

ONION PRODUCTION FROM TRANSPLANTS IN 2019

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Introduction

Interest in an earlier start for onion harvest and marketing has led to interest in transplanting onions. In the Treasure Valley, onions are available out of the field from mid-August through October and then out of storage from October through March. An earlier harvest would extend the time when local onions are available, which is important for onion processors and possibly for onion packing sheds. Onion varieties suitable for processing into onion rings must be single centered, produce large bulbs, and store well. Previous research at the OSU Malheur Experiment Station (MES) has shown that when onions are grown from transplants, they can be harvested starting in July (Shock et al. 2004, 2007–2009, and 2011–2018). The 2019 trial evaluated 7 onion varieties grown from transplants potentially suitable for processing or fresh market. Two varieties were grown from transplants produced in a greenhouse at MES, and five varieties were grown from transplants produced in Arizona.

Materials and Methods

Transplants were grown at MES in a heated greenhouse with minimum air temperatures during the day of 65°F and 45°F at night. Onion seed of varieties ‘OLYS15-1294’ (Crookham Co., Caldwell, ID) and ‘8019A’ (New Zealand Onion, Pukekohe, New Zealand) were planted in the greenhouse in flats with a vacuum seeder at 72 seeds/flat. The seed was sown on a 1-inch layer of Sun Gro Horticulture professional growing mix (Sun Gro Horticulture, Agawam, MA). The seed was then covered with 1 inch of the potting mix. The flats were placed in metal trays in the greenhouse. Immediately after planting, the trays were filled enough water to allow the flats to be kept moist. Variety 8019A was planted in the greenhouse on January 2, and OLYS15-1294 was planted on January 22. Onion seedlings of 8019A began emerging on January 12, and seedlings of OLYS15-1294 began emerging on February 3. Transplants were grown without supplemental light. Bare-rooted transplants of ‘Montero’ (BASF Vegetable Seeds, Parma, ID), ‘Avenger’ (Crookham Co.), ‘Jasmine’ (Crookham Co.), ‘SVNG 1561’ (Monsanto, Payette ID), and ‘Elsye’ (Enza Zaden, Salinas, CA) were grown in Arizona during the winter of 2018–2019.

Onions were grown from the transplants on an Owyhee silt loam at MES previously planted to wheat. After the wheat was harvested in 2018, the stubble was shredded, the field was irrigated to sprout unharvested wheat kernels, and then the field was disked. A soil analysis taken in the fall of 2018 showed a pH of 7.7, 2.5% organic matter, 6 ppm nitrogen (N) as nitrate, 2 ppm N as ammonium, 41 ppm phosphorus (P), 323 ppm potassium (K), 9 ppm sulfur (S), 2751 ppm calcium, 500 ppm magnesium, 186 ppm sodium, 2.9 ppm zinc (Zn), 2 ppm manganese (Mn), 1.7 ppm copper (Cu), 11 ppm iron, and 1.1 ppm boron (B). Based on the soil analysis, 50 lb N/acre, 22 lb P/acre, 42 lb K/acre, 80 lb S/acre, 12 lb Mn/acre, and 1 lb B/acre were

broadcast before plowing. In addition to the chemical fertilizer, 10 ton/acre of composted cattle feedlot manure was broadcast before plowing. Based on an analysis of the manure, 186 lb N/acre, 107 lb P/acre, and 375 lb K/acre were added from the manure. After plowing and groundhogging, the field was fumigated with Vapam[®] at 15 gal/acre and bedded at 22 inches.

Drip tape was laid at 4-inch depth between pairs of onion beds before planting. The drip tape had emitters spaced 12 inches apart and an emitter flow rate of 0.22 gal/min/100 ft (Toro Aqua-Traxx, Toro Co., El Cajon, CA). The distance between the tape and the center of each double row of onions was 11 inches.

Varieties 8019A and OLYS15-1294, grown in the greenhouse, were transplanted on March 21 and March 22, respectively. Varieties Montero, Avenger, Jasmine, SVNG 1561, and Elsyé, grown in Arizona, were transplanted on March 29. The onions were transplanted on four 22-inch beds in double rows 3 inches apart. The spacing between plants in each row was 4.8 inches, equivalent to 120,000 plants/acre. Plots of each variety were 20 ft long by 4 double rows wide. The experimental design was a randomized complete block with five replicates.

The onion crop was managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. The herbicide Prowl[®] H₂O (pendimethalin) at 2 pt/acre (0.95 lb ai/acre) was broadcast for weed control on April 5. Thrips were controlled by ground application using the following insecticides: Aza-Direct[®] (azadirachtin) at 12 oz/acre (0.00093 lb ai/acre) and M-Pede[®] (potassium salts of fatty acids) at 123 oz/acre on May 9, Aza-Direct at 12 oz/acre and Movento[®] (spirotetramat) at 5 oz/acre (0.008 lb ai/acre) on May 14 and May 30, and Agri-Mek[®] SC (abamectin) at 3.5 oz/acre (0.02 lb ai/acre) on June 5.

A total of 92 lb N/acre was applied in four 23-lb increments during the season as urea ammonium nitrate solution (URAN) injected through the drip tape.

Onions were irrigated automatically to maintain the soil water tension (SWT) in the onion root zone below 20 cb (Figure. 1, Shock et al. 2000). Soil water tension was measured with eight granular matrix sensors (GMS, Watermark soil moisture sensor model 200SS, Irrrometer Co. Inc., Riverside, CA) installed at 8-inch depth in the center of the double row. Sensors had been calibrated to SWT (Shock et al. 1998). The GMS were connected to the datalogger via multiplexers (AM16/32, Campbell Scientific, Logan, UT). The datalogger (CR1000, Campbell Scientific) read the sensors and recorded the SWT every hour. The datalogger automatically made irrigation decisions every 12 hours. The field was irrigated if the average SWT of the eight sensors was 20 cb or higher. The irrigations were controlled by the datalogger using a controller (SDM-CD16AC, Campbell Scientific) connected to a solenoid valve. Irrigation durations were 8 hours, 19 min, to apply 0.48 inch of water. The water supply was well water maintained at a constant water pressure of 35 psi. The pressure in the drip lines was maintained at 10 psi by a pressure-regulating valve. The automated irrigation system was started on April 18 and terminated on August 6.

On July 23, July 30, and August 6, bulbs from 6 ft of the middle two double rows in each plot were topped and bagged. Varieties Avenger and Elsyé started maturing earlier than the other varieties and harvest began 1 week earlier (July 16, July 23, and July 30). Bolted onions were counted in each plot on July 16. Decomposing bulbs were not bagged. At each harvest, onions in each plot were rated visually for the percentage of tops that were down and percent dry leaves. 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 (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Bulb counts per 50 lb of super colossal onions were calculated for each plot of every variety by weighing and counting all super colossal bulbs during grading.

After grading, bulbs from each harvest were stored in a shed at ambient temperature for 2 weeks. After 2 weeks the bulbs were evaluated for single centers and for the number of sprouted or decomposed bulbs.

Twenty-five onions ranging in diameter from 3½ to 4¼ inches from each plot from each harvest were rated for single centers. The onions were cut equatorially through the bulb middle and separated into single-centered and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the diameter of the first single ring: small multiple-centered onions had diameters under 1½ inch, medium multiple-centered onions had diameters from 1½ to 2¼ inches, and large multiple-centered onions had diameters over 2¼ inches. Onions were considered “functionally single centered” for processing if they were single centered or had a small multiple center.

Variety differences were compared using repeated measures analysis of variance. Means separation was determined using a protected Fisher’s least significant difference test at the 5% probability level, LSD (0.05).

Results and Discussion

Avenger and Elsyé

July 16 harvest. Marketable yield for Avenger was 1162 cwt/acre and for Elsyé was 1282 cwt/acre on July 16 (Table 1). The percentage of functionally single-centered bulbs was 75% for Avenger and 68% for Elsyé (Table 3). The percentage of tops down at harvest was 90% for both varieties (Table 5). Bulb decomposition after 2 weeks of storage was 15% for Avenger and 12% for Elsyé (Table 5).

July 23 harvest. Marketable yield for Avenger was 1192 cwt/acre and for Elsyé was 1401 cwt/acre on July 23 (Table 1). The percentage of functionally single-centered bulbs was 82% for Avenger and 84% for Elsyé (Table 3). The percentage of tops down at harvest was for 94% Avenger and 99% for Elsyé (Table 5). Bulb decomposition after 2 weeks of storage was 6% for Avenger and 10% for Elsyé (Table 5).

July 30 harvest. Marketable yield for variety Avenger was 1342 cwt/acre and for Elsyé was 1507 cwt/acre on July 30 (Table 1). The percentage of functionally single-centered bulbs was 83% for Avenger and 89% for Elsyé (Table 3). The percentage of tops down at harvest was 94% for Avenger and 98% for Elsyé (Table 5). Bulb decomposition after 2 weeks of storage was 4% for Avenger and 0% for Elsyé (Table 5).

Montero, Jasmine, OLYS15-1294, SVNG1561, and 8019A

July 23 harvest. For the four yellow varieties, marketable yield on July 23 ranged from 1149 cwt/acre for OLYS15-1294 to 1472 cwt/acre for SVNG1561 (Table 2). For the yellow varieties, the percentage of functionally single-centered bulbs averaged 91% and ranged from 87% for Jasmine to 96% for OLYS15-1294 (Table 4). The percentage of tops down at harvest averaged

55% and ranged from 30% for OLYS15-1294 to 90% for Jasmine (Table 6). Bulb decomposition or sprouting after 2 weeks of storage averaged 4.8% and ranged from 3% for Montero to 5.6% for OLYS15-1294 and SVNG1561.

For the red variety 8019A, marketable yield was 684 cwt/acre, the percentage of functionally single-centered bulbs was 52%, the percentage of tops down at harvest was 55%, and bulb decomposition or sprouting after 2 weeks of storage was 3.2% (Tables 2, 4, and 6).

July 30 harvest. For the yellow varieties, marketable yield on July 30 ranged from 1215 cwt/acre for OLYS15-1294 to 1638 cwt/acre for SVNG1561 (Table 2). The percentage of functionally single-centered bulbs averaged 95% and ranged from 92% for SVNG1561 to 99% for OLYS15-1294 (Table 4). The percentage of tops down at harvest averaged 81% and ranged from 72% for OLYS15-1294 to 90% for Jasmine (Table 6). Bulb decomposition or sprouting after 2 weeks of storage averaged 1.2% and ranged from 0% for Montero and OLYS15-1294 to 3% for Jasmine.

For the red variety 8019A, marketable yield was 719 cwt/acre, the percentage of functionally single-centered bulbs was 66%, the percentage of tops down at harvest was 90%, and bulb decomposition or sprouting after 2 weeks of storage was 0.8% (Tables 2, 4, and 6).

August 6 harvest. For the yellow varieties, marketable yield on August 6 ranged from 1355 cwt/acre for OLYS15-1294 to 1678 cwt/acre for SVNG1561 (Table 2). The percentage of functionally single-centered bulbs averaged 79% and ranged from 61% for SVNG1561 to 94% for OLYS15-1294 (Table 4). The percentage of tops down at harvest averaged 92% and ranged from 90% for OLYS15-1294 to 94% for SVNG1561 (Table 6). Bulb decomposition or sprouting after 2 weeks of storage averaged 1.6% and ranged from 0% for Montero to 4% for Jasmine.

For the red variety 8019A, marketable yield was 734 cwt/acre, the percentage of functionally single-centered bulbs was 43%, the percentage of tops down at harvest was 94%, and bulb decomposition or sprouting after 2 weeks of storage was 2% (Tables 2, 4, and 6).

Overall

Bulb yields were high in 2019. The growing degree-days (50–86°F) from April through July were close to average in 2019 (Table 7). For comparison, performance data for Montero, which was in the transplant trials in 2014–2019, is presented in Table 8. The pattern of maturity for Montero in 2019 was similar to previous years, with the percentage of tops down at last harvest at 93%. However, the tops remained greener longer than in previous years, with the percentage of dry leaves at the final harvest (15%) lower than in previous years.

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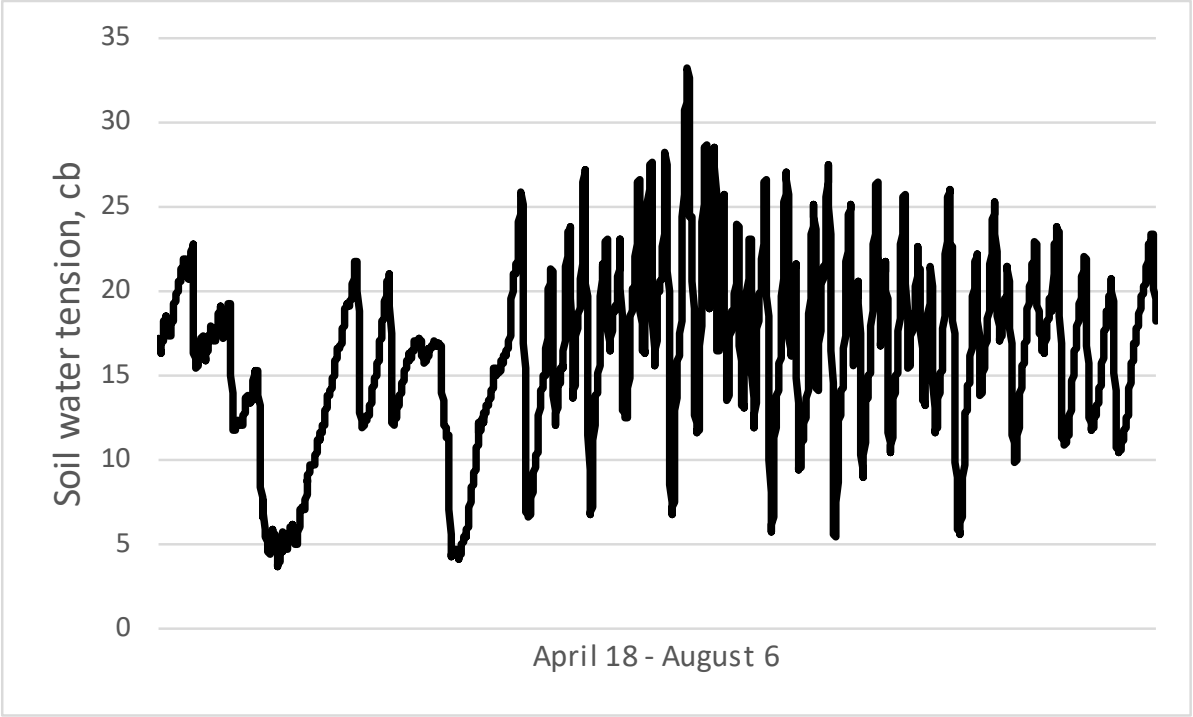


Figure 1. Soil water tension at 8-inch depth, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

Table 1. Bulb yield and grade over three harvest dates for two yellow onion varieties grown from transplants, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

| Company | Variety | Total yield | Marketable yield by grade | | | | | | | Total rot | Plate rot | Slime rot | Black mold | Bulb counts >4¼ in | |
|-----------------------------------|---------|-------------|---------------------------|--------|---------|--------|---------|-------|---------|---------------|-----------|---------------------|------------|--------------------|----------|
| | | | Total | >4¼ in | 4-4¼ in | 3-4 in | 2¼-3 in | Small | Doubles | | | | | | Sunscald |
| | | | ----- cwt/acre ----- | | | | | | | ----- % ----- | | ----- #/50 lb ----- | | | |
| July 16 harvest | | | | | | | | | | | | | | | |
| Crookham | Avenger | 1178.9 | 1161.9 | 144.5 | 550.6 | 451.0 | 15.8 | 5.9 | 6.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 32.5 |
| Enza Zaden | Elsye | 1297.8 | 1281.9 | 355.7 | 516.7 | 397.3 | 12.2 | 3.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 34.6 |
| | Average | 1238.4 | 1221.9 | 250.1 | 533.6 | 424.2 | 14.0 | 4.7 | 3.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 33.5 |
| July 23 harvest | | | | | | | | | | | | | | | |
| Crookham | Avenger | 1242.5 | 1192.0 | 242.7 | 474.7 | 462.8 | 11.8 | 4.6 | 0.0 | 0.0 | 3.7 | 0.0 | 3.7 | 0.0 | 31.1 |
| Enza Zaden | Elsye | 1412.1 | 1400.9 | 441.6 | 537.4 | 409.6 | 12.3 | 3.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 30.8 |
| | Average | 1327.3 | 1296.4 | 342.2 | 506.0 | 436.2 | 12.0 | 3.9 | 0.0 | 0.0 | 1.8 | 0.0 | 1.8 | 0.0 | 30.9 |
| July 30 harvest | | | | | | | | | | | | | | | |
| Crookham | Avenger | 1438.8 | 1342.2 | 439.8 | 544.2 | 345.5 | 12.8 | 6.2 | 0.0 | 0.0 | 7.0 | 0.0 | 7.0 | 0.0 | 29.8 |
| Enza Zaden | Elsye | 1531.4 | 1506.7 | 596.6 | 558.1 | 328.2 | 23.8 | 13.4 | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 29.6 |
| | Average | 1485.1 | 1424.4 | 518.2 | 551.1 | 336.9 | 18.3 | 9.8 | 0.0 | 0.0 | 3.7 | 0.0 | 3.7 | 0.0 | 29.7 |
| Average over harvest dates | | | | | | | | | | | | | | | |
| Crookham | Avenger | 1286.7 | 1232.0 | 275.7 | 523.2 | 419.8 | 13.4 | 5.6 | 0.0 | 0.0 | 5.4 | 0.0 | 5.4 | 0.0 | 31.1 |
| Enza Zaden | Elsye | 1413.8 | 1396.5 | 464.6 | 537.4 | 378.4 | 16.1 | 6.7 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 31.7 |
| | Average | 1350.3 | 1314.2 | 370.2 | 530.3 | 399.1 | 14.8 | 6.1 | 0.0 | 0.0 | 2.8 | 0.0 | 2.8 | 0.0 | 31.4 |
| LSD (0.05) Variety | | 72.7 | 98.1 | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| LSD (0.05) Date | | 83.6 | 143.7 | 92.6 | NS | NS | NS | 8.1 | NS | NS | NS | NS | NS | NS | 2.9 |
| LSD (0.05) Variety x Date | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Table 2. Bulb yield and grade over three harvest dates for four yellow onion varieties and one red variety (8019A) grown from transplants, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

| Company | Variety | Total yield | Marketable yield by grade | | | | | | | | Total rot | Plate rot | Slime rot | Black mold | Bulb counts >4¼ in |
|-----------------------------------|-------------|-------------|---------------------------|--------|---------|--------|---------|-------|---------|----------|---------------|-----------|-----------|------------|--------------------|
| | | | Total | >4¼ in | 4-4¼ in | 3-4 in | 2¼-3 in | Small | Doubles | Sunscald | | | | | |
| | | | ----- cwt/acre ----- | | | | | | | | ----- % ----- | | | #/50 lb | |
| July 23 harvest | | | | | | | | | | | | | | | |
| Nunhems | Montero | 1283.9 | 1266.9 | 209.4 | 582.0 | 473.3 | 2.2 | 5.1 | 0.0 | 0.0 | 0.9 | 0.5 | 0.4 | 0.0 | 32.4 |
| Crookham | Jasmine | 1434.0 | 1429.7 | 510.5 | 573.1 | 332.4 | 13.7 | 4.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 30.6 |
| | OLYS15-1294 | 1157.0 | 1149.4 | 136.7 | 492.7 | 508.3 | 11.6 | 7.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 32.3 |
| Seminis | SVNG1561 | 1476.5 | 1471.9 | 542.5 | 623.1 | 300.4 | 5.9 | 2.9 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 31.0 |
| | Average | 1337.9 | 1329.5 | 349.8 | 567.7 | 403.6 | 8.3 | 5.0 | 0.0 | 0.0 | 0.3 | 0.1 | 0.1 | 0.0 | 31.6 |
| New Zealand Onion | 8019A | 703.0 | 684.1 | 0.0 | 42.9 | 578.4 | 62.8 | 15.4 | 0.0 | 0.0 | 0.5 | 0.5 | 0.0 | 0.0 | |
| July 30 harvest | | | | | | | | | | | | | | | |
| Nunhems | Montero | 1367.3 | 1348.9 | 221.0 | 666.3 | 451.0 | 10.6 | 5.3 | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 32.6 |
| Crookham | Jasmine | 1519.9 | 1458.8 | 569.9 | 562.2 | 306.6 | 20.0 | 2.3 | 0.0 | 0.0 | 4.1 | 0.0 | 4.1 | 0.0 | 29.4 |
| | OLYS15-1294 | 1224.3 | 1214.8 | 195.1 | 561.4 | 442.5 | 15.8 | 8.2 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 32.4 |
| Seminis | SVNG1561 | 1650.8 | 1637.5 | 651.3 | 666.4 | 313.5 | 6.3 | 2.7 | 0.0 | 0.0 | 0.7 | 0.0 | 0.7 | 0.0 | 30.5 |
| | Average | 1440.6 | 1415.0 | 409.3 | 614.1 | 378.4 | 13.2 | 4.6 | 0.0 | 0.0 | 1.3 | 0.0 | 1.3 | 0.0 | 31.2 |
| New Zealand Onion | 8019A | 738.9 | 718.8 | 5.9 | 54.8 | 577.2 | 80.9 | 20.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 33.8 |
| August 6 harvest | | | | | | | | | | | | | | | |
| Nunhems | Montero | 1423.4 | 1398.9 | 358.0 | 673.1 | 363.1 | 4.8 | 0.0 | 0.0 | 0.0 | 1.7 | 0.0 | 1.7 | 0.0 | 30.5 |
| Crookham | Jasmine | 1616.1 | 1462.3 | 878.4 | 364.9 | 209.4 | 9.5 | 0.0 | 0.0 | 1.1 | 8.8 | 0.4 | 7.0 | 1.4 | 26.3 |
| | OLYS15-1294 | 1364.3 | 1354.7 | 489.9 | 551.0 | 297.9 | 15.9 | 3.0 | 0.0 | 0.1 | 0.4 | 0.0 | 0.4 | 0.0 | 30.2 |
| Seminis | SVNG1561 | 1745.8 | 1677.7 | 990.8 | 503.8 | 182.0 | 1.2 | 0.0 | 0.0 | 1.0 | 2.9 | 0.2 | 2.6 | 0.1 | 26.3 |
| | Average | 1537.4 | 1473.4 | 679.3 | 523.2 | 263.1 | 7.8 | 0.7 | 0.0 | 0.0 | 3.5 | 0.1 | 2.9 | 0.0 | 28.3 |
| New Zealand Onion | 8019A | 754.4 | 733.7 | 0.0 | 75.2 | 597.7 | 60.8 | 12.2 | 0.0 | 0.0 | 1.1 | 1.1 | 0.0 | 0.0 | |
| Average over harvest dates | | | | | | | | | | | | | | | |
| Nunhems | Montero | 1342.7 | 1323.6 | 246.3 | 630.4 | 441.4 | 5.5 | 4.0 | 0.0 | 0.0 | 0.9 | 0.2 | 0.7 | 0.0 | 32.0 |
| Crookham | Jasmine | 1516.7 | 1449.4 | 636.9 | 509.7 | 288.1 | 14.8 | 2.3 | 0.0 | 1.1 | 4.0 | 0.1 | 3.4 | 1.4 | 28.9 |
| | OLYS15-1294 | 1248.5 | 1239.6 | 273.9 | 535.0 | 416.2 | 14.5 | 6.2 | 0.0 | 0.1 | 0.2 | 0.0 | 0.1 | 0.0 | 31.6 |
| Seminis | SVNG1561 | 1624.4 | 1595.7 | 728.2 | 597.8 | 265.3 | 4.4 | 1.8 | 0.0 | 1.0 | 1.2 | 0.1 | 1.1 | 0.1 | 29.2 |
| | Average | 1433.1 | 1402.1 | 471.3 | 568.2 | 352.7 | 9.8 | 3.6 | 0.0 | 0.5 | 1.6 | 0.1 | 1.3 | 0.4 | 30.5 |
| New Zealand Onion | 8019A | 730.5 | 710.7 | 2.1 | 56.4 | 583.5 | 68.7 | 16.2 | 0.0 | 0.0 | 0.5 | 0.5 | 0.0 | 0.0 | 33.8 |
| LSD (0.05) Variety | | 83.1 | 95.5 | 153.7 | 75.2 | 83.8 | 11.2 | 6.1 | NS | NS | 1.9 | NS | 2.1 | NS | 1.1 |
| LSD (0.05) Date | | 46.4 | 48.1 | 68.1 | NS | NS | NS | NS | NS | NS | 1.0 | NS | 1.1 | NS | 1.2 |
| LSD (0.05) Variety x Date | | NS | NS | 152.2 | NS | NS | NS | NS | NS | NS | 2.3 | NS | 2.4 | NS | NS |

Table 3. Single- and multiple-centered bulbs and bolting over three harvest dates for two yellow onion varieties grown from transplants, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

| Company | Variety | Multiple center | | | Single center | | |
|-----------------------------------|---------|-----------------|--------|-------|-------------------------|---------------------|----------------------|
| | | Large | Medium | Small | Functional ^a | Bullet ^b | Bolters ^c |
| ----- % ----- | | | | | | | |
| July 16 harvest | | | | | | | |
| Crookham | Avenger | 4.8 | 20.0 | 24.8 | 75.2 | 50.4 | 0.4 |
| Enza Zaden | Elsye | 3.0 | 28.8 | 22.7 | 68.2 | 45.5 | 0.6 |
| | Average | 3.9 | 24.4 | 23.7 | 71.7 | 48.0 | 0.5 |
| July 23 harvest | | | | | | | |
| Crookham | Avenger | 3.2 | 14.4 | 51.2 | 82.4 | 31.2 | |
| Enza Zaden | Elsye | 2.0 | 14.0 | 50.0 | 84.0 | 34.0 | |
| | Average | 2.6 | 14.2 | 50.6 | 83.2 | 32.6 | |
| July 30 harvest | | | | | | | |
| Crookham | Avenger | 5.6 | 11.2 | 38.4 | 83.2 | 44.8 | |
| Enza Zaden | Elsye | 1.0 | 10.0 | 55.0 | 89.0 | 34.0 | |
| | Average | 3.3 | 10.6 | 46.7 | 86.1 | 39.4 | |
| Average over harvest dates | | | | | | | |
| Crookham | Avenger | 4.5 | 15.2 | 38.1 | 80.3 | 42.1 | |
| Enza Zaden | Elsye | 2.0 | 17.6 | 42.6 | 80.4 | 37.8 | |
| | Average | 3.3 | 16.4 | 40.3 | 80.3 | 40.0 | |
| LSD (0.05) Variety | | NS | NS | NS | NS | NS | NS |
| LSD (0.05) Date | | NS | NS | 6.9 | NS | NS | NS |
| LSD (0.05) Variety x Date | | NS | NS | NS | NS | NS | NS |

^aFunctional single centers are the small multiple centers plus the bullet single centers.

^bBullet: single center.

^cBolted onions were counted in each plot on July 16.

Table 4. Single- and multiple-centered bulbs and bolting over three harvest dates for four yellow onion varieties and one red variety (8019A) grown from transplants, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

| Company | Variety | Multiple center | | | Single center | | |
|-----------------------------------|----------------|-----------------|--------|-------|-------------------------|---------------------|----------------------|
| | | Large | Medium | Small | Functional ^a | Bullet ^b | Bolters ^c |
| ----- % ----- | | | | | | | |
| July 23 harvest | | | | | | | |
| Nunhems | Montero | 0.0 | 7.0 | 11.0 | 93.0 | 82.0 | 0.0 |
| Crookham | Jasmine | 0.8 | 12.0 | 36.8 | 87.2 | 50.4 | 1.4 |
| | OLYS15-1294 | 1.6 | 2.4 | 8.0 | 96.0 | 88.0 | 0.0 |
| Seminis | SVNG1561 | 0.8 | 11.2 | 60.0 | 88.0 | 28.0 | 0.0 |
| | Average | 0.8 | 8.2 | 29.0 | 91.1 | 62.1 | 0.3 |
| New Zealand Onion | 8019A (TAS027) | 11.2 | 36.8 | 32.8 | 52.0 | 19.2 | 0.0 |
| July 30 harvest | | | | | | | |
| Nunhems | Montero | 0.0 | 4.0 | 7.0 | 96.0 | 89.0 | |
| Crookham | Jasmine | 4.0 | 2.4 | 20.0 | 93.6 | 73.6 | |
| | OLYS15-1294 | 0.0 | 0.8 | 4.0 | 99.2 | 95.2 | |
| Seminis | SVNG1561 | 0.0 | 8.0 | 44.0 | 92.0 | 48.0 | |
| | Average | 1.0 | 3.8 | 18.8 | 95.2 | 76.5 | |
| New Zealand Onion | 8019A (TAS027) | 8.8 | 25.6 | 44.0 | 65.6 | 21.6 | |
| August 6 harvest | | | | | | | |
| Nunhems | Montero | 2.0 | 10.0 | 10.0 | 88.0 | 78.0 | |
| Crookham | Jasmine | 8.3 | 18.3 | 19.2 | 73.3 | 54.2 | |
| | OLYS15-1294 | 2.4 | 3.2 | 7.3 | 94.3 | 87.0 | |
| Seminis | SVNG1561 | 7.2 | 32.0 | 27.2 | 60.8 | 33.6 | |
| | Average | 5.0 | 15.9 | 15.9 | 79.1 | 63.2 | |
| New Zealand Onion | 8019A (TAS027) | 21.2 | 36.3 | 32.4 | 42.5 | 10.1 | |
| Average over harvest dates | | | | | | | |
| Nunhems | Montero | 0.4 | 6.4 | 9.2 | 93.2 | 84.0 | |
| Crookham | Jasmine | 4.1 | 10.4 | 25.8 | 85.5 | 59.8 | |
| | OLYS15-1294 | 1.3 | 2.1 | 6.4 | 96.5 | 90.1 | |
| Seminis | SVNG1561 | 2.7 | 17.1 | 43.7 | 80.3 | 36.5 | |
| | Average | 2.1 | 9.0 | 21.3 | 88.9 | 67.6 | |
| New Zealand Onion | 8019A (TAS027) | 13.2 | 32.7 | 36.7 | 54.1 | 17.5 | |
| LSD (0.05) Variety | | 2.6 | 4.4 | 8.9 | 5.8 | 9.1 | NS |
| LSD (0.05) Date | | 2.1 | 5.4 | NS | 6.4 | 5.4 | NS |
| LSD (0.05) Variety x Date | | NS | NS | 14.0 | NS | NS | NS |

^aFunctional single centers are the small multiple centers plus the bullet single centers.

^bBullet: single center.

^cBolted onions were counted in each plot on July 23.

Table 5. Maturity at harvest and bulb quality 2 weeks after harvest over three harvest dates for two yellow onion varieties grown from transplants, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

| Company | Variety | Maturity at harvest | | Bulb quality 2 weeks after harvest | | | |
|-----------------------------------|---------|---------------------|--------------|------------------------------------|------------|-------------------------|------------------------------|
| | | Tops down | Leaf dryness | Sprouted | Decomposed | Sprouted and decomposed | Total sprouted or decomposed |
| ----- % ----- | | | | | | | |
| July 16 harvest | | | | | | | |
| Crookham | Avenger | 90.0 | 0.0 | 0.0 | 15.2 | 3.2 | 18.4 |
| Enza Zaden | Elsye | 90.0 | 0.0 | 0.0 | 12.0 | 0.0 | 12.0 |
| | Average | 90.0 | 0.0 | 0.0 | 13.6 | 1.6 | 15.2 |
| July 23 harvest | | | | | | | |
| Crookham | Avenger | 94.0 | 12.0 | 0.8 | 4.8 | 0.0 | 5.6 |
| Enza Zaden | Elsye | 98.8 | 8.8 | 1.0 | 9.1 | 0.0 | 10.1 |
| | Average | 96.4 | 10.4 | 0.9 | 7.0 | 0.0 | 7.9 |
| July 30 harvest | | | | | | | |
| Crookham | Avenger | 94.0 | 12.0 | 0.8 | 3.2 | 0.0 | 4.0 |
| Enza Zaden | Elsye | 97.5 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Average | 95.8 | 11.0 | 0.4 | 1.6 | 0.0 | 2.0 |
| Average over harvest dates | | | | | | | |
| Crookham | Avenger | 92.7 | 8.0 | 0.5 | 7.7 | 1.1 | 9.3 |
| Enza Zaden | Elsye | 95.4 | 6.3 | 0.3 | 7.0 | 0.0 | 7.4 |
| | Average | 94.0 | 7.1 | 0.4 | 7.4 | 0.5 | 8.4 |
| LSD (0.05) Variety | | NS | NS | NS | NS | NS | NS |
| LSD (0.05) Date | | 3.5 | 2.0 | NS | 4.3 | NS | 4.6 |
| LSD (0.05) Variety x Date | | NS | NS | NS | NS | NS | NS |

Table 6. Maturity at harvest and bulb quality 2 weeks after harvest over three harvest dates for four yellow onion varieties and one red onion variety (8019A) grown from transplants, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

| Company | Variety | Maturity at harvest | | Bulb quality 2 weeks after harvest | | | |
|-----------------------------------|-------------|---------------------|--------------|------------------------------------|------------|-------------------------|------------------------------|
| | | Tops down | Leaf dryness | Sprouted | Decomposed | Sprouted and decomposed | Total sprouted or decomposed |
| ----- % ----- | | | | | | | |
| July 23 harvest | | | | | | | |
| Nunhems | Montero | 67.5 | 7.5 | 0.0 | 3.0 | 0.0 | 3.0 |
| Crookham | Jasmine | 90.0 | 8.0 | 0.0 | 4.8 | 0.0 | 4.8 |
| | OLYS15-1294 | 30.0 | 1.0 | 4.8 | 0.0 | 0.8 | 5.6 |
| Seminis | SVNG1561 | 34.0 | 2.0 | 1.6 | 4.0 | 0.0 | 5.6 |
| | Average | 55.4 | 4.6 | 1.6 | 3.0 | 0.2 | 4.8 |
| New Zealand Onion | 8019A | 84.0 | 20.0 | 0.0 | 3.2 | 0.0 | 3.2 |
| July 30 harvest | | | | | | | |
| Nunhems | Montero | 85.0 | 8.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| Crookham | Jasmine | 90.0 | 10.0 | 0.0 | 3.2 | 0.0 | 3.2 |
| | OLYS15-1294 | 72.0 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Seminis | SVNG1561 | 76.0 | 7.0 | 0.0 | 1.6 | 0.0 | 1.6 |
| | Average | 80.8 | 7.9 | 0.0 | 1.2 | 0.0 | 1.2 |
| New Zealand Onion | 8019A | 90.0 | 23.0 | 0.0 | 0.8 | 0.0 | 0.8 |
| August 6 harvest | | | | | | | |
| Nunhems | Montero | 92.5 | 15.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Crookham | Jasmine | 92.5 | 18.8 | 0.0 | 4.0 | 0.0 | 4.0 |
| | OLYS15-1294 | 90.0 | 8.0 | 0.0 | 0.8 | 0.0 | 0.8 |
| Seminis | SVNG1561 | 94.0 | 13.0 | 0.0 | 1.6 | 0.0 | 1.6 |
| | Average | 92.3 | 13.7 | 0.0 | 1.6 | 0.0 | 1.6 |
| New Zealand Onion | 8019A | 93.8 | 45.0 | 0.0 | 2.0 | 0.0 | 2.0 |
| Average over harvest dates | | | | | | | |
| Nunhems | Montero | 79.5 | 9.5 | 0.0 | 1.2 | 0.0 | 1.2 |
| Crookham | Jasmine | 90.7 | 11.8 | 0.0 | 4.0 | 0.0 | 4.0 |
| | OLYS15-1294 | 64.0 | 5.0 | 1.6 | 0.3 | 0.3 | 2.1 |
| Seminis | SVNG1561 | 68.0 | 7.3 | 0.5 | 2.4 | 0.0 | 2.9 |
| | Average | 75.6 | 8.4 | 0.5 | 2.0 | 0.1 | 2.6 |
| New Zealand Onion | 8019A | 88.9 | 28.2 | 0.0 | 2.0 | 0.0 | 2.0 |
| LSD (0.05) Variety | | 6.8 | 2.5 | NS | NS | NS | NS |
| LSD (0.05) Date | | 3.0 | 1.7 | 1.1 | NS | NS | 1.9 |
| LSD (0.05) Variety x Date | | 6.8 | 3.8 | NS | NS | NS | NS |

Table 7. Monthly growing degree-days (50–86°F) in 2014–2019 and the 25-year average, Malheur Experiment Station, Oregon State University, Ontario, OR.

| Year | | | | | Total |
|----------------|-------|-----|------|------|------------|
| | April | May | June | July | April-July |
| 2014 | 227 | 424 | 544 | 779 | 1974 |
| 2015 | 241 | 427 | 674 | 716 | 2059 |
| 2016 | 305 | 405 | 576 | 680 | 1967 |
| 2017 | 169 | 380 | 533 | 766 | 1848 |
| 2018 | 225 | 471 | 516 | 733 | 1945 |
| 2019 | 213 | 372 | 530 | 698 | 1813 |
| Avg. 1993-2018 | 199 | 372 | 512 | 704 | 1793 |

Table 8. Average % of tops down, leaf dryness, and marketable yield at three harvest dates for 'Montero' onions grown from transplants, 2014–2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

| | Year | 9-Jul | 14-Jul | 16-Jul | 21-Jul | 23-Jul | 28-Jul | 30-Jul | 4-Aug | 6-Aug |
|------------------------------|------|-------|--------|--------|--------|--------|--------|--------|-------|-------|
| % tops down | 2014 | | | | 12 | | 40 | | 76 | |
| | 2015 | | 18 | | 54 | | 80 | | | |
| | 2016 | | 0 | | 16 | | 58 | | | |
| | 2017 | | | | 22 | | 70 | | 80 | |
| | 2018 | 36 | | 62 | | 88 | | | | |
| | 2019 | | | | | 68 | | 85 | | 93 |
| % dry leaves | 2014 | | | | 16 | | 28 | | 32 | |
| | 2015 | | 0 | | 20 | | 32 | | | |
| | 2016 | | 0 | | 12 | | 20 | | | |
| | 2017 | | | | 12 | | 24 | | 30 | |
| | 2018 | 6 | | 20 | | 34 | | | | |
| | 2019 | | | | | 8 | | 9 | | 15 |
| Marketable yield cwt/acre | 2014 | | | | 826 | | 911 | | 1024 | |
| | 2015 | | 730 | | 847 | | 898 | | | |
| | 2016 | | 731 | | 931 | | 1154 | | | |
| | 2017 | | | | 768 | | 841 | | 947 | |
| | 2018 | 934 | | 975 | | 1086 | | | | |
| | 2019 | | | | | 1267 | | 1349 | | 1399 |