ECKHOFF, J.L.A.*, and J.W. BERGMAN, Montana State University, Eastern Agricultural Research Center, 1501 N. Central Ave., Sidney, MT 59270. **Sugarbeet (*Beta vulgaris*) production under sprinkler and flood irrigation.**

Introduction and objectives: 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 sprinkler systems because of efficiency of this system.

This objectives of this study, now in its fifth 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 was planted to stand in a commercial field at the MSU Eastern Agricultural Research Center from 1997-2000. 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 in Table 1, precipitation amounts are in Table 2, varieties, planting and harvest dates are in Table 3.

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 during the growing season. Water samples were collected by pumping each well dry, then collecting recharge water. Irrigation and run-off water was also collected for evaluation of nitrate content. Soil was sampled from each well site for nitrogen content before planting, and following harvest.

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. Ground water data, soil data, and sugarbeet data were statistically compared using a single factor ANOVA.

Table 1. Irrigation dates.

1997		1998		1999		2000	
Sprinkler	Flood	Sprinkler	Flood	Sprinkler	Flood	Sprinkler	Flood
21 May	22 May	5 May	5 May	28 Jun	1 Jul	25 Apr	3 May
12 Jun	17 Jun	29 May	1 Jul	12 Jul	22 Jul	14 Jun	26 Jun
27 Jun	30 Jun	29 Jun	13 Jul	21 Jul	5 Aug	28 Jun	14 Jul
17 Jul	18 Jul	15 Jul	28 Jul	4 Aug	19 Aug	18 Jul	26 Jul
29 Jul	28 Jul	21 Jul	10 Aug	18 Aug	1 Sep	28 Jul	7 Aug
5 Aug	11 Aug	28 Jul	24 Aug	26 Aug		18 Aug	18 Aug
18 Aug	25 Aug	3 Aug		2 Sep		7 Sep	28 Aug
		12 Aug				14 Sep	
		25 Aug					

Table 2. Precipitation in cm at the EARC.

	1997	1998	1999	2000	52-year average
Oct-Mar	10.57	8.43	17.98	3.89	7.75
Apr	4.60	0.18	1.27	2.13	2.84
May	2.01	3.92	6.65	3.89	5.00
Jun	4.32	7.11	10.90	5.13	7.16
Jul	14.53	3.86	7.75	8.28	5.28
Aug	5.21	6.27	1.83	2.21	3.73
Sep	0.69	2.44	3.51	2.87	3.33

Table 3. Planting and harvest dates.

	1997	1998	1999	2000
Planting date	6 May	22 Apr	28 Apr	21 Apr
Harvest Date	25 Sep	18 Sep	21 Sep	18 Sep
Variety	Beta 2398	Beta 1252	HH 112	Beta 2185

Results and discussion: Plant population under sprinkle irrigation was significantly greater than population under flood irrigation in 2000, and was greater, but not significantly so in 1997 and 1998 (Table 4). Stands were lower in general in 1998 and 2000 because of dry conditions at planting (Table 2). Plots were irrigated early in those years to improve emergence (Table 1).

Sucrose content, root yield, and sucrose yield of flood irrigated sugarbeets were significantly greater than that of sprinkler irrigated sugarbeet in 1997 and 1999, while impurities of the flood irrigated beets were lower than impurities of the sprinkler irrigated beets in those years (Table 4). Sodium (Na) and amino-N were greater under sprinkler irrigation in three of the four years, and potassium (K) was greater under sprinkler irrigation in two of the four years. Because of the lower impurity contents, sugarbeet under the flood irrigation system had less loss to molasses and higher extraction in 1997, 1999 and 2000.

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

	1997		1998		1999		2000	
	Spr	Fld	Spr	Fld	Spr	Fld	Spr	Fld
Tare	0.94	0.94	0.91	0.91	0.84a	0.91b	0.89a	0.94b
Harvest Stand, plants/ha	107266	100910	86432	80293	95641	99145	85538b	75459a
Sucrose Content, %	17.20a	18.32b	15.74	15.18	16.23a	17.88b	17.83	18.51
Root yield, Mg/ha	48.4a	51.3b	58.2	59.6	56.0a	66.3b	69.9	63.8
Sucrose Yield, kg/ha	8324a	9423b	9237	9060	9117a	11879b	12488	11880
Na, ppm	564b	312a	710	688	538b	266a	316b	224a
K, ppm	1808b	1627a	1552	1429	1923b	1795a	1704	1690
Amino-N, ppm	402b	267a	268	188	295b	161a	208b	146a
Loss to Molasses	1.55b	1.16a	1.34	1.16	1.42b	1.04a	1.10b	0.96a
Percent Extraction	90.7a	93.7b	91.3	92.3	91.2a	94.1b	93.8a	94.8b

Different letters behind values in the same year indicate significant difference at $p<0.05$.

Concentration of nitrate was much greater in ground water under flood irrigation than in ground water under sprinkler irrigation in 1997 and 1998 (Table 5). Ground water nitrate under sprinkle irrigation was greater early in the season in 1999, but nitrate concentration under flood irrigation increased throughout the season, while nitrate concentration under the sprinkler remained fairly constant. 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 nitrate 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.

Sprinkle and flood irrigation water and run-off water from flood irrigation were analyzed for nitrate content. Sprinkler irrigation produced no run-off. Irrigation water contained very little nitrate, while run-off water always contained at least twice the concentration of nitrates as the irrigation water (Table 5).

Table 5. Nitrates in irrigation, run-off, and ground water in ppm under sugarbeet grown under two irrigation systems. Ground water values are average of 4 wells under each irrigation system at each date. Samples from 2000 have not been analyzed yet.

1997					1998					1999				
Date	Spr	Fld	Irr H_2O	Run -off	Date	Spr	Fld	Irr H_2O	Run -off	Date	Spr	Fld	Irr H_2O	Run -off
6 Jun	6.9	6.7			8 Jun	8.8	16.2			2 Jun	10.5	4.0		
25 Jun	8.7	18.2			7 Jul	8.5	22.7			1 Jul			0.2	0.4
30 Jun			0.2	2.6	13 Jul			0.4	1.9	7 Jul	10.1	7.6		
18 Jul			0.4	1.0	6 Aug	6.1	18.1			4 Aug	12.7	8.7		
22 Jul	10.7	24.8			10 Aug			0.1	2.7	5 Aug			<0.1	2.6
28 Jul			0.5	1.2	4 Sep	5.5	29.0			19 Aug			0.5	1.0
11 Aug			0.1	2.6						17 Sep	8.8	9.9		
14 Aug	8.9	15.5												

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

	1997*		1998**		1999**		2000**	
	Spr	Fld	Spr	Fld	Spr	Fld	Spr	Fld
P, ppm, 0-15	12	25	25	25	18	21	17	19
K, ppm 0-15	516	519	544	507	494	498	548	378
N, kg/ha, 0-30 cm	22	15	11	11	11	12	16	12
N, kg/ha, 30-60 cm	7	8	7	7	8	8	7	7
N, kg/ha, 60-90 cm	7	7	7	7	8	7	7	7
N, kg/ha, 90-120 cm	9	7	7	7	9	7	7	7
N, kg/ha, 0-120 cm	45	37	32	32	36	32	37	33

* average of four soil cores for each treatment; ** average of six soil cores for each treatment

Soil was sampled to a depth of 120 cm following harvest (Table 6). Soil phosphorus (P) content was lower following sugarbeet under sprinkler irrigation than sugarbeet under flood irrigation in 1997 and soil K was lower under flood irrigation in 2000.

Conclusions: Sugarbeet had greater sucrose content, root yield and sucrose yield, lower impurities and greater extraction under flood irrigation than under sprinkler irrigation. Ground water under flood irrigation had greater nitrate concentration than ground water under sprinkler irrigation, especially at the lower end of the field. Run-off water from flood irrigation had greater nitrate concentration than the irrigation water applied to 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.