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 growing onions from transplants. Our earlier research showed that onions, grown from transplants started in the winter in a greenhouse, can be harvested in July (Shock et al. 2004). Through 2009 transplants were grown locally as required by the local onion white rot quarantine that prohibited importation of onion transplants from areas outside the Treasure Valley. Onion transplant production in the Treasure Valley is relatively expensive due to the need for a heated greenhouse during the winter. Transplants produced from field-grown, over-wintering varieties performed inconsistently and the available over-wintering varieties do not have adequate bulb quality and appearance (Shock et al. 2006, 2007).

Another alternative to greenhouse-grown transplants is to grow transplants in unheated "low tunnel" cold frames (Shock et al. 2008, 2009). In 2007 and 2008, transplants produced in unheated "low tunnel" cold frames performed poorly compared to transplants produced in a heated greenhouse. Onion seed in the low tunnels emerged in early February which resulted in small plants at transplanting time. Onion seed in the low tunnels was planted on January 17 in 2007 and on December 17 in 2008 and the seed emerged emerged on February 12 and 18 in 2007 and 2008, respectively.

For the 2009 season, onion seed was planted on December 3, 2008 in the low tunnels to try again for earlier emergence. The 2008-2009 trial compared the performance of onion from transplants produced in low tunnels and in a heated greenhouse.

Materials and Methods

A 44-inch bed was made in a field of Nyssa silt loam on December 2, 2008. Two drip tapes were laid 11 inches to each side of the bed center. Seed of cultivar 'Ranchero' (Nunhems, Parma, ID) was broadcast on the bed surface at a rate of 144 seeds/ft^2 on December 3. The onion seed was covered with 0.25- to 0.5-inch depth of shredded bark mulch. The low tunnel was made by laying a 6-ft-wide plastic sheet 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 from number 10-gauge smooth galvanized steel wire. The hoops were inserted 6 inches into the ground at the bed edges. The low tunnel was 20 inches high at the center.

The low tunnel was irrigated after planting to wet the soil surface. Thereafter the field was irrigated when the soil water tension at 4-inch depth in the bed center reached 20 cb (1 cb = 1 kPa)(Shock et al. 2005). Soil water tension 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 an AM-400 meter (Mike Hansen Co., East Wenatchee, WA).

In addition to the low tunnel cold frame, transplants of variety Ranchero were also grown in a heated greenhouse (65°F day, 45°F night air temperatures). Onion seed of Ranchero was planted in flats with a vacuum seeder at 72 seeds/flat on January 23, 2009. 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.

On March 31, transplants from the low tunnel and from the greenhouse were transplanted to a field of Owyhee silt loam. The seedlings were planted in double rows spaced 3 inches apart on 22-inch beds. The spacing between plants in each single row was 6 inches (3 inches apart in each 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 avoid yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. On April 27, Prowl® at 2 pints/acre and Select® at 10 oz/acre were broadcast for weed control. On May 11, Goal® at 10 oz/acre, Buctril® at 12 oz/acre, and Poast® at 1.2 pints/acre were broadcast for weed control. Aza-Direct® at 8 oz/acre and Success® at 16 oz/acre were broadcast on June 9 and June 18 for thrips control. Lannate® at 3 pints/acre was broadcast on July 10 for thrips control. Not all of these late cultural practices were necessary for these onions, but the transplants were planted in a large field of onions to be harvested in September and so the transplants received all cultural practices appropriate for the full-season onion trials.

The field was furrow irrigated as necessary to maintain soil water tension at 8-inch depth at 25 cb. Soil water tension was monitored by six granular matrix sensors centered at 8-inch depth below the onion row (Shock 2003) . The sensors were automatically read three times a day with an AM-400 meter.

The field was fertilized with a total of 150 lb nitrogen (N)/ac as urea. Fifty pounds of N/acre were water run on May 14 and 100 lb N/acre were sidedressed on May 23.

At each harvest date, onions in each plot were evaluated subjectively for maturity by visually rating the percentage of onions with the tops down and the percent dryness of the foliage. The percent maturity was calculated as the average percentage of onions with tops down and the percent dryness.

On July 22, July 29, and August 6, 6.7 ft of the middle 2 double rows in each four row plot were topped and bagged. Decomposing 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), 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 (<2.25 inches), 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.

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 under 1.5 inch, “medium” had diameters from 1.5 to 2.25 inches, and “large” had diameters over 2.25 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 repeated measures analysis of variance. Means separation was determined using Fisher’s least significant difference test at the 5 percent probability level, LSD (0.05).

Results and Discussion

Emergence

Onion seed in the greenhouse emerged on February 2 (10 days after planting) and onion seed in the low tunnels emerged on February 16 (75 days after planting). The earlier planting (Dec. 3, 2008) did not result in earlier emergence than in 2007 or 2008. The greenhouse transplants were substantially larger than the low tunnel transplants. At the time of transplanting, the greenhouse transplants had two to three true leaves while the low tunnel transplants had only one to two true leaves.

July 22 Harvest

On July 22, onion bulbs grown from the low tunnel and the greenhouse had marketable yields of 377cwt/acre and 695 cwt/acre, respectively (Table 1). The onions from greenhouse transplants had significantly higher jumbo yield (624 cwt/acre) than those grown from low tunnel transplants (296 cwt/acre).

July 29 Harvest
The onion bulbs grown from greenhouse transplants had significantly higher colossal and jumbo yield than those grown from low tunnel transplants (Table 1).

August 6 Harvest
The onion bulbs grown from greenhouse transplants had significantly higher total, supercolossal and colossal yield than those grown from low tunnel transplants (Table 1).

Single Centers
Averaged over the three harvests, the onions grown from low tunnel transplants had significantly higher percentage of large multiple centers and a significantly lower percentage of functionally single-centered onions than those grown from the greenhouse transplants (Table 2).

Planting the seed early (Dec. 3) in the low tunnels in 2008 for 2009 transplants did not result in earlier emergence and larger transplants than January 17 or Dececember 17 plantings the previous 2 years. We do not know whether an earlier planting date (earlier than Dec. 3) in the low tunnels might result in earlier emergence and adequate growth. Over the 3 years of these studies, the onions from greenhouse transplants have had higher yields and grade than those from the low tunnel transplants (Table 3).

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Table 1. Performance of onions (cv. Ranchero) grown from transplants produced in unheated low tunnel cold frames and in a heated greenhouse at three harvest dates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2009.

Harvest date Transplant source	Total yield	Marketable yield by grade					Bulb counts >4¼ in	Small	No. 2	Rot	Maturity
		Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in					
	---------- cwt/acre ----------						#/50 lb	--- cwt/acre ---		------- % -------	
22-Jul											
Low tunnel	385	377	0	5.8	296	75.3	0.0	8.0	0.0	0.8	12.5
Greenhouse	695	694	0	40.8	624	29.1	0.0	1.0	0.0	0.0	4.5
Average	540	536	0	23.3	460	52.2	0.0	4.5	0.0	0.4	8.5
29-Jul											
Low tunnel	483	482	0	47.5	403	31.5	0.0	1.0	2.9	0.0	23.0
Greenhouse	852	851	0	186.6	659	5.7	0.0	0.9	0.0	0.0	15.0
Average	668	667	0	117.1	531	18.6	0.0	1.0	1.5	0.0	19.0
6-Aug											
Low tunnel	535	528	0	63.6	454	11.1	0.0	6.9	0.0	0.0	30.0
Greenhouse	936	935	105.2	392.8	435	1.5	25.1	1.0	0.0	0.2	29.0
Average	736	732	52.6	228.2	445	6.3	12.6	3.9	0.0	0.1	29.5
Average											
Low tunnel	468	463	0	39	384	39.3	0.0	5.3	1.0	0.3	21.3
Greenhouse	828	827	35.1	206.7	573	12.1	25.1	1.0	0.0	0.1	16.3
LSD (0.05)											
Treatment	78	81	16.3	55.8	77	7.2	NS	4.3	NS	NS	NS
Harvest date	88	87	16.6	56.8	NS	12.1	NS	NS	NS	NS	6.1
Trt X date	NS	NS	23.5	80.3	151	17	NS	NS	NS	NS	NS

Table 2. Bulb single centeredness of onions (cv. Ranchero) grown from transplants produced in unheated low tunnel cold frames and in a heated greenhouse at three harvest dates, Malheur Experiment Station, Oregon State University, Ontario, OR.

	Multiple center			Single center	
Harvest date Transplant source	Large >2¼ inches[a]	Medium 1½ to 2¼ inches	Small <1½ inch	Functional[b]	Single
22-Jul	---------- % ----------				
Low tunnel	8.0	4.0	5.6	88.0	82.4
Greenhouse	4.0	7.0	7.0	89.0	82.0
Average	6.0	5.5	6.3	88.5	82.2
29-Jul					
Low tunnel	13.3	10.0	8.0	76.7	68.7
Greenhouse	5.0	5.0	7.0	90.0	83.0
Average	9.2	7.5	7.5	83.3	75.8
6-Aug					
Low tunnel	8.0	14.5	5.3	77.5	72.2
Greenhouse	2.5	9.5	8.0	88.0	80.0
Average	5.3	12.0	6.7	82.7	76.1
Average					
Low tunnel	9.9	9.8	6.4	80.3	73.9
Greenhouse	3.8	7.2	7.3	89.0	81.7
LSD (0.05)					
Treatment	4.5	NS	NS	8.7	NS
Harvest date	NS	NS	NS	NS	NS
Trt X date	NS	9.3	NS	NS	NS

[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 6 years compared to those produced in low tunnels over 3 years. Malheur Experiment Station, Oregon State University, Ontario, OR.

Year	Transplant source	Transplant date	Harvest date	Total yield	Marketable yield by grade			Bulb counts	Functional single center[a]
					Total	>4¼ in	4-4¼ in	>4¼ in	
				---------- cwt/acre ----------				#/50 lb	%
2002	greenhouse	15-Mar	23-Jul	921	921	102	328	29.1	100.0
2003	greenhouse	19-Mar	22-Jul	945	942	71	459	32	82.0
2006	greenhouse	12-Apr	19-Jul	580	561	0	43		98.4
2006	greenhouse	12-Apr	3-Aug	693	691	0	133		92.0
2007	greenhouse	29-Mar	30-Jul	944	944	89	443	31.5	77.0
2007	low tunnel	29-Mar	30-Jul	686	683	21	155	35.1	90.0
2008	greenhouse	8-Apr	1-Aug	683	680		102		99.2
2008	low tunnel	8-Apr	1-Aug	524	516		13		85.0
2009	greenhouse	31-Mar	29-Jul	852	851	0	187		90.0
2009	low tunnel	31-Mar	29-Jul	483	482	0	48		76.7

[a]single center plus small multiple center.