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 careful irrigation scheduling and maintenance of soil moisture (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 no drier than -20 kPa. It is not known whether 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. Soil analysis indicated the need for 60 lb Nitrogen (N)/acre, 100 lb phosphorus/acre, 100 lb Potassium/acre, 70 lb sulfur/acre, 2 lb copper/acre, and 1 lb boron/acre, which was broadcast in the fall. Onion (cv. ‘Vaquero’, Nunhems, Parma, ID) was planted in 2 double rows, spaced 22 inches apart (center of double row to center of double row) on 44-inch beds on March 17, 2004. The 2 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 4-inch depth between the 2 double onion rows at the same time as planting. 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 2. The trial was irrigated on April 5 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, and the water application rate was 0.10 inch/hour.

The experimental design was a randomized complete block with five replicates. There were six drip-irrigated treatments that consisted of five timings of short-duration water stress and an unstressed check. Each plot was 4 rows by 50 ft. Each plot had a ball valve allowing manual control of irrigations. The water stress was applied by turning the water off manually 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: two-leaf stage (water off May 5, water back on June 2), four-leaf stage (water off May 25, water back on June 4), early six-leaf stage (water off June 2, water back on June 11), late six-leaf stage (water off June 11, water back on June 16), and eight-leaf stage (water off June 18, water back on June 24).

Soil water potential (SWP) was measured in each plot with four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co. Inc., 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 SWP 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 SWP 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 13. 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 plant nutrient analyses. Urea ammonium nitrate solution at 50 lb N/acre was applied through the drip tape on May 27 and on June 17.

Prior to onion emergence, Roundup® at 24 oz/acre was sprayed on March 29. The field had Prowl®(1lb ai/acre) broadcast on April 12 for postemergence weed control. Approximately 0.45 inch of water was applied through the minisprinkler system on April 12 to incorporate the Prowl. The field had Goal® at 0.12 lb ai/acre, Buctril® at 0.12 lb ai/acre, and Poast® at 0.28 lb ai/acre applied on May 25. Thrips were controlled with one aerial application of Warrior® on June 12, one aerial application of Warrior (0.03 lb ai/acre) plus Lannate® (0.4 lb ai/acre) on June 25, one aerial application of Warrior (0.03 lb ai/acre) plus MSR®(0.5 lb ai/acre) on July 17, and one aerial application of Warrior (0.03 lb ai/acre) plus Lannate (0.4 lb ai/acre) on July 31.

On September 9 the onions were lifted to cure. On September 15, onions in the central 40 ft of the middle 2 double rows in each plot 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. The onions were graded on December 9. 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 (<2.25 inch), medium (2.25-3 inches), jumbo (3-4 inches), colossal (4-4.25

inches), and supercolossal (>4.25 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 doubles” have diameters less than 1.5 inch, “intermediate doubles” have diameters from 1.5 to 2.25 inches, and “blowouts” have diameters greater than 2.25 inches. Single-centered onions are classed as a “bullet”. Onions are considered functionally single centered for processing if they are a “bullet” or “small double.” The number and location of translucent scales in each bulb was also recorded.

Results and Discussion

The SWP 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 SWP reached -60 kPa. In addition to being difficult to catch the SWP when it first reaches -60 kPa, the drip tape was located 11 inches from the soil moisture sensors, which caused a short delay between the onset of irrigations and when the wetting front reached the sensors, so that they would begin responding to the irrigations.

At no stage did water stress affect onion single centeredness or the incidence of bulbs with translucent scale in 2004 (Table 1). Single-centered “bullet” and functionally single-centered bulbs averaged 80.5 and 93.8 percent, respectively. Bulbs with translucent scale averaged 1.1 percent. In 2003, water stress at the four-leaf and six-leaf stages resulted in significantly lower single-centered and functionally single-centered bulbs than the unstressed check (Shock et al. 2004). In 2004 there were relatively few other sources of stress than those imposed by the trial treatments, suggesting a possible role of multiple sources of stress influencing multiple-centered bulbs.

The short-duration water stress in this trial did not affect onion yield or grade. The average onion yields in this trial were: 1,016.4 cwt/acre total yield, 980.5 cwt/acre marketable yield, 7.0 cwt/acre supercolossal yield, 164.3 cwt/acre colossal yield, and 786.4 cwt/acre jumbo yield. In contrast, in a previous study by Hegde (1986), onion yield and size were reduced by short-duration water stress to -85 kPa, with the onions otherwise irrigated at -45 kPa. In that study, the SWP at which the onions were irrigated was drier (-45 kPa) than in our study (-20 kPa) and the irrigation frequency was much lower, possibly causing the difference in results.

References

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Table 1. Onion multiple-center rating and translucent scale response to timing of water stress, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

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