

IRRIGATION MANAGEMENT FOR DRIP-IRRIGATED ONIONS

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Ontario, Oregon, 1997

Summary

Onions were submitted to 8 soil water potential treatments using subsurface drip irrigation. Onions were grown on 2 double rows spaced 22 inches apart on 44-inch beds with a drip tape buried 6 inches deep in the bed center. Soil water potential was maintained nearly constant at 5 levels by automated, high frequency irrigations based on soil water potential measurements at 8-inch depth. The highest total, marketable, and colossal onion yields were achieved with the wettest soil water potential, -10 kPa. Reducing the soil water potential below -20 kPa after July 15 did not decrease storage rot but reduced the yield of colossal onions. Maintenance of soil water potential at -10 and -20 kPa required 36 and 27 acre-inches of applied water, respectively. Onion evapotranspiration for 1997 totaled 27 acre-inches from emergence to the last irrigation.

Introduction

Previous research with furrow irrigated onions at the Malheur Experiment Station has demonstrated the sensitivity of onions to small water deficits and the need to maintain small negative soil water potentials for optimum yield (Shock et al., 1994). The superior water application efficiency with subsurface drip irrigation allows for more precise irrigation management than with furrow irrigation. With subsurface drip irrigation, onions can be irrigated at different soil water potentials and the soil water potential can be maintained nearly constant, avoiding the oscillations in soil water common with furrow or sprinkler irrigation. The objective of this trial was to evaluate the effects of different soil water potentials on onion yield and quality.

Methods

The trial was conducted on an Owyhee silt loam previously planted to wheat at the Malheur Experiment Station. A soil sample taken from the top foot on March 8, 1995, showed a pH of 7, 1.5% organic matter, 5 ppm nitrate-N, and 7 ppm ammonium-N, 20 ppm P, and 1.8 ppm Zn.

The field was ripped twice, plowed, groundhogged twice, fumigated with Telone C-17 at 20 gpa and bedded into 22-inch centers in the fall of 1996. Onions (cv. Vision,

Petoseed, Payette, ID) were planted in 4 double rows spaced 22 inches apart in 44-inch beds on April 16. Onions were planted at 140,000 seeds/acre (4.1 inches/seed). Drip tape (Nelson Irrigation Corp., Walla Walla, WA) was laid at the same time as planting at 6-inch depth between the two double onion rows. The drip tape had emitters spaced 12 inches apart and a flow rate of 0.49 gal/minute/100 feet. The trial was irrigated on April 23, April 25, and May 2 with a microsprinkler system (R10 Turbo Rotator, Nelson Irrigation Corp., Walla Walla, WA) in order to enhance uniform onion emergence. Risers were spaced 25 feet apart and connected to 3 flexible polyethylene hoses spaced 30 feet apart. Onions started emerging on May 1.

Irrigation treatments consisted of five soil water potential levels (-10, -20, -30, -50, and -70 kPa), maintained nearly constant during the entire season, and three treatments where the soil water potential was maintained constant at -20 kPa until July 15 and then decreased to -30, -50, or -70 kPa for the remainder of the season. The soil water potential (8-inch depth) was maintained constant by 0.06 acre-inch/acre of water applied up to 8 times a day based on soil water potential readings every 3 hours. The irrigation treatments were started on June 13. The 8 irrigation treatments were replicated five times and arranged in a randomized complete block design. Plots were 2 beds wide and 50 feet long.

Soil water potential was monitored in each plot by five granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrrometer Co., Riverside, CA). In each plot, four GMS were installed at 8-inch depth from the surface of the soil, and one GMS was installed at the 18-inch depth. All GMS were installed below one of the two onion double rows in the plot center. The 200 GMS and two soil temperature sensors installed 8 and 18 inches deep were connected via five multiplexers (AM 410 multiplexer, Campbell Scientific, Logan, UT) to a datalogger (CR 10 datalogger, Campbell Scientific, Logan, UT). The datalogger was programmed to read the GMS, read the temperature sensors, calculate the soil water potential at the 8 inch depth in each plot and, if necessary, irrigate the plots individually, according to the plot's irrigation criteria. GMS were calibrated to soil water potential (Barnum and Shock, 1992). The irrigations were controlled automatically by the datalogger using a controller (SDM CD16AC controller, Campbell Scientific, Logan, UT) connected to solenoid valves in each plot. The pressure in the drip lines was maintained at 10 psi by pressure regulators in each plot. The amount of water applied to each plot was recorded daily from a water meter installed between the solenoid valve and the drip tape. Irrigations were terminated on August 29.

Onion evapotranspiration (E_t) was estimated using an AgriMet (U.S. Bureau of Reclamation, Boise, ID) weather station at the Malheur Experiment Station and a modified Penman equation (Wright, 1982). Onion E_t was estimated and recorded from crop emergence until the final irrigation.

Fertilizer solutions were applied through the drip lines via a venturi injector (Mazzei injector Model 1087). Uran at 20 lb N/acre was applied on June 2, June 17, June 23, June 26, and July 11, for a season-long total of 100 lb N/acre. A plant sample was taken from the field for nutrient analyses on July 14. The plants were washed, the roots were analyzed for nitrate-N, phosphate-P, K, sulfate-S, and the leaves were analyzed for micronutrients by Tremblay Consulting (Jerome, Idaho).

The field was sprayed before onion emergence with Roundup at 2 quarts/acre on April 29 to kill emerging weeds. Post-emergence weed control was obtained by the application of Goal at 10 oz/acre (1.9 oz ai/acre), Buctril at 12 oz/ac (4 oz ai/acre), and Poast at 16 oz/ac (2.9 oz ai/acre) on May 30. On August 11 the field was sprayed with Warrior at 3.8 oz/acre, Ridomil MZ at 2.5 lb/acre and Kocide at 1 quart/acre for thrips and downy mildew control. On August 16 the field was sprayed with Malathion at 1 quart/acre and Dithane at 2 quarts/acre for thrips and downy mildew control.

The onions were lifted on September 22. On September 25 the onions in the central 40 feet of the middle two double rows in each plot were topped, bagged, and placed into storage. The onions were graded out of storage on December 16. Onion bulbs were graded according to their diameters: small (<2.25 inches), medium (2.25-3 inches), jumbo (3-4 inches), colossal (4-4.5 inches), and supercolossal (>4.5 inches). Split bulbs were graded as Number Two's regardless of diameter. Marketable onions out of storage were considered to be perfect onions without rot in the medium, jumbo, colossal, and supercolossal size classes. All bulbs from each plot were counted during grading to determine the actual plant population.

Results and Discussion

The microsprinkler system used to germinate the onions resulted in uniform emergence. The average plant population was 105,900 plants/acre. Analysis of onion leaves and roots showed all nutrients analyzed to be within the established sufficiency range.

The automated drip irrigation system maintained the soil water potential at 8-inch depth relatively constant for the -10 kPa and -20 kPa treatments (Fig. 1). The soil water potential at 8-inch depth for the -30 kPa, -50 kPa, and -70 kPa treatments oscillated more and the oscillations increased with decreasing soil water potential. The soil water potential at 20-inch depth generally was close to the soil water potential at 8-inch depth. A failure in the datalogger program in early July resulted in a brief cessation of all irrigations, allowing the soil water potential to decrease briefly for all treatments. The soil water potential decreased rapidly with the termination of irrigation on August 29.

The total amount of water applied with the drip irrigation system from May 14 to August 29 was 36, 27, 22, 18, and 14 acre-inches/acre for the -10, -20, -30, -50, and -70 kPa treatments, respectively. Onion E_t in 1997 totaled 27 acre-inches, indicating the

possibility of deep percolation and nitrate leaching with the -10 kPa treatment. Water applications to the -20 kPa treatment tracked E_t during the season (Fig. 2).

The highest total, marketable, and colossal onion yield were achieved with the wettest soil water potential, -10 kPa (Fig. 3). Supercolossal onion yields were low in this trial and not responsive to soil water potential level. Supercolossal yields might have been higher with lower plant populations.

Reducing the soil water potential level after July 15 below -20 kPa failed to reduce storage rot, but tended to reduce colossal onion yield (Table 1). Storage rot was low in this trial, averaging 1.6%.

Literature Cited

Barnum, J.M., and C.C. Shock. 1992. Comparison of soil water monitoring equipment in a controlled temperature weighing lysimeter. *Agronomy Abstracts*, ASA, Madison, WI. p. 318.

Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 1994. Soil water potential criteria for onion irrigation, 1994 trial. Oregon State University Agricultural Experiment Station, Special Report 947: 68-78.

Wright, J.L. 1982. New evapotranspiration crop coefficients. *J. Irrig. Drain. Div.*, ASCE 108 (1): 57-74.

Table 1. Effect of reducing the soil water potential late in the season on onion yield and quality for subsurface drip irrigated onions, Malheur Experiment Station, Oregon State University, Ontario, OR, 1997.

Soil water potential		No. two	Rot	Medium	Jumbo	Colossal	Super colossal	Marketable	Total yield
Early	After July 15								
---- kPa ----		----- cwt/acre -----							
-20	-20	35.2	15.9	11.4	477.9	386.2	6.8	882.3	933.3
-20	-30	90.9	13.1	13.4	502.4	314.1	0.9	830.9	934.8
-20	-50	42.7	20.1	11.2	614.9	267.3	1.9	895.3	958.1
-20	-70	46.8	9.0	15.1	543.2	184.7	1.2	744.1	799.9
LSD (0.05)		NS	NS	NS	NS	105.3	NS	NS	NS

Figure 1. Soil water potential for drip irrigated onions. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1997.

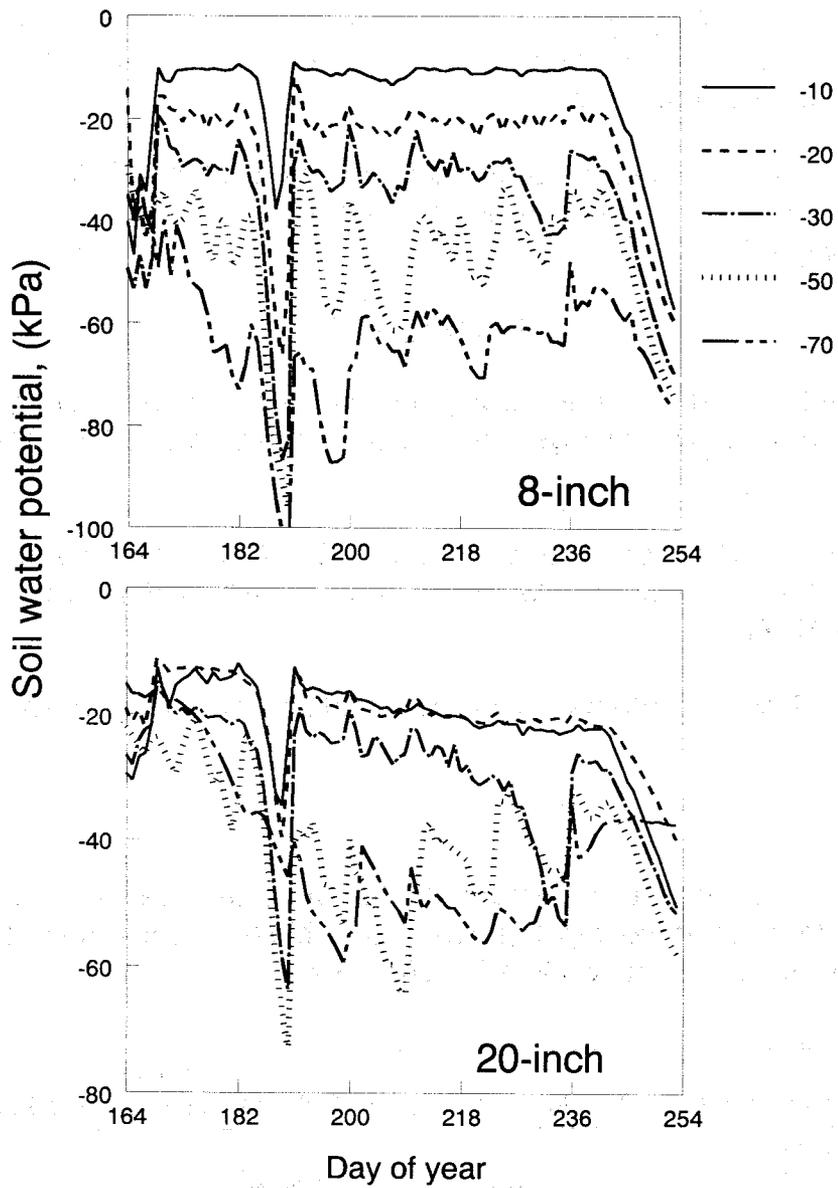


Figure 2. Cumulative water applied to drip irrigated onions. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1997.

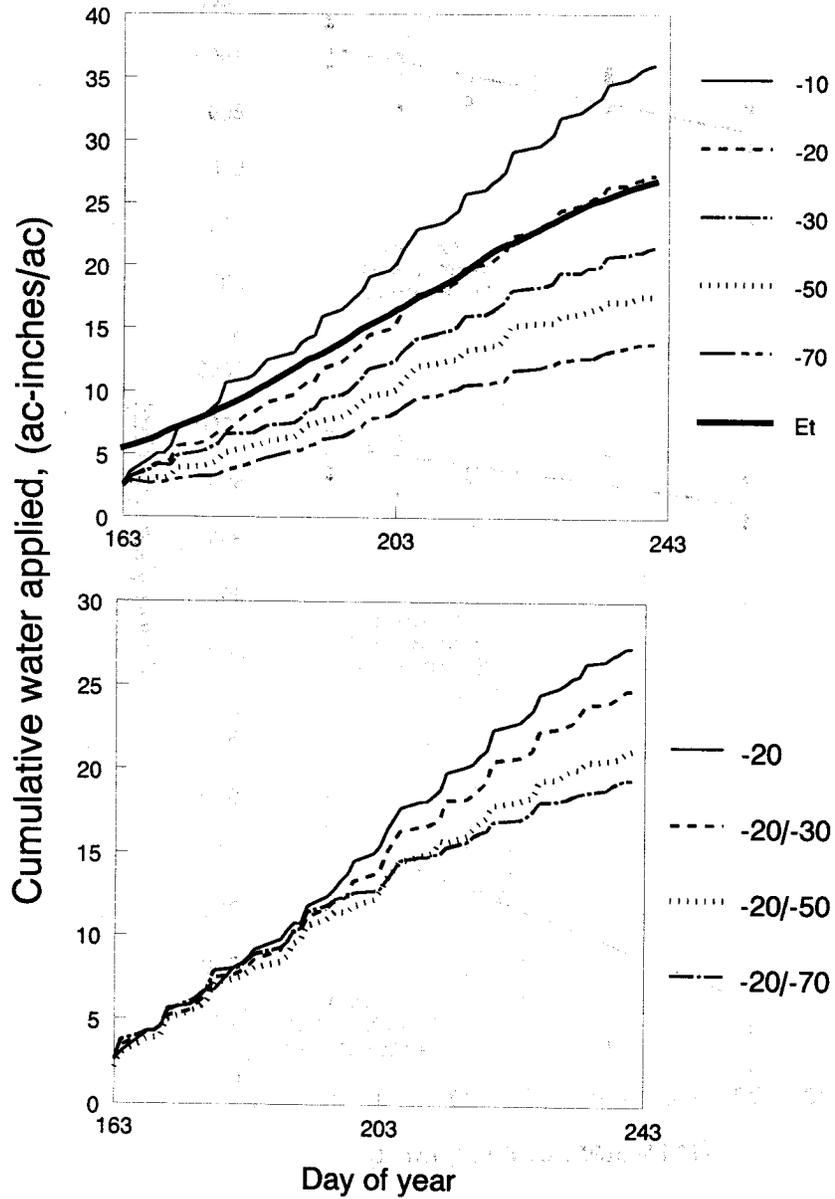


Figure 3. Onion yield response to soil water potential at 8-inch depth. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1997.

