Onion Response to Different Water Qualities

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ABSTRACT

Onions are one of the highest value and most-widely grown vegetable crops in Colorado. Onions are also one of the most salt-sensitive crops and are susceptible to water deficits due to the shallow nature of their root system. In Colorado and other rapidly urbanizing western states, the competition for water resources is dramatically increasing. As a result, growers are using alternative water sources that often have lower quality than sources originating directly from streams and rivers.

In 2007, a study was conducted to characterize the response of commonly-grown onion cultivars (Ranchero, X-202, Cometa, and Red Bull) to irrigation waters having an average electrical conductivity (EC) of about 1.0 dS.m-1 (low EC river water) or 2.8 dS.m-1 (high EC groundwater). The timings and amounts of irrigations were the same for both water treatments throughout the growing season and all irrigations were delivered via a drip system.

Overall, onion yields were high regardless of irrigation water source. However, total marketable yield was significantly less for all varieties when irrigated with high EC water compared to low EC. The red variety (Red Bull) had the greatest decrease in total marketable yield (23.9 %) when irrigated with the high EC water. The proportion of jumbo class onions (>3" in diameter) was also significantly reduced. As a result, economic losses were realized for all onion varieties when irrigated with the high EC water.

INTRODUCTION

Growers in the Arkansas Valley of Colorado face increasing pressure to conserve water along with other natural resources. Recent droughts and heightened competition for water from rapidly growing urban areas have compelled many growers to adopt more efficient irrigation methods like drip.

In Colorado, irrigation water derived from the Arkansas River and its shallow alluvial aquifer can be of poor quality. The Arkansas River, for example,

is one of the most saline rivers for its size in the country (Miles, 1977). Furrow irrigation can aggravate salt accumulation in the root zone and can lessen the quality of water that is returned to the river (Bartolo et al., 1995; Halvorson et al., 2002). Applied properly, drip irrigation can successfully manage water that is high in salt content (Hartz, 1994).

Many Colorado growers adopting drip irrigation rely on systems that are designed to use groundwater rather than surface water. In contrast to surface water, groundwater is free of sediment and is available on a more timely and reliable basis, making it ideal for drip irrigation. Unfortunately, groundwater often contains 2-3 times the amount of salt than surface water.

Onions are one of the more salt-sensitive crops. Yield reductions can occur when the electrical conductivity (EC) of the saturated soil paste extract reaches 1.2 dS.m-1 or the EC of irrigation water reaches 0.8 dS.m-1. Yield reductions of 50% can be realized when the EC of irrigation waters are as little as 2.9 dS.m-1 (Ayers, 1977). Some research, however, suggests that yield reductions due to salinity may vary with onion cultivar and may not be as severe if salinity is due to calcium and sulfur-containing salts rather than sodium-containing salts (Doss et al, 2003)

This study was conducted to characterize the response of four commonly-grown onion cultivars to irrigation waters having an EC of 1.0 dS.m-1 (river/surface water) or 2.8 dS.m-1 (groundwater). The derived information will help growers manage their diminishing water resources more efficiently and economically.

MATERIALS AND METHODS

This field study was conducted on a Rocky Ford silty clay loam soil at Colorado State University's Arkansas Valley Research Center (AVRC) in Rocky Ford, Colorado. The plot area had been fallow in 2006. Two irrigation water sources were examined as the main plots: surface water diverted from the Arkansas River and groundwater derived from a shallow (25-30 feet deep) alluvial aquifer on the AVRC site. The surface water varied slightly in salinity during the course of the season but had an average electrical conductivity (EC) of approximately 1.0 dS.m-1. The groundwater had an EC of 2.8 dS.m-1. Other characteristics of the water sources are noted in Table 1.

Component	Groundwater*	Surface**
Calcium	283 ppm	111 ppm
Sodium	133 ppm	64 ppm
Hardness - CaCO3	1022 ppm	420 ppm
Sulfate	1053 ppm	365 ppm
Specific Conductance	2.77 ds/m	1.00 ds/m
TDS	1764 ppm	720 ppm

Table 1: Chemical characteristics of ground and surface waters.* Analysis at AVRC, ** EPA analysis at Arkansas River

Four commonly-grown onion varieties were selected as the subplots. The varieties were 'Ranchero' (Nunhems) and X-202 (Waldow), yellow-skinned types, 'Cometa' (Nunhems), a white-skinned type, and Red Bull (Bejo), a red-skinned type. Onions were direct-seeded on March 12, 2007 at a seeding rate of about 130,000 seeds per acre. Four rows of onion were planted on beds with 60 inches between centers.

Onion rows were spaced 12 inches apart and in-row spacing between onions seeds was approximately 3.1 inches. Each sub-plot was 25 feet long and one bed (5 feet) wide. Borders beds were placed on each side of the sampling areas to avoid any cross contamination from irrigation treatments.

Irrigation water was delivered via drip lines (Netafim-8 mil,12" emitter-.22 gph). There were two drip lines per bed, spaced 12 inches apart and at a depth of 4 inches. Each drip line was equidistance from two onion rows (Figure 1). Throughout the season, both water sources were delivered in the same quantity and at the same time.

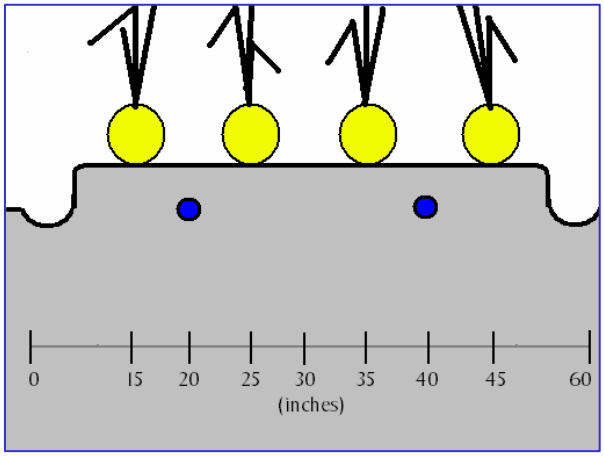

Figure 1: Planting and drip line configuration

Irrigation timing and duration was based on weather data collected from a nearby electronic weather station, the need to enter fields for cultural operations, and estimated soil moisture content from *Watermark Sensors*. All cultural practices were consistent with others used in Colorado (Schwartz and Bartolo, 1998).

Soil samples were taken prior to planting, near bulbing and after harvest. Each time, samples were taken at two locations in the bed: below the inside seed-row and in the middle of the furrow between the raised beds. Samples were taken at depths of 0-6", 6-12", 1-2', and 2-3'. Soil salinity was estimated by developing a curve comparing the saturated pasted extract with a 1:1 soil-water extract.

Onions were harvested September 7th and held in storage until grading in October. Marketable onion sizes were colossal (<4" diameter), jumbo (3 to 4" diameter), and medium (2 to 3" diameter). Onion yields were expressed as bags (one bag = 50 lbs) of fresh onion weight per acre.

RESULTS

Total marketable yield was lowered significantly in all varieties when irrigated with the high EC water. The red variety (Red Bull) had a 23.9% decrease in yield when irrigated with the high EC water (Figure 2).

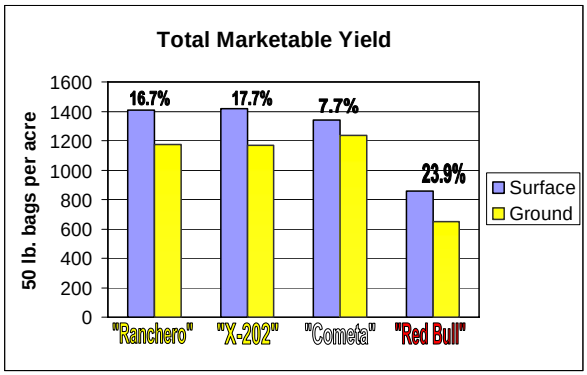

Figure 2: Total market yield of onion varieties grown with surface and well water. (DMRT: $p<0.1$)

Soil salinity was measured after harvest (September 21st) at different locations in the production bed. Salinity levels generally reflected the salt content of the water sources (Figure 3). The highest salinity levels were detected at the surface layers and at outside of the production bed (furrow), near the edge

of the wetting front.

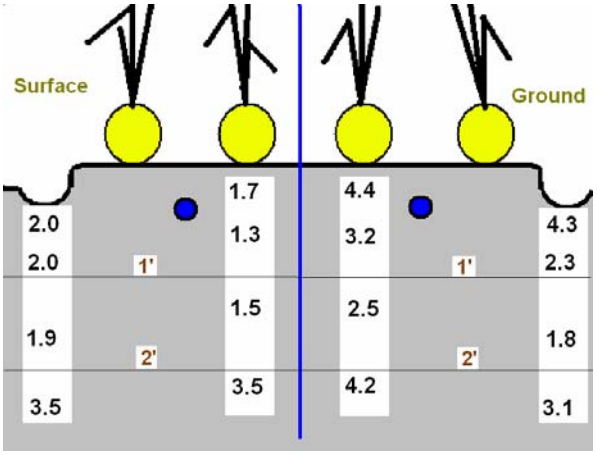

Figure 3: Electrical conductivity (in dS.m-1) of the soil measured at depths of 0-6", 6-12", 1-2', and 2-3" below the seed row and bed furrow. Samples were taken on September 21, 2007.

CONCLUSIONS

As seen in past studies, onion response to high salinity in the Arkansas Valley of Colorado may not be as severe as those predicted by other studies; studies conducted with soils and waters more influenced by the presence of sodium salts. As a result, growers using groundwater may be able to manage salinity by choosing varieties that are more tolerant of salinity and irrigating with a sufficient volume of water to prevent excessive build-up of salt in the soil profile.

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