Fine-tuning Applied Nitrogen Rates for Sprinkler and Flood Irrigated Sugarbeet Production

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Introduction

Good nitrogen (N) management is one of the most important aspects of a high-yielding, high-quality sugarbeet crop. Too little available N limits yield, while too much reduces root quality by increasing crown tissue (Halvorson et al., 1978). Applying excess N can cause surface and ground water contamination from typical irrigation practices, as well as increasing producers' input costs. An irrigation management study demonstrated that sprinkler irrigated sugarbeets had lower quality than flood irrigated sugarbeets (Eckhoff et al., 2005). Groundwater and runoff under flood irrigation had greater nitrate-N concentrations compared to groundwater and runoff under sprinkler irrigation. These data suggest that N was lost under flood irrigation because of leaching and runoff. Sugarbeets under sprinkler irrigation appear to need less N because of less leaching and runoff under sprinkler irrigation. The objective of this study was to fine-tune nitrogen recommendations for sugarbeets produced under sprinkler and flood irrigation.

Methods

This study was conducted for four years at the Eastern Agricultural Research Center in Sidney, MT. Soil was a fine smectitic frigid Vertic Argiustolls (Savage silty clay) with an average organic matter content of 2.5%. Using a randomized complete block design, N was applied so that available N rates, including residual soil N (0-4 ft.), were 100, 125, 150, 175, and 200 lb/N ac. A check treatment with no applied N was included. Plots were seeded with the variety AC927 using a commercial six-row planter. Insecticides, herbicides and fungicides were applied as needed. Plots were also hand-weeded each year. The test site was fall-irrigated each year prior to planting and then irrigated throughout the growing season, as determined by monitoring soil moisture. Flood irrigation delivered about 3 inches of water with each cycle, while sprinkler irrigation delivered about 1 inch of water with each cycle. Two groundwater wells were placed on the upper end and two wells on the lower end of each irrigation system, for a total of four wells. Ground water was sampled for nitrate-N content throughout the growing season by pumping each well dry, then collecting the recharge water. Samples of irrigation water and drainage water were also collected for evaluation of nitrate-N content.

Results

When analyzed across four years, sugarbeets under flood irrigation had the highest root yield, sucrose yield, and extractable sucrose with 175 lb/ac available N, although the yields achieved with 125 and 150 lb/ac available N were not significantly different (Table 1). When analyzed across four years, sugarbeets under sprinkler irrigation had greatest root yield, sucrose yield, and extractable sucrose with 125 lb/ac available N, although the yields achieved with 100 and 150 lb/ac available N were not significantly different. As the amount of applied N was increased under flood irrigation, sucrose loss to molasses increased slightly and percent extraction decreased slightly with each increase in applied N. Under sprinkler irrigation, sugarbeets at all applied N rates had significantly greater sucrose loss to molasses and significantly lower percent extraction, than sugarbeets with no applied N. 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 2). Nitrate-N concentrations in drainage water were greater than in irrigation water, indicating N loss to runoff.

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Table 1. Yield of sugarbeets with six N-rates from 2003 to 2006. Data analyzed across years using ANOVA.

Available N Soil nitrate-N (0-4 ft) + Applied N (lb/ac)	Irrigation	Sucrose Content (%)	Sucrose Loss to Molasses (%)	Extraction Efficiency (%)	Root Yield (t/ac)	Gross Sucrose Yield (lb/ac)	Extractable Sucrose (lb/ac)
*	flood	18.93	0.95	95.0	30.5	11430	10860
100	flood	18.79	0.97	94.8	31.5	11690	11080
125	flood	18.84	1.00	94.6	32.3	11990	11340
150	flood	18.63	1.05	94.3	32.5	11920	11230
175	flood	18.50	1.07	94.1	33.7	12240	11500
200	flood	18.39	1.07	94.1	31.6	11490	10820
Average		18.81	1.02	94.6	30.8	11470	10840
LSD (P=0.05)		0.29	0.06	0.40	1.20	500	492
*	sprinkler	19.13	0.99	94.8	30.3	11480	10880
100	sprinkler	18.59	1.13	93.8	31.9	11740	11020
125	sprinkler	18.60	1.13	93.9	32.9	12110	11370
150	sprinkler	18.47	1.14	93.8	31.9	11690	10960
175	sprinkler	18.34	1.13	93.8	31.4	11360	10650
200	sprinkler	18.20	1.15	93.6	31.0	11170	10460
Average		18.73	1.12	94.0	30.8	11430	10740
LSD (P=0.05)		0.37	0.09	0.63	1.6	593	573

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

Table 2. Nitrate-N concentrations (ppm) in groundwater (GW), irrigation water, and drainage water (from flood irrigation only) under flood and sprinkler irrigated sugarbeets.

2003	23-Jun	8-Jul	21-Jul	4-Aug	18-Aug	2-Sep	15-Sep
Flood GW	3.2	11.2	15.3	14.2	11.8	10.8	10.5
Sprinkler GW	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
Flood drainage 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
Flood GW	5.6	7.0	7.9	10.7	11.5	10.2	10.2
Sprinkler GW	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	
Flood drainage 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	
Flood GW	1.19	2.96	2.77	4.88	3.87	3.23	
Sprinkler GW	1.44	1.63	1.73	2.2	1.98	1.62	
Irrigation ditch	0.10	0.06	0.1	0.12	0.06	0.06	
Flood drainage ditch	0.91	0.32	0.71	3.21	1.44	1.12	
2006	17-Jun	26-Jun	10-Jul	24-Jul	7-Aug	21-Aug	4-Sep
Flood GW	8.5	8.8	8.5	9.5	9.6	10.5	8.6
Sprinkler GW	4.7	5.0	5.7	6.0	5.1	4.7	4.3
Irrigation ditch	0.2	0.3	<0.1	0.4	1.0	<0.1	1.1
Flood drainage ditch	0.7	0.6	1.0	0.5	0.2	2.3	0.3

Fertilizer Facts:

- Sugarbeets grown under sprinkler irrigation achieved greatest root and sucrose yield with lower rates of available N than sugarbeets grown under flood irrigation at the same rates of available N.
- Sprinkler irrigated sugarbeets had more impurities, greater sucrose loss to molasses and lower extraction than flood irrigated sugarbeets.
- Sugarbeets grown on clay soil under sprinkler irrigation need less applied N because less N is lost through leaching and runoff as compared to sugarbeets grown under flood irrigation.

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