Sugarbeet (*Beta vulgaris*) production under sprinkler and flood irrigation.

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Introduction

The lower Yellowstone River valley produces irrigated sugarbeet, mostly by furrow flood irrigation. Irrigated sugarbeet acreage in this area is increasing, and the potential for additional irrigated acres is great. Some acres now under flood irrigation are being converted to sprinkler irrigation, while newly developed irrigated acres are mostly under pivot sprinkler systems because of efficiency of this system.

This objectives of this study, now in its third year, are to compare yield and quality of sugarbeet produced under furrow-flood irrigation with sugarbeet produced under low-pressure sprinkler irrigation, and to evaluate ground water nitrates under the two irrigation systems.

Materials and methods

Sugarbeet 'B2398' was planted in 1997 and 'B1252' was planted in 1998. Sugarbeet was planted to stand in a commercial field on 6 May 1997 and 22 April 1998. Half of the field was irrigated using furrow flood irrigation (7.5 cm for each irrigation) and the other half was irrigated using a low-pressure overhead linear sprinkler system (2.0-2.5 cm for each irrigation). Irrigation dates are shown in Table 1. Precipitation amounts are shown in Table 2.

Two wells that reached the ground water were placed at each end of each irrigation system, for a total of eight wells. Ground water was sampled for nitrate content throughout the growing season. Water samples were collected by pumping each well dry, then collecting recharge water. Soil was sampled from each well site for nitrogen content before planting, and following harvest. Sugarbeet petioles were collected in 1998 and analyzed for nitrate content.

Sugarbeet samples were harvested from the upper and lower ends of each irrigation system for yield and quality determinations. Harvest sites were near well and soil sampling sites. Harvest dates were 25 September 1997 and 18 September 1998. Ground water data, soil data, and sugarbeet data were statistically compared using a single factor ANOVA.

Table 1. Irrigation dates.

1997		1998	
Sprinkler	Flood	Sprinkler	Flood
21 May	22 May	5 May	5 May
12 Jun	17 Jun	29 May	1 Jul
27 Jun	30 Jun	29 Jun	13 Jul
17 Jul	18 Jul	15 Jul	28 Jul
29 Jul	28 Jul	21 Jul	10 Aug
5 Aug	11 Aug	28 Jul	24 Aug
18 Aug	25 Aug	3 Aug	
		12 Aug	
		25 Aug	

Table 2. Precipitation in cm at the EARC in 1997 and 1998.

	1997	1998	50-year average
Oct-Mar	10.57	8.43	7.77
Apr	4.60	0.18	2.90
May	2.01	3.92	5.00
Jun	4.32	7.11	7.14
Jul	14.53	3.86	5.18
Aug	5.21	6.27	3.84
Sep	0.69	2.44	3.35

Results

Sugarbeet petioles were not collected in 1997. Petiole nitrate contents in 1998 decreased under both irrigation systems throughout the growing season (Table 3). By August, sugarbeet in the upper end of the field, especially under flood irrigation, had lower petiole nitrates, suggesting that N in the upper end of the flooded field had either leached below the root zone or moved down the field with irrigation water.

Table 3. Sugarbeet petiole nitrate concentrations, ppm – 1998.

Irrigation	Field site	Sample date 29 Jun	6 Aug	17 Aug
Flood	Upper	22,350	12,580	6,370
	Lower	22,950	12,300	12,650
Sprinkler	Upper	18,800	8,670	8,390
	Lower	19,850	10,810	10,785

No significant differences in plant population were detected between the two irrigation systems in either year (Table 4), although the population under the sprinkler was slightly greater in both years. Stands were lower in 1998 because of dry conditions at planting. Germination in 1998 was uneven, and plots were irrigated early to improve germination and emergence.

Sucrose content, root yield, and sucrose yield were not affected by irrigation system in either year (Table 4). Sucrose content was greater in 1997, but root yields and sucrose yields were greater in 1998. Different varieties were used in the two years. Root yields were slightly higher under flood irrigation in both years, but the difference was not statistically significant.

Sodium (Na), potassium (K) and amino-N were greater under sprinkler irrigation both years, but the difference was significant only in 1997 (Table 4). Because of the lower impurity contents, sugarbeet under the flood irrigation system had less loss to molasses and higher extraction both years, although the difference was significant only in 1997.

Table 4. Harvest stands, root and sucrose yield, and impurities of sugarbeet grown under sprinkler and flood irrigation.

	1997 Sprinkler	1997 Flood	1998 Sprinkler	1998 Flood	$LSD_{0.05}$
Harvest Stand, plants/ha	107200	100900	86400	80300	12660
Sucrose Content, Percent	17.20	18.32	15.74	15.18	1.20
Root yield, Mg/ha	48.4	51.3	58.2	59.6	6.3
Sucrose Yield, Kg/ha	8320	9420	9240	9060	1220
Na, ppm	564	312	710	688	233
K, ppm	1808	1627	1552	1429	169
Amino-N, ppm	402	267	268	188	82
Loss to Molasses	1.55	1.16	1.34	1.16	0.27
Percent Extraction	90.7	93.7	91.3	92.3	2.25

Concentration of nitrates was much greater in the ground water under flood irrigation than in the ground water under sprinkler irrigation in both years (Table 5). Nitrate concentration in the ground water increased sooner and more rapidly under flood irrigation than sprinkler irrigation, and remained high throughout the season. The greatest concentration of nitrates was detected under the lower end of the flood irrigated sugarbeet (data not shown), while little difference was detected in ground water nitrate concentration under the upper and lower end of the sprinkler irrigated sugarbeet.

Table 5. Ground water nitrates in ppm under sugarbeet grown under two irrigation systems. Value is an average of four wells under each irrigation system at each date.

	1997			1998	
Date	Sprinkler	Flood	date	Sprinkler	Flood
6 Jun	6.9	6.7	8 Jun	8.8	16.2
12 Jun	8.3	7.7	15 Jun	12.8	23.1
18 Jun	8.4	16.0	23 Jun	7.3	24.9
25 Jun	8.7	18.2	29 Jun	4.8	21.5
9 Jul	10.2	15.0	7 Jul	8.5	22.7
16 Jul	11.1	17.1	13 Jul	8.9	19.9
22 Jul	10.7	24.8	6 Aug	6.1	18.1
31 Jul	10.7	22.8	20 Aug	6.5	21.2
8 Aug	8.1	21.0	4 Sep	5.5	29.0
14 Aug	8.9	15.5	11 Sep	5.0	20.7

Soil was sampled to a depth of four feet following harvest in both years (Table 6). Soil phosphorus (P) content was lower following sugarbeet under sprinkler irrigation than sugarbeet under flood irrigation in 1997, and soil nitrogen (N) content was greater following sugarbeet under sprinkler than sugarbeet under flood in 1997, particularly at the upper end of the field (data not shown). Soil chemistry was similar under the two irrigation systems in 1998.

Table 6. Soil chemistry following sprinkler and flood irrigated sugarbeet.

	1997*		1998**	
	Sprinkler	Flood	Sprinkler	Flood
P, ppm, 0-15	12	25	25	25
K, ppm 0-15	516	519	544	507
N, kg/ha, 0-30 cm	22	15	11	11
N, kg/ha, 30-60 cm	7	8	7	7
N, kg/ha, 60-90 cm	7	7	7	7
N, kg/ha, 90-120 cm	9	7	7	7
N, kg/ha, 0-120 cm	45	37	32	32

* average of four soil cores

** average of six soil cores

Conclusion

Sugarbeet sucrose content, root yield and sucrose yield were not affected by type of irrigation, but sugarbeet under flood irrigation had lower impurities and greater extraction. Ground water under flood irrigation had greater nitrate concentration than ground water under sprinkler irrigation, especially at the lower end of the field. These data suggest that flood irrigation leached nitrogen below the root zone, or moved it to the lower end of the field or off the field as run-off. Sugarbeet under sprinkler irrigation may need less nitrogen because of less leaching and run-off. This research will continue.