EVALUATION OF TWO AUTOMATED IRRIGATION SCHEDULING METHODS FOR DRIP IRRIGATED POTATO

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Introduction

Irrigation scheduling for potato can use soil water tension, soil water content, or crop evapotranspiration estimates. Measurement of evapotranspiration and the use of an allowable soil water depletion value can be used to automatically schedule irrigations. Netafim (Fresno, CA) has developed an irrigation scheduling method for potato using evapotranspiration estimates. The Malheur Experiment Station has developed soil water tension criteria for automatically or manually initiating potato irrigations. A range of soil water tensions were evaluated for their effect on potato yield, grade and processing quality under furrow, sprinkler, and drip irrigation on silt loam soil. For furrow or sprinkler irrigated potato the ideal irrigation criterion is 50 to 60 cb (Eldredge et al., 1992; Shock et al., 1993, 2003). For drip irrigation, which uses a higher irrigation frequency, the ideal criterion is 25 to 30 cb (Shock et al., 2002). Soil water tension has been measured using granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA). Granular matrix sensors were calibrated to soil water tension (Shock, 2003). Granular matrix sensors are inexpensive, require little maintenance, and can be used to schedule irrigations automatically using controllers and electric valves. This trial tested two automatic drip irrigation scheduling methods with two new processing potato varieties (Payette Russet and Clearwater Russet).

Methods

The trial was conducted on an Owyhee silt loam previously planted to wheat at the Malheur Experiment Station, Ontario, Oregon. A soil analysis taken in the fall of 2017 showed that the top foot of soil had a pH of 7.8, 2.6% organic matter, 8 ppm nitrate-N, 3 ppm ammonium-N, 37 ppm phosphorus (P), 469 ppm potassium (K), 16 ppm sulfur (S), 3243 ppm calcium (Ca), 563 ppm magnesium (Mg), 278 ppm sodium, 7 ppm zinc (Zn), 4 ppm manganese (Mn), 2.4 ppm copper (Cu), 11 ppm iron, and 0.3 ppm boron (B). In the fall of 2017, the wheat stubble was shredded and the field was irrigated. The field was then disked, moldboard plowed, and groundhogged. Based on the soil analysis, 25 lb of N/acre as urea 44 lb of P/acre as monoammonium phosphate, 104 lb of K/acre as potassium chloride, 200 lb of S/acre as elemental sulfur, 7 lb of Mn/acre as manganese sulfate, 1 lb of Cu/acre as copper sulfate, 1 lb per acre Zn as zinc sulfate, and 4 lb of B/acre as Granubor II were broadcast before plowing.

Following plowing, the field was fumigated with 20 gal/acre of Telone® II (dichloropropene) and bedded on 36-inch row spacing.

On March 29, 2018, 100 lb N as urea and Admire® (Imidacloprid) at 7 oz/acre (0.25 lb ai/acre) was shanked into both sides of the beds at 6-inch depth. On April 3, seed of Payette Russet and Clearwater Russet was cut by hand into 2.5-oz seed pieces, treated with Maxim® MZ (fludioxonil, mancozeb) dust, and stored to suberize. To accelerate inherent slow sprouting, Payette Russet seed pieces were dipped for five minutes in a solution of 2 mg of giberellic acid/liter prior to application of Maxim MZ dust.

The experimental design was a randomized complete block design with two treatments, two variety split plots, and six replicates. The treatments were two automated irrigation scheduling methods: 1) irrigation scheduling based on soil water tension (OSU), 2) irrigation scheduling based on potato evapotranspiration (Netbeat). Main plots were six potato rows wide by 80 ft long. Each main plot was divided into two variety split plots (Payette Russet and Clearwater Russet).

Potato seed pieces were planted on April 4-5 using a using a 2-row assist-feed planter with 9-inch seed spacing in 36-inch rows. Red potatoes were planted between variety split plots as markers to separate the split plots at harvest.

After planting, the plots were reconfigured by slightly flattening the 36-inch hills to create 72-inch beds with two potato rows. Drip tape was installed 2 inches deep and 4 inches to the inside of each potato row. The drip tape (Dripnet PC, Netafim, Fresno, CA) had emitters spaced 12 inches apart and an emitter flow rate of 0.16 gal/hour at 10 psi.

After all bed preparation operations were finished, a sprinkler irrigation system was installed and herbicide was broadcast on the whole field using a ground sprayer. Herbicide was a mixture of 1.33 pints per acre (1.3 lb ai) of Dual II Magnum® (metolachlor), 2 pints (0.83 lb ai) per acre of Prowl® (pendimethalin), and 32 oz/acre of Roundup®. The herbicides were incorporated by applying 0.75 inch of water to the whole field with the sprinkler irrigation system. After the herbicide was incorporated, the sprinkler system was removed and the drip irrigation system for the treatments was connected. The field was sprayed with Matrix® herbicide (rimsulfuron) at 1.5 oz/acre (0.4 oz ai/acre) on May 22.

Soil water tension in all main plots of all treatments was measured using four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA) in Clearwater Russet split plots. The sensors were installed at 8-inch depth below each of the middle two potato rows in each Clearwater Russet split plot. The datalogger (CR1000, Campbell Scientific, Logan, UT) read and recorded the SWT every hour.

The OSU treatment was irrigated automatically using the datalogger based on soil water tension (SWT) feedback. The datalogger automatically irrigated all plots in the OSU treatment when the average SWT of all OSU treatment plots reached or exceeded 25 cb. Irrigation durations were 7 hours to apply 0.6 inches of water. The datalogger made irrigation decisions every 8 hours. The datalogger controlled the irrigations for the OSU treatment using a controller (SDM CD16AC controller, Campbell Scientific) and solenoid valves (Rainbird, Azusa, CA). Automatic irrigations were started on May 31 and terminated on September 2.

The Netbeat treatment was irrigated automatically based on potato evapotranspiration using a controller (NMC-Junior Pro Irrigation, Netafim).

The water for the drip system was supplied by a well that maintained a continuous and constant water pressure of 30 psi. Water applied to each treatment was measured by totalizing flow meters (model M, Netafim) read five times per week. The total water applied to each treatment was measured from emergence to the last irrigation on September 2. Approximately 2 inches of water were applied uniformly to each treatment from emergence to the start of automated irrigations on May 31. Potato evapotranspiration (ET_c) was calculated with a modified Penman equation (Wright, 1982) using data collected at the Malheur Experiment Station by an AgriMet weather station. Potato ET_c was estimated and recorded from crop emergence on May 6 until September 9.

Plant nutrition was monitored by weekly petiole and soil solution analyses starting June 8 and ending August 10 (Tables 2, 3, and 4). To avoid damage to the harvest rows, petiole and soil samples were collected from the border rows in each split plot. Composite petiole and soil samples were made that combined the samples from all the replicates of each variety in each treatment. The petiole and soil samples were analyzed by Western Laboratories, Inc., Parma Idaho. Plant nutrients were applied through the drip system to the respective treatments only if both the root tissue and soil solution analyses concurrently indicated a deficiency (Table 5).

The potatoes were sprayed aerially on June 12 and June 27 with the fungicide Bravo® (chlorothalonil) at 1 pt/acre (0.75 lb ai/acre). The field was sprayed aerially on July 28 and August 20 with the insecticides Agri-Mek® (abamectin) at 3.5 oz/acre (0.02 lb ai/acre) and Movento® (Spirotetramat) at 5 oz/acre (0.08 lb ai/acre).

On August 21, plants in each split plot were evaluated subjectively for maturity.

The potato vines were flailed on October 1. Thirty feet of the middle four rows of each variety split plot in each main plot were harvested on October 15. All tubers from each split plot were placed into burlap sacks and placed in a barn where they were kept under tarps. All sacks from each split plot were weighed. Four sacks from a representative area in each split plot were selected for grading. Tubers were graded by market class (U.S. No. 1 and U.S. No. 2) and weight (<4 oz, 4-6 oz, 6-10 oz, 10-20 oz, and >20 oz). Tubers were graded as U.S. No. 2 if any of the following conditions occurred: growth cracks, bottleneck shape, abnormally curved shape, or two or more knobs. Marketable tubers are U.S. No. 1 and U.S. No. 2 larger than 4 oz. A 20-tuber sample from each split plot was placed into storage. The storage temperature was gradually reduced to 45°F.

After 6 weeks in storage, a 10-tuber sample from each plot was evaluated for specific gravity, fry color, and internal defects. Ten tubers per plot were cut lengthwise and the center slices from each tuber were fried for 2.5 min in 375°F soybean oil. Percent light reflectance was measured on the stem and bud ends of each slice. Percent light reflectance was measured using a Photovolt Reflectance Meter model 577-A (Photovolt Instruments, Minneapolis, MN), with a green tristimulus filter, calibrated to read 0% light reflectance on the black standard cup and 71.7% light reflectance on the white porcelain standard plate. Specific gravity of all varieties was measured from a 10-tuber sample from each plot using the weight-in-air, weight-in-water method.

On January 24, 2019, ten tubers from each split plot of the OSU and Netbeat treatments were analyzed for nutrient content and moisture. Tuber nutrient content and moisture were used to calculate tuber nutrient uptake in the harvested yield.

Data were analyzed with the General Linear Models analysis of variance procedure using NCSS (Number Cruncher Statistical Systems, Kaysville, UT) using Fisher's protected LSD (least significant difference) for means separation at the 95% confidence level.

Results and Discussion

The petiole NO_3 concentration for Payette Russet remained above the critical level during the season for both irrigation scheduling systems (Fig. 1). For Clearwater Russet, the petiole NO_3 concentration remained close to the critical level during the season for both irrigation scheduling systems (Fig. 2). The soil solution nitrogen concentration remained above the critical level all season for both varieties with both irrigation scheduling systems (Fig. 3). A total of 25 lb N/acre was applied through the drip tape during the season (Table 1). Despite the limited amount of N applied during the season, the soil contained substantial amounts of total available N (Table 2). Previous research has shown that with carefully scheduled irrigations, N fertilizer requirements for potato are low (Feibert et al., 1998). Soil solution and petiole analyses for the other nutrients are found in tables 3 and 4 and the amounts of nutrients applied based on the analyses are in table 2.

Treatment differences

The three irrigation scheduling systems maintained the soil water tension around the target values (Fig. 4). The OSU irrigation scheduling applied 41 irrigations and on average each irrigation applied 0.79 inches of water (Table 5). The Netbeat and Arable irrigation scheduling applied fewer irrigations (29 and 26 irrigations, respectively) and on average each irrigation applied 1.1 inches and 1.3 inches of water, respectively.

From crop emergence on May 6 until the last irrigation, potato ET_c totaled 31.5 inches and precipitation totaled 1.05 inches. The total amounts of water applied plus precipitation were similar: 33.4, 33.5, and 33.5 inches for the OSU, Netbeat, and Arable irrigation scheduling, respectively (Table 5). All three irrigation scheduling systems applied water at a rate that closely tracked ET_c (Fig. 5).

There were no statistically significant differences in yield or grade between irrigation scheduling systems, except for yield of tubers 4 to 6 oz (Table 6). The Netbeat irrigation scheduling had slightly lower yield of tubers 4 to 6 oz than the other irrigation scheduling systems. There was no statistically significant difference in water use efficiency between irrigation scheduling systems. There was no statistically significant difference in tuber fry color and specific gravity between irrigation scheduling systems. The only internal tuber defect encountered was internal brown spot, with no statistically significant difference between treatments.

There was no statistically significant difference between treatments in tuber nutrient content or tuber nutrient uptake (Tables 7 and 8).

Variety differences

Averaged over treatments, Clearwater Russet had higher total and marketable yield than Payette Russet (Table 6). Averaged over treatments, Clearwater Russet had higher yield of larger tubers than Payette Russet. Payette Russet had higher yields of smaller tubers than Clearwater Russet. There was no statistically significant difference in tuber fry color and specific gravity between

varieties. There was no statistically significant difference in the percentage of tubers with internal brown spot between varieties.

Averaged over treatments, the harvested tubers of Clearwater Russet removed 275 lb/acre of nitrogen and 433 lb/acre of potassium, considerably more than the amounts of fertilizer applied. Clearwater Russet had higher tuber concentrations of potassium and magnesium than Payette Russet (Table 7). Based on total yield, Clearwater Russet had higher tuber uptake of nitrogen, phosphorus, potassium, sulfur, magnesium, and boron than Payette Russet (Table 8).

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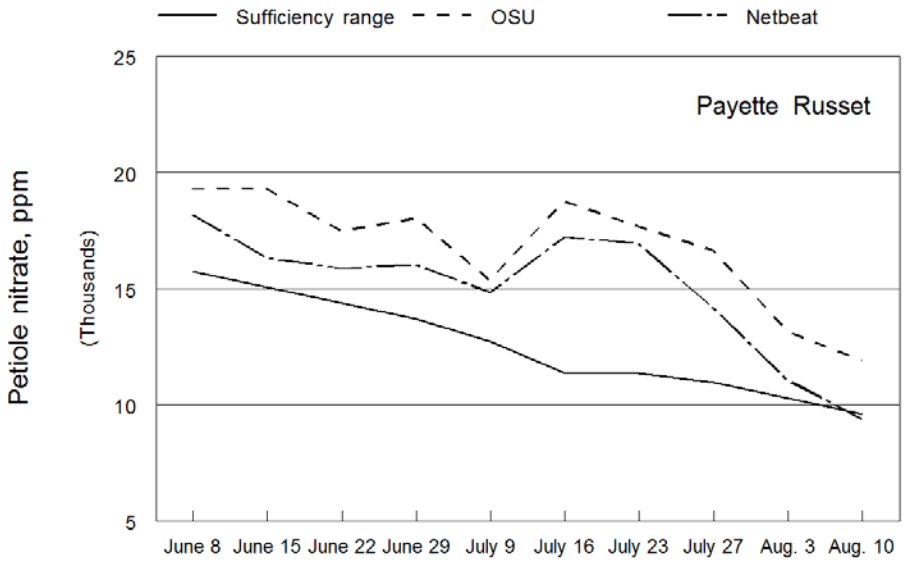

Figure 1. Payette Russet petiole nitrate over time with two irrigation scheduling treatments. Malheur Experiment Station, Oregon State University, Ontario, OR.

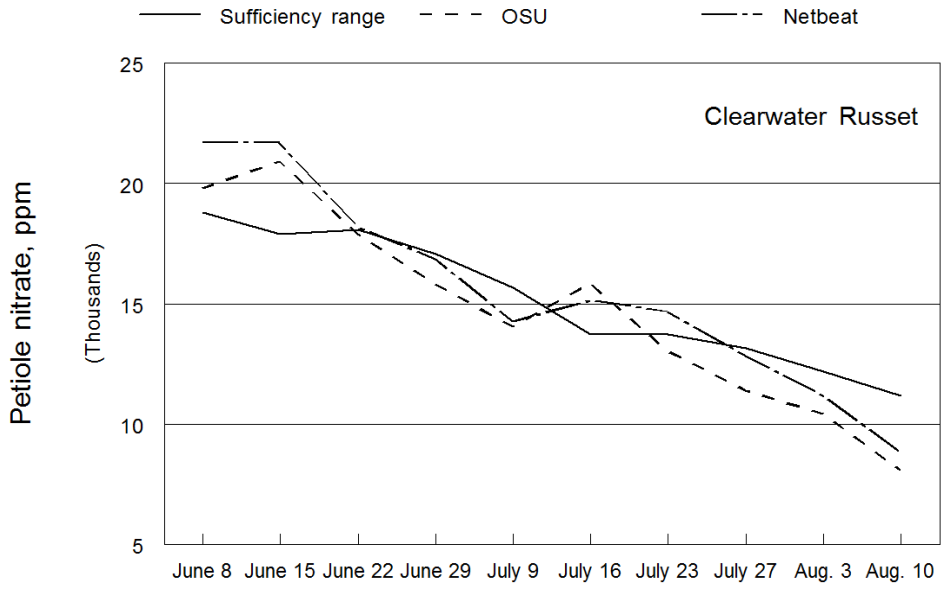

Figure 2. Clearwater Russet petiole nitrate over time with two irrigation scheduling treatments. Malheur Experiment Station, Oregon State University, Ontario, OR.

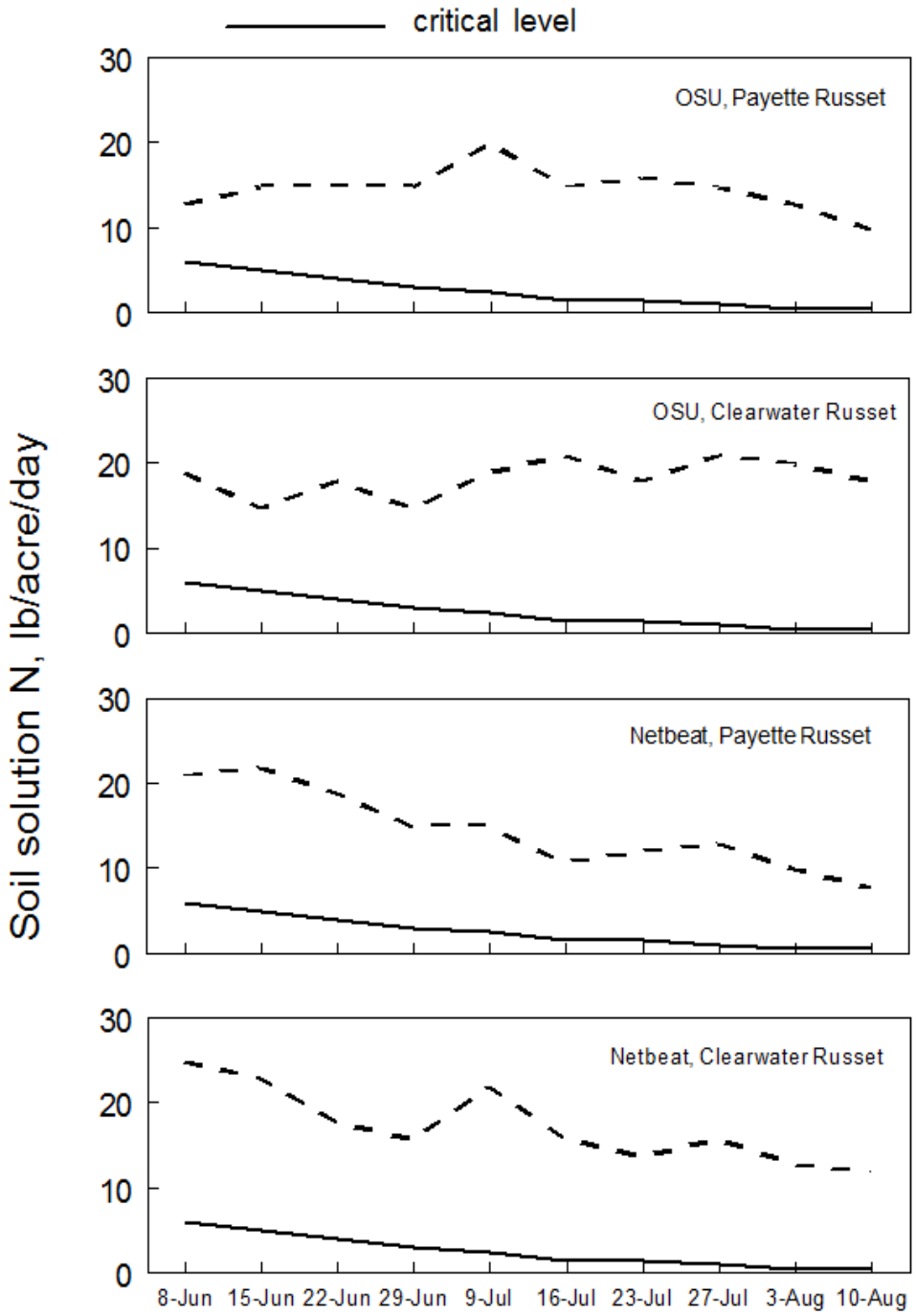

Figure 3. Soil solution nitrogen over time with two irrigation scheduling treatments and two varieties. Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 1. Nutrients applied to two potato varieties with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

Date	N	K	Mg	Mn	S
13-Jun			5	0.25	
20-Jun		5	5		
29-Jun	10	10	3		
5-Jul	15	10	3		5
20-Jul		18			
25-Jul		15			
30-Jul		10			
7-Aug		10			
14-Aug		20			
Total	25	98	16	0.25	5

Nitrogen was applied as Uran (32% N), potassium as potassium chloride, manganese was applied as manganese carbonate (5%), magnesium was applied as magnesium carbonate (3%), and sulfur as elemental sulfur (52%).

Table 2. Total available soil N for two potato varieties with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

	OSU		Netbeat	
Date	Payette Russet	Clearwater Russet	Payette Russet	Clearwater Russet
		-------- lb/acre ---------		
8-Jun	93	132	144	174
15-Jun	108	105	156	162
22-Jun	102	129	132	129
29-Jun	105	108	105	114
9-Jul	138	135	108	153
16-Jul	102	144	75	114
23-Jul	114	126	84	99
27-Jul	102	147	90	114
3-Aug	90	141	69	90
10-Aug	72	126	57	81

Table 3. Potato petiole analyses for two varieties with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

	OSU		Netbeat	
Date	Payette Russet	Clearwater Russet	Payette Russet	Clearwater Russet
		P, 0.2 - 0.55 %		
8-Jun	0.7	0.61	0.69	0.64
15-Jun	0.71	0.69	0.72	0.67
22-Jun	0.74	0.54	0.67	0.6
29-Jun	0.47	0.59	0.59	0.46
9-Jul	0.55	0.38	0.51	0.43
16-Jul	0.36	0.30	0.36	0.31
23-Jul	0.29	0.25	0.28	0.26
27-Jul	0.26	0.24	0.28	0.21
3-Aug	0.29	0.26	0.26	0.3
10-Aug	0.3	0.25	0.25	0.26
		K, 7.5 - 15%		
8-Jun	10.0	8.6	9.1	8.3
15-Jun	8.8	9.1	9.2	8.9
22-Jun	9.3	9.1	8.9	9.5
29-Jun	10.0	10.8	10.7	10.6
9-Jul	9.4	9.3	9.5	9.9
16-Jul	8.3	8.2	8.5	8.5
23-Jul	6.6	6.6	7.6	8.6
27-Jul	7.8	7.5	7.8	7.9
3-Aug	8.3	7.5	7.5	7.7
10-Aug	6.7	7.5	7.0	6.9
		S, 0.2 - 0.55%		
8-Jun	0.28	0.3	0.31	0.29
15-Jun	0.32	0.36	0.31	0.33
22-Jun	0.37	0.31	0.33	0.30
29-Jun	0.31	0.40	0.38	0.34
9-Jul	0.35	0.29	0.31	0.31
16-Jul	0.35	0.35	0.39	0.29
23-Jul	0.35	0.37	0.38	0.34
27-Jul	0.38	0.41	0.41	0.28
3-Aug	0.39	0.32	0.37	0.3
10-Aug	0.37	0.29	0.39	0.3
		Ca, 0.45 - 2%		
8-Jun	1.22	0.82	1.21	0.95
15-Jun	1.11	0.87	1.18	0.89
22-Jun	1.35	1.11	1.36	0.99
29-Jun	1.46	1.28	1.56	1.08
9-Jul	1.83	1.35	1.58	1.26
16-Jul	2.14	1.46	1.98	1.41
23-Jul	1.72	1.62	1.77	1.46
27-Jul	2.06	2.05	2.08	1.55
3-Aug	2.31	2.22	1.89	1.74
10-Aug	1.9	2.06	1.8	1.6
		Mg, 0.4 - 1.7%		
8-Jun	0.42	0.37	0.42	0.47
15-Jun	0.37	0.35	0.39	0.37
22-Jun	0.42	0.41	0.41	0.4
29-Jun	0.50	0.50	0.43	0.43
9-Jul	0.54	0.56	0.44	0.46
16-Jul	0.66	0.52	0.55	0.51
23-Jul	0.54	0.56	0.55	0.50
27-Jul	0.68	0.72	0.64	0.62
3-Aug	0.71	0.70	0.5	0.60
10-Aug	0.66	0.70	0.61	0.52

Table 3. (Continued.) Potato petiole analyses for two varieties with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

	OSU		Netbeat	
Date	Payette Russet	Clearwater Russet	Payette Russet	Clearwater Russet
	---------- Zn, 23 - 55 ppm ----------			
8-Jun	52	58	75	61
15-Jun	40	54	69	71
22-Jun	32	50	58	68
29-Jun	41	41	53	62
9-Jul	42	52	65	74
16-Jul	50	42	52	66
23-Jul	35	37	40	51
27-Jul	42	27	34	41
3-Aug	40	31	32	41
10-Aug	47	37	39	32
	---------- Mn, 33 - 70 ppm ----------			
8-Jun	101	96	90	80
15-Jun	79	82	82	77
22-Jun	88	77	65	72
29-Jun	71	65	67	60
9-Jul	69	72	62	71
16-Jul	68	85	68	84
23-Jul	68	81	50	77
27-Jul	84	83	50	86
3-Aug	93	62	58	94
10-Aug	84	57	41	92
	---------- Cu, 5 - 30 ppm ----------			
8-Jun	21	24	27	23
15-Jun	19	17	21	21
22-Jun	16	15	18	18
29-Jun	13	12	13	14
9-Jul	12	11	13	11
16-Jul	11	10	12	9
23-Jul	10	8	11	8
27-Jul	9	8	9	6
3-Aug	7	9	7	7
10-Aug	7	9	8	7
	---------- B, 21 - 55 ppm ----------			
8-Jun	61	60	52	53
15-Jun	79	45	37	42
22-Jun	63	35	31	37
29-Jun	52	41	32	44
9-Jul	46	44	41	32
16-Jul	45	57	48	40
23-Jul	32	48	34	33
27-Jul	39	55	38	40
3-Aug	40	53	37	52
10-Aug	37	42	35	43

Table 4. Soil solution analyses for two potato varieties with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

	OSU		Netbeat	
Date	Payette Russet	Clearwater Russet	Payette Russet	Clearwater Russet
	---------- P, 0.6 lbs ----------			
8-Jun	1.10	2.20	1.60	2.30
15-Jun	1.60	1.30	2.10	1.50
22-Jun	2.40	1.10	2.30	2.20
29-Jun	2.50	1.50	2.80	1.90
9-Jul	1.60	1.50	2.50	1.60
16-Jul	1.90	1.70	2.00	1.30
23-Jul	1.90	1.80	2.00	1.80
27-Jul	2.00	2.20	1.20	1.90
3-Aug	1.60	1.90	1.60	1.70
10-Aug	1.30	1.50	1.20	2.00
	---------- K, 7 lbs ----------			
8-Jun	6.5	9.8	10.2	11.2
15-Jun	5.5	11.2	9.2	8.5
22-Jun	5.0	10.3	7.0	7.8
29-Jun	4.3	7.9	6.1	7.4
9-Jul	4.9	6.6	5.3	6.4
16-Jul	4.6	5.8	5.1	5.1
23-Jul	5.0	6.1	5.6	6.0
27-Jul	5.6	7.2	6.5	6.3
3-Aug	4.6	5.6	5.8	5.1
10-Aug	5.4	4.8	4.7	5.1
	---------- S, 2 lbs ----------			
8-Jun	5.1	4.2	3.0	3.3
15-Jun	4.9	3.9	4.0	2.9
22-Jun	5.3	4.3	4.6	3.1
29-Jun	4.8	2.5	2.5	2.8
9-Jul	4.1	3.7	3.4	3.8
16-Jul	3.7	3.6	3.5	2.0
23-Jul	4.0	2.0	4.1	1.2
27-Jul	6.0	2.9	5.9	1.8
3-Aug	3.9	3.3	3.2	2.2
10-Aug	3.5	3.2	1.6	2.6
	---------- Ca, 3 lbs ----------			
8-Jun	6.2	6.2	6.4	5.9
15-Jun	6.4	5.0	6.2	4.8
22-Jun	4.9	5.3	5.0	5.5
29-Jun	4.8	5.1	5.4	5.4
9-Jul	3.8	4.3	5.8	4.3
16-Jul	4.4	5.0	6.1	5.3
23-Jul	4.6	3.8	4.7	4.6
27-Jul	4.6	4.6	4.7	4.6
3-Aug	5.2	5.3	4.8	4.8
10-Aug	4.9	5.1	4.0	4.5
	---------- Mg, 1 lb ----------			
8-Jun	0.5	0.4	0.5	0.4
15-Jun	0.4	0.5	0.5	0.3
22-Jun	0.7	0.5	0.8	0.5
29-Jun	0.8	0.6	0.8	0.6
9-Jul	0.8	0.7	1.0	0.8
16-Jul	1.0	0.8	1.2	0.9
23-Jul	1.3	1.1	1.3	1.0
27-Jul	1.1	1.3	1.2	1.1
3-Aug	0.9	1.0	1.1	0.9
10-Aug	0.9	0.9	0.8	0.8

Table 4. (Continued.) Soil solution analyses for two potato varieties with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

	OSU		Netbeat	
Date	Payette Russet	Clearwater Russet	Payette Russet	Clearwater Russet
	---------- Zn, 56 g ----------			
8-Jun	183	168	156	141
15-Jun	135	126	180	123
22-Jun	168	96	168	129
29-Jun	147	78	141	129
9-Jul	108	96	105	105
16-Jul	87	117	75	90
23-Jul	72	123	90	75
27-Jul	90	96	105	96
3-Aug	66	78	81	78
10-Aug	66	57	69	60
	---------- Mn, 40 g ----------			
8-Jun	15	66	69	42
15-Jun	18	78	60	30
22-Jun	18	57	42	24
29-Jun	21	75	54	33
9-Jul	27	93	48	42
16-Jul	33	81	60	54
23-Jul	36	105	63	66
27-Jul	33	84	54	48
3-Aug	39	69	42	39
10-Aug	33	60	45	33
	---------- Cu, 28 g ----------			
8-Jun	129	162	144	78
15-Jun	117	135	117	90
22-Jun	108	132	102	96
29-Jun	96	99	96	90
9-Jul	81	84	69	81
16-Jul	75	75	60	69
23-Jul	78	84	69	78
27-Jul	60	72	57	63
3-Aug	54	54	51	57
10-Aug	48	45	39	66
	---------- B, 28 g ----------			
8-Jun	21	14	17	23
15-Jun	15	15	15	20
22-Jun	20	17	12	24
29-Jun	24	20	18	32
9-Jul	29	23	23	33
16-Jul	36	21	18	30
23-Jul	32	27	23	32
27-Jul	38	30	27	36
3-Aug	27	26	23	26
10-Aug	23	20	18	23

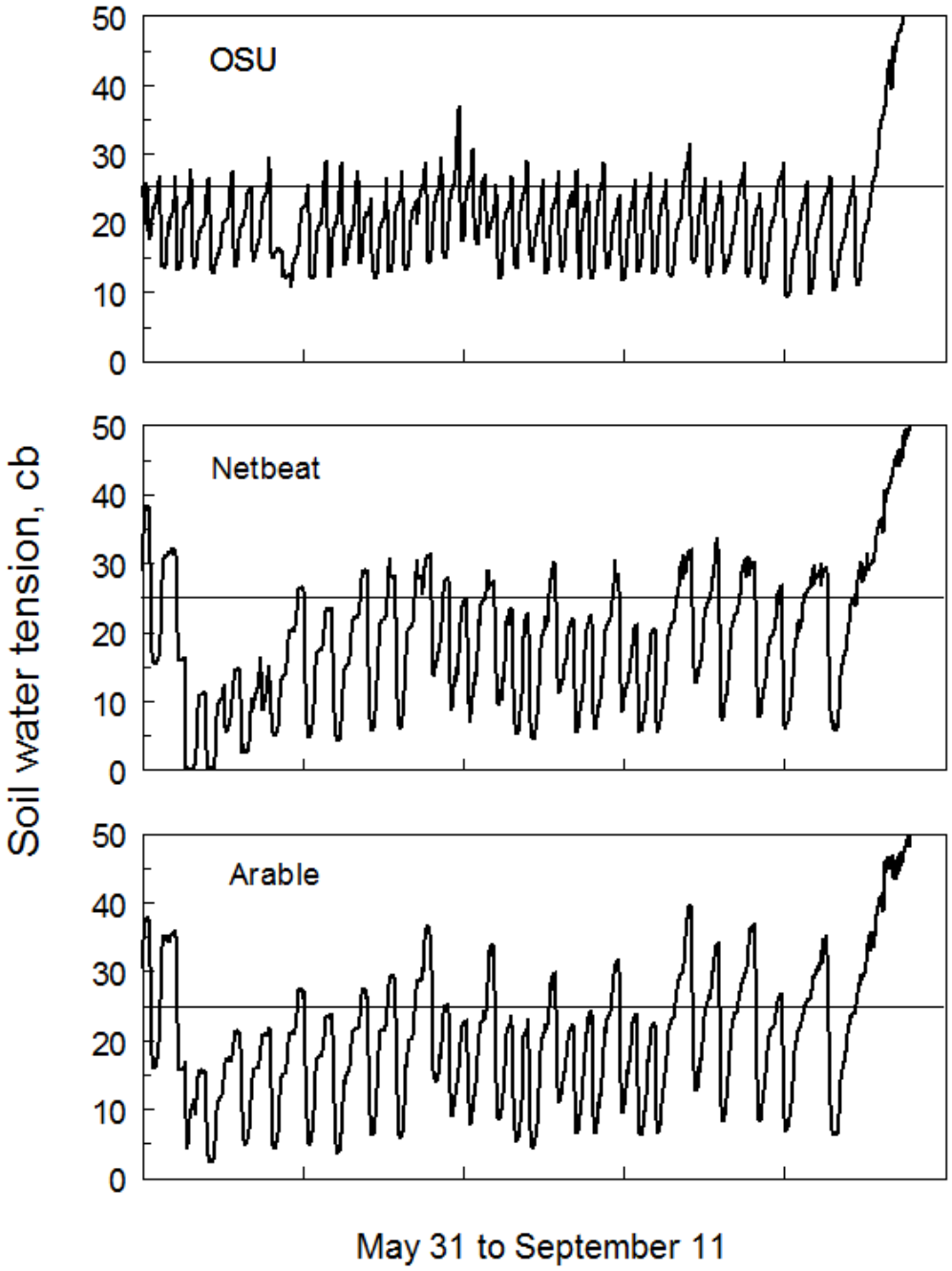

Figure 4. Soil water tension at 8-inch depth for three irrigation scheduling treatments. Malheur Experiment Station, Oregon State University, Ontario, OR.

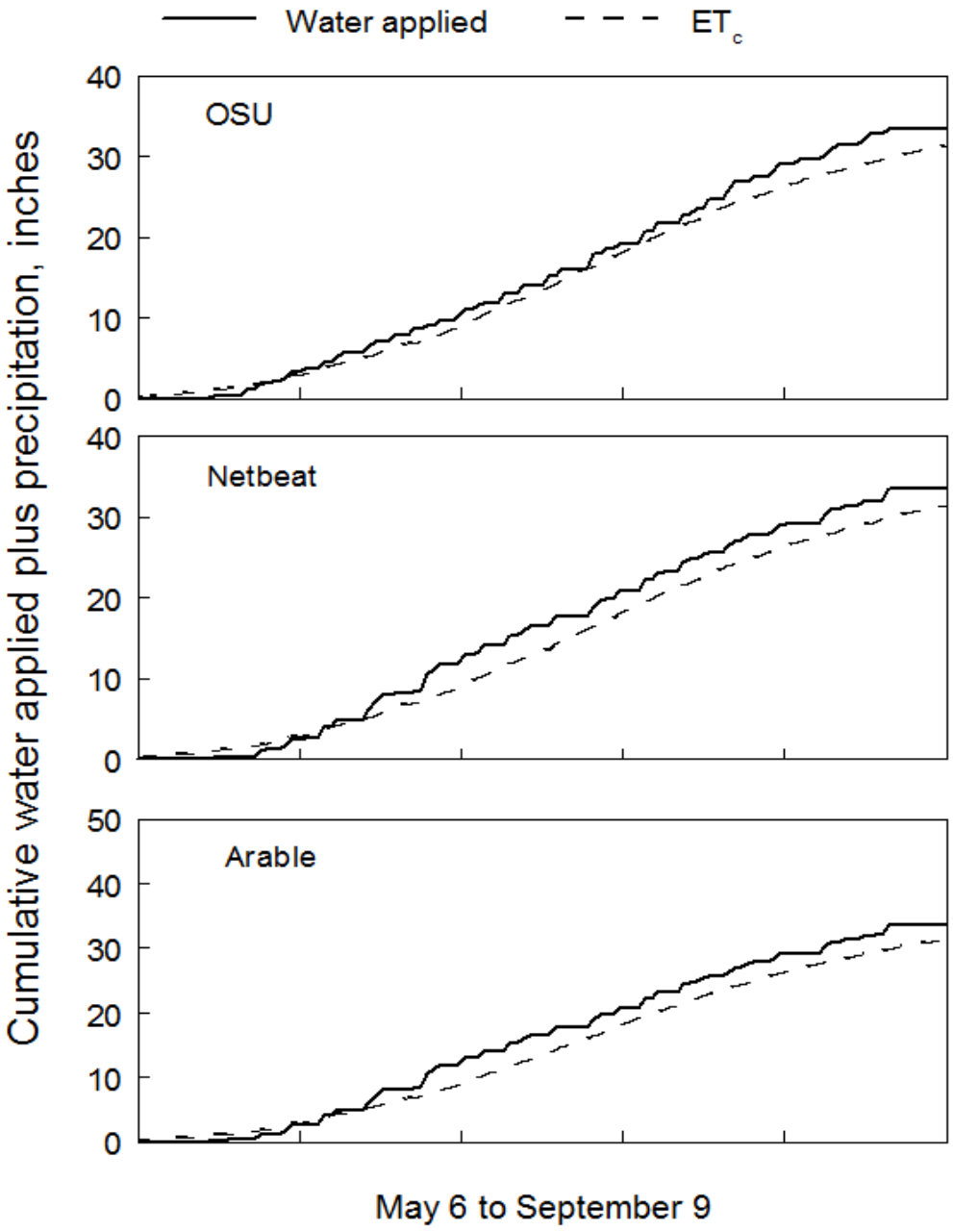

Figure 5. Cumulative water applied plus precipitation for three irrigation scheduling treatments. Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 5. Number of irrigations, total water applied, and average soil water tension for three irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

Irrigation scheduling	No. of irrigations	Water applied/irrigation	Total water applied plus precipitation		Average soil water tension
		inches	inches	% of ET_c	cb
OSU	41	0.8	33.4	106.4	19.5
Netbeat	29	1.1	33.5	106.7	17.4
Arable	26	1.3	33.5	106.7	19.0

Table 6. Yield, grade, and processing quality of two potato varieties grown with three irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

					U.S. No. 1												
Irrigation scheduling	Variety	Total yield	Marketable	U.S. No. 1	Total	>20 oz	10-20 oz	6-10 oz	4-6 oz	U.S. No. 2	< 4 oz	Cull	Water use efficiency*	Fry color	Sugar ends	Internal brown spot	Specific gravity
		---- cwt/acre ----		%	---------- cwt/acre ----------									--------- % ---------			
OSU	Payette Russet	748.3	737.1	98.5	737.1	1.7	131.6	247.5	201.9	4.3	154.4	6.9	22.4	42.2	0	10.0	1.100
	Clearwater Russet	861.6	839.6	97.3	839.6	63.6	401.7	224.8	97.5	19.1	52.0	3.0	25.8	39.9	0	18.3	1.093
	Average	805.0	788.4	97.9	788.4	32.7	266.7	236.1	149.7	11.7	103.2	4.9	24.1	41.0	0	14.2	1.097
Netbeat	Payette Russet	743.9	732.7	98.5	732.7	1.8	162.2	287.9	152.3	6.5	128.6	4.7	22.2	41.3	0	18.3	1.099
	Clearwater Russet	904.4	878.4	97.1	878.4	65.8	404.6	263.0	93.0	21.0	52.0	5.1	27.0	40.6	0	10.0	1.091
	Average	824.2	805.5	97.8	805.5	33.8	283.4	275.4	122.6	13.7	90.3	4.9	24.6	40.9	0	14.2	1.095
Arable	Payette Russet	766.8	758.0	98.8	758.0	3.9	155.0	276.8	186.8	4.5	135.5	4.2	22.9	43.5	0	8.3	1.100
	Clearwater Russet	879.1	846.2	96.2	846.2	63.4	371.8	260.5	94.6	30.4	55.8	2.5	26.2	41.6	0	3.3	1.103
	Average	822.9	802.1	97.5	802.1	33.7	263.4	268.6	140.7	17.5	95.7	3.4	24.6	42.6	0	5.8	1.102
Average	Payette Russet	753.0	603.1	98.6	742.6	2.5	149.6	270.7	180.3	5.1	139.5	5.3	22.5	42.3	0	12.2	1.100
	Clearwater Russet	881.7	801.4	96.9	854.7	64.3	392.7	249.4	95.0	23.5	53.3	3.5	26.3	40.7	0	10.6	1.096
LSD (0.05)	Treatment	NS	NS	NS	NS	NS	NS	NS	18.8	NS	NS	NS	NS	NS	NS	NS	NS
	Variety	22.7	34.4	NS	25.9	18.3	27.0	NS	15.9	9.8	15.4	NS	0.7	NS	NS	NS	NS
	Trt X Var	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 7. Tuber nutrient concentration (dry weight basis) of two potato varieties grown with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

Irrigation scheduling	Variety	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B
		%						ppm				
OSU	Payette Russet	1.21	0.22	1.75	0.12	0.09	0.09	10.33	38.17	3.67	264.50	23.67
	Clearwater Russet	1.21	0.22	1.86	0.12	0.07	0.11	9.83	39.17	2.83	285.83	25.50
	Average	1.21	0.22	1.81	0.12	0.08	0.10	10.08	38.67	3.25	275.17	24.58
Netbeat	Payette Russet	1.32	0.22	1.82	0.12	0.08	0.10	11.50	33.33	2.67	287.00	26.00
	Clearwater Russet	1.31	0.25	2.11	0.13	0.08	0.12	12.17	36.33	2.50	285.67	25.83
	Average	1.31	0.24	1.96	0.13	0.08	0.11	11.83	34.83	2.58	286.33	25.92
Average	Payette Russet	1.26	0.22	1.79	0.12	0.08	0.10	10.92	35.75	3.17	275.75	24.83
	Clearwater Russet	1.26	0.24	1.98	0.12	0.07	0.12	11.00	37.75	2.67	285.75	25.67
LSD (0.05)	Treatment	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Variety	NS	NS	0.16	NS	NS	0.02	NS	NS	NS	NS	NS
	Trt X Var	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 8. Tuber nutrient uptake in the harvested tubers of two potato varieties grown with two irrigation scheduling systems. Malheur Experiment Station, Oregon State University, Ontario, OR.

Irrigation scheduling	Variety	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B
		lb/acre										
OSU	Payette Russet	229.2	41.7	330.1	22.2	16.9	17.6	0.2	0.7	0.1	4.9	0.5
	Clearwater Russet	262.2	47.8	401.6	25.6	14.2	23.9	0.2	0.8	0.1	6.1	0.6
	Average	245.7	44.8	365.9	23.9	15.6	20.8	0.2	0.8	0.1	5.5	0.5
Netbeat	Payette Russet	242.4	41.1	335.5	22.3	14.1	18.0	0.2	0.6	0.1	5.3	0.5
	Clearwater Russet	287.9	55.9	465.0	28.4	16.9	26.9	0.3	0.8	0.1	6.4	0.6
	Average	265.1	48.5	400.2	25.3	15.5	22.4	0.2	0.7	0.1	5.9	0.5
Average	Payette Russet	235.8	41.4	332.8	22.2	15.5	17.8	0.2	0.7	0.1	5.1	0.5
	Clearwater Russet	275.1	51.8	433.3	27.0	15.5	25.4	0.2	0.8	0.1	6.3	0.6
LSD (0.05)	Treatment	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Variety	12.4	4.7	28.9	3.1	NS	3.0	NS	NS	NS	NS	0.1
	Trt X Var	NS	NS	40.9	NS	NS	NS	NS	NS	NS	NS	NS