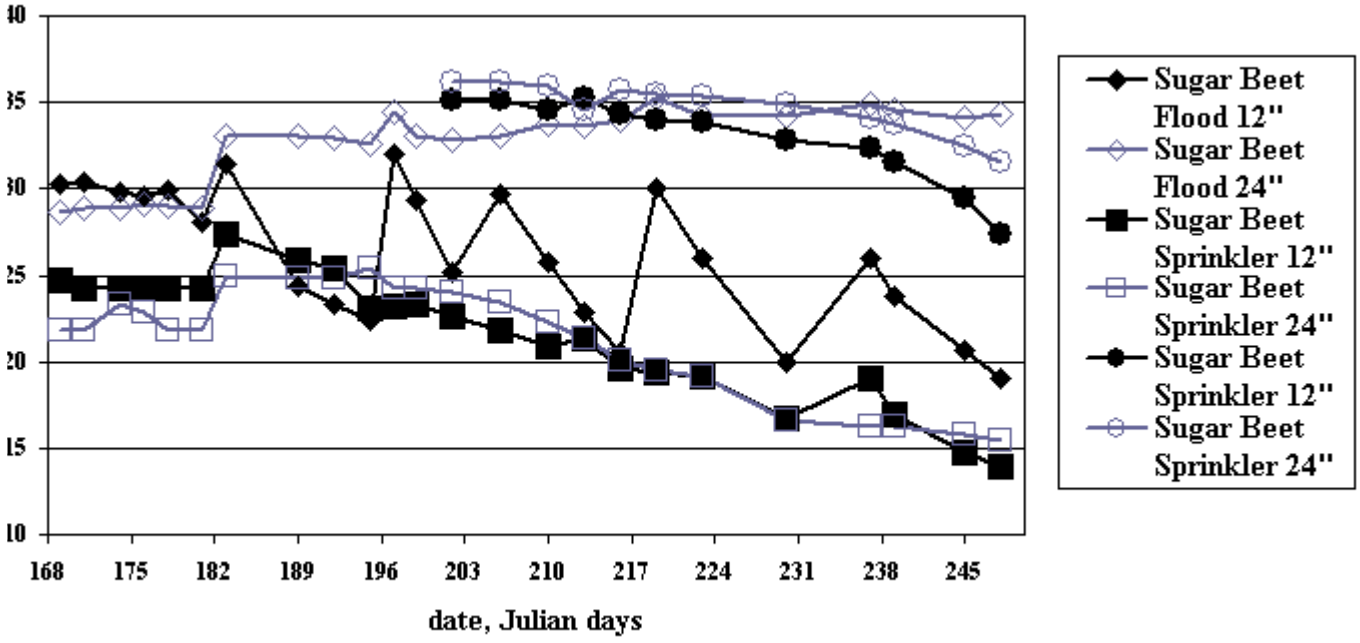
ANOVA, single factor							
Available N, lb/ac	Irrigation	Harvest Stand, plants/acre	% tare	Percent sucrose	Root Yield T/acre	Gross Sucrose Yield, Lb/acre	Extractable Sucrose, Lb/acre
No applied N	flood	21300	92.0ab	19.02 b	26.3a	10010a	9456a
Recommended – 20%	flood	22140	93.2 b	18.92 b	29.2 b	11060 b	10450 b
Recommended – 10%	flood	20090	91.9ab	19.06 b	29.6 b	11290 b	10580 b
Recommended	flood	19750	92.8 b	18.23a	**31.6 b**	**11510 b**	**10750 b**
Recommended + 10%	flood	21180	92.8 b	18.34a	30.0 b	11000ab	10320ab
Recommended + 20%	flood	21540	91.0a	18.57ab	29.8 b	11060 b	10380ab
Probability		0.664	0.091	0.003	0.004	0.069	0.132

CV s/mean		12.8	1.5	2.2	7.0	7.6	7.9
$LSD_{0.05}$		ns	1.6	0.49	2.4	996	972
No applied N	sprinkler	24810	92.6	19.47	30.9	12010	11250
Recommended – 20%	sprinkler	26620	90.1	18.74	31.6	11820	10980
Recommended – 10%	sprinkler	28920	90.9	19.09	33.6	**12830**	**11960**
Recommended	sprinkler	25410	89.5	18.85	32.2	12160	11260
Recommended + 10%	sprinkler	25290	90.6	18.59	32.0	11860	10950
Recommended + 20%	sprinkler	26020	90.4	18.58	31.3	11660	10770
Probability		0.724	0.100	0.439	0.873	0.745	0.682
CV s/mean		17.9	2.0	4.4	11.6	11.1	11.3
$LSD_{0.05}$		ns	2.0	ns	ns	ns	ns
ANOVA, multiple factors							
No applied N		23050	92.3	19.24 c	28.6a	11010	10350
Recommended – 20%		24380	91.6	18.83abc	30.4ab	11440	10710
Recommended – 10%		24500	91.4	19.07 bc	31.6 b	12060	11270
Recommended		22580	91.2	18.54ab	31.9 b	11830	11010
Recommended + 10%		23230	91.7	18.47a	31.0ab	11430	10630
Recommended + 20%		23780	90.7	18.58ab	30.5ab	11360	10580
	flood	21000	92.3	18.69	29.4	10990	10320
	sprinkler	26180	90.7	18.89	31.9	12060	11190
N rate		0.759	0.238	0.025	0.103	0.262	0.350
Irrigation		<0.001	<0.001	0.209	<0.001	<0.001	0.001
N x I		0.540	0.028	0.666	0.559	0.565	0.509

Table 3. Quality of sugarbeets with six N-rates. Data analyzed using ANOVA.

ANOVA, single factor						
Available N, lb/ac	Irrigation	Na ppm	K ppm	Amino-N ppm	Sucrose loss to molasses	Percent extraction
No applied N	flood	360	1688	163a	1.05	94.5
Recommended – 20%	flood	295	1663	181ab	1.04	94.5
Recommended – 10%	flood	318	1732	233 bc	1.15	93.8
Recommended	flood	352	1746	249 c	1.19	93.4
Recommended + 10%	flood	363	1659	238 bc	1.15	93.7
Recommended + 20%	flood	330	1664	243 c	1.14	93.8
Probability		0.950	0.686	0.023	0.314	0.277
CV s/mean		38.6	6.8	23.6	12.0	1.0
$LSD_{0.05}$		ns	ns	61	ns	ns
No applied N	sprinkler	365	1807	243	1.22	93.7
Recommended – 20%	sprinkler	374	1861	298	1.32	92.9
Recommended – 10%	sprinkler	367	1878	269	1.28	93.3
Recommended	sprinkler	426	1908	320	1.40	92.5
Recommended + 10%	sprinkler	442	1906	320	1.41	92.4
Recommended + 20%	sprinkler	467	1892	337	1.43	92.2
Probability		0.817	0.799	0.534	0.616	0.599
CV s/mean		38.2	7.0	31.3	17.7	1.7
$LSD_{0.05}$		ns	ns	ns	ns	ns
ANOVA, multiple factors						
No applied N		363	1747	203a	1.14	94.1
Recommended – 20%		334	1762	239ab	1.18	93.7
Recommended – 10%		342	1805	251ab	1.22	93.5
Recommended		389	1827	284 b	1.29	93.0
Recommended + 10%		402	1782	279 b	1.28	93.1
Recommended + 20%		398	1778	290 b	1.29	93.0
	flood	336	1692	218	1.12	94.0
	sprinkler	407	1875	298	1.34	92.8
N rate		0.765	0.675	0.043	0.227	0.205
Irrigation		0.039	<0.001	<0.001	<0.001	<0.001
N x I		0.923	0.795	0.853	0.873	0.847

Figure 1. Soil moisture under sprinkler and flood irrigated sugarbeets during the growing season.



Soil moisture was measured throughout the growing season using soil moisture probes that measured soil moisture at 12 and 24 inches below the soil surface. Soil moisture at 12 inches under flood irrigation fluctuated throughout the season (Figure 1), peaking immediately following each irrigation, then dropping by up to 20% until the next irrigation. The general trend of soil moisture at 12 inches under flood irrigation continued to decrease throughout the growing season. Soil moisture at 24 inches under flood irrigation remained relatively constant during the growing season, increasing from less than 30% to 35% with the first two irrigations and staying between 30-35% moisture until harvest.

The initial probe in the sprinkler site was near the edge of the field, and during the growing season, it was determined that the soil moisture being measured was not representative of soil moisture or the rest of the field under the sprinkler, so a second probe was placed under the sprinkler that was located farther from the edge of the field. The initial soil moisture under sprinkler irrigation indicated that soil moisture under the sprinkler started out lower than soil moisture under flood irrigation, and continued to decrease. The second probe was put into place in July. Soil moisture measured with the second probe at 12 inches under the sprinkler did not fluctuate, but decreased steadily from 35% moisture to 27% moisture. Soil moisture at 12 inches measured with the second probe under

the sprinkler was greater than soil moisture under the flood irrigation at all times. Soil moisture measured with the second probe at 24 inches under the sprinkler was very similar to soil moisture under flood irrigation.

Summary: Sugarbeet grown under sprinkler irrigation had greater stand and greater root yield than sugarbeet grown under flood irrigation. Sugarbeet grown under sprinkler irrigation had more impurities and greater sucrose loss to molasses. Greatest sucrose yield was achieved with the recommended rate of N under flood irrigation and with 10% less than the recommended rate under sprinkler irrigation.

Soil moisture at 12 inches under flood irrigation fluctuated throughout the season, peaking immediately following each irrigation, then dropping by up to 20% until the next irrigation. Soil moisture at 12 inches under sprinkler irrigation did not fluctuate but steadily decreased throughout the growing season. Soil moisture at 24 inches was similar under the two irrigation regimes.