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

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The objective of this study was to fine-tune nitrogen recommendations for sugarbeets produced under sprinkler and flood irrigation. The study was conducted for four years at the MSU Eastern Agricultural Research Center in Sidney, MT. Soil is a fine smectitic frigid Vertic Argiustolls (Savage silty clay). The test site was fall-irrigated each year prior to planting. Residual soil N was determined to a depth of four feet. Using a randomized complete block design, N was applied at rates so that available N, including residual soil N, was 100, 125, 150, 175, and 200 lb N/ac. A check treatment with no applied N was included. The variety AC927 was planted to stand with a commercial six-row planter. Insecticides, herbicides and fungicides were applied as needed. Plots were also hand-weeded each year.

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

	2003	2004	2005	2006
previous crop, 1 year prior	malt barley	durum	malt barley	malt barley
previous crop, 2 years prior	potatoes	potatoes	sugarbeets	sugarbeets
residual soil N to 4 ft, lb/ac	45	28	73	46
N application date	Oct 4, 2002	Sep 17, 2003	Apr 26	May 11
planting date	Apr 28	Apr 22	Apr 26	May 11
harvest date	Sep 18	Oct 1	Sep 27	Sep 26
growing season precipitation, inches	8.82	7.62	10.16	11.81

Results: When analyzed across four years, sugarbeets under flood irrigation had greatest root yield, sucrose yield, and extractable sucrose with 175 lb/a available N, although the yields achieved with 125 and 150 lb/ac available N were not significantly different. When analyzed across four years, sugarbeets under sprinkler irrigation had greatest root yield, sucrose yield, and extractable sucrose with 125 lb/a available N (Table 2), although the yields achieved with 100 and 150 lb/ac available N were not significantly different. Impurities and sucrose loss to molasses continued to increase slightly as applied N was increased under flood irrigation. Impurities and sucrose loss to molasses were significantly greater with any rate of applied N than with no applied N under sprinkler irrigation (Table 3).

Table 2. Yield of sugarbeets with six N-rates. Data analyzed across years using ANOVA. **2003-2006**

Available N (N to 4 ft plus applied N,	Irrigation	Harvest stand, plants/acre	% tare	Percent sucrose	Root yield, T/acre	Gross sucrose yield,	Extractable sucrose, lb/acre

lb/ac)						lb/acre	
*	flood	31700	8.4	18.93	30.5	11430	10860
100	flood	32000	9.2	18.79	31.5	11690	11080
125	flood	32480	9.6	18.84	32.3	11990	11340
150	flood	31880	8.6	18.63	32.5	11920	11230
175	flood	31550	8.3	18.50	33.7	12240	11500
200	flood	30780	9.4	18.39	31.6	11490	10820
Average		32010	8.5	18.81	30.8	11470	10840
$LSD_{0.05}$		ns	1.0	0.29	1.2	500	492
*	sprinkler	36270	7.9	19.13	30.3	11480	10880
100	sprinkler	35350	10.0	18.59	31.9	11740	11020
125	sprinkler	35550	9.6	18.60	32.9	12110	11370
150	sprinkler	34910	9.6	18.47	31.9	11690	10960
175	sprinkler	32900	9.4	18.34	31.4	11360	10650
200	sprinkler	32790	9.8	18.20	31.0	11170	10460
Average		35300	9.2	18.73	30.8	11430	10740
$LSD_{0.05}$		2449	1.1	0.37	1.6	593	573

* 46 lb/a in 2006, 73 lb/a in 2005, 28 lb/ac in 2004, 45 lb/ac in 2003

Table 3. Quality of sugarbeets with six N-rates. Data analyzed across years using ANOVA. **2003-2006**

Available N, N to 4 ft and applied N, lb/ac	Irrigation	Na ppm	K ppm	Amino-N ppm	Sucrose loss to molasses	Percent extraction
*	flood	242	1647	142	0.95	95.0
100	flood	253	1608	165	0.97	94.8
125	flood	269	1625	176	1.00	94.6
150	flood	293	1631	201	1.05	94.3
175	flood	288	1643	215	1.07	94.1
200	flood	306	1632	210	1.07	94.1
Average		274	1633	183	1.02	94.6
$LSD_{0.05}$		44	ns	24	0.06	0.4
*	sprinkler	266	1617	169	0.99	94.8
100	sprinkler	321	1754	211	1.13	93.8
125	sprinkler	314	1729	219	1.13	93.9
150	sprinkler	330	1711	226	1.14	93.8
175	sprinkler	345	1682	221	1.13	93.8
200	sprinkler	356	1699	231	1.15	93.6
Average		324	1708	216	1.12	94.0
$LSD_{0.05}$		60	75	38	0.09	0.63

* 46 lb/a in 2006, 73 lb/a in 2005, 28 lb/ac in 2004, 45 lb/ac in 2003

Ground water nitrate-N concentrations were greater under flood irrigation than under sprinkler irrigation during the entire growing season in all years tested (Table 4). Irrigation water was low in nitrate-N. Nitrate-N concentration in drainage water was greater than nitrate-N concentration of irrigation water, indicating loss of nitrogen to run-off.

Table 4. Nitrate-N concentrations (ppm) in irrigation water, drainage water, and ground water under flood irrigated and sprinkler irrigated sugarbeets.

2003	23-Jun	8-Jul	21-Jul	4-Aug	18-Aug	2-Sep	15-Sep
ground water under flood	3.2	11.2	15.3	14.2	11.8	10.8	10.5
ground water under sprinkler	2.8	2.9	2.7	2.4	2.3	2.3	2.4
irrigation water	0.1	0.1	0.1	0.1	0.1	0.1	0.1
drain ditch water	1.74	1.75	1.35	1.56	1.68	1.81	1.37
2004	7-Jun	21-Jun	6-Jul	19-Jul	2-Aug	18-Aug	8-Sep
ground water under flood	5.6	7.0	7.9	10.7	11.5	10.2	10.2
ground water under sprinkler	3.2	5.1	5.9	5.3	5.1	4.9	5.5
irrigation water	0.1	0.4	0.1	0.1	0.1	0.1	

drain ditch water	6.1	8.1	2.1	2.0	3.4	2.1	2.8
2005	6-Jul	20-Jul	1-Aug	22-Aug	12-Sep	20-Sep	
ground water under flood	1.2	3.0	2.8	4.9	3.9	3.2	
ground water under sprinkler	1.4	1.6	1.7	2.2	2.0	1.6	
irrigation water	0.1	0.1	0.1	0.1	0.1	0.1	
drain ditch water	0.9	0.3	0.7	3.2	1.4	1.1	
2006	17-Jun	26-Jun	10-Jul	24-Jul	7-Aug	21-Aug	4-Sep
ground water under flood	8.5	8.8	8.5	9.5	9.6	10.5	8.6
ground water under sprinkler	4.7	5.0	5.7	6.0	5.1	4.7	4.3
irrigation water	0.2	0.3	<0.1	0.4	1.0	<0.1	1.1
drain ditch water	0.7	0.6	1.0	0.5	0.2	2.3	0.3

Summary: Nitrogen rate achieving greatest root and sucrose yield was lower under sprinkler irrigation than under flood irrigation. Sprinkler irrigated sugarbeets had greater loss to molasses than flood irrigated sugarbeets. A higher concentration of nitrate-N was detected in ground water under flood irrigation than under sprinkler irrigation. A higher concentration of nitrate-N was detected in drainage water than in irrigation water. These data indicate that on clay soil, sugarbeets grown under sprinkler irrigation need less applied N than sugarbeets grown under flood irrigation, because less N is lost through leaching and run-off. Growers who switch from flood to sprinkler irrigation on clay soil may over-fertilize sugarbeets under sprinkler irrigation, resulting in poorer quality sugarbeets and lower economic return.