FINE-TUNING NITROGEN RECOMMENDATIONS FOR SPRINKLER AND FLOOD IRRIGATED SUGARBEET

J. L. A. ECKHOFF* and C. R. FLYNN
Montana State University, Eastern Agricultural Research Center
1501 N. Central Avenue, Sidney, MT 59270

Introduction: Good nitrogen (N) management is one of the most important aspects of a high-yielding, high-quality sugarbeet crop. Not enough N limits yield, while too much N reduces quality by increasing crown tissue (2). Excess N can also cause surface and ground water contamination and increases input costs. An irrigation management study conducted at Sidney, MT, compared sugarbeet grown under furrow flood irrigation with sugarbeet grown under sprinkler irrigation (1). Sprinkler irrigated sugarbeet consistently had lower sucrose content and greater sucrose loss to molasses (SLM). Ground water under flood irrigation had greater nitrate-N concentration than ground water under sprinkler irrigation. Run-off water from flood irrigation had greater nitrate-N concentration than the irrigation water applied to the field. These data showed that flood irrigation leached N below the root zone, or moved it off the field as run-off. A sugarbeet crop under sprinkler irrigation may need less applied N because less N is lost to leaching and run-off under sprinkler than under flood irrigation. The objective of this study was to fine-tune N recommendations for sugarbeet produced under sprinkler and flood irrigation.

Materials and methods: The study was conducted for four years at the MSU Eastern Agricultural Research Center in Sidney, MT. Soil is Savage silty clay. The test site was fall-irrigated each year prior to planting. Using a randomized complete block design, N was applied at rates so that available N, including residual soil N to 120 cm, was 112, 141, 169, 197, and 225 kg N/ha. A check treatment with no applied N was included. Plots were planted to stand with the variety AC927 using a commercial six-row planter. Insects, weeds and pathogens were controlled when necessary. Plots were irrigated as needed, as determined by monitoring soil moisture. Flood irrigation delivered about 8 cm of water with each irrigation, while sprinkler irrigation delivered about 2.5 cm of water with each irrigation. Wells that reached the ground water were placed with two wells on the upper end and two wells on the lower end of each irrigation system, for a total of four wells under each irrigation system. Ground water was sampled for nitrate-N content during the growing season. Water samples were collected by pumping each well dry, then collecting recharge water. Irrigation and drainage water were also collected to evaluate for nitrate-N content.

Table 1. Agronomic information for sugarbeet grown under sprinkler and flood irrigation in this study.

	2003	2004	2005	2006
previous crop, 1 year prior	malt barley	durum	malt barley	malt barley
previous crop, 2 years prior	potato	potato	sugarbeet	sugarbeet
residual soil N to 120 cm, kg/ha	51	32	82	52
N application date	Oct 4, 2002	Sep 17, 2003	Apr 26, 2005	May 11, 2006
planting date	Apr 28	Apr 22	Apr 26	May 11
harvest date	Sep 18	Oct 1	Sep 27	Sep 26
growing season precip, cm	22.4	19.4	25.8	30.0

Results: When analyzed across four years, sugarbeet under flood irrigation had greatest root yield, sucrose yield, and extractable sucrose with 197 kg/ha available N, although the yields achieved with 169 kg/ha available N were not significantly different (Table 2). When analyzed across four years, sugarbeet under sprinkler irrigation had greatest root yield, sucrose yield, and extractable sucrose with 141 kg/ha available N, although the yields achieved with 112 and 169 kg/ha available N were not significantly different. Impurities and SLM continued to increase slightly as applied N was increased under flood irrigation. Impurities and SLM 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 120 cm and applied N, kg/ha	Irrigation	Harvest Stand, plants/ha	Percent tare	Percent sucrose	Root Yield Mg/ha	Gross Sucrose Yield, kg/ha	Extractable Sucrose, kg/ha
*	flood	78300	8.4	18.93	68.3	12859	12218
112	flood	79040	9.2	18.79	70.6	13151	12465
141	flood	80225	9.6	18.84	72.4	13489	12758
169	flood	78750	8.6	18.63	72.8	13410	12634
197	flood	77930	8.3	18.50	75.5	13770	12938
225	flood	76025	9.4	18.39	70.8	12926	12172
Average		78380	8.5	18.81	71.7	13268	12531
LSD $_{0.05}$		ns	1.0	0.29	2.7	562	554
*	sprinkler	89590	7.9	19.13	67.9	12915	12240
112	sprinkler	87315	10.0	18.59	71.5	13208	12398
141	sprinkler	87810	9.6	18.60	73.7	13624	12791
169	sprinkler	86230	9.6	18.47	71.5	13151	12330
197	sprinkler	81265	9.4	18.34	70.3	12780	11981
225	sprinkler	80990	9.8	18.20	69.4	12566	11768
Average		85530	9.2	18.73	70.7	13041	12251
LSD $_{0.05}$		6049	1.1	0.37	3.6	667	573

* 52 kg/ha in 2006, 82 kg/ha in 2005, 32 kg/ha in 2004, 51 kg/ha in 2003

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

2003-2006

Available N, N to 120 cm and applied N, kg/ha	Irrigation	Na ppm	K ppm	Amino-N ppm	Sucrose loss to molasses	Percent extraction
*	flood	242	1647	142	0.95	95.0
112	flood	253	1608	165	0.97	94.8
141	flood	269	1625	176	1.00	94.6
169	flood	293	1631	201	1.05	94.3
197	flood	288	1643	215	1.07	94.1
225	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
112	sprinkler	321	1754	211	1.13	93.8
141	sprinkler	314	1729	219	1.13	93.9
169	sprinkler	330	1711	226	1.14	93.8
197	sprinkler	345	1682	221	1.13	93.8
225	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

* 52 kg/ha in 2006, 82 kg/ha in 2005, 32 kg/ha in 2004, 51 kg/ha in 2003

Ground water nitrate-N concentrations were greater under flood irrigation than under sprinkler irrigation during the entire growing season in all of the years tested (Table 4). Nitrate-N concentration in irrigation water was low. 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 sugarbeet.

2003	23-Jun	8-Jul	21-Jul	4-Aug	18-Aug	2-Sep	15-Sep
ground water, flood	3.2	11.2	15.3	14.2	11.8	10.8	10.5
ground water, sprinkler	2.8	2.9	2.7	2.4	2.3	2.3	2.4
irrigation ditch	0.1	0.1	0.1	0.1	0.1	0.1	0.1
drain ditch	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, flood	5.6	7.0	7.9	10.7	11.5	10.2	10.2
ground water, sprinkler	3.2	5.1	5.9	5.3	5.1	4.9	5.5
irrigation ditch	0.1	0.4	0.1	0.1	0.1	0.1	
drain ditch	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, flood	1.19	2.96	2.77	4.88	3.87	3.23	
ground water, sprinkler	1.44	1.63	1.73	2.20	1.98	1.62	
irrigation ditch	0.10	0.06	0.10	0.12	0.06	0.06	
drain ditch	0.91	0.32	0.71	3.21	1.44	1.12	

Summary: Sugarbeet grown under sprinkler irrigation achieved greatest root and sucrose yield with lower rates of available N than sugarbeet grown under flood irrigation. Sprinkler irrigated sugarbeet had greater SLM than flood irrigated sugarbeet, with any amount of applied N. A higher concentration of nitrate-N was detected in ground water under flood irrigation than under sprinkler irrigation. These data indicate that sugarbeet grown on clay soil under sprinkler irrigation needs less applied N than sugarbeet grown under flood irrigation, because of less loss of N through leaching and run-off. Growers who switch from flood to sprinkler irrigation may over-fertilize sugarbeet under sprinkle irrigation, resulting in poorer quality sugarbeet and lower economic return.

References:

1. Eckhoff, J. L.A., J.W. Bergman, and C.R. Flynn. 2005. Sugarbeet (Beta vulgaris L.) production under sprinkler and flood irrigation. J. Sugar Beet Res. 42:19-30.

2. Halvorson, A.D., G.P. Hartman, D.F. Cole, V.A. Haby, and D.E. Baldridge. 1978. Effect of N fertilization on sugarbeet crown tissue production and processing quality. Agon. J. 70:876-880.