

2016 ONION VARIETY TRIALS

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Introduction

Direct-seeded yellow, white, and red onion varieties were evaluated in the field for plant disease, thrips, maturity, bolting, and bulb single centers. Out of storage the varieties were evaluated for yield, grade, and bulb decomposition. Eight early-season yellow varieties and one early-season red variety were planted in March and were harvested and graded in early August. Forty-seven full-season varieties (39 yellow, 5 red, and 3 white) were planted in March, harvested in September, and were graded out of storage in February 2017. Each year, growers and seed industry representatives have the opportunity to examine the varieties at our annual Onion Variety Field Day in late August and during bulb evaluations in January. Onion varieties are evaluated objectively for bolting, yield, grade, single centers, and storability. Varieties are evaluated subjectively for maturity, thrips leaf damage, iris yellow spot virus, bulb shape, bulb shape uniformity, flesh brightness, and skin color and retention.

Materials and Methods

Onions were grown in 2016 on an Owyhee silt loam previously planted to wheat. A soil analysis taken in the fall of 2015 showed that the top foot of soil had a pH of 7.6, 3.1% organic matter, 8 ppm nitrate, 2 ppm ammonium, 36 ppm phosphorus (P), 437 ppm potassium (K), 13 ppm sulfur (S), 2,873 ppm calcium, 724 ppm magnesium (Mg), 305 ppm sodium, 1.6 ppm zinc (Zn), 7 ppm manganese (Mn), 1 ppm copper (Cu), 25 ppm iron, and 0.3 ppm boron (B). In the fall of 2015, the wheat stubble was shredded and the field was irrigated. The field was then disked, moldboard plowed, and groundhogged. Based on a soil analysis, 44 lb of P/acre, 50 lb of K/acre, 180 lb of S/acre, 9 lb of Zn/acre, 1 lb of Mn/acre, 1 lb Cu/acre, and 2 lb of B/acre were broadcast before plowing. After plowing, the field was fumigated with K-Pam[®] at 15 gal/acre and bedded at 22 inches.

The experimental designs for the full-season and the early-maturing trials were randomized complete blocks with five replicates. A sixth nonrandomized replicate was planted for demonstrating onion variety performance to growers and seed company representatives at the Onion Variety Day. Both trials were planted on March 17 in plots 4 double rows wide and 27 ft long. The early-maturing trial had 8 varieties from 3 seed companies and the full-season trial had 47 varieties from 9 seed companies.

Seed was planted in double rows spaced 3 inches apart at 9 seeds/ft of single row. Each double row was planted on beds spaced 22 inches apart. Planting was done with customized John Deere Flexi Planter units equipped with disc openers. Immediately after planting, the field received a narrow band of Lorsban 15G[®] at 3.7 oz/1,000 ft of row (0.82 lb ai/acre) over the seed rows and the soil surface was rolled. Onion emergence started on April 5. On May 9, alleys 4 ft wide were cut between plots, leaving plots 23 ft long. On May 16-20, the seedlings were hand thinned

to a spacing of 4.75 inches between individual onion plants in each single row, or 120,000 plants/acre.

The field had drip tape laid at 4-inch depth between pairs of beds during 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.

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. For weed control, the following herbicides were broadcast on May 2: GoalTender[®] at 0.09 lb ai/acre (4 oz/acre), Buctril[®] at 12 oz/acre, Poast[®] at 0.25 lb ai/acre (16 oz/acre), and Prowl[®] H₂O at 0.83 lb ai/acre (2 pt/acre).

For thrips control, the following insecticides were applied: Movento[®] at 5 oz/acre and Aza-Direct[®] at 12 oz/acre on May 26 and June 2 by ground application; Agri-Mek[®] SC at 3.5 oz/acre on June 10 and 17 by ground application; Radiant[®] at 10 oz/acre on June 25, and July 2 and 23 by aerial application; Lannate[®] at 3 pt/acre on July 10, 17, and 30 by aerial application.

Urea ammonium nitrate solution (URAN) at 20 lb nitrogen (N)/acre was applied through the drip tape weekly starting May 10 and ending June 10, totaling 80 lb N/acre. Starting on June 14, root tissue and soil solution samples were taken every week from field borders (variety ‘Vaquero’) and analyzed for nutrients by Western Laboratories, Inc., Parma Idaho (Tables 1 and 2).

Nutrients were applied through the drip tape only if both the root tissue and soil solution analyses concurrently indicated a deficiency (Table 3). Nitrogen was applied at the fixed amount previously mentioned, but was limited to 80 lb/acre, because the soil solution test indicated the soil was supplying the crop with ample amounts of N. Ample supplies of soil N are also indicated by the amounts of total available soil N during the season (Table 4). Potassium was deficient in both the soil and the roots on several sampling dates. A total of 100 lb K/acre was applied in 20-lb increments during the season based on the soil and tissue analyses.

Table 1. Onion root tissue nutrient content in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Nutrient		Jun 14	Jun 23	Jun 29	Jul 6	Jul 13	Jul 20	Jul 27	Aug 3
NO ₃ -N (ppm)	Sufficiency range	8501	7667	6833	6000	5168	4338	3508	2678
NO ₃ -N (ppm)		5107	4564	4266	3948	3049	2842	3132	2830
P (%)	0.32 - 0.7	0.59	0.47	0.45	0.58	0.68	0.55	0.42	0.34
K (%)	2.7 - 6.0	2.21	3.09	2.71	1.69	2.37	2.03	2.36	2.10
S (%)	0.24 - 0.85	1.27	0.79	0.90	1.28	1.06	0.90	0.68	0.68
Ca (%)	0.4 - 1.2	0.54	0.79	0.63	0.71	0.50	0.70	0.74	1.11
Mg (%)	0.3 - 0.6	0.33	0.33	0.26	0.32	0.30	0.20	0.21	0.20
Zn (ppm)	25 - 50	97	73	85	65	71	82	64	45
Mn (ppm)	35 - 100	174	207	185	100	125	74	62	84
Cu (ppm)	6 - 20	29	18	10	15	18	20	16	11
B (ppm)	19 - 60	25	34	38	20	21	29	40	58

Table 2. Weekly soil solution analyses in the onion variety trial. Data represent the amount of each plant nutrient per day that the soil can potentially supply to the crop. Numbers following each nutrient are the critical levels. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Nutrient	Critical level,	Jun 14	Jun 23	Jun 29	Jul 6	Jul 13	Jul 20	Jul 27	Aug 3
	lb or oz/acre								
N	Critical level, lb/acre	8.6	7.8	7	6.2	5.4	4.6	3.8	2.8
N		29.6	21.0	24.0	21.4	20.6	18.4	17.1	14.1
P	0.7 lb	1.2	1.4	1.8	1.1	1.3	1.2	1.7	2.4
K	5 lb	3.4	4.8	6.5	4.1	2.6	3.8	5.2	5.2
S	1 lb	4.6	5.6	8.2	5.9	4.4	6.6	5.0	4.6
Ca	3 lb	4.2	3.9	5.1	4.1	4.0	5.4	7.6	5.4
Mg	2 lb	5.5	7.4	10.6	6.3	5.6	7.9	7.4	4.7
Zn	1 oz	2.6	3.4	4.0	3.4	3.6	2.9	2.0	2.6
Mn	1 oz	1.6	0.9	0.5	0.3	0.4	0.4	0.5	0.7
Cu	0.4 oz	0.7	0.8	1.1	0.8	0.8	1.1	1.5	0.9

Table 3. Nutrients applied through the drip irrigation system in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Date	N	K
----- lb/acre -----		
May 10	20	
May 25	20	
Jun 1	20	
Jun 10	20	
Jun 20		20
Jun 24		20
Jul 8		20
Jul 15		20
Jul 21		20
Total	80	100

Table 4. Soil available N (NO₃ + NH₄) in the top foot of soil in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Date	Available soil N, lb/acre
Jun 14	207
Jun 23	147
Jun 29	168
Jul 6	150
Jul 13	144
Jul 20	129
Jul 27	120
Aug 3	99

Onions were irrigated automatically to maintain the soil water tension (SWT) in the onion root zone below 20 cb (Shock et al. 2000). Soil water tension was measured with eight granular matrix sensors (GMS, Watermark Soil Moisture Sensors 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 (AM 16/32, 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 of the eight sensors was a SWT of 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 was supplied from a well and pump that maintained a continuous and 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 26 and irrigations ended on September 2.

Onions in the early-maturing trial were evaluated for maturity, severity of symptoms of iris yellow spot virus (IYSV), and bolting on August 1. Onions in the full-season trial were evaluated for maturity on August 1 and 15. On August 9, onions in the full-season trial were evaluated for IYSV and thrips damage severity. Onions in each plot were evaluated subjectively for maturity by visually rating the percentage of onions with the tops down and the percent dry leaves. For IYSV, onions in each plot were given a subjective rating on a scale of 0 to 5 of increasing severity of IYSV symptoms. The rating was 0 if there were no symptoms, 1 if 1-25% of foliage was diseased, 2 if 26-50% of foliage was diseased, 3 if 51-75% of foliage was diseased, 4 if 76-99% of foliage was diseased, and 5 if 100% of foliage was diseased. For thrips leaf damage, each plot was given a subjective rating on a scale of 0 to 10 for increasing severity of leaf damage from thrips feeding. The number of bolted onion plants was counted in each plot.

Onions from the middle two double rows in each plot in the early-maturity trial were topped by hand and bagged on August 8. Onions from the early-maturity trial were graded on August 10. After grading, onions were stored in a shed at ambient air temperature for 2 weeks, after which the onions were evaluated for decomposition and sprouting.

The onions in the full-season trial were lifted on September 12 to field cure. Onions from the middle two rows in each plot of the full-season trial were topped by hand and bagged on September 16. The bags were put in storage on September 26. The storage shed was ventilated and the temperature was slowly decreased to maintain air temperature as close to 34°F as possible. Onions from the full-season trial were graded out of storage on February 1-6, 2017.

After harvest, bulbs from one of the border rows in each plot of both trials were rated for single centers. Twenty-five consecutive onions ranging in diameter from 3½ to 4¼ inches were rated. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) 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 inside diameter of the first entire single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing if they were single centered (bullet) or had a small multiple center.

During grading, bulbs were separated according to quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs

infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. 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. Marketable yield consisted of No.1 bulbs larger than 2¼ inches.

During grading, one bag from each plot was saved for additional evaluations of internal bulb quality. Fifty bulbs from each plot were cut longitudinally and evaluated for the presence of incomplete scales, dry scales, internal bacterial rot, and internal rot caused by *Fusarium proliferatum*. Incomplete scales were defined as scales that had more than 0.25 inch from the center of the neck missing or any part missing lower down on the scale. Dry scales were defined as scales that had either more than 0.25 inch from the center of the neck dry or any part dry lower down on the scale.

After grading, two replicates of each yellow and red variety were evaluated for bulb shape, bulb shape uniformity, firmness, skin color, skin retention, and flesh brightness on January 31, 2017. The quality characteristics were evaluated by a group of 10 people without knowing the variety identities. Evaluators included OSU personnel, seed company employees, and others.

The varieties from each of the early-maturity and full-season trials were compared for yield, grade, internal quality, and disease expression. Varietal differences were determined using analysis of variance. Means separation was determined using a protected Fisher's least significant difference test at the 5% probability level, LSD (0.05). The least significant difference LSD (0.05) values in each table should be considered when comparisons are made between varieties for significant differences in their performance characteristics. Differences between varieties equal to or greater than the LSD value for a characteristic should exist before any variety is considered different from any other variety in that characteristic. Variety performance varies by year. Growers are encouraged to review performance over a number of years before choosing a variety to plant.

Results

While April of 2016 broke a record for growing degree-days, the months of May through September were either slightly above or slightly below average for growing degree-days (Table 5, Fig. 1).

Early-maturing Trial

On August 8, all varieties had at least 20% tops down (Table 6). After 2 weeks of storage, bulb sprouting and decomposition were low, averaging 0.4 % of total bulbs (Table 6). The percentage of onions that were functionally single centered averaged 46.9% and ranged from 13.6% for 'Yosemite' to 72.8% for 'Avalon' (Table 7). Total yield averaged 753 cwt/acre, ranging from 288 cwt/acre for 903M to 1,023 cwt/acre for 'Ovation' (Table 8).

Full-season Trial

On August 1, the percentage of tops down averaged 22% and ranged from 4% for 'Joaquin', 'Advantage', and 'Trigger' to 78% for 'Ridge Line' (Table 9). By August 15, the percentage of tops down averaged 70% and ranged from 28% for Trigger, to 98% for 'Traverse'. The severity

of thrips leaf damage, on a scale from 0 to 10, averaged 3 and ranged from 1.6 for 'Morpheus' and 'Oracle' to 5.4 for 8217 and 'Marengo'. Bolting averaged 0.2% and ranged from 0% for numerous varieties to 1.4% for 'Dulce Reina'. Iris yellow spot virus severity was low in this trial, with all varieties having a rating of 1 (0-25% of foliage diseased), with no statistically significant differences between varieties.

The percentage of functionally single-centered bulbs averaged 76.8% and ranged from 37.6% for 'Calibra' to 99.2% for 'Arcero' (Table 10).

Marketable yield averaged 903 cwt/acre and ranged from 167 cwt/acre for 8217 to 1,180 cwt/acre for Advantage (Table 11). Vaquero, Advantage, 16000, 'Barbaro', SV6646, SV6672, Joaquin, Oracle, 'Yukon', 'Ranchero', 'Scout', 'Granero', 'Pandro', and 'Esteem' were among the varieties with the highest marketable yield. Storage decomposition averaged 6% and ranged from 0.9% for 'Hamilton' to 27% for 'White Cloud'.

Subjective Quality Evaluation

Subjective bulb quality ratings can be found in Table 14 and explanation of the rating system can be found in Figure 2 and Tables 12 and 13. Significant variations were found between varieties in all the subjective characteristics except bulb shape.

Internal Defect Evaluation

A high percentage of bulbs had incomplete or dry scales (Table 15). The percentage of bulbs with internal decomposition was much lower than in 2015. Most of the internal decomposition occurred in the bulbs that also had incomplete scales. The presence of internal decomposition could not be detected from the outer appearance or feel of the bulbs. There were significant differences between varieties for incomplete or dry scales and internal decomposition. The percentage of bulbs with incomplete or dry scales without internal decomposition averaged 54% and ranged from 29.3% for 'Tucannon' to 77.6% for Ridge Line (Table 15). Total internal decomposition (bacterial and fungal) averaged 1.8% and ranged from 0% for 'Legend', Morpheus, 'Montero', Barbaro, and SV4643NT to 6.1% for 'Diamond Swan'.

Acknowledgements

This project was funded by the Idaho-Eastern Oregon Onion Committee, cooperating onion seed companies, Oregon State University, the Malheur County Education Service District, and supported by Formula Grant nos. 2016-31100-06041 and 2016-31200-06041 from the USDA National Institute of Food and Agriculture.

References

- Shock, C.C., J. Barnum, and M. Seddigh. 1998. Calibration of Watermark soil moisture sensors for irrigation management. Irrigation Association. Proceedings of the International Irrigation Show. Pages 139-146. San Diego, CA.
- Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2000. Irrigation criteria for drip-irrigated onions. *HortScience* 35:63-66.

Table 5. Monthly cumulative growing degree-days (50-86°F), Malheur Experiment Station, Oregon State University, Ontario, OR.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1993	0	0	58	139	451	371	473	556	459	239	17	4	2768
1994	0	5	172	242	398	507	712	695	523	195	7	0	3456
1995	2	60	77	155	330	443	646	566	469	170	16	12	2945
1996	0	19	103	188	286	490	662	614	377	216	37	11	3004
1997	3	10	122	167	447	508	632	665	489	215	35	0	3293
1998	0	4	95	175	268	436	737	690	529	220	40	5	3198
1999	0	9	81	175	320	467	629	651	458	268	69	1	3127
2000	1	13	79	277	380	541	702	684	421	202	8	0	3309
2001	0	0	122	176	433	502	680	712	507	231	62	0	3424
2002	0	4	76	202	375	564	749	620	457	230	37	11	3325
2003	1	11	134	164	370	580	782	714	479	338	27	8	3610
2004	0	0	189	264	322	535	727	657	410	238	7	1	3349
2005	0	19	126	193	342	446	692	685	435	215	6	0	3158
2006	0	18	48	204	406	597	791	647	446	219	60	4	3441
2007	0	20	183	220	441	543	796	644	442	184	50	6	3528
2008	0	2	39	144	389	512	713	665	452	228	36	6	3186
2009	1	7	66	209	415	509	702	644	523	130	34	0	3239
2010	1	5	92	159	248	467	671	605	470	271	50	0	3037
2011	0	11	46	106	272	423	676	699	531	221	11	4	2999
2012	1	8	129	253	353	484	751	694	512	222	56	12	3475
2013	0	8	130	226	407	549	745	717	491	201	18	7	3498
2014	0	22	116	227	424	544	779	685	503	293	36	17	3647
2015	7	71	190	241	427	674	716	700	461	347	33	9	3876
2016	0	42	129	305	405	576	680	683	443	227	78	0	3570
Avg 1993-2015	1	14	108	196	370	508	703	661	471	230	33	5	3273

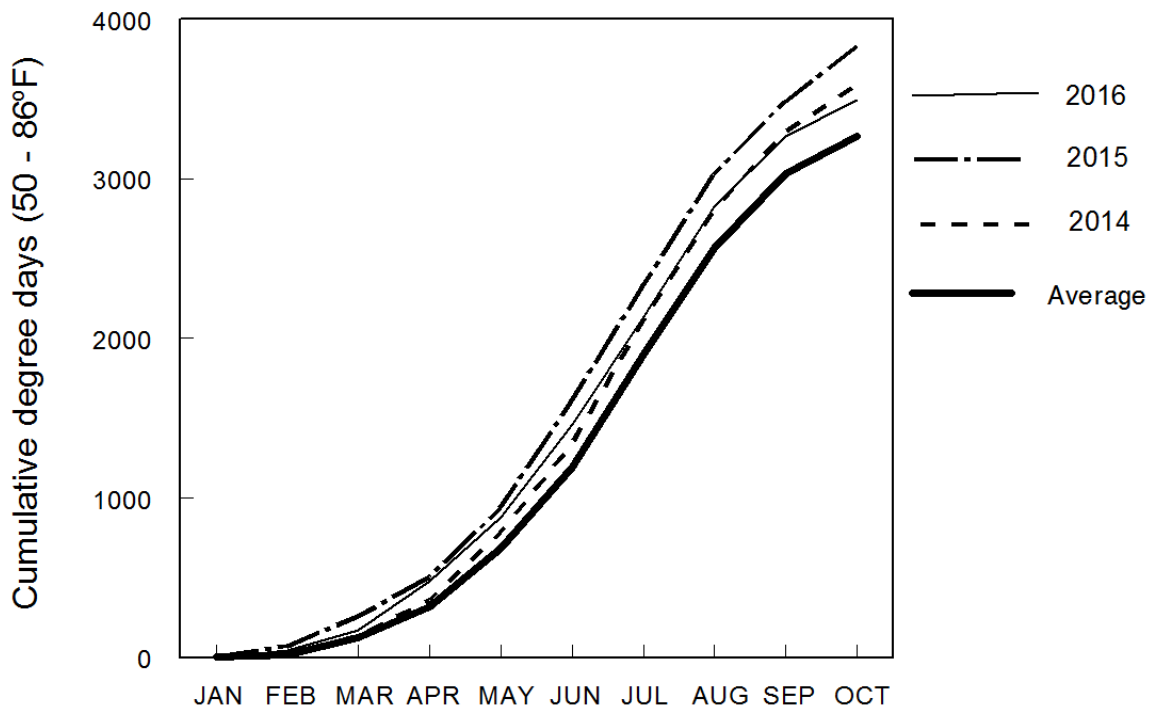


Figure 1. Growing degree-days (50-86°F) for 2014-2016 and 21-year average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Table 6. Bulb quality 2 weeks after harvest for early-maturing onion varieties lifted and harvested August 8, 2016, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Maturity at harvest		Bulb quality 2 weeks after harvest			
		tops down	leaf dryness	sprouted	decomposed	sprouted and decomposed	total sprouted or decomposed
----- % -----							
Crookham	Avalon	28	9	0.6	0.9	0.0	1.5
	Scout	34	13	0.0	0.0	0.0	0.0
New Zealand Onion	903M	90	56	0.0	0.0	0.0	0.0
	902SX	88	46	0.0	0.0	0.0	0.0
	903SX	86	34	0.0	0.0	0.0	0.0
Sakata	Ovation	54	16	0.5	0.5	0.0	1.0
	Yosemite	72	18	0.0	0.8	0.0	0.8
	Spanish Medallion	60	14	0.0	0.0	0.0	0.0
	Average	64	26	0.1	0.3	0.0	0.4
LSD (0.05)		10	7	NS	NS	NS	NS

Table 7. Single- and multiple-center bulb ratings for early-maturing onion varieties lifted and harvested August 8, 2016, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bulb color	Multiple center			Single center		
			large	medium	small	functional ^a	bullet	Bolting
----- % -----								
Crookham	Avalon	Y	12.0	15.2	8.8	72.8	64.0	0.84
	Scout	Y	14.4	24.8	9.6	60.8	51.2	0.84
New Zealand Onion	903M	R	4.8	33.6	56.0	61.6	5.6	0.00
	902SX	R	23.5	46.0	30.5	30.5	0.0	0.00
	903SX	R	16.0	44.8	36.0	39.2	3.2	0.00
Sakata	Ovation	Y	25.6	26.4	12.8	48.0	35.2	0.25
	Yosemite	Y	42.4	44.0	10.4	13.6	3.2	0.15
	Spanish Medallion	Y	19.2	32.0	11.2	48.8	37.6	0.54
	Average		19.7	33.4	21.9	46.9	25.0	0.33
LSD (0.05)			11.1	15.1	12.8	13.9	7.0	0.36

^aFunctional single-centered bulbs are the small multiple center plus the bullet-centered onion.

Table 8. Yield and grade performance of early-maturing onion varieties lifted and harvested August 8, 2016, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bulb color	Total yield	Marketable yield by grade							Split root	Total rot	Neck rot	Plate rot	Bulb counts >4¼ in
				total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small No. 2s	%					
Crookham	Avalon	Y	979.9	967.5	38.4	339.3	562.1	27.8	9.3	0.0	0.04	0.12	0.00	0.12	33.6
	Scout	Y	980.2	967.4	39.1	374.8	531.5	22.0	10.6	0.0	0.00	0.23	0.00	0.23	33.4
New Zealand Onion	903M	R	288.0	199.7	0.0	0.0	50.3	149.4	81.9	0.6	0.39	0.00	0.00	0.00	
	902SX	R	406.9	336.8	0.0	0.0	180.5	156.3	63.7	2.2	0.19	0.07	0.00	0.07	
	903SX	R	421.6	350.0	0.0	0.0	194.2	155.7	60.9	0.8	0.32	0.74	0.00	0.74	
Sakata	Ovation	Y	1022.7	1001.1	90.4	410.3	476.3	24.0	8.5	0.0	0.15	0.50	0.37	0.13	32.0
	Yosemite	Y	924.5	902.1	14.8	246.3	591.4	49.6	12.9	4.6	0.10	0.00	0.00	0.00	31.3
	Spanish Medallion	Y	998.3	984.6	86.3	379.4	489.5	29.3	11.2	0.0	0.03	0.07	0.00	0.07	31.4
	Average		752.7	713.6	33.6	218.8	384.5	76.8	32.4	1.0	0.15	0.22	0.05	0.17	32.3
LSD (0.05)			83.8	80.9	25.9	62.3	62.1	19.1	8.3	NS	0.20	0.40	NS	0.30	NS

Table 9. Maturity, bolting, and thrips leaf damage ratings of full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Seed company	Variety	Bulb color	Aug 1		Aug 15		Bolting	Thrips leaf damage ^a
			Tops down	Leaf dryness	Tops down	Leaf dryness		
A. Takii	Grand Perfection	Y	12	5	76	19	0.15	2.6
	Ridge Line	Y	78	26	95	39	0.00	4.2
	Traverse	Y	72	22	98	43	0.00	4.2
Bejo	Calibra	Y	44	16	91	31	0.05	3.6
	Crockett	Y	10	4	59	22	0.00	3.6
	Delgado	Y	20	5	87	19	0.10	2.8
	Hamilton	Y	14	3	58	22	0.30	3.4
	Legend	Y	18	5	89	21	0.05	3.0
	Sedona	Y	12	5	73	22	0.00	3.6
Crookham	Advantage	Y	4	2	29	14	0.59	2.2
	Esteem	Y	20	11	68	24	0.25	3.6
	Morpheus	Y	20	3	84	15	0.30	1.6
	Oracle	Y	6	0	46	14	0.40	1.6
	Pontiac	Y	20	16	66	34	0.05	4.4
	Scout	Y	28	8	89	21	0.69	2.4
	Trigger	Y	4	2	28	15	0.10	2.4
	Red Beret	R	26	30	74	48	0.00	5.2
	White Cloud	W	30	5	89	17	0.40	2.0
Hazera	Cruiser	Y	30	14	85	28	0.20	4.0
	37-86	Y	36	6	87	21	0.00	2.8
	37-93	W	6	0	56	15	0.35	2.0
New Zealand Onion	8217	R	20	44	36	62	0.00	5.4
Nunhems	Anillo	Y	18	4	72	25	0.10	3.4
	Arcero	Y	14	6	58	24	0.00	2.8
	Granero	Y	16	5	81	20	0.54	2.8
	Ranchero	Y	14	4	81	19	0.10	2.6
	Joaquin	Y	4	4	36	18	0.15	2.4
	Montero	Y	50	20	90	33	0.05	3.8
	Pandero	Y	8	0	54	17	0.25	2.2
	Vaquero	Y	18	5	77	20	0.45	2.2
	Marengo	R	22	32	86	56	0.00	5.4
Sakata	Arruba	Y	34	6	89	19	0.54	1.8
	Dulce Reina	Y	12	3	50	16	1.43	1.8
	Lasso	Y	32	3	85	19	0.30	2.0
	Yukon	Y	18	7	74	20	0.40	2.2
Seminis	Barbaro	Y	12	3	52	20	0.05	2.4
	Belmar	Y	18	6	64	22	0.20	3.0
	Swale	Y	20	5	67	22	0.00	2.8
	Tucannon	Y	32	4	90	17	0.00	2.2
	16000	Y	20	3	88	19	0.59	2.2
	SV6646	Y	17	5	84	21	0.00	2.6
	SV6672	Y	24	6	89	19	0.74	2.4
	SV4643NT	R	58	28	89	60	0.00	4.0
D. Palmer	Saffron	Y	12	7	54	25	0.00	3.4
	Diamond Swan	W	20	7	54	20	0.69	2.8
	Cherry Mountain	R	10	22	32	34	0.00	4.0
	DPLD 1520	Y	7	4	40	23	0.05	2.4
Average			22	9	70	25	0.23	3.0
LSD (0.05)			10	6	14	5	0.37	0.6

^aThrips leaf damage: 0 = no damage, 10 = most damage.

Table 10. Single- and multiple-center ratings for full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Seed company	Variety	Bulb color	Multiple center			Single center	
			large	medium	small	functional ^a	bullet
			----- % -----				
A. Takii	Grand Perfection	Y	15.2	19.2	24.0	65.6	41.6
	Ridge Line	Y	14.4	31.2	38.4	54.4	16.0
	Traverse	Y	3.2	29.6	47.2	67.2	20.0
Bejo	Calibra	Y	35.2	27.2	28.8	37.6	8.8
	Crockett	Y	16.8	12.8	42.4	70.4	28.0
	Delgado	Y	16.0	15.2	47.2	68.8	21.6
	Hamilton	Y	34.0	14.5	13.7	51.5	37.8
	Legend	Y	26.8	27.2	36.8	46.0	9.2
	Sedona	Y	28.5	16.3	22.5	55.1	32.6
Crookham	Advantage	Y	0.0	4.0	8.0	96.0	88.0
	Esteem	Y	4.0	0.8	18.4	95.2	76.8
	Morpheus	Y	6.4	1.6	11.2	92.0	80.8
	Oracle	Y	6.4	4.0	20.8	89.6	68.8
	Pontiac	Y	12.0	6.4	15.2	81.6	66.4
	Scout	Y	24.0	14.4	21.6	61.6	40.0
	Trigger	Y	2.4	4.0	16.8	93.6	76.8
	Red Beret	R	4.0	3.2	19.2	92.8	73.6
	White Cloud	W	32.6	29.4	23.7	38.0	14.3
Hazera	Cruiser	Y	6.4	9.6	40.0	84.0	44.0
	37-86	Y	7.2	6.4	23.2	86.4	63.2
	37-93	W	1.6	0.8	16.0	97.6	81.6
New Zealand Onion	8217	R	17.0	17.8	29.0	65.2	36.2
Nunhems	Anillo	Y	3.2	3.2	6.4	93.6	87.2
	Arcero	Y	0.0	0.8	16.0	99.2	83.2
	Granero	Y	5.6	4.8	20.8	89.6	68.8
	Ranchero	Y	12.0	3.2	24.8	84.8	60.0
	Joaquin	Y	2.4	4.0	16.0	93.6	77.6
	Montero	Y	3.2	2.4	14.4	94.4	80.0
	Pandero	Y	7.2	8.8	31.2	84.0	52.8
	Vaquero	Y	14.4	5.6	22.4	80.0	57.6
	Marengo	R	5.6	8.7	28.4	85.7	57.3
Sakata	Arruba	Y	12.0	4.0	28.0	84.0	56.0
	Dulce Reina	Y	16.0	11.2	22.4	72.8	50.4
	Lasso	Y	16.8	12.0	31.2	71.2	40.0
	Yukon	Y	24.0	9.6	25.6	66.4	40.8
Seminis	Barbaro	Y	5.6	4.0	20.0	90.4	70.4
	Belmar	Y	15.2	5.6	22.4	79.2	56.8
	Swale	Y	10.4	12.8	29.6	76.8	47.2
	Tucannon	Y	8.7	5.6	34.2	85.7	51.4
	16000	Y	12.8	8.8	18.4	78.4	60.0
	SV6646	Y	10.4	5.6	28.0	84.0	56.0
	SV6672	Y	10.4	16.7	15.2	72.9	57.8
	SV4643NT	R	20.5	14.7	25.3	64.8	39.5
D. Palmer	Saffron	Y	25.6	10.4	47.2	64.0	16.8
	Diamond Swan	W	28.2	13.7	34.0	58.1	24.1
	Cherry Mountain	R	16.8	8.0	29.6	75.2	45.6
	DPLD 1520	Y	8.0	1.6	22.4	90.4	68.0
Average			13.0	10.2	25.1	76.8	51.7
LSD (0.05)			8.2	8.8	11.2	11.6	13.0

^aFunctional single-centered bulbs are the small multiple center plus the bullet-centered onion.

Table 11. Yield and grade of full-season experimental and commercial onion varieties graded out of storage in February 2017, Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

Seed company	Variety	Bulb color	Total yield	Marketable yield by grade						No. 2s	Bulb counts >4¼ in	Total rot	Neck rot	Plate rot	Black mold
				Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small						
				----- cwt/acre -----						#/50 lb	--- % of total yield ---				
A. Takii	Grand Perfection	Y	974	920	209.3	355.9	331.4	23.7	9.1	12.6	30.2	3.2	0.9	2.3	0.0
	Ridge Line	Y	745	716	6.6	140.1	510.5	58.7	14.0	0.0	30.6	2.0	0.9	1.1	0.0
	Traverse	Y	651	619	3.5	82.7	489.5	43.8	13.0	0.0	30.0	2.8	0.4	2.3	0.0
Bejo	Calibra	Y	735	687	12.5	149.9	492.7	31.7	13.6	18.0	21.0	2.5	1.0	1.5	0.0
	Crockett	Y	837	786	19.7	214.4	504.1	47.9	13.7	23.5	31.4	1.7	1.2	0.5	0.0
	Delgado	Y	933	877	84.3	322.9	444.0	25.9	9.6	10.2	30.5	4.0	2.2	1.8	0.0
	Hamilton	Y	893	855	35.6	293.2	494.8	31.8	14.5	15.1	31.6	0.9	0.4	0.5	0.0
	Legend	Y	883	838	40.7	247.0	520.2	30.4	10.0	16.0	33.5	2.1	0.3	1.8	0.0
	Sedona	Y	968	935	103.6	413.3	400.3	17.7	9.1	7.1	31.3	1.8	1.2	0.6	0.0
Crookham	Advantage	Y	1180	1082	318.9	388.7	360.0	14.6	7.8	5.4	31.9	7.4	6.4	1.1	0.0
	Esteem	Y	901	875	57.8	269.3	519.0	29.4	10.9	0.0	31.8	1.7	0.8	0.8	0.0
	Morpheus	Y	1062	1016	164.9	394.5	428.6	28.5	10.2	3.1	30.4	3.0	2.4	0.7	0.0
	Oracle	Y	1106	1062	205.3	416.8	416.5	23.1	10.3	4.3	32.8	2.8	2.5	0.3	0.0
	Pontiac	Y	790	747	31.3	179.5	468.4	68.2	19.9	4.6	35.2	2.2	2.1	0.2	0.0
	Scout	Y	1159	1042	236.2	427.4	353.9	24.2	8.4	0.0	29.7	9.5	9.4	0.1	0.0
	Trigger	Y	947	914	156.1	373.6	360.6	23.4	9.4	2.2	31.1	2.4	1.7	0.7	0.0
	Red Beret	R	439	357	0.0	5.2	268.9	83.3	37.5	0.0		10.4	10.4	0.0	0.0
	White Cloud	W	1116	805	113.9	302.8	368.8	19.2	8.0	1.8	29.0	26.5	26.1	0.4	0.0
Hazera	Cruiser	Y	801	760	35.6	190.1	485.2	48.7	19.7	0.0	30.1	2.7	0.3	2.4	0.0
	37-86	Y	889	842	162.5	266.9	383.5	29.3	10.6	4.2	30.8	3.7	2.2	1.5	0.0
	37-93	W	1005	748	98.5	285.1	342.9	21.1	8.1	2.9	30.5	24.1	23.7	0.4	0.0
New Zealand Onion	8217	R	166	74	0.0	0.0	19.2	55.1	50.7	3.2		23.8	23.8	0.0	0.0

Table 11. (Continued) Yield and grade of full-season experimental and commercial onion varieties graded out of storage in February 2017, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bulb color	Total yield	Marketable yield by grade						No. 2s	Bulb counts >4¼ in	Total rot	Neck rot	Plate rot	Black mold
				Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small						
				----- cwt/acre -----						#/50 lb	--- % of total yield ---				
Nunhems	Anillo	Y	899	859	96.2	326.4	409.0	27.3	11.0	0.0	33.6	3.3	1.8	1.5	0.0
	Arcero	Y	985	936	137.5	399.9	380.6	17.7	8.0	0.0	30.4	4.5	3.4	1.1	0.0
	Granero	Y	1050	1020	142.9	447.0	406.6	23.6	8.9	3.7	30.7	1.6	0.5	1.2	0.0
	Ranchero	Y	1107	1053	324.2	406.7	310.5	11.5	4.7	5.6	29.3	4.1	3.4	0.8	0.0
	Joaquin	Y	1118	1067	249.8	431.5	361.9	24.1	7.2	0.0	30.1	4.0	2.3	1.7	0.0
	Montero	Y	872	830	47.5	295.0	467.2	20.2	7.9	0.0	33.3	4.0	2.5	1.6	0.0
	Pandero	Y	1057	1021	157.0	422.5	413.3	28.3	8.6	6.9	31.2	1.9	1.2	0.7	0.0
	Vaquero	Y	1169	1110	276.3	450.2	357.5	25.6	8.2	1.6	31.0	4.1	2.5	1.7	0.0
	Marengo	R	378	323	1.9	9.9	228.2	82.7	37.9	0.0	27.5	4.3	4.3	0.0	0.0
Sakata	Arruba	Y	1014	952	195.9	341.4	385.3	29.6	12.3	2.9	29.0	4.5	4.2	0.3	0.0
	Dulce Reina	Y	984	902	244.9	337.0	293.6	26.4	10.8	2.8	29.1	6.9	6.0	0.9	0.0
	Lasso	Y	975	929	133.4	393.8	375.1	26.9	9.8	9.2	29.8	2.8	2.2	0.6	0.0
	Yukon	Y	1106	1060	253.0	448.4	343.4	14.8	6.2	4.2	29.8	3.3	2.9	0.3	0.0
Seminis	Barbaro	Y	1117	1073	303.1	381.4	362.5	26.4	10.7	3.0	29.5	2.7	1.3	1.4	0.0
	Belmar	Y	994	903	142.9	344.6	378.0	37.2	10.8	9.4	30.1	6.5	5.2	1.3	0.0
	Swale	Y	999	952	141.7	378.7	398.1	33.6	7.8	1.5	31.6	3.8	2.9	0.9	0.0
	Tucannon	Y	999	969	149.3	383.0	411.1	26.0	8.5	4.6	30.6	1.7	0.9	0.8	0.0
	16000	Y	1116	1076	273.3	433.2	348.8	21.2	8.8	0.0	30.3	2.8	1.5	1.3	0.0
	SV6646	Y	1103	1068	224.5	461.3	364.5	17.9	5.9	5.2	30.0	2.3	0.7	1.6	0.0
	SV6672	Y	1123	1068	205.6	452.0	389.8	20.6	6.5	0.0	30.3	4.5	3.1	1.5	0.0
	SV4643NT	R	406	307	0.0	28.2	209.1	69.3	32.1	0.0		16.5	16.5	0.0	0.0
D. Palmer	Saffron	Y	608	506	17.1	94.1	360.6	33.7	13.1	67.6	32.2	3.9	2.3	1.7	0.0
	Diamond Swan	W	825	620	113.5	213.7	272.0	20.4	10.8	10.6	29.5	21.9	21.9	0.1	0.0
	Cherry Mountain	R	339	223	0.0	1.7	148.7	72.4	33.4	10.2		21.4	21.0	0.4	0.0
	DPLD 1520	Y	925	808	240.2	342.9	217.5	7.7	5.1	10.7	30.1	11.7	11.0	0.7	0.0
Average			903	834	131.3	296.7	373.5	32.4	13.1	6.3	30.5	6.2	5.2	1.0	0.0
LSD (0.05)			127	135	65.9	88.2	85.2	15.8	7.1	9.4	3.3	5.5	5.5	1.2	NS

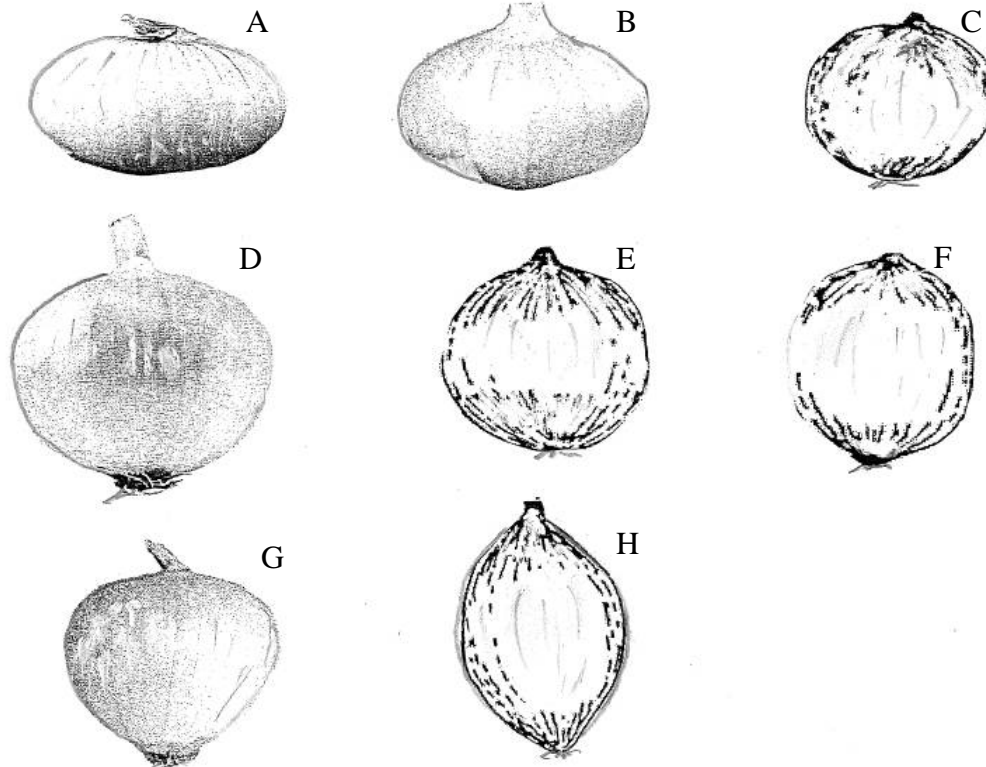


Figure 2. Onion bulb shape rating system (see Table 12). Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 12. Description of bulb shapes, see Fig. 2.

Bulb shape	
Scale	Shape
A	Flat
B	Granex
C	Flattened globe
D	Globe
E	Blocky globe
F	Tall globe
G	Top
H	Torpedo

Table 13. Onion variety subjective quality evaluation rating system.

Characteristic	Scale	Description
Bulb shape	A-H	see Fig. 2
Skin color	1-5	1 = light, 5 = dark
Bulb shape uniformity	1-5	1 = disuniform shape, 5 = uniform shape
Firmness	1-5	1 = soft, 5 = hard
Skin retention	1-5	1 = bald, 5 = no cracks
Flesh brightness	1-5	yellow varieties: 1 = yellow, 5 = white red varieties: 1 = dark red, 5 = pale red white varieties: 1 = less white, 5 = very white

Table 14. Subjective evaluations of onion appearance and firmness by variety on January 31, 2017, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Color	Bulb shape ^a	Skin color ^b	Bulb shape uniformity ^b	Firmness ^b	Scale retention ^b	Flesh brightness ^b
			a - h			1 - 5		
A. Takii	Grand Perfection	Y	d	3.0	2.3	3.0	3.3	3.8
	Ridge Line	Y	d	3.0	3.0	3.0	2.8	2.5
	Traverse	Y	c	3.0	4.0	3.0	2.5	3.0
Bejo	Calibra	Y	e	4.3	3.5	3.8	5.0	4.0
	Crockett	Y	e	4.0	2.5	5.0	5.0	4.0
	Delgado	Y	d	4.0	4.0	3.8	4.5	4.0
	Hamilton	Y	d	4.0	4.0	4.8	5.0	4.5
	Legend	Y	d	4.0	4.0	4.8	5.0	4.0
	Sedona	Y	d	4.0	3.0	4.0	4.0	3.0
Crookham	Advantage	Y	f	3.3	4.0	3.3	4.0	3.0
	Esteem	Y	d	3.0	3.0	3.5	3.5	3.5
	Morpheus	Y	d	3.0	3.8	3.5	4.5	4.0
	Oracle	Y	e	3.5	3.5	3.5	4.5	4.5
	Pontiac	Y	f	3.5	2.8	3.0	4.0	3.0
	Scout	Y	c	2.0	3.0	2.5	2.5	3.5
	Trigger	Y	d	4.0	2.5	3.5	4.3	3.5
	White Cloud	W	d	2.0	3.5	2.8	4.0	2.8
Hazera	Cruiser	Y	e	3.5	4.0	3.8	3.3	3.3
	37-86	Y	d	4.0	3.0	4.0	3.5	3.0
	37-93	W	d	2.8	4.0	2.8	4.0	2.3
Nunhems	Anillo	Y	d	4.0	4.0	3.8	4.3	4.0
	Arcero	Y	d	3.5	3.5	4.0	4.5	4.0
	Granero	Y	d	3.8	3.5	4.3	4.0	3.5
	Ranchero	Y	d	3.0	4.0	3.0	4.0	4.0
	Joaquin	Y	d	4.0	4.0	3.8	5.0	3.5
	Montero	Y	c	3.0	3.0	3.0	4.0	3.3
	Pandero	Y	d	4.3	4.0	4.3	4.8	3.8
	Vaquero	Y	c	3.0	3.0	3.3	3.5	4.0
Sakata	Arruba	Y	d	2.5	3.5	3.0	3.0	4.3
	Dulce Reina	Y	d	2.8	2.5	2.5	3.5	4.0
	Lasso	Y	c	3.0	3.5	3.3	3.5	4.1
	Yukon	Y	c	3.0	2.5	3.0	2.5	3.5
Seminis	Barbaro	Y	d	3.5	4.0	3.3	3.5	4.0
	Belmar	Y	d	4.0	2.8	3.5	4.0	3.8
	Swale	Y	d	3.5	3.0	2.8	3.8	2.5
	Tucannon	Y	d	4.0	3.5	4.5	4.0	3.3
	16000	Y	d	3.0	3.0	3.0	3.5	3.5
	SV6646	Y	d	3.5	4.0	3.5	3.8	3.5
	SV6672	Y	d	3.0	3.0	2.6	3.3	3.5
		average		d	3.4	3.4	3.5	3.9
D. Palmer	Saffron	Y	d	4.0	3.5	4.3	5.0	3.5
	Diamond Swan	W	d	3.5	3.5	3.0	4.0	3.0
	DPLD 1520	Y	e	3.0	3.5	3.5	4.0	4.0
	average		d	3.4	3.4	3.5	3.9	3.6
LSD (0.05)			1	0.7	NS	1.0	0.9	1.1

^aBulb shape: see Fig. 2.

^bSubjective ratings are described in Table 12.

Table 15. Internal bulb decomposition of full-season experimental and commercial onion varieties cut after grading, February 2017, Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

Seed company	Variety	Perfect bulbs	Bulbs with decomposition						Total internal decomposition ^c
			Incomplete or dry scale without decomposition ^a	Incomp. or dry scale + internal bacterial rot	Incomp. or dry scale + internal <i>F. proliferatum</i> ^b rot	Internal bacterial rot	Internal <i>F. proliferatum</i> rot	%	
A. Takii	Grand Perfection	61.6	38.0	0.4	0.0	0.0	0.0	0.4	
	Ridge Line	21.2	77.6	0.4	0.8	0.0	0.0	1.2	
	Traverse	24.6	72.6	1.2	1.6	0.0	0.0	2.8	
Bejo	Calibra	32.8	66.0	0.4	0.8	0.0	0.0	1.2	
	Crockett	32.5	67.1	0.0	0.4	0.0	0.0	0.4	
	Delgado	44.2	55.0	0.4	0.4	0.0	0.0	0.8	
	Hamilton	26.5	71.1	0.4	2.0	0.0	0.0	2.4	
	Legend	44.0	56.0	0.0	0.0	0.0	0.0	0.0	
	Sedona	34.6	63.0	2.0	0.4	0.0	0.0	2.4	
Crookham	Advantage	61.5	37.7	0.8	0.0	0.0	0.0	0.8	
	Esteem	30.9	67.5	1.2	0.4	0.0	0.0	1.6	
	Morpheus	57.2	42.8	0.0	0.0	0.0	0.0	0.0	
	Oracle	50.2	47.2	0.6	2.0	0.0	0.0	2.6	
	Pontiac	23.8	74.1	0.8	1.2	0.0	0.0	2.0	
	Scout	39.3	59.5	0.0	0.8	0.4	0.0	1.2	
	Trigger	59.6	36.8	2.7	0.8	0.0	0.0	3.5	
	Red Beret	40.5	58.3	0.4	0.8	0.0	0.0	1.2	
	White Cloud	63.7	33.8	2.1	0.4	0.0	0.0	2.5	
Hazera	Cruiser	26.9	71.9	0.0	1.2	0.0	0.0	1.2	
	37-86	45.0	54.6	0.0	0.4	0.0	0.0	0.4	
	37-93	62.8	33.6	0.4	2.4	0.8	0.0	3.6	
New Zealand Onion	8217	64.3	31.2	0.4	4.1	0.0	0.0	4.6	

Table 15. (Continued) Internal bulb decomposition of full-season experimental and commercial onion varieties cut after grading, February 2017, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Perfect bulbs	Bulbs with decomposition					Total internal decomposition ^c
			Incomplete or dry scale without decomposition ^a	Incomp. or dry scale + internal bacterial rot	Incomp. or dry scale + internal <i>F. proliferatum</i> ^b rot	Internal bacterial rot	Internal <i>F. proliferatum</i> rot	
			----- % -----					
Nunhems	Anillo	23.0	75.0	0.8	1.2	0.0	0.0	2.0
	Arcero	42.7	52.6	2.4	1.2	1.2	0.0	4.8
	Granero	52.8	46.8	0.0	0.4	0.0	0.0	0.4
	Ranchero	48.4	50.4	1.2	0.0	0.0	0.0	1.2
	Joaquin	50.0	49.6	0.4	0.0	0.0	0.0	0.4
	Montero	37.9	62.1	0.0	0.0	0.0	0.0	0.0
	Pandero	40.1	59.0	0.0	0.8	0.0	0.0	0.8
	Vaquero	41.5	58.1	0.4	0.0	0.0	0.0	0.4
	Marengo	41.6	57.2	0.8	0.4	0.0	0.0	1.2
Sakata	Arruba	53.4	45.4	0.4	0.8	0.0	0.0	1.2
	Dulce Reina	61.6	37.2	0.8	0.4	0.0	0.0	1.2
	Lasso	55.4	43.8	0.8	0.0	0.0	0.0	0.8
	Yukon	50.5	47.5	1.2	0.6	0.2	0.0	2.1
Seminis	Barbaro	40.4	59.6	0.0	0.0	0.0	0.0	0.0
	Belmar	50.4	48.8	0.0	0.8	0.0	0.0	0.8
	Swale	50.8	46.0	2.8	0.4	0.0	0.0	3.2
	Tucannon	68.3	29.3	1.2	0.8	0.4	0.0	2.4
	16000	51.8	45.8	2.0	0.4	0.0	0.0	2.4
	SV6646	44.8	53.2	1.6	0.0	0.4	0.0	2.0
	SV6672	34.5	62.7	2.4	0.4	0.0	0.0	2.8
	SV4643NT	36.3	63.7	0.0	0.0	0.0	0.0	0.0
D. Palmer	Saffron	36.5	62.3	0.8	0.4	0.0	0.0	1.2
	Diamond Swan	49.1	44.8	4.0	1.6	0.0	0.4	6.1
	Cherry Mountain	37.8	58.9	0.0	3.3	0.0	0.0	3.3
	DPLD 1520	31.9	62.7	4.0	1.4	0.0	0.0	5.4
	average	44.2	54.0	0.9	0.8	0.1	0.0	1.8
LSD (0.05)		18.1	18.0	NS	NS	NS	NS	3.4

^aIncomplete or dried scales extending 0.25 inch or more into bulb from neck.

^b*Fusarium proliferatum*.

^cInternal bacterial and *F. proliferatum* rot with or without incomplete or dry scales.