PROCESSING POTATO PRODUCTION WITH LOW FLOW DRIP TAPE OR ULTRA-LOW FLOW TAPE

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Abstract

The potato (Solanum tuberosum L.) cultivars ‘Russet Burbank’ and ‘Umatilla Russet’ were grown using low flow (0.22 gal/min/100 ft) or ultra-low flow (0.11 gal/min/100 ft) drip tape on two-row beds with a single drip tape supplying irrigation water to two rows of plants. Drip tape and cultivar factors were replicated four times on plots four rows wide by 100 ft long, in a randomized complete block design. All fertilizer was applied as solutions injected into the drip system during irrigation, in response to petiole nutrient analyses. ‘Umatilla Russet’ produced higher total and marketable yields, and six times more U.S. No. 1 grade tubers than ‘Russet Burbank’, with acceptable quality for processing. ‘Russet Burbank’ specific gravity was too low (1.074 g cm⁻³) and fry color was too dark (38.5 percent average light reflectance and 43 percent sugar-ends) for processing into frozen product. Total yield of both varieties exceeded 22 tons/acre with total N fertilizer applied at 178 lb/acre and average total water applied at 22.1 inches. There was no difference in potato production with either cultivar between low flow and ultra-low flow drip tape, indicating potato drip irrigation systems may be designed using either tape flow rate.

Introduction

Potato production is increasing worldwide, particularly production of potato for processing into frozen convenience or food service products. In Turkey, in an arid, irrigated production area with soils and climate similar to the Pacific Northwest region of the USA, potato production currently uses large inputs of nitrogen fertilizer and irrigation water (Halitligil et al. 2002). This trial was conducted to test drip irrigation methods that could be used in Turkey, and to test the feasibility of producing processing varieties of potato with lower inputs of fertilizer and water than currently are used.

In heavy soils, use of ultra-low flow tape can be a strategic advantage, allowing the water to soak into the soil in the vicinity of each emitter, rather than coming to the soil surface where it runs irregularly across the soil. If the water distribution is poor, it can have negative consequences on crop yield and quality.
Materials and Methods

An Owyhee silt loam field was used for this experiment following a winter wheat (Triticum aestivum L.) crop. After the wheat stubble was flailed, the field was irrigated and disked. A soil test taken 1 October 2001 showed the top foot of soil had 40 lb N/acre, 1.8 percent organic matter, and pH 8.1. Fall fertilizer applied was 50 lb N/acre, 160 lb P₂O₅/acre, 100 lb K₂O/acre, 40 lb SO₄-S/acre, 190 lb elemental S/acre, 10 lb Zn/acre, 4 lb Mn/acre, 2 lb Cu/acre, and 1 lb B/acre. The field was deep ripped, moldboard plowed, fumigated with 1,3-dichloropropene (Telone II) at 25 gal/acre and bedded in the fall. The soil was sampled in spring from the top and second foot, and the analysis reported pH 8.1, ECe 0.62, 2 percent free lime, 1.8 percent organic matter, and cation exchange capacity of 15 mg/100g in the top foot of soil, and available nitrate and ammonium N 91 lb/acre in the top 2 ft of soil.

Certified seed tubers of ‘Russet Burbank’ and ‘Umatilla Russet’ potato cultivars were cut by hand into 2-oz pieces and treated with Tops-MZ plus Gaucho in an alder (Alnus sp.) bark dust (Snake River Chemical, Inc., Caldwell, ID). Seed pieces were planted on 26 April, 2002, at 9-inch depth on 3-ft row spacing with 9-inch seed spacing. A two-row per bed configuration was maintained at planting by removing the center furrowing shovel from the two-row planter. After planting, flat-topped beds were formed with a spike-toothed bed harrow and winged shovels that dragged a 12-ft length of chain to pull soil into the bed center. Metolachlor (Dual) at 2 lb/acre plus pendimethalin (Prowl) at 1 lb/acre was applied for weed control on 28 April and incorporated with the bed harrow. Rimsulfuron (Matrix) herbicide was applied at 1.5 oz/acre on 16 May.

Drip tape (T-tape, T-Systems International, Inc., San Diego, CA) 5/8-inch diameter, 5-mm wall thickness, with 12-inch emitter spacing, and a water delivery rate of either 0.22 gal/min/100 ft or 0.11 gal/min/100 ft was installed at 2-inch depth between two rows of ‘Russet Burbank’ and ‘Umatilla Russet’ cultivars. Plots were four rows wide by 100 ft long. The four combinations of two potato varieties and two drip tapes were replicated four times in a randomized complete block design. The total area of drip-irrigated potato in this experiment was approximately 0.5 acre, which was surrounded by a border of drip-irrigated potato.

Fungicide applications to help control early blight (Alternaria solani) and prevent late blight (Phytophthora infestans) infection started with an aerial application of mefenoxam and chlorothalonil (Ridomil Gold plus Bravo) at 0.19 gal/acre on 4 June, and was followed with Dithane at 0.5 gal/acre on 16 June. Chlorothalonil (Bravo) at 0.19 gal/acre plus sulfur (Super-six flowable sulfur) at 1 gal/acre plus Boron (Ag Concepts Corp., Bliss, ID) at 0.1 gal/acre was applied on 3 July. Powdered sulfur (Continental Sulfur Co., LLC, Kilgore, TX) was applied at 30 lb/acre by airplane on 23 July to control mites (Tetranychus urticae) and powdery mildew (Erysiphe chicoracearum).

Potato evapotranspiration (ETₒ) was estimated using an AgriMet weather station and was also calculated using the Class A pan at the weather station (USDA) at Malheur Experiment Station. Soil water potential was monitored using tensiometers (Irrometer
Co., Inc., Riverside, CA) and Granular Matrix Sensors (Watermark soil moisture sensors, model 200SS, Irrometer Co., Inc., Riverside, CA).

Irrigation was started on 6 June. Irrigation for each tape flow rate treatment used a separate programmable irrigation control valve (Netafim Aqua Pro, Netafim, Tel Aviv, Israel), programmed to apply daily ETc as estimated by the Agrimet weather station. According to the results of a 21 June petiole sample (Western Laboratories, Parma, ID), the first urea application was 89 lb N/acre for all treatments on 8 July. In addition Mn, Zn, and Cu were applied to all treatments following the urea application. All fertilizer applications were made using a positive-displacement injector (Dosmatic Model A30, Dosmatic USA, Inc., Carrollton, TX) set at a 1:44 ratio, from a 110-gal fertilizer solution mixing tank.

The second petiole sample was collected from all plots on 19 July. According to the petiole sample results, Zn, Mn, Cu, and B were applied to all treatments on 23 July.

The second urea application, on 25 July, was 89 lb N/acre for all treatments, with the micro-plots isolated from the application. The third petiole sample was collected on 2 August. According to the petiole test results, P, K, Zn, Mn, Cu, and B were applied to all treatments on 5-7 August.

The vines were flailed on 4 October. Tubers from 36 ft of the two middle rows of each plot were harvested 5 October, and graded 7 October. On 8 and 9 October the length-to-width ratio and specific gravity by the mass-in-air, mass-in-water method were measured. Samples of 20 tubers from each plot were fried and light reflectance of each end of the fried strips was measured.

Treatment differences were compared using analysis of variance and protected least significant differences at the 5 percent probability level, (LSD (0.05)).

Results and Discussion

Cultivar Performance and Comparisons

Potato cultivar influenced every potato variable measured in this study (Table 1). 'Umatilla Russet' produced on average 521 cwt/acre of which 446 cwt/acre was marketable. 'Russet Burbank' produced less, 465 cwt/acre, of which only 326 cwt/acre was marketable. The low marketability of 'Russet Burbank' was due to cull tubers and tubers with symptoms of decomposition.

A large contrast between the two cultivars was the very low percent of U.S. No. 1 tubers for 'Russet Burbank'. The weather was unusually hot during early July, a time when tuber development can respond to heat by producing secondary growth. The very low yield of U.S. No. 1 tubers (48 cwt/acre) may be attributed to hot soil, aggravated by the
use of drip irrigation. Under sprinkler irrigation, irrigation not only provides water for plant transpiration, but also cools the plants and the soil.

Tuber processing quality parameters were substantially different between ‘Russet Burbank’ and ‘Umatilla Russet’ (Table 1). The ‘Umatilla Russet’ produced higher quality fried products, whereas ‘Russet Burbank’ had low specific gravity, dark fry colors, and a high proportion of sugar ends (42.7 percent).

**Contrast between Drip Tapes**

Drip tape type influenced none of the potato attributes measured in this study. Both the low flow tape (0.22 gal/min/100 ft) and the ultra-low flow tape (0.11 gal/min/100 ft) functioned satisfactorily.

Both tapes were managed to fully meet daily potato water demand (Fig. 1), so the irrigation frequency was the same, once per day. The only differences were the rate and duration of irrigation, where the lower rate was offset by a longer duration. In the context of this trial, both tapes did a similar job meeting the potato crop water demand.

This trial was conducted on silt loam with a relatively high water intake rate, and water was not observed to puddle near emitters and or run over the surface of the soil in either tape configuration. With a soil that has a lower water infiltration rate, even low flow tape can deliver water faster than the soil can take up water close to the emitters. When the soil water intake is exceeded, water from the emitter reaches the soil surface and then runs irregularly across the soil surface. Ultra-low flow tape may be preferred in such circumstances.

Ultra-low flow tape may have a strategic advantage in spreading a limited water supply simultaneously over a larger area. Ultra-low flow tape also gives an advantage in designing drip systems, allowing smaller diameter delivery lines and lower cost distribution systems. Ultra-low flow tape can be a disadvantage if suspended particles clog the smaller emitters. In the current trial, none of the potential advantages or disadvantages of ultra-low flow tape were pertinent.

**Acknowledgments**

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**References**

Table 1. Yield, grade, and processing quality of 'Russet Burbank' and 'Umatilla Russet' potato grown with drip-irrigation. Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Tape Flow</th>
<th>Total yield</th>
<th>Total marketable</th>
<th>Yield by grade category</th>
<th>Fry color</th>
<th>Sugar ends</th>
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<tr>
<td></td>
<td>gal/min/100 ft</td>
<td>---cwt/acre---</td>
<td>%</td>
<td>---------------</td>
<td>cwt/acre</td>
<td>%</td>
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<tr>
<td>Russet Burbank</td>
<td>0.11</td>
<td>462</td>
<td>313</td>
<td>8.9 42 4 22 16 271 44 29 77</td>
<td>2.40 1.0755</td>
<td>28.9 49.0</td>
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<td>469</td>
<td>339</td>
<td>11.5 54 5 29 20 286 45 22 63</td>
<td>2.38 1.0726</td>
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<td>465</td>
<td>326</td>
<td>10.2 48 4 26 18 278 45 25 70</td>
<td>2.39 1.0740</td>
<td>28.0 48.9</td>
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<td>518</td>
<td>451</td>
<td>57.8 299 30 179 89 152 65 1 2</td>
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<td>45.1 52.7</td>
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<td>443</td>
<td>53.1 279 25 171 83 164 61 6 15</td>
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<td>Umatilla Russet Mean</td>
<td>521</td>
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<td>Overall Mean</td>
<td>Mean</td>
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<td>386</td>
<td>32.8 168 16 100 52 218 54 14 39</td>
<td>2.12 1.0821</td>
<td>36.7 50.8</td>
</tr>
</tbody>
</table>

LSD (0.05) Cultivar    | 38        | 33          | 6.1 37 18 24 14 27 8 6 21 | 0.08 0.0018 | 2.2 1.2 | 1.3 6.3 |
LSD (0.05) Tape        | NS*       | NS          | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
LSD (0.05) C x T       | NS        | NS          | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

*NS = not significant.
Figure 1. Water applied through drip irrigation to 'Umatilla Russet' and 'Russet Burbank' potatoes compared to the cumulative potato evapotranspiration (Cum ET). Water was applied using low flow (0.22 gal/min/100 ft) or ultra-low flow (0.11 gal/min/100 ft) drip tape. Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.