ONION PRODUCTION FROM TRANSPLANTS GROWN IN A LOW TUNNEL COLD FRAME AND IN A GREENHOUSE

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Introduction

Increased interest in an earlier start for the onion harvest season has led to interest in transplanting. Our earlier research showed that onions can be harvested in July when grown from transplants started in the winter in a greenhouse (Shock et al. 2004). Transplants must be grown locally as required by the local onion white rot quarantine that prohibits importation of onion transplants from areas outside the Treasure Valley. Onion transplant production in the Treasure Valley is expensive due to the need for heated greenhouse production during the winter. Transplants produced from field-grown overwintering varieties have performed inconsistently and the available overwintering varieties do not have adequate bulb quality and appearance (Shock et al. 2006, 2007). Another alternative would be to plant seed in the winter and grow transplants in unheated "low tunnel" cold frames. This trial evaluated the performance of onion transplants produced in low tunnels and in a heated greenhouse.

Materials and Methods

Two 44-inch beds were made in a field of Nyssa silt loam on January 8, 2007. On January 9, 50 lb phosphate (P_2O_5)/acre, 0.5 lb zinc (Zn)/acre, and 100 sulfur (S)/acre were broadcast on the bed surface. Onion seed of variety 'Ranchero' (Nunhems, Parma, ID) was broadcast on the bed surface at 1 seed/inch^2 on January 16. The onion seed was covered with 0.25 to 0.5 inch of shredded bark mulch. Two drip tapes were laid 11 inches to each side of the bed center. On January 17, low tunnel cold frames were assembled over each bed. A 6-ft-wide plastic sheet was laid over wire hoops leaving about 6 inches of plastic on the outside of each bed side. The excess plastic was covered with soil to secure the plastic. The 76-inch-long hoops were made of number 10 gauge smooth galvanized steel wire. The hoops were inserted about 6 inches in the ground at the bed edges. The low tunnel was about 20 inches tall at the center. One bed was covered with perforated plastic and the other with solid plastic.

The beds were irrigated after planting as required to wet the bed surface. Emergence in both low tunnels started on February 12. Thereafter, the beds were irrigated when the soil water tension at 4-inch depth in the bed center reached 20 cb (1 cb = 1 kPa) (Shock et al. 2000). Soil water tension in each low tunnel was monitored by 6 granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co. Inc., Riverside, CA) centered at 4-inch depth below the bed center. The sensors were automatically read three times a day with two AM-400 meters (Mike Hansen Co., East Wenatchee, WA).

Temperature sensors were installed in the soil and air in each low tunnel. Three sets of four sensors were installed in each low tunnel in the bed center. Each set had a sensor 4 inches above the soil surface and one at 1-inch, 2-inch, and 4-inch depths. The temperature was read hourly by a datalogger (CR10, Campbell Scientific, Logan, UT).

In addition to the low tunnel cold frames, transplants were also grown in a heated greenhouse (65°F day, 45°F night air temperatures). Onion seed of variety Ranchero was planted in flats with a vacuum seeder at 72 seeds/flat on January 18, 2007. The seed was sowed on a 1-inch layer of Sunshine general purpose potting mix. The seed was then covered with 1 inch of potting mix. The flats were watered immediately after planting and were kept moist until emergence on February 1.

On March 29, the 1- to 2-leaf onions from each low tunnel and the 2- to 3-leaf onions from the greenhouse were transplanted to a field of Owyhee silt loam. The seedlings were planted in double rows on 22-inch beds. The spacing between plants in each single row was 6 inches (every 3 inches in the double row), equivalent to 95,000 plants per acre. Plots of each treatment were 20 ft long by 4 double rows wide arranged in a randomized complete block design with 5 replicates.

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. Weeds were controlled with an application of Prowl® at 1 lb ai/acre on April 13. On May 18, Aza-Direct® at 0.0062 lb ai/acre and Success® at 0.25 lb ai/acre were applied for thrips control, and Select® at 0.25 lb ai/acre and Prowl at 0.24 lb ai/acre were applied for weed control. On June 1, Aza-Direct at 0.0062 lb ai/acre and Success at 0.25 lb ai/acre were applied for thrips control. Subsequent insecticide applications for thrips control were done aerially: June 16, Lannate® at 0.9 lb ai/acre; July 6, Carzol® at 1.15 lb ai/acre; July 15, Lannate at 0.9 lb ai/acre and Poast® at 0.28 lb ai/acre (grass control); and August 3, Lannate at 0.9 lb ai/acre. Not all of these late treatments were necessary for these onions, but they were planted in a field to be harvested in September and received all treatments appropriate for these full season trials.

The field was sidedressed with urea at 120 lb N/acre on May 11. On June 11, the field was sidedressed with 100 lb N/acre as urea.

On July 12, July 30, and August 14, 6.7 ft of the middle two rows in each plot were topped and bagged. Decomposed bulbs were not bagged. Following each harvest the onions were graded. Bulbs were separated according to quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), and bulbs infected with neck rot (*Botrytis allii*) in the neck or side, plate rot (*Fusarium oxysporum*), or black mold (*Aspergillus niger*). The

No. 1 bulbs were graded according to diameter: small (<2¼ inches), 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.

Onion bulbs from all harvests were rated for single centers. Twenty-five onions ranging in diameter from 3.5 to 4.25 inches from each plot were rated. 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" had diameters less than 1½ inch, "medium" had diameters from 1½ to 2¼ inches, and "large" had diameters over 2¼ inches. Onions were considered "functionally single centered" for processing if they were single centered or had a small multiple center.

Treatment differences were compared using ANOVA and protected least significant differences at the 5 percent probability level, LSD (0.05).

Results and Discussion

Onion seed in the greenhouse emerged on February 1 (14 days to emergence) and onion seed in the low tunnels emerged on February 12 (27 days to emergence). Air temperature in the greenhouse oscillated within a narrower range than air temperature in the low tunnels (Figs. 1 and 2). A heater malfunction on the night of January 31 allowed air temperature in the greenhouse to drop to 24°F. At the time of transplanting, the greenhouse transplants had two to three true leaves and the low tunnel transplants had one to two true leaves. The greenhouse transplants were substantially larger than the low tunnel transplants.

At the first two harvests (July 12 and July 30) the greenhouse transplants had significantly higher total yield and colossal bulb yield than either solid or perforated-plastic low tunnel transplants (Table 1). At the last harvest (August 14) the greenhouse transplants had significantly higher total yield and supercolossal bulb yield than either low tunnel transplants. At the last harvest the low tunnel solid plastic transplants had a higher yield of supercolossal bulbs than the low tunnel perforated-plastic transplants. There was a constant increase in marketable yield between the first and last harvest (Table 1, Fig. 3). Supercolossal bulb yield showed a large increase between the second and third harvest compared to the first and second harvest.

Averaged over harvest dates, the greenhouse transplants had higher total and marketable yield and yield of supercolossal and colossal bulbs.

At the first harvest there was no significant difference in bulb single centeredness between transplant types (Table 2). At the second harvest the greenhouse transplants had a significantly lower percentage of functionally single-centered bulbs than the low tunnel solid-plastic transplants. At the third harvest the greenhouse transplants had signifcantly lower percentage of functionally single-centered bulbs than the low tunnel transplants. The greenhouse transplants had 20 percent bolted bulbs on July 30 and 19 percent bolted bulbs on August 14 compared to no bolting for the low tunnel transplants. At the time of transplanting, the greenhouse transplants had one to two leaves more than the low tunnel transplants and were substantially larger. The higher bolting with the greenhouse transplants could be related to their being more susceptible to vernalization than the low tunnel transplants. The last killing frost (≤ 32°F) was on May 4, with numerous killing frosts in April. Onion variety Ranchero, direct seeded in the same field and with emergence on March 30, showed only 0.2 percent bolting.

In 2007, the greenhouse transplants resulted in higher yield and grade, but lower percentage of single-centered bulbs than the low tunnel transplants. The performance of the greenhouse transplants simply in terms of yield and grade in 2007 was consistent with performance of greenhouse transplants in 2002 and 2003 (Table 3). Yields of onions grown from greenhouse transplants in 2006 were reduced by excessive thrips and iris yellow spot virus infestations. The lower number of single-centered bulbs with the greenhouse transplants in 2007 compared to previous years is not known. In 2006, the transplants were at the same stage as in 2007 (2-3 leaves), but transplanting occurred later in 2006.

The results suggest that transplants from the low tunnel cold frames were too small and might perform better in future trials if the seed had been planted earlier.

References

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

Shock, C.C., E. B. G. Feibert, and L.D. Saunders. 2004. Onion production from transplants in the Treasure Valley. Oregon State University Agricultural Experiment Station Special Report 1055:47-52.

Shock, C.C., E. B. G. Feibert, and L.D. Saunders. 2006. Onion production from transplants. Oregon State University Agricultural Experiment Station Special Report 1075:45-50.

Shock, C.C., E. B. G. Feibert, and L.D. Saunders. 2007. Evaluation of overwintering onion for production in the Treasure Valley, 2005-2006 trial. Oregon State University Agricultural Experiment Station Special Report 1075:43-44.

Table 1. Performance data from three harvest dates for onion variety Ranchero grown from transplants. Transplants were produced in unheated low tunnel cold frames and in a heated greenhouse, Malheur Experiment Station, Oregon State University, Ontario, OR.

Transplant source	Total yield	Marketable yield by grade					Bulb counts >4¼ in	Small	No. 2	Rot
		Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in				
	---- cwt/acre ----						#/50 lb	-- cwt/acre --		%
12 July										
Greenhouse	671.6	664.6	4.7	147.0	467.7	45.2	37.8	7.1	0.0	0.0
Low tunnel perforated[a]	351.7	305.8	0.0	2.8	196.1	106.9	na	46.0	0.0	0.0
Low tunnel solid[b]	328.5	294.4	0.0	0.0	187.7	106.8	na	34.1	0.0	0.0
average	455.5	425.9	1.6	49.9	286.4	88.0	37.8	29.6	0.0	0.0
30 July										
Greenhouse	944.0	944.0	89.2	442.5	404.0	8.3	31.5	0.0	0.0	0.0
Low tunnel perforated	737.0	734.1	20.8	169.0	519.9	24.4	34.6	2.8	0.0	0.0
Low tunnel solid	685.8	683.2	20.9	154.9	478.2	29.2	35.1	2.6	0.0	0.0
average	796.0	794.3	45.1	259.4	469.0	20.8	33.2	1.7	0.0	0.0
14 August										
Greenhouse	1,341.3	1,332.7	716.0	455.1	160.7	0.8	27.2	2.0	0.0	6.7
Low tunnel perforated	1,035.2	1,026.5	178.5	418.8	315.0	19.1	28.9	4.2	6.7	0.0
Low tunnel solid	1,064.6	1,016.2	315.9	423.7	297.9	9.1	29.9	5.7	8.7	0.0
average	1,139.7	1,136.4	451.3	454.6	220.3	10.2	28.7	3.3	5.1	0.2
Average										
Greenhouse	985.6	980.4	270.0	348.2	344.1	18.1	30.1	3.0	0.0	0.2
Low tunnel perforated	708.0	688.8	90.3	220.2	326.9	51.5	31.0	16.9	2.2	0.0
Low tunnel solid	704.9	687.4	137.7	195.5	304.7	49.5	31.4	14.7	2.9	0.0
LSD (0.05) transplant source	87.4	90.6	72.7	66.4	NS	24.6	1.8	7.1	NS	NS
LSD (0.05) date	41.1	42.6	58.2	46.9	62.9	19.3	1.9	5.3	NS	NS
LSD (0.05) date X transpl.source	71.3	NS	100.8	81.1	108.9	NS	NS	9.1	NS	NS

[a]perforated plastic.
[b]solid plastic.

Table 2. Bulb single centeredness and bolting from three harvest dates for onion variety Ranchero grown from transplants. Transplants were produced in unheated low tunnel cold frames and in a heated greenhouse, Malheur Experiment Station, Oregon State University, Ontario, OR.

Transplant source	Multiple center: Large >2¼ inches[a]	Multiple center: Medium 1½ to 2¼ inches	Multiple center: Small <1½ inch	Single center	Functional single center[b]	Bolting
	%					
12 Jul						
Greenhouse	0.0	0.8	11.2	88.0	99.2	0.0
Low tunnel perforated	2.3	0.6	9.1	88.0	97.1	0.0
Low tunnel solid	3.5	1.0	4.0	91.5	95.5	0.0
Average	1.6	1.1	9.3	88.0	97.3	0.0
30 Jul						
Greenhouse	9.1	14.4	11.7	64.8	76.5	20.0
Low tunnel perforated	7.2	4.0	5.6	83.2	88.8	0.0
Low tunnel solid	7.3	2.7	4.7	85.3	90.0	0.0
Average	7.8	6.7	7.4	78.2	85.5	6.8
14 Aug						
Greenhouse	6.0	26.0	11.0	57.0	68.0	19.0
Low tunnel perforated	4.0	8.0	15.0	73.0	88.0	0.0
Low tunnel solid	4.0	8.0	14.0	74.0	88.0	0.0
Average	4.8	13.9	12.8	68.5	81.3	6.3
Average						
Greenhouse	5.2	13.6	11.4	69.9	81.3	13.0
Low tunnel perforated	4.3	4.3	10.9	80.5	91.5	0.0
Low tunnel solid	4.8	3.7	7.2	84.3	91.5	0.0
LSD (0.05) transplant source	NS	3.7	NS	9.2	5.7	5.3
LSD (0.05) date	3.6	5.1	NS	9.3	7.2	2.6
LSD (0.05) date X transplant source	NS	8.8	NS	NS	12.5	4.5

[a]diameter of the first continuous ring.
[b]single center plus small multiple center.

Table 3. Onion yield for variety Ranchero grown from transplants produced in a heated greenhouse over 4 years compared to low tunnels in 2007, Malheur Experiment Station, Oregon State University, Ontario, OR.

Year	Transplant date	Transplant source	Stage at transplanting	Harvest date	Total yield	Marketable yield by grade: Total	Marketable yield by grade: >4¼ in	Marketable yield by grade: 4-4¼ in	Bulb counts >4¼ in	Functional single center[a]
			No. of true leaves		cwt/acre				#/50 lb	%
2002	15 March	greenhouse	1-2	July 23	921.4	921.4	102.4	327.9	29.1	100.0
2003	19 March	greenhouse	1-2	July 22	944.9	942.4	70.7	459.3	32.0	82.0
2006	12 April	greenhouse	2-3	July 19	579.8	560.5	0.0	42.5		98.4
2006	12 April	greenhouse	2-3	August 3	693.3	690.5	0.0	132.7		92.0
2007	29 March	greenhouse	2-3	July 30	944.0	944.0	89.2	442.5	31.5	77.0
2007	29 March	low tunnel perforated	1-2	July 30	737.0	734.1	20.8	169.0	34.6	89.0
2007	29 March	low tunnel solid	1-2	July 30	685.8	683.2	20.9	154.9	35.1	90.0

[a]single center plus small multiple center.

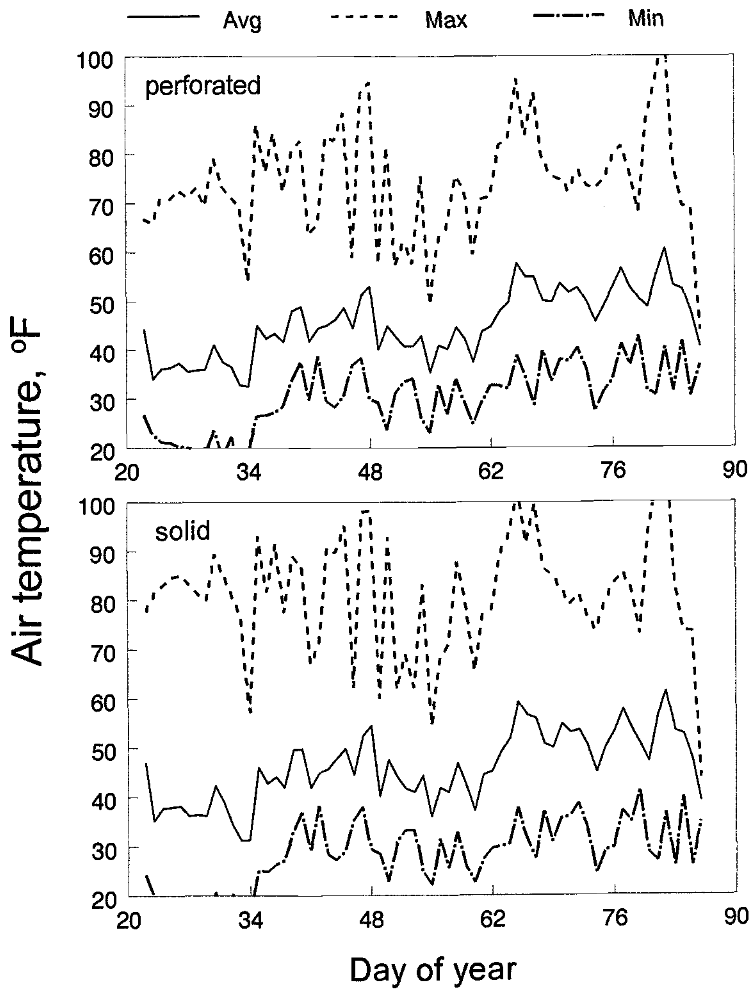

Figure 1. Daily average, maximum, and minimum air temperature in unheated low tunnels covered with perforated and solid plastic, Malheur Experiment Station, Oregon State University, Ontario, OR.

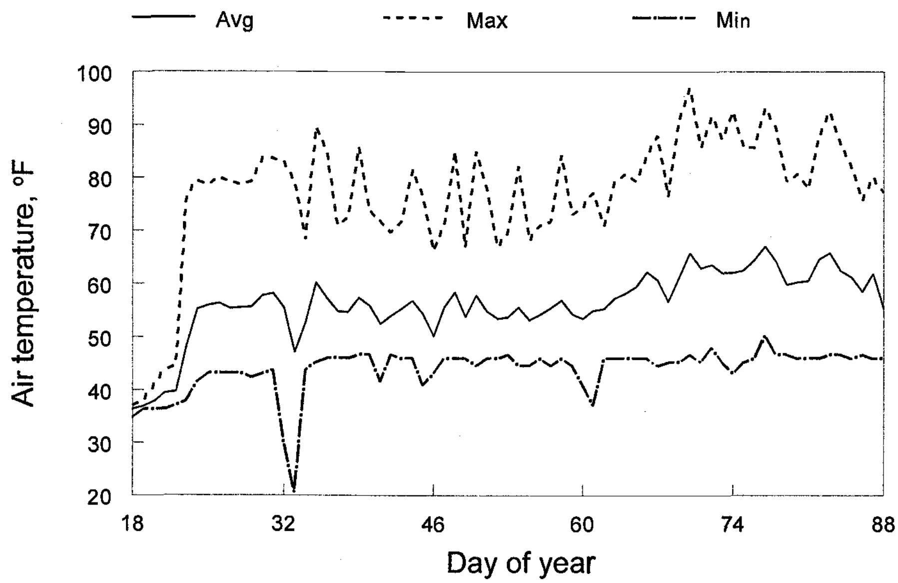

Figure 2. Daily average, maximum, and minimum air temperature in a heated greenhouse, Malheur Experiment Station, Oregon State University, Ontario, OR.

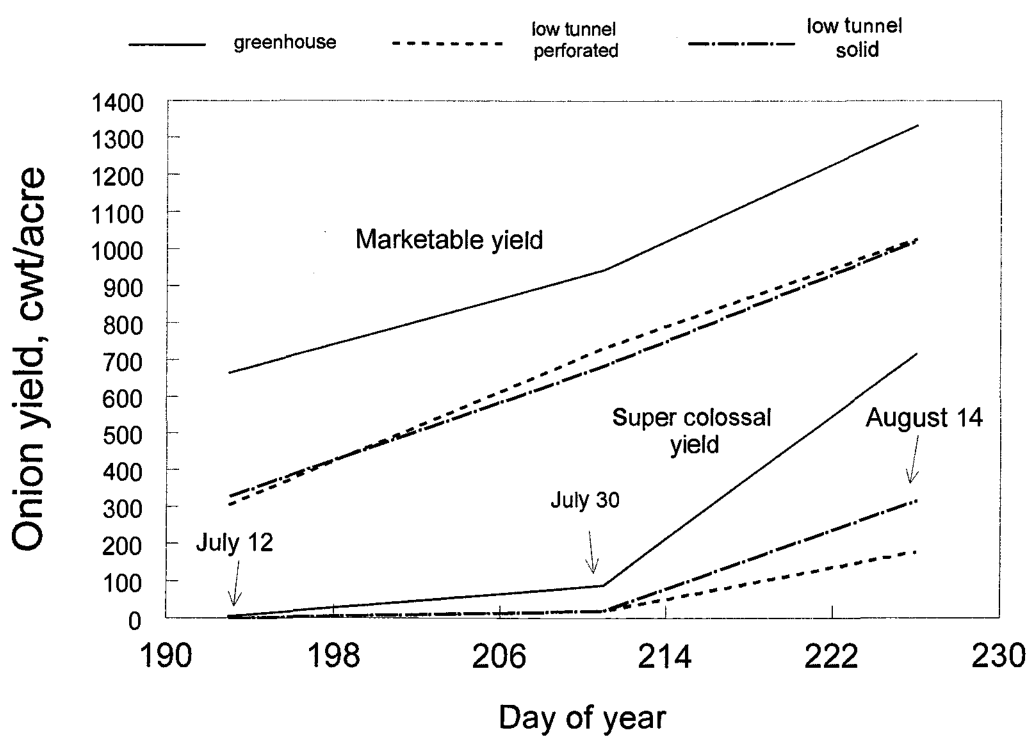

Figure 3. Marketable and supercolossal bulb yield at three harvest dates for onion variety Ranchero grown from transplants. Transplants were produced in unheated low tunnel cold frames covered with solid or perforated plastic and in a heated greenhouse, Malheur Experiment Station, Oregon State University, Ontario, OR.