EFFECTS OF HEATING AND FREEZING ON TRANSLUCENT SCALE IN ONION BULBS

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Ontario, OR, 2002

Summary

Onions from a furrow-irrigated and from a drip-irrigated field were harvested and submitted to heat treatments (80, 90, 100, 110, and 120°F) in a forced-air oven for 20 hours. Onions were also submitted to 30°F for 20 hours. The incidence of translucent scale was low for all treatments except the 120°F treatment. Averaged over time and over the two fields, 30 percent of the bulbs treated to 120°F showed translucent scale.

Introduction

Onion translucent scale is a physiological disorder in which the bulb scales or rings acquire a translucent or watery appearance. Causes of translucent scale remain unknown. Research has shown that specific conditions during field curing and artificial drying temperatures are associated with translucent scale (Solberg and Boe 1997). Prolonged field curing and high artificial drying temperatures are associated with translucent scale. The objective of this trial was to elucidate the influence of short term heating and freezing on translucent scale development in the Treasure Valley of Oregon and Idaho.

Methods

Onions from two fields were harvested for the temperature treatments.

Procedures for Field 1

The onions were grown at the Malheur Experiment Station, Ontario, Oregon on an Owyhee silt loam previously planted to wheat. In the fall of 2001, the wheat stubble was shredded and the field was disked, irrigated, ripped, moldboard-plowed, roller-harrowed, fumigated with Telone C-17 at 20 gal/acre, and bedded. Before plowing, 100 lb P_2O_5/acre, 100 lb K/acre, 50 lb Mg/acre, 10 lb Zn/acre, 3 lb Cu/acre, and 1 lb B/acre were broadcast.

On March 22, onion seed (cv. 'Vaquero', Sunseeds, Morgan Hill, CA) was planted in two double rows, spaced 22 inches apart on 44-inch beds. Onion seed was planted at 150,000 seeds per acre. 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 on March 25. The field was sidedressed with urea at 90 lb N/acre on May 15 and on June 11.

The trials were managed to avoid yield reductions from weeds, pests, and diseases. Weeds were controlled with a cultivation on April 18 and with an application of Goal at 0.12 lb ai/acre, Buctril at 0.37 lb ai/acre, Poast at 0.74 lb ai/acre, and Prowl at 1 lb ai/acre on May 31. After lay-by the field was hand weeded as necessary. Aerial applications of Poast at 0.74 lb ai/acre were made on July 31 and August 8. Thrips were controlled with four aerial applications of Warrior and Lannate (June 19, July 2, July 18, and August 6) and one aerial application of Warrior on June 10. Warrior was applied at 0.03 lb ai/acre and Lannate was applied at 0.26 lb ai/acre.

The trial was furrow irrigated when the soil water potential at 8-inch depth reached -20 kPa. Soil water potential was monitored by six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA) installed in mid-June below the onion row at 8-inch depth. Sensors were automatically read three times a day with an AM-400 meter (Mike Hansen Co., East Wenatchee, WA). The last irrigation was on August 29.

The onions were lifted on September 9 to field cure. Onions were topped by hand into bins on September 18. The onions were placed into storage on September 20.

Procedures for Field 2

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 on 44-inch beds on April 4, 2002. Onion was planted at 150,000 seeds/acre. Drip tape (T-tape, T-systems International, San Diego, CA) was laid simultaneously with 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 0.22 gal/minute/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. The trial was irrigated on April 8, April 20, April 24, April 27, and April 30 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. Onions started emerging on April 18.

Fertilizer was applied through the drip tape as ammonium phosphate at 50 lb N/acre and 96 lb P/acre on June 12. On June 19 and June 27, ammonium phosphate at 25 lb N/acre and 48 lb P/acre was applied through the drip tape. On June 13, zinc chelate at 0.25 lb Zn/acre, copper chelate at 0.2 lb Cu/acre, and boric acid at 0.1 lb B/acre were injected through the drip tape. On June 20, magnesium sulfate at 5 lb Mg/acre was injected through the drip tape. On July 3, magnesium sulfate at 5 lb Mg/acre and copper chelate at 0.2 lb Cu/acre were injected through the drip tape.

The soil water potential at 8-inch depth was maintained nearly constant at -20 kPa by applying 0.06 acre-inch/acre of water up to eight times a day as needed based on automated soil water potential readings every 3 hours (Shock et al. 2000). The automated drip irrigation system was started on May 22.

Postemergence weed control was obtained by an application of Prowl (1.7 lb ai/acre) and Poast (0.2 lb ai/acre) on May 2 and an application of Goal (0.12 lb ai/acre), Buctril (0.12 lb ai/acre), and Poast (0.28 lb ai/acre) on May 23. Approximately 0.3 inch of water was applied through the minisprinkler system on May 2 to incorporate the Prowl. Thrips were controlled with four aerial applications of Warrior and Lannate (June 19, July 2, July 18, and August 6) and one aerial application of Warrior on June 10. Warrior was applied at 0.03 lb ai/acre and Lannate was applied at 0.26 lb ai/acre.

On September 10 the onions were lifted to field cure. On September 19, onions were topped into bins. The bins were placed into storage on September 23. The storage shed was managed to maintain an air temperature of approximately 34°F.

Procedures for Heat Treatments

Starting on October 7, the onions from each field were divided into four lots and placed into crates. Each lot was subdivided and submitted to seven temperature treatments: 30, 80, 90, 100, 110, and 120°F. The heat treatments were achieved by placing the bulbs in a forced air oven for 20 hours. The freezing treatment was achieved by placing the bulbs in a walk-in cooler with circulating air for 20 hours. Bulb temperatures during heating and cooling treatments were measured with temperature probes read by dataloggers (Hobo datalogger, Onset Computer Corp., Bourne, MA). Each datalogger had four probes that measured bulb temperature at 0.08-, 0.4-, and 1.6-inch depth. The fourth probe measured bulb temperature in the bulb neck. The bulb temperatures were replicated by the use of four dataloggers. A fifth datalogger measured air temperature from four probes. The onions in each crate were weighed before and after the temperature treatments. After being treated the onions were placed in nylon mesh bags. The bags were weighed and placed into storage. Four bags from each treatment were weighed and evaluated monthly for the occurrence of translucent scale starting on October 22. Each bulb was cut equatorially and checked for translucent scale. The number and location of translucent scales in each bulb was recorded.

Results and Discussion

Onions were evaluated after treatment and each successive month.

October

Field 1 (furrow irrigated) had a significantly higher percentage of bulbs with translucent scale than field 2 (drip irrigated) on October 22 (Table 1), suggesting a greater water stress. Soil water potential in field 1 oscillated between 0 kPa and -20 kPa, with two periods when the soil water potential was drier than -20 kPa (Fig. 1). Soil water potential in field 2 oscillated around -20 kPa, with two periods when the soil water potential was drier than -20 kPa (Fig. 2). Soil water potential during the periods of excessive dryness in field 1 reached lower values than in field 2. The periods of excessive dryness in field 1 could have resulted in higher bulb temperatures and consequently more translucent scale than in field 2. Water potential patterns was not the only difference between these two fields, so the difference in translucent scale between onions from the two fields remains unknown.

In both fields the percentage of bulbs with translucent scale in the check treatment was low, averaging 0.9 percent. In both fields the highest percentage of bulbs with translucent scale resulted from the 120°F treatment. In field 1, the 90 and 100°F treatments also resulted in a higher percentage of translucent scale than the check. In field 2 the 80°F treatment also resulted in a higher percentage of translucent scale than the check. Exposure of the bulbs to freezing temperature did not result in translucent scale.

November

There was no significant difference between fields in any of the measured parameters (Table 1). Heat treatment at 120°F resulted in the highest percentage of bulbs with translucent scale and was the only treatment resulting in a higher percentage of bulb with translucent scale than the check.

December

In both fields the highest percentage of bulbs with translucent scale resulted from the 120°F treatment. In field 2, the 30°F treatment also resulted in a higher percentage of translucent scale than the check.

The percentage of bulbs with translucent scale was relatively stable over time. The average number of translucent scales in bulbs with translucent scales was highest with the 120 °F treatment. Heat treatment at 120°F resulted in the translucent scale being on average located midway between the bulb center and the outermost ring. The translucent scales in the other treatments were located closer to the surface.

The forced-air oven temperature treatments were effective in increasing the bulb temperature up to 1.6-inch depth in the onion (Fig. 3). The maximum bulb temperatures achieved for the heated onions generally approximated the intended temperature treatment (Fig. 4). The minimum temperature achieved for the cold-treated bulbs was lower than the intended 30°F (Fig. 5).

References

Solberg, S.O., and E. Boe. 1997. The influence of crop management on watery scales in onions--a survey in southeastern Norway. In: Translucent and leathery scales in bulb onions (*Allium cepa* L.). Norwegian Crop Research Institute, Doctor Scientarum Theses 30.

Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2000. Irrigation criteria for drip-irrigated onions. HortSci. 35:63-66.

Table 1. Effect of temperature treatment of onion bulbs in a forced-air oven for 20 hours on onion translucent scale. Onion bulbs were treated in early October and evaluated for translucent scale monthly starting October 22. Malheur Experiment Station, Oregon State University, Ontario, OR 2002.

Temperature treatment, °F	Percent of bulbs with translucent scales			Average number of translucent scales*			Average location of translucent scales†		
Field 1 (D1)	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
30	0.0	5.0	0.0	na	0.8	0.0	na	0.5	0.0
none	0.9	1.8	0.0	0.8	1.3	0.0	1.5	0.9	0.0
80	13.4	0.0	0.0	6.9	0.0	0.0	4.3	0.0	0.0
90	18.2	7.7	0.0	6.3	0.7	0.0	3.6	0.7	0.0
100	22.4	1.0	0.0	6.5	0.5	0.0	3.7	1.6	0.0
110	0.0	1.8	0.0	na	0.4	0.0	na	0.3	0.0
120	40.7	38.6	35.6	4.6	4.8	5.2	5.9	6.2	6.7
Average	13.7	8.0	5.1	3.6	1.2	0.7	3.2	1.5	1.0
Field 2 (C1)	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
30	0.0	0.0	5.0	na	0.0	2.5	na	0.0	1.4
none	1.0	2.2	0.0	1.8	2.3	0.0	1.0	2.4	0.0
80	12.0	2.3	0.0	6.9	0.9	0.0	4.0	0.9	0.0
90	2.8	3.3	2.0	1.6	1.5	0.5	3.2	4.1	2.8
100	0.0	1.2	1.0	na	3.3	1.5	na	1.8	2.1
110	1.2	0.0	0.0	1.3	0.0	0.0	0.8	0.0	0.0
120	22.9	19.9	22.1	3.5	4.1	5.1	7.3	7.2	6.6
Average	6.7	4.1	4.3	2.5	1.7	1.4	3.3	2.3	1.8
Field 1, Field 2 average	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
30	0.0	2.5	2.5	na	0.4	1.3	na	0.3	0.7
none	0.9	2.0	0.0	1.3	1.8	0.0	1.3	1.6	0.0
80	12.7	1.1	0.0	6.9	0.4	0.0	4.1	0.5	0.0
90	10.5	5.5	1.0	3.9	1.1	0.3	3.4	2.4	1.4
100	11.2	1.1	0.5	3.2	1.9	0.8	1.9	1.7	1.1
110	0.6	0.9	0.0	0.6	0.2	0.0	0.4	0.2	0.0
120	31.8	29.2	28.9	4.0	4.4	5.1	6.6	6.7	6.6
Average	9.7	6.1	4.7	2.8	1.5	1.1	2.5	1.9	1.4
LSD (0.05) Trt	6.5	5.3	3.4	1.9	2.2	1.7	2	1.9	1.4
LSD (0.05) Field	2.8	NS	NS	0.8	NS	NS	NS	NS	NS
LSD (0.05) Trt X Field	7.5	NS	4.3	2	NS	NS	1.8	NS	NS

*Average number of translucent scales in bulbs with translucent scales.
†Scale number counted from bulb outside.

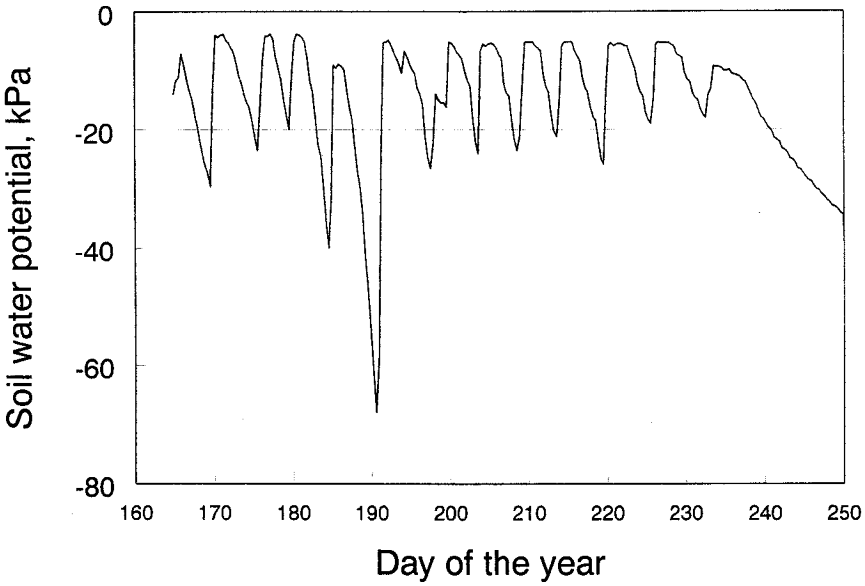

Figure 1. Soil water potential over time at 8-inch depth for field 1 (furrow irrigated). Malheur Experiment Station, Oregon State University, Ontario, OR 2002.

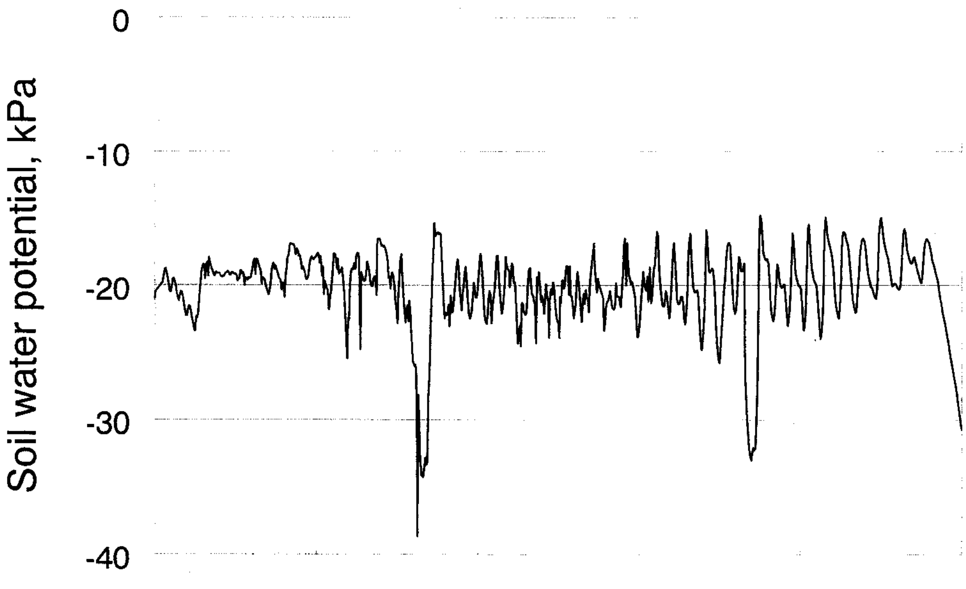

Figure 2. Soil water potential over time at 8-inch depth for field 2 (drip irrigated). Malheur Experiment Station, Oregon State University, Ontario, OR 2002.

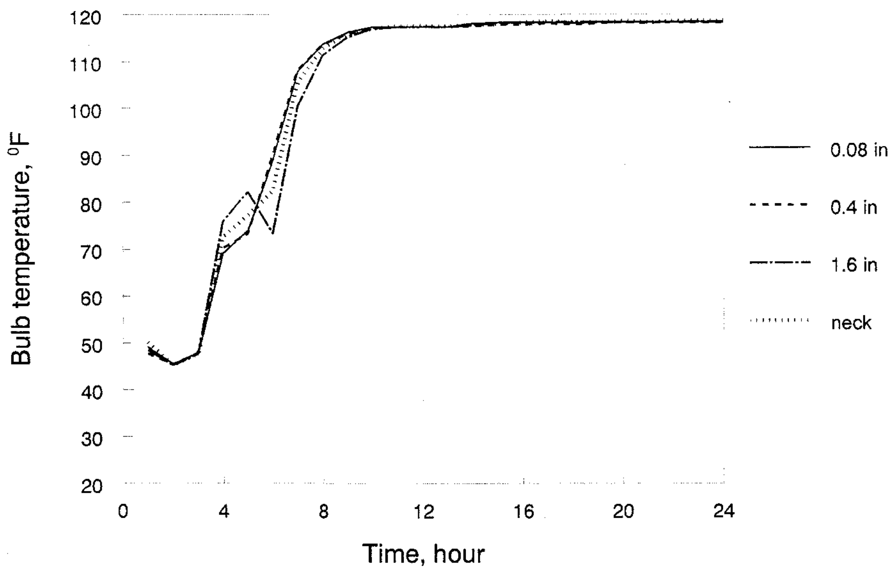

Figure 3. Onion bulb temperature at four depths over time for onions submitted to 120°F in a forced-air oven. Temperature data is based on the average of four replicate readings. Malheur Experiment Station, Oregon State University, Ontario, OR 2002.

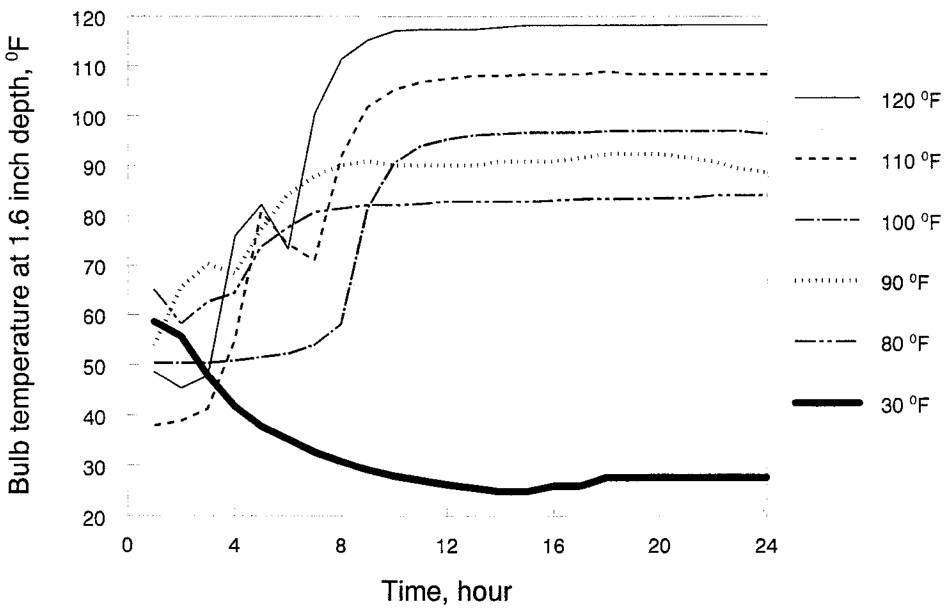

Figure 4. Onion bulb temperature at 1.6-inch depth over time for onions submitted to six temperature treatments in a forced-air oven. Temperature data is based on the average of four replicate readings. Maximum 1.6-inch bulb temperatures reached were 84, 93, 97, 109, and 118°F, for the 80, 90, 100, 110, and 120°F treatments, respectively. Malheur Experiment Station, Oregon State University, Ontario, OR 2002.

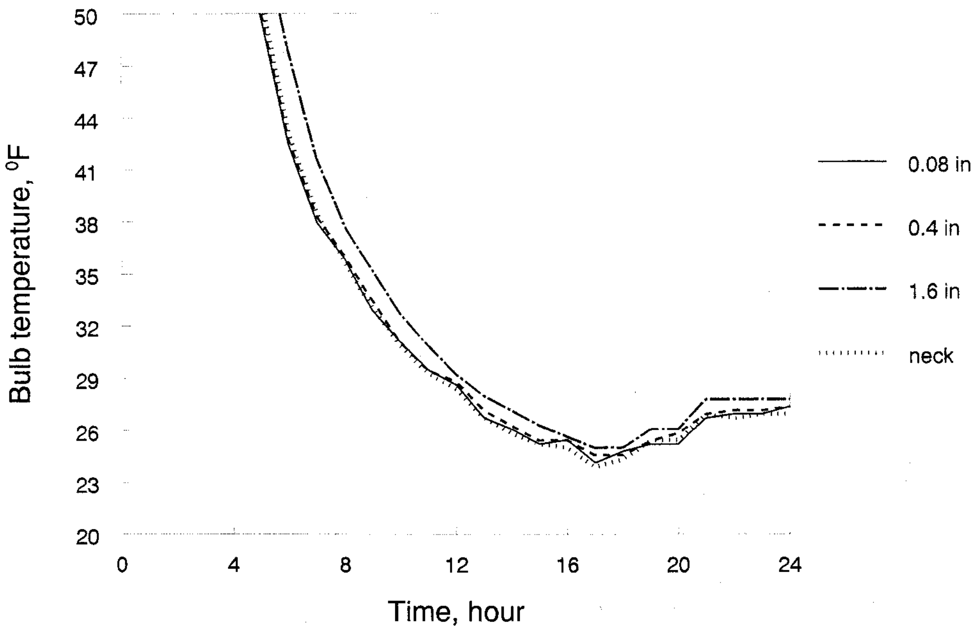

Figure 5. Onion bulb temperature at four depths over time for onions submitted to freezing. Temperature data is based on the average of four replicate readings. Minimum 1.6-inch bulb temperature reached was 25°F. Malheur Experiment Station, Oregon State University, Ontario, OR 2002.