PLANTING CONFIGURATION AND PLANT POPULATION EFFECTS ON DRIP-IRRIGATED UMATILLA RUSSET YIELD AND GRADE

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Introduction

Drip irrigation of potato for processing in theTreasure Valley is not a standard production practice. However, drip irrigation could provide several advantages to growers, including no tailwater runoff from the field, the ability to apply fertilizer to the crop root zone, precise irrigation application, minimal leaching of chemicals or salts to the groundwater, and reduced canopy moisture with reduced risk of fungal foliar diseases. Drip irrigation systems are costly to install and manage, and growers are reluctant to install them on fields where capital has already been spent to install furrow or sprinkler irrigation systems. To be profitable for potato production, drip irrigation should provide yield and quality above that obtainable with other irrigation methods. This study was conducted to test modified planting configurations on the standard 72-inch tractor wheel spacing used in Treasure Valley potato production, to test whether changes in the planting configuration could improve 'Umatilla Russet' response to drip irrigation.

By placing two rows on a single bed, plants would be spread apart over the soil surface. They should not come immediately into competition with each other for sunlight during June, increasing yield potential. Spreading the plants across the bed allows a higher plant population, which could enhance yield and reduce the number of oversize potatoes. Furthermore, the distribution of plants across the soil surface would provide better soil shading during June, a factor that might result in better tuber quality. When potato seeds are planted directly in line with the drip tape, the roots and new tubers are directly in the most saturated part of the soil. By placing the drip tape offset from the seed, roots and tubers would develop in a less saturated part of the potato bed, favoring tuber quality.

Methods

The experiment was conducted on Owyhee silt loam, following winter wheat, where potato had not been planted for 3 years. In September 2002, after the wheat stubble had been chopped and irrigated, the field was disked. A soil test taken on September 9, 2002 showed 18 ppm NO_3, 18 ppm P, 306 ppm K, organic matter 2.2 percent, and pH 7.6. Fall fertilizer was spread to apply 21 lb N/acre, 100 lb P_2O_5/acre, 60 lb K_2O/acre, 60 lb S/acre, 30 lb Mg/acre, 4 lb Zn/acre, 2 lb Cu/acre, 1 lb Mn/acre, and 1 lb B/acre. The field was deep ripped, disked, and Telone II was applied at 25 gal/acre, and the soil was bedded on 36-inch spacing. On April 4, 2003, Roundup was applied at 1 qt/acre to control winter annual weeds and volunteer wheat.

Certified seed of Umatilla Russet was cut by hand into 2-oz seed pieces and treated with Tops MZ + Gaucho dust. On April 23 and 24, the cut seed was planted 8 inches deep using a custom-built potato plot planter. The planter used cups on chains driven by a ground wheel, with interchangeable drive sprockets providing the adjustment of seed spacing in the row. Four individual planter units could be slid to different positions on the frame so that two or four rows could be planted at various between-row spacings. On April 28, the beds were shaped using a spike bed harrow pulling wide shovels to maintain the wheel furrows and dragging a chain to pull soil into the center of the bed and smooth the top flat.

The treatments consisted of two populations, 18,150 and 24,200 plants per acre, with each population planted in three configurations. Drip tapes were shanked into the beds on May 6. Configuration 1 was 2 rows 36 inches apart on a nominal 72-inch bed (72 inches furrow to furrow) with a drip tape directly above each row of potatoes (Table 1). Configuration 2 was 2 rows 36 inches apart on a 72-inch bed with the drip tapes offset 7 inches to the inside of the bed from each potato row. Configuration 3 was 4 rows on a 72-inch bed with 16 inches between the pairs of rows, and the paired rows 14 inches apart, with the drip tape centered between the pairs of rows. Plants were staggered in the paired rows. Plots were 20 ft long by two beds (12 ft) wide, replicated four times.

Prowl at 1 lb/acre plus Dual at 2 lb/acre was applied on May 1. On May 6 the drip tape was installed in each plot using a pair of drip tape injectors and spools mounted on a tool bar and moved to the correct spacing for each treatment. The drip tape was T-tape 0.22 gal/hour/100 ft, with 12-inch emitter spacing. Matrix herbicide was applied at 1.25 oz/acre on May 28. The first irrigation was applied on June 6, and included Vydate at 2.1 pint/acre in irrigation water acidified to pH 5 by injection of sulfuric acid. Bravo plus Ridomil Gold was applied by aerial application on June 7, and again on June 25. Bravo fungicide plus liquid sulfur was applied by aerial applicator on July 2, and again on August 8. Sulfur dust was applied by aerial applicator on July 20 at 40 lb S/acre.

Irrigations were controlled by a CR10 data logger (Campbell Scientific, Logan, UT) connected to a multiplexer that provided connections for two Watermark (Irrometer, Riverside, CA) soil moisture sensors in each plot. The sensors were installed in a plant row at the seedpiece depth. The data logger was connected through relays to a 24VAC solenoid valve for each treatment. The drip tape on each set of four plots of a treatment was plumbed through 0.5-inch PVC pipe to six solenoid valves supplied with water under constant pressure. The soil moisture sensors were read by the datalogger every 3 hours. At midnight and noon the datalogger calculated the average sensor readings for each treatment. If the average soil water potential for a treatment was below -30 kPa, the valve opened for 3 hours to apply a 0.2-inch irrigation.

Fertilizer solution was injected into the drip system in response to bi-weekly petiole tests. The total fertilizer applied from June 19 to August 14, both through the drip system and by aerial application, was 108 lb N/acre, 28 lb P_2O_5/acre, 12 lb K_2O/acre, 14 lb SO_4/acre, 40 lb S/acre, 0.03 lb Ca/acre, 0.5 lb Mg/acre, 0.61 lb Zn/acre, 1.15 lb Mn/acre, 0.69 lb Cu/acre, 0.06 lb Fe/acre, and 0.01 lb B/acre.

On October 2 the vines were flailed from the potato plants and on October 9 the potatoes were dug. The tubers from 15 ft of the center two rows of each four row plot were bagged and graded. Data were statistically analyzed using the ANOVA procedure in NCSS.

Results and Discussion

There was a significant interaction between planting configuration and plant population in total yield (Table 2). The low-population standard configuration yielded 556 cwt/acre, significantly more than the 470 cwt/acre total yield in the standard configuration at the high plant population, 24,200 plants per acre.

For the marketable yield category, comprised of the U.S. No. 1 and No. 2 tubers over 4 oz, there was a significant difference between the high and the low plant population on the standard configuration. The average marketable yield was higher with the low plant population, and there was a significant interaction between population and configuration because the marketable yield of the standard configuration at the high plant population was 333 cwt/acre, which was significantly lower than all other treatments.

There were no significant differences in percent of U.S. No. 1 tubers among the treatments. The overall average percent of U.S. No. 1 tubers, 66 percent, was lower than usual for Umatilla Russet at this location. Percent U.S. No. 1 tubers ranged from 70 percent for the staggered double row (configuration 3) at the low plant population, to 63 percent for the two rows per bed with the drip tapes offset 7 inches (configuration 2) at the high population.

The high plant population produced significantly more small, 4- to 6-oz, U.S. No. 1 tubers, and undersized tubers. There were no significant differences in yield of 6- to 12-oz U.S. No. 1 tubers. The high plant population produced less 12- to 16-oz and over 16-oz U.S. No. 1 yield. Total U.S. No. 1 yield was significantly higher at the low plant population with configuration 1.

The yield of U.S. No. 2 tubers was significantly greater with the low plant population. The high plant population standard configuration produced the least U.S. No. 2 yield, but that treatment also produced the most undersize tubers of less than 4 oz. Based on this trial for one season at one location, there was no advantage to plant double rows of Umatilla Russet, increase the plant population, or offset the drip tape 7 inches from the plant row.

Table 1. Relationship of planting configuration treatments in the planting configuration trial to one common potato production planting configuration, Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.

Configuration	Rows and row widths	Plant population	Drip tape placement relative to plant row
	per 36-inch bed	Plants/acre	
Common grower practice	1 row	18,150	none
Treatments in this trial	per 72-inch bed		
Treatment 1	2 rows	18,150	in row
Treatment 2	2 rows	18,150	offset 7 inches from row
Treatment 3	2 double rows	18,150	between double rows
Treatment 4	2 rows	24,200	in row
Treatment 5	2rows	24,200	offset 7 inches from row
Treatment 6	2 double rows	24,200	between double rows

Table 2. Yield and grade of Umatilla Russet grown at two plant populations and three planting configurations with respect to the drip tape, Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.

Population		Total yield	Total marketable yield	U.S. No. 1 yield >4 oz						U.S. No. 2 >4 oz	Undersized < 4 oz
				Percent	4-6 oz	6-12 oz	12-16 oz	>16 oz	Total		
plants/acre	Tape configuration	--------cwt/acre--------		%	------------------------------------cwt/acre------------------------------------						
18,150	1	556.4	469.9	67.9	77.6	191.8	58.9	48.8	377.1	92.8	86.4
18,150	2	516.7	447.4	65.4	70.3	178.4	54	36.6	339.2	108.2	69.2
18,150	3	516	459.3	70.4	68.9	201.9	66.4	24.7	361.9	97.4	56.7
Mean		529.7	458.9	67.9	72.3	190.7	59.8	36.7	359.4	99.5	70.8
24,200	1	469.7	333.3	63.4	113.3	155.1	18.1	11.1	297.6	35.7	136.4
24,200	2	530.9	424.8	62.7	91.8	169.3	47.8	26.7	335.6	89.2	106.1
24,200	3	533	447.2	67	98.4	200.7	43.1	15.4	357.6	89.6	85.8
Mean		511.2	401.8	64.4	101.2	175	36.3	17.7	330.3	71.5	109.4
Average	1	513.1	401.6	64.1	95.5	173.5	38.5	30	337.4	64.3	111.4
Average	2	523.8	436.1		81.1	173.9	50.9	31.7	337.4	98.7	87.7
Average	3	524.5	453.3	68.7	83.7	201.3	54.8	20.1	359.8	93.5	71.3
Overall mean		520.5	430.3	66.1	86.7	182.9	48.1	27.2	344.8	85.5	90.1
LSD (0.05) Population		22.5	31.8	NS	13.5	NS	13.4	13.3	33.1	19.2	22.7
LSD (0.05) Configuration		NS	39	NS	16.6	NS	NS	NS	NS	23.2	27.8
LSD (0.05) PxC.		39	55.1	NS	NS	NS	NS	NS	NS	NS	NS
LSD (0.05) Replicate		NS	45	NS	NS	40.6	NS	NS	46.8	NS	32