EFFECT OF SHORT-DURATION WATER STRESS ON ONION SINGLE CENTEREDNESS AND TRANSLUCENT SCALE

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Introduction

In earlier trials we have shown that onion yield and grade are very responsive to soil water (Shock et al. 1998b, 2000). Using a high-frequency automated drip-irrigation system, the soil water potential at 8-inch depth that resulted in maximum onion yield, grade, and quality after storage was determined to be -20 kPa. Short term water stress, caused by irrigation errors, could result in internal bulb defects such as multiple centers and translucent scale. This trial tested the effects of short-duration water stress at different times during the season on onion single centeredness and translucent scale.

Materials and Methods

The onions were grown at the Malheur Experiment Station, Ontario, Oregon on an Owyhee silt loam previously planted to wheat. Onion (cv. 'Vaquero', Sunseeds, Morgan Hill, CA) was planted in two double rows, spaced 22 inches apart (center of double row to center of double row) on 44-inch beds on March 17, 2003. The two rows in the double row were spaced 3 inches apart. Onion was planted at 150,000 seeds/acre. Drip tape (T-tape, T-systems International, San Diego, CA) was laid at 6-inch depth between the two double onion rows on March 28. The distance between the tape and the double row was 11 inches. The drip tape had emitters spaced 12 inches apart and a flow rate of 0.22 gal/min/100 ft.

Immediately after planting the onion rows received 3.7 oz of Lorsban 15G per 1,000 ft of row (0.82 lb ai/acre), and the soil surface was rolled. Onion emergence started on April 7. The trial was irrigated on April 14 with a minisprinkler system (R10 Turbo Rotator, Nelson Irrigation Corp., Walla Walla, WA) for even stand establishment. Risers were spaced 25 ft apart along the flexible polyethylene hose laterals that were spaced 30 ft apart.

The experimental design was a randomized complete block with five replicates. There were five treatments that consisted of four timings of short-duration water stress and an unstressed check. The water stress was applied by turning the water off to all plots in a treatment until the average soil water potential at 8-inch depth for the treatment reached -60 kPa; at this point, the water to all plots in that treatment was turned on again. Each treatment was stressed once during the season. The four timings for the stress treatments were: four-leaf stage (water off June 2, water back on June 10), early six-leaf stage (water off June 16, water back on June 21), late six-leaf stage (water off June 26, water back on July 2) , and eight-leaf stage (water off July 7, water back on July 11).

Soil water potential was measured in each plot with four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA) installed at 8-inch depth in the center of the double row. Sensors were calibrated to SWP (Shock et al. 1998a). The GMS were connected to the datalogger with three multiplexers (AM 410 multiplexer, Campbell Scientific, Logan, UT). The datalogger read the sensors and recorded the soil water potential every hour. The irrigations were controlled by the datalogger using a relay driver (A21 REL, Campbell Scientific, Logan, UT) connected to a solenoid valve. Irrigation decisions were made every 12 hours by the datalogger: if the average soil water potential at 8-inch depth in the unstressed treatment plots was -20 kPa or less the field was irrigated for 4 hours. The pressure in the drip lines was maintained at 10 psi by a pressure regulator. Irrigations were terminated on September 2.

Onion tissue was sampled for nutrient content on June 4 and 19. The roots from four onion plants in each check plot were washed with deionized water and analyzed for nutrient content by Western Labs, Parma, ID. The onions in all treatments were fertilized according to the nutrient analyses. Fertilizer was applied through the drip tape: ammonium sulfate at 25 lb N/acre on May 30, urea ammonium nitrate solution at 25 lb N/acre on June 5, June 16, and June 25, and zinc chelate at 0.25 lb Zn/acre and copper chelate at 0.2 lb Cu/acre on June 25.

Roundup at 24 oz/acre was sprayed on March 28. The field had Prowl (1lb ai/acre) broadcast on April 21 for postemergence weed control. Approximately 0.4 inch of water was applied through the minisprinkler system on April 21 to incorporate the Prowl. The field had Buctril at 0.12 lb ai/acre and Poast at 0.4 lb ai/acre applied on April 28. Thrips were controlled with one aerial application of Warrior on June 5 and two aerial applications of Warrior (0.03 lb ai/acre) plus Lannate (0.4 lb ai/acre) on July 16 and August 4.

On September 11 the onions were lifted to field cure. On September 17, onions in the central 40 ft of the middle two double rows in each subplot were topped and bagged. The bags were placed into storage on September 29. The storage shed was managed to maintain an air temperature of approximately 34°F. On December 11 the onions were graded. Bulbs were separated according to quality: bulbs without blemishes (No. 1s), double bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), plate rot (bulbs infected with the fungus *Fusarium* oxysporum), and black mold (bulbs infected with the fungus *Aspergillus niger*). The No. 1 bulbs were graded according to diameter: small (<2¼ inch), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and supercolossal (>4¼ inches). Bulb counts per 50 lb of supercolossal onions were determined for each plot of every variety by weighing and counting all supercolossal bulbs during grading.

After grading, 50 bulbs ranging in diameter from 3.5 to 4.25 inches from each plot were rated for single centers and translucent scale. The onions were cut equatorially through the bulb middle and, if multiple centered, the long axis of the inside diameter of the first single ring was measured. These multiple-centered onions were ranked according to the diameter of the first single ring: "small double" had diameters <1½ inch, "intermediate double" had diameters from 1½-2¼ inches, and "blowout" had diameters >2¼ inches. Single-centered onions were classed as a "bullet". Onions were considered functionally single centered for processing if they were a "bullet" or "small double." The number and location of translucent scales in each bulb was also recorded.

Results and Discussion

The soil water potential at 8-inch depth during the stress treatments reached values lower than the planned -60 kPa (Fig. 1). Irrigations for the plots being stressed were restarted as soon as the soil water potential reached -60 kPa. However, because the drip tape was located 11 inches from the soil moisture sensors, there was a short delay between the onset of irrigation and when the wetting front reached the sensors, when the soil moisture sensors began responding to the irrigations.

Water stress at the four-leaf (early June) and at the six-leaf (mid-June) stages resulted in fewer bullet single-centered and functionally single-centered onions than the unstressed check (Table 1). Water stress at the later stages did not affect onion single-centeredness. Water stress at the four-leaf stage resulted in higher percentage of blowout multiple centered onions. Water stress did not affect translucent scale. The level of translucent scale was very low, with all of the treatments having less than 1 percent of bulbs with translucent scales. In contrast to a previous study (Hegde 1986), the short-duration water stress in this trial did not affect onion yield or grade. Onion yield and size were reduced by short-duration water stress to -85 kPa, with the onions otherwise irrigated at -45 kPa (Hegde 1986). In the study by Hegde, the soil water potential at which the onions were irrigated was drier (-45 kPa) than in this study (-20 kPa) and the irrigation frequency was much lower, possibly causing the difference in results. The average onion yields in this trial were: 860 cwt/acre total yield, 837 cwt/acre marketable yield, 8 cwt/acre super colossal yield, 155 cwt/acre colossal yield, and 652 cwt/acre jumbo yield.

References

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Table 1. Onion multiple-center rating response to timing of water stress, Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.

Water stress timing	Blowout	Intermediate double	Small double	Bullet	Functionally single centered "Bullet + small double"
	%				
Check, no stress	2.5	14.0	14	69.5	83.5
4-leaf stage, early June	10.5	20.0	17	52.5	69.5
6-leaf stage, mid-June	4.5	26.0	15.5	54.0	69.5
6-leaf stage, late June	1.5	12.0	21.5	65.0	86.5
8-leaf stage, early July	3.5	18.5	16.0	62.0	78.0
LSD (0.05)	3.7	7.9	NS	10.9	8.5

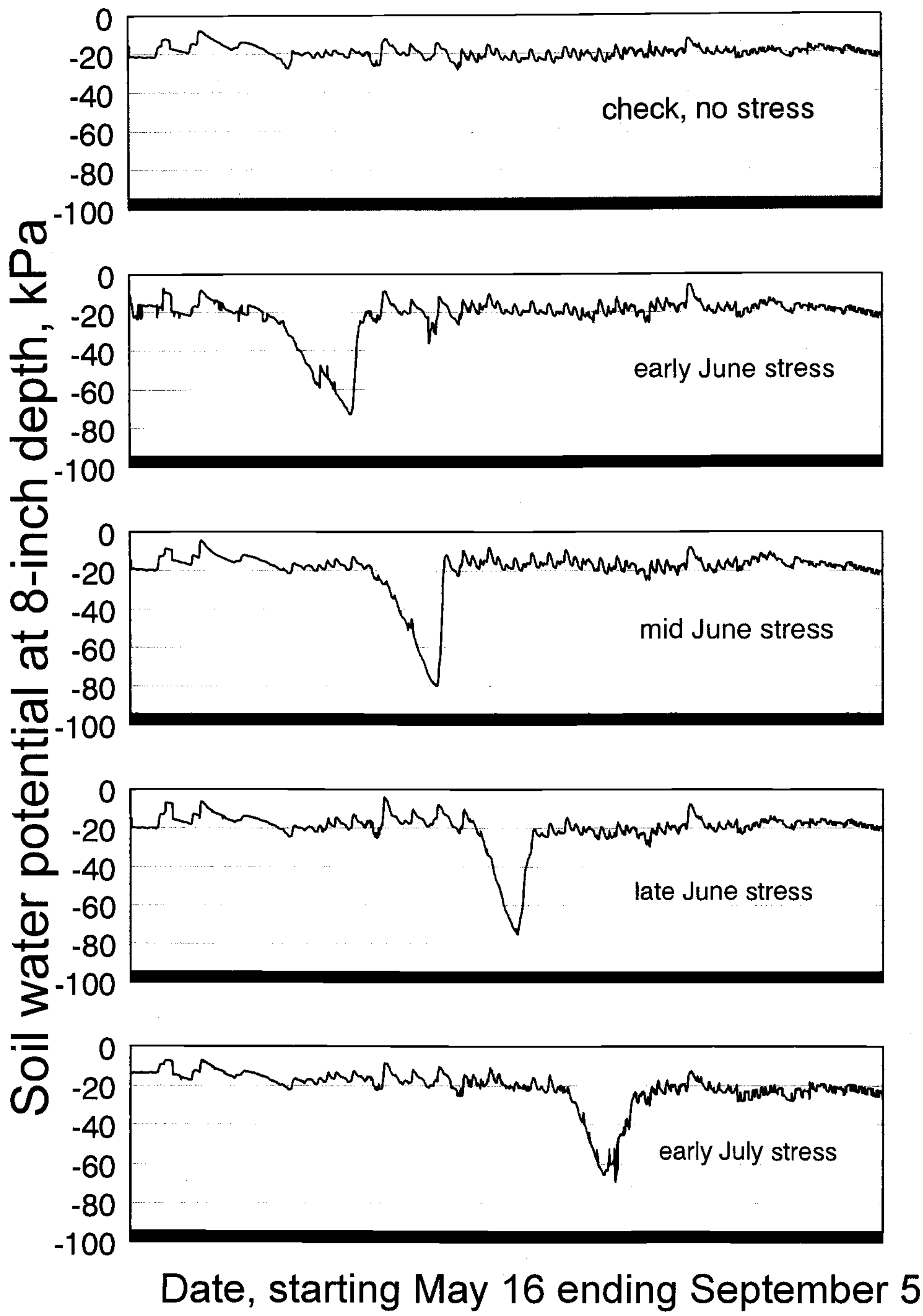

Figure 1. Soil water potential for onions irrigated at -20 kPa with an automated drip irrigation system and submitted to short-duration water stress, Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.