

2017 ONION VARIETY TRIALS

Clinton C. Shock, Erik B. G. Feibert, Alicia Rivera, Kyle D. Wieland, and Lamont D. Saunders, Malheur Experiment Station, Oregon State University, Ontario, OR

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. Four early-season yellow varieties were planted in April and were harvested and graded in early August. Fifty-one full-season varieties (34 yellow, 14 red, and 3 white) were planted in April, harvested in October, and were graded out of storage in January 2018. 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 2017 on an Owyhee silt loam previously planted to wheat. A soil analysis taken in the fall of 2016 showed that the top foot of soil had a pH of 8.2, 3.7% organic matter, 4 ppm nitrate, 3 ppm ammonium, 15 ppm phosphorus (P), 395 ppm potassium (K), 9 ppm sulfur (S), 3774 ppm calcium, 549 ppm magnesium (Mg), 208 ppm sodium, 0.6 ppm zinc (Zn), 17 ppm manganese (Mn), 0.4 ppm copper (Cu), 47 ppm iron, and 0.5 ppm boron (B). In the fall of 2016, the wheat stubble was shredded and the field was irrigated. The field was then disked. Based on a soil analysis, 55 lb of P/acre, 200 lb of S/acre, 9 lb of Zn/acre, 1 lb Cu/acre, and 1 lb of B/acre were broadcast before plowing. Also before plowing, 10 tons/acre of composted cattle manure were broadcast. The manure supplied 196 lb nitrogen (N)/acre, 156 lb P/acre, and 342 lb K/acre. The field was then moldboard plowed, and groundhogged. After groundhogging, 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 April 4 in plots 4 double rows wide and 27 ft long. The early-maturing trial had 4 varieties from 2 seed companies and the full-season trial had 51 varieties from 10 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/1000 ft of row (0.82 lb ai/acre) over the seed rows and the soil surface was rolled. Onion emergence started on April 20. On May 2, alleys 4 ft wide were cut between plots, leaving plots 23 ft long. On May 23-25, 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: Prowl[®] H₂O at 0.83 lb ai/acre (2 pt/acre) and Poast[®] at 0.25 lb ai/acre (16 oz/acre) on May 4; GoalTender[®] at 0.09 lb ai/acre (4 oz/acre) and Buctril[®] at 16 oz/acre on May 15; and Prowl H₂O at 0.31 lb ai/acre (0.75 pt/acre) and Poast at 0.5 lb ai/acre (32 oz/acre) on June 4.

For thrips control, the following insecticides were applied by ground: Movento[®] at 5 oz/acre on May 26; Movento at 5 oz/acre and Aza-Direct[®] at 12 oz/acre on June 2; Agri-Mek[®] SC at 3.5 oz/acre on June 15 and 23. The following insecticides were applied by air: Radiant[®] at 10 oz/acre on July 1, 8, and 30; Lannate[®] at 3 pt/acre on July 17 and 23.

Urea ammonium nitrate solution (URAN) was applied through the drip tape weekly starting May 1 and ending June 28, totaling 120 lb N/acre. Starting on May 26, 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 120 lb/acre, because the soil solution test indicated the soil was supplying the crop with adequate amounts of N after June 27. The amounts of total available soil N went above the critical level of 80 lb N/acre (Sullivan et al. 2001) starting July 11 (Table 4).

Table 1. Onion root tissue nutrient content in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2017.

Nutrient		26-May	12-Jun	19-Jun	27-Jun	4-Jul	11-Jul	17-Jul	24-Jul	31-Jul	7-Aug
NO ₃ -N (ppm)	Sufficiency range	8500	7667	7000	6000	5000	4338	3000	2000	1834	1000
NO ₃ -N (ppm)		3743	4431	3988	4378	5472	6782	5746	5134	3944	3704
P (%)	0.32 - 0.7	0.34	0.27	0.39	0.47	0.52	0.58	0.5	0.48	0.43	0.62
K (%)	2.7 - 6.0	2.81	3.11	3.74	4.44	4.37	4.09	3.18	2.93	2.03	2.32
S (%)	0.24 - 0.85	0.72	0.7	0.95	0.99	0.81	0.96	0.77	0.74	0.72	0.91
Ca (%)	0.4 - 1.2	1.03	0.92	0.72	0.83	1	1.15	1.03	0.84	1.01	1.12
Mg (%)	0.3 - 0.6	0.4	0.35	0.33	0.33	0.3	0.37	0.34	0.38	0.4	0.47
Zn (ppm)	25 - 50	44	33	41	31	37	34	35	32	31	27
Mn (ppm)	35 - 100	124	114	131	109	116	120	115	97	76	90
Cu (ppm)	6 - 20	17	14	20	15	14	11	9	8	9	7
B (ppm)	19 - 60	22	20	25	19	22	25	31	35	42	33

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, 2017.

Nutrient	Critical level,	26-May	12-Jun	19-Jun	27-Jun	4-Jul	11-Jul	17-Jul	24-Jul	31-Jul	7-Aug
	lb or g/acre										
N	Critical level, lb/acre	8.6	7.8	7	6	5	4.6	4	3	2	2
N		5.4	4.6	4	6.6	10.9	12.9	13.1	16	16	14.6
P	0.7 lb	1	1.3	0.7	0.8	1.1	1.3	1.5	1.1	1.2	1
K	5 lb	5	5.1	4.3	5.3	4.3	5.3	6	6.9	5.2	6.5
S	1 lb	4.1	3.1	2.1	2	2.4	3	3.7	4.4	5.1	3.9
Ca	3 lb	9.5	7.8	10.5	8.8	7.8	6.9	6.8	5.9	5.2	5.1
Mg	2 lb	17.9	14	8.3	8	6.8	7.5	7.8	8.3	8.8	7.5
Zn	28 g	27	33	27	33	42	51	63	72	75	66
Mn	28 g	24	18	9	15	27	30	33	30	36	39
Cu	12 g	6	9	6	12	15	18	15	18	21	24

Table 3. Nutrients applied through the drip irrigation system in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2017.

Date	N	P	K
	----- lb/acre -----		
1-May	30		
26-May	15		11
2-Jun	15	5	
9-Jun	15		
13-Jun	15		
22-Jun	15		
28-Jun	15		
Total	120	5	11

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, 2017.

Date	Available soil N, lb/acre
26-May	38
12-Jun	32
19-Jun	28
27-Jun	46
4-Jul	76
11-Jul	90
17-Jul	92
24-Jul	112
31-Jul	112
7-Aug	102

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 May 10 and irrigations ended on September 5.

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 15, onions in the full-season trial were also evaluated for IYSV, thrips damage severity, and bolting. 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 22 to field cure. Onions from the middle two rows in each plot of the full-season trial were topped by hand and bagged on October 2. The bags were put in storage on October 11. 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 January 9-12, 2018.

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* or other fungi. 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. This evaluation was not finished at the time of the printing of this report. The results will be published later.

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 16, 2018. The quality characteristics were evaluated by a group of 10 people who did not know 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

The rate of accumulation and total number of growing degree-days (50-86°F) in 2017 were close to the 24-year average, until July (Fig. 1), which had higher than average growing degree-days (Fig. 2). The SWT remained close to the target during the season (Fig. 3).

Early-maturing Trial

On August 11, all varieties had at least 39% tops down (Table 5). After 2 weeks of storage, bulb sprouting and decomposition were low, averaging 0.4% of total bulbs (Table 5). The percentage of onions that were functionally single centered averaged 55.9% and ranged from 49.9% for 'Avalon' and 'Great Western' to 65.2% for 'Spanish Medallion' (Table 6). Total yield averaged 1087 cwt/acre, ranging from 1019 cwt/acre for Great Western to 1122 cwt/acre for 'Scout' (Table 7).

Full-season Trial

On August 1, the percentage of tops down averaged 9% and ranged from 0% for several varieties to 82% for 10058 (Table 8). By August 15, the percentage of tops down averaged 53% and ranged from 16% for ‘Sedona’ to 96% for 10058. The severity of thrips leaf damage, on a scale from 0 to 10, averaged 2.6 and ranged from 1.0 for ‘Lasso’ and 10043 to 5.2 for ROL221-222. None of the varieties had bolting in 2017. 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 among varieties.

The percentage of functionally single-centered bulbs averaged 68% and ranged from 26% for TAS027 to 98.7% for ‘Oloroso’ (Table 9).

Marketable yield averaged 957 cwt/acre and ranged from 298 cwt/acre for ROM 223-224 to 1357 cwt/acre for Scout (Table 10). ‘Joaquin’, Scout, SV6672, ‘Ranchero’, ‘Morpheus’, ‘Barbaro’, SV6646, 16000, ‘Dulce Reina’, and ‘Grand Perfection’ were among the varieties with the highest marketable yield. Storage decomposition averaged 3% and ranged from 0.2% for ‘Arcero’ to 22% for ‘White Cloud’.

Subjective Quality Evaluation

Subjective bulb quality ratings can be found in Table 13 and explanation of the rating system can be found in Figure 4 and Tables 11 and 12. Significant variations were found among varieties in all the subjective characteristics except bulb shape uniformity.

Internal Defect Evaluation

The percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 56% and ranged from 12% for 10043 to 97% for ‘Marengo’ (Table 14). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 2% and ranged from 0% for ‘Delgado’, Avalon, ‘Caoba’, 10043, and 10058 to 12% for ROM223-224. For most varieties, most of the internal decomposition occurred in bulbs with incomplete scales. In 2017, most of the internal decomposition was caused by black mold (Table 15).

Acknowledgements

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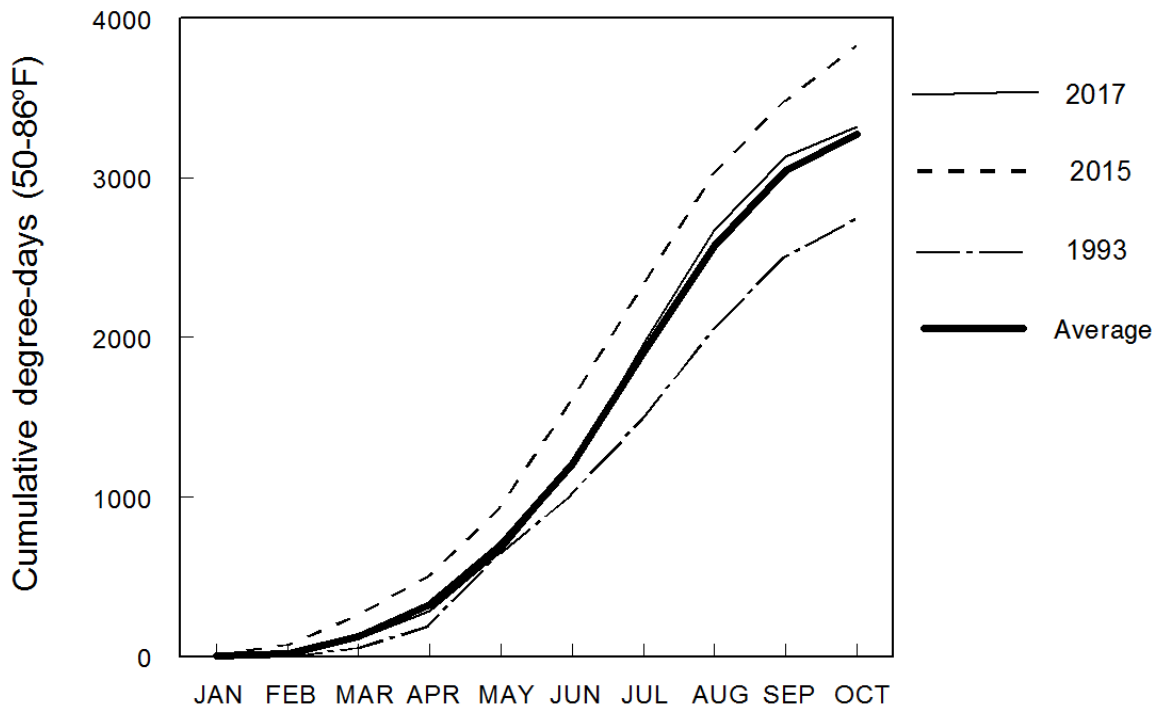


Figure 1. Cumulative growing degree-days (50-86°F) for 2015-2017 and 24-year average, Malheur Experiment Station, Oregon State University, Ontario, OR, 2017.

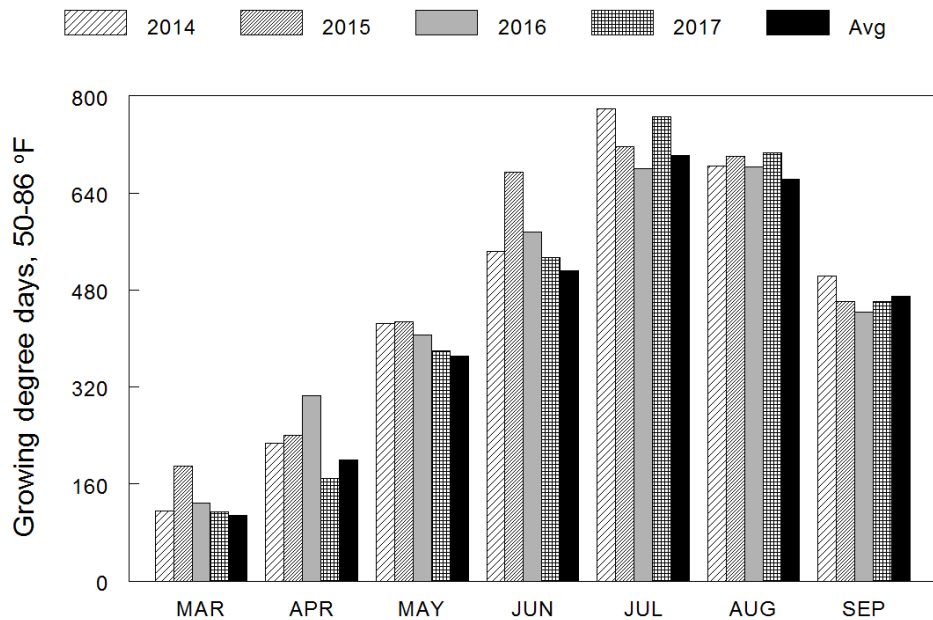


Figure 2. Monthly growing degree-days (50-86°F) for 2014-2017 and 24-year average, Malheur Experiment Station, Oregon State University, Ontario, OR, 2017.

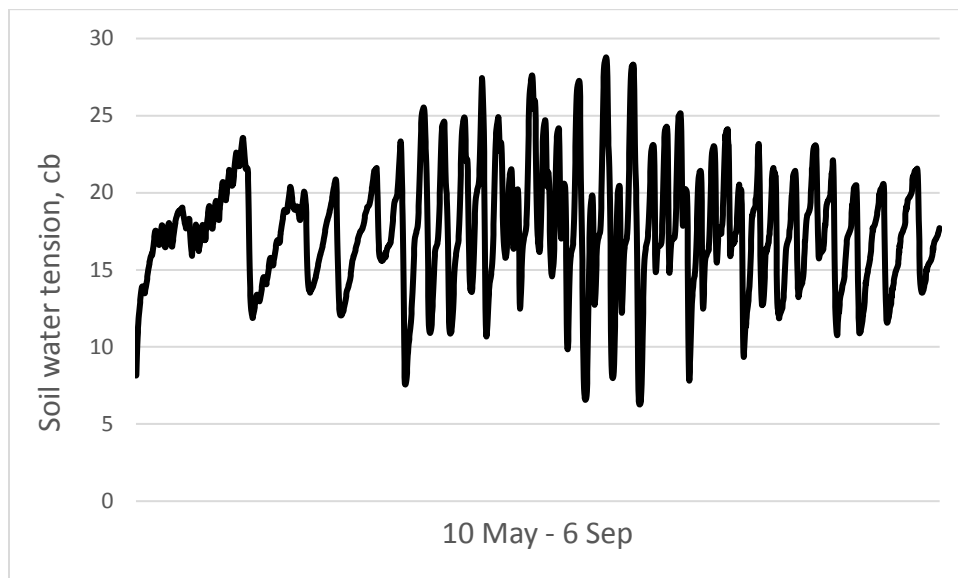


Figure 3. Soil water tension at 8-inch depth below the onion row. Malheur Experiment Station, Oregon State University, Ontario, OR, 2017.

Table 5. Bulb quality 2 weeks after harvest for early-maturing onion varieties lifted and harvested August 14, 2017, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Maturity Aug. 11		Bulb quality 2 weeks after harvest			
		Tops down	Leaf dryness	sprouted	decomposed	sprouted and decomposed	total sprouted or decomposed
		----- % -----					
Crookham	Avalon	39	4	0.0	0.2	0.0	0.0
	Scout	41	4	0.0	0.7	0.0	0.7
Sakata	Great Western	50	10	0.5	0.2	0.0	0.7
	Spanish Medallion	43	5	0.0	0.4	0.0	0.4
	Average	43	6	0.1	0.4	0.0	0.4
LSD (0.05)		NS	3	NS	NS	NS	NS

Table 6. Single- and multiple-center bulb ratings for early-maturing onion varieties lifted and harvested August 14, 2017, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
		----- % -----				
Crookham	Avalon	22.1	28.0	13.5	49.9	36.5
	Scout	14.3	27.2	20.5	58.5	38.0
Sakata	Great Western	21.3	28.8	12.3	49.9	37.6
	Spanish Medallion	11.8	23.0	21.8	65.2	43.4
	Average	17.4	26.8	17.0	55.9	38.9
LSD (0.05)		NS	NS	NS	NS	NS

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

Table 7. Yield and grade performance of early-maturing onion varieties lifted and harvested August 14, 2017, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade							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				
		----- cwt/acre -----							----- % -----		#/50 lb		
Crookham	Avalon	1104.2	1094.8	40.6	376.6	658.8	18.9	7.3	0.0	0.0	0.0	0.0	31.5
	Scout	1122.4	1114.5	44.1	403.8	647.9	18.7	6.1	0.0	0.0	0.0	0.0	32.0
Sakata	Great Western	1018.8	977.4	29.9	222.1	680.5	44.9	16.8	4.3	0.0	0.0	0.0	32.6
	Spanish Medallion	1103.0	1094.5	81.7	398.8	590.2	23.8	8.6	0.0	0.0	0.0	0.0	31.1
	Average	1087.1	1070.3	49.1	350.3	644.4	26.6	9.7	1.1	0.0	0.0	0.0	31.8
LSD (0.05)		NS	88.4	NS	81.9	NS	17.4	NS	NS	NS	NS	NS	NS

Table 8. Maturity, bolting, and thrips leaf damage ratings of full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2017.

Seed company	Variety	Bulb color	1-Aug		15-Aug		9-Aug Thrips leaf damage ^a
			Tops down	Leaf dryness	Tops down	Leaf dryness	
			----- % -----				0 - 10
A. Takii	Grand Perfection	Y	2	0	26	8	2.2
Bejo	Dawson	Y	6	0	58	10	2.6
	Delgado	Y	4	0	70	10	2.0
	Hamilton	Y	6	0	16	10	3.2
	Legend	Y	6	0	76	8	1.8
	Sedona	Y	0	0	16	10	2.8
Crookham	Avalon	Y	12	0	76	9	1.4
	Scout	Y	10	0	70	9	1.8
	Morpheus	Y	4	0	62	8	1.2
	Advantage	Y	0	0	24	7	1.4
	OLYX08-640	Y	18	0	82	16	3.6
	Red Devil	R	6	0	72	19	4.4
	Red Beret	R	4	4	62	22	4.2
	Purple Haze	R	0	0	30	22	4.6
	White Cloud	W	6	0	72	10	1.6
Enza Zaden	Caoba	Y	6	0	44	8	1.2
	10043	Y	6	0	70	8	1.0
	Monastrell	R	68	10	90	26	3.8
	10058	R	82	12	96	30	4.2
Hazera	Rhino	Y	2	0	82	9	1.8
New Zealand Onion	TAS016	R	2	6	22	28	5.0
	TAS018	R	64	10	90	26	4.0
	TAS027	R	46	10	86	22	4.0
	ROL221-222	R	8	10	30	34	5.2
	ROM223-224	R	0	4	18	32	4.8
Nunhems	Annillo	Y	4	0	26	10	2.6
	Arcero	Y	2	0	26	10	2.2
	Granero	Y	2	0	64	10	2.2
	Ranchero	Y	4	0	59	10	2.4
	Joaquin	Y	0	0	30	7	1.6
	Montero	Y	8	2	69	11	3.0
	Oloroso	Y	2	2	26	10	2.6
	Pandero	Y	0	0	32	9	2.0
	Vaquero	Y	4	0	52	10	1.8
	Salsa	R	2	2	22	22	4.4
Marengo	R	6	2	56	20	3.4	
Sakata	Aruba	Y	6	0	72	8	1.4
	Lasso	Y	10	0	70	9	1.0
	Dulce Reina	Y	4	0	54	8	1.2
	Yukon	Y	4	0	56	10	2.0
Seminis	Barbaro	Y	0	0	22	9	2.2
	Swale	Y	0	0	44	10	2.0
	Tucannon	Y	4	0	68	8	1.4
	16000	Y	4	0	60	9	1.4
	SV4058	W	2	0	44	10	2.0
	SV6646	Y	0	0	42	10	2.2
	SV6672	Y	2	0	38	10	1.8
	SV4643NT	R	24	8	83	28	4.0
D. Palmer	Saffron	Y	2	0	38	10	2.2
	Diamond Swan	W	0	0	36	9	1.8
	Cherry Mountain	R	6	0	54	13	3.4
Average			9	2	53	14	2.6
LSD (0.05)			8	3	11	4	0.7

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

Table 9. Single- and multiple-center ratings for full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2017.

Seed company	Variety	Bulb color	Multiple center			Single center	
			large	medium	small	functional ^a	bullet
			----- % -----				
A. Takii	Grand Perfection	Y	16.0	22.0	20.0	62.0	42.0
Bejo	Dawson	Y	4.0	8.0	29.6	88.0	58.4
	Delgado	Y	21.6	34.4	21.6	44.0	22.4
	Hamilton	Y	25.6	20.8	23.2	53.6	30.4
	Legend	Y	32.8	35.2	21.6	32.0	10.4
	Sedona	Y	23.2	25.4	34.3	51.4	17.1
Crookham	Avalon	Y	21.9	23.8	25.3	54.3	29.1
	Scout	Y	22.9	27.9	20.4	49.2	28.8
	Morpheus	Y	4.8	4.8	13.6	90.4	76.8
	Advantage	Y	6.4	16.8	12.0	76.8	64.8
	OLYX08-640	Y	2.4	2.4	14.4	95.2	80.8
	Red Devil	R	4.0	5.6	12.0	90.4	78.4
	Red Beret	R	6.4	10.4	11.2	83.2	72.0
	Purple Haze	R	0.0	8.0	15.2	92.0	76.8
	White Cloud	W	24.0	26.4	21.6	49.6	28.0
	Enza Zaden	Caoba	Y	36.0	29.6	20.0	34.4
10043		Y	31.2	27.2	27.2	41.6	14.4
Monastrell		R	18.4	32.0	34.4	49.6	15.2
10058		R	26.0	32.0	37.0	42.0	5.0
Hazera	Rhino	Y	7.2	20.0	26.4	72.8	46.4
New Zealand Onion	TAS016	R	14.5	26.5	46.1	59.0	12.9
	TAS018	R	23.4	34.6	29.2	42.0	12.8
	TAS027	R	39.0	35.0	23.0	26.0	3.0
	ROL221-222	R	23.0	22.0	33.0	55.0	22.1
	ROM223-224	R	20.2	13.6	21.7	66.1	44.4
Nunhems	Annillo	Y	3.2	3.2	6.5	93.6	87.1
	Arcero	Y	3.0	3.0	11.0	94.0	83.0
	Granero	Y	5.6	20.0	20.8	74.4	53.6
	Ranchero	Y	15.2	17.6	29.6	67.2	37.6
	Joaquin	Y	1.6	9.1	22.4	89.3	66.9
	Montero	Y	2.7	5.3	8.0	92.0	84.0
	Oloroso	Y	1.3	0.0	12.0	98.7	86.7
	Pandero	Y	7.5	25.7	35.8	66.8	31.0
	Vaquero	Y	2.4	9.7	29.0	87.9	58.9
	Salsa	R	25.6	20.0	23.2	54.4	31.2
Marengo	R	8.0	20.3	24.8	71.7	46.9	
Sakata	Aruba	Y	12.0	11.2	15.2	76.8	61.6
	Lasso	Y	16.0	13.0	20.0	71.0	51.0
	Dulce Reina	Y	13.6	16.0	22.4	70.4	48.0
	Yukon	Y	19.2	19.2	30.4	61.6	31.2
Seminis	Barbaro	Y	0.8	8.1	17.4	91.1	73.8
	Swale	Y	14.3	17.0	28.7	68.7	39.9
	Tucannon	Y	3.0	7.8	16.8	89.2	72.4
	16000	Y	8.3	12.3	15.5	79.5	64.0
	SV4058	W	5.6	16.8	20.0	77.6	57.6
	SV6646	Y	4.0	16.0	20.0	80.0	60.0
	SV6672	Y	13.0	20.4	20.1	66.5	46.5
	SV4643NT	R	19.2	12.8	23.2	68.0	44.8
D. Palmer	Saffron	Y	22.4	27.2	32.8	50.4	17.6
	Diamond Swan	W	20.8	25.6	27.2	53.6	26.4
	Cherry Mountain	R	16.8	10.4	21.6	72.8	51.2
Average			14.1	17.9	22.5	68.0	45.5
LSD (0.05)			10.2	9.5	11.1	13.0	13.9

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

Table 10. Yield and grade of full-season experimental and commercial onion varieties graded out of storage in January 2018, 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	1183	1157	235.7	469.7	431.7	20.0	7.7	2.7	31.8	1.4	1.2	0.2	0.0
Bejo	Dawson	Y	940	905	22.9	294.9	539.9	47.4	20.6	6.9	34.0	0.9	0.1	0.8	0.0
	Delgado	Y	1025	983	73.0	293.5	571.8	44.3	14.6	20.8	33.5	0.7	0.3	0.3	0.1
	Hamilton	Y	1011	980	56.5	306.2	571.4	45.8	11.0	16.8	31.7	0.3	0.3	0.0	0.0
	Legend	Y	921	879	8.6	202.3	642.1	26.0	9.0	22.4	35.0	1.1	0.8	0.1	0.1
	Sedona	Y	1102	1016	59.4	333.0	596.6	27.0	8.6	69.1	33.1	0.7	0.5	0.1	0.2
Crookham	Avalon	Y	1294	1047	205.1	360.9	450.0	31.1	9.5	10.7	28.9	17.6	10.3	0.1	7.2
	Scout	Y	1357	1243	323.5	506.1	394.9	18.0	7.4	11.1	28.8	7.1	3.4	0.2	3.5
	Morpheus	Y	1237	1203	202.0	503.0	469.3	28.2	6.4	6.0	31.8	1.8	1.4	0.1	0.2
	Advantage	Y	1193	1119	251.9	453.2	397.9	16.2	7.3	3.2	30.6	5.3	4.9	0.1	0.3
	OLYX08-640	Y	811	793	3.2	77.5	650.5	61.7	15.2	1.0	32.5	0.3	0.1	0.2	0.0
	Red Devil	R	606	571	0.0	18.3	457.0	95.9	21.3	7.0		1.3	0.9	0.2	0.2
	Red Beret	R	613	569	5.1	36.3	438.5	89.3	27.3	6.5	30.1	1.8	0.9	0.7	0.2
	Purple Haze	R	633	607	0.0	14.0	482.0	110.8	15.2	3.1		1.2	0.8	0.2	0.2
White Cloud	W	1191	887	107.9	318.3	436.6	24.2	10.2	36.4	29.9	22.1	0.7	0.3	21.1	
Enza Zaden	Caoba	Y	1104	1047	100.7	420.2	498.6	27.8	9.4	32.9	30.8	1.3	0.6	0.4	0.3
	10043	Y	1028	950	73.3	254.8	591.2	30.3	17.0	53.8	31.0	0.7	0.4	0.2	0.1
	Monastrell	R	655	498	6.7	30.4	400.8	60.1	15.6	34.9	31.1	16.8	15.2	0.0	1.6
	10058	R	688	531	5.5	19.5	405.9	100.6	22.7	63.2	28.3	11.6	11.2	0.2	0.2
Hazera	Rhino	Y	1047	1007	99.2	363.8	521.0	22.5	6.5	14.9	32.4	1.9	1.6	0.2	0.0
New Zealand Onion	TAS016	R	448	326	0.0	0.0	140.8	185.3	51.1	70.3		0.2	0.2	0.0	0.0
	TAS018	R	463	392	0.0	1.1	253.2	138.1	45.7	19.9		1.1	0.3	0.8	0.0
	TAS027	R	544	476	0.0	2.1	358.2	115.9	44.6	13.8		1.7	0.5	1.3	0.0
	ROL221-222	R	333	167	0.0	0.0	48.3	118.9	67.9	91.6		2.0	1.9	0.1	0.0
	ROM223-224	R	298	183	0.0	0.0	50.4	133.1	67.1	36.4		4.0	1.8	2.1	0.0

Table 10. (Continued) Yield and grade of full-season experimental and commercial onion varieties graded out of storage in January 2018, 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	Annillo	Y	1032	1014	73.6	381.3	532.0	27.0	13.6	1.4	31.9	0.4	0.2	0.2	0.0
	Arcero	Y	1094	1073	111.9	410.4	522.4	28.5	16.0	2.4	30.6	0.2	0.1	0.1	0.0
	Granero	Y	1032	997	80.6	337.9	539.0	39.8	20.6	7.2	30.8	0.7	0.2	0.2	0.3
	Ranchero	Y	1249	1204	196.7	480.2	494.4	32.4	14.1	12.5	30.3	1.5	1.0	0.0	0.6
	Joaquin	Y	1268	1251	293.1	464.8	467.7	25.4	8.6	3.4	31.0	0.4	0.2	0.1	0.1
	Montero	Y	966	942	49.0	305.9	550.1	37.2	11.4	4.8	32.5	0.7	0.4	0.3	0.0
	Oloroso	Y	915	893	20.9	202.3	630.9	39.0	10.9	1.7	34.5	1.1	0.4	0.4	0.3
	Pandero	Y	1136	1097	170.6	457.1	441.1	28.5	10.0	15.1	31.6	1.2	0.4	0.6	0.2
	Vaquero	Y	1163	1134	181.3	446.3	468.8	38.1	16.7	4.2	29.7	0.7	0.2	0.1	0.4
	Salsa	R	637	495	0.0	41.5	387.4	65.9	43.8	83.3		2.5	1.7	0.8	0.0
	Marengo	R	739	698	0.0	17.3	612.1	68.2	20.0	16.3		0.7	0.5	0.1	0.1
Sakata	Aruba	Y	1123	1077	209.1	383.7	448.1	35.6	14.4	22.9	30.3	0.8	0.5	0.1	0.2
	Lasso	Y	1061	992	96.8	356.5	507.4	31.2	13.4	13.2	32.2	4.1	4.0	0.1	0.0
	Dulce Reina	Y	1243	1166	294.8	416.2	426.0	29.3	8.1	11.4	30.1	4.6	1.5	0.0	3.1
	Yukon	Y	1201	1115	231.8	440.5	426.0	16.6	8.8	42.6	29.9	3.0	2.2	0.1	0.8
Seminis	Barbaro	Y	1220	1198	373.8	418.4	382.5	23.8	9.6	0.0	29.3	1.0	0.4	0.6	0.0
	Swale	Y	1128	1086	168.8	398.8	490.6	28.0	13.6	9.6	31.2	1.7	0.5	0.7	0.5
	Tucannon	Y	1038	1002	127.5	333.1	501.6	39.5	11.4	15.6	31.5	0.9	0.2	0.2	0.5
	16000	Y	1187	1167	315.4	423.9	406.1	22.0	9.6	3.7	30.1	0.6	0.1	0.4	0.1
	SV4058	W	1091	984	127.8	350.2	483.0	23.0	9.5	6.9	31.1	8.4	2.2	0.3	5.9
	SV6646	Y	1210	1187	258.3	485.3	424.6	19.3	8.8	2.9	29.6	0.9	0.2	0.7	0.0
	SV6672	Y	1252	1204	315.5	444.0	419.5	24.6	10.3	10.1	28.6	2.3	0.9	0.2	1.2
	SV4643NT	R	674	574	3.0	50.4	455.6	64.8	24.2	60.6	34.5	2.7	1.4	1.3	0.0
D. Palmer	Saffron	Y	760	668	11.8	97.7	505.8	52.6	18.2	69.4	37.0	0.6	0.3	0.2	0.1
	Diamond Swan	W	1051	938	98.4	315.0	497.7	26.5	9.2	57.5	32.5	4.5	2.6	0.8	1.1
	Cherry Mountain	R	604	506	0.0	31.7	420.0	54.7	27.0	57.2		2.1	2.0	0.1	0.0
	average		957	886	110.8	270.0	455.7	49.8	18.1	23.4	31.4	3.0	1.7	0.3	1.0
LSD (0.05)			94	110	46.2	68.4	90.5	22.9	10.1	17.0	2.2	4.5	3.9	0.9	2.7

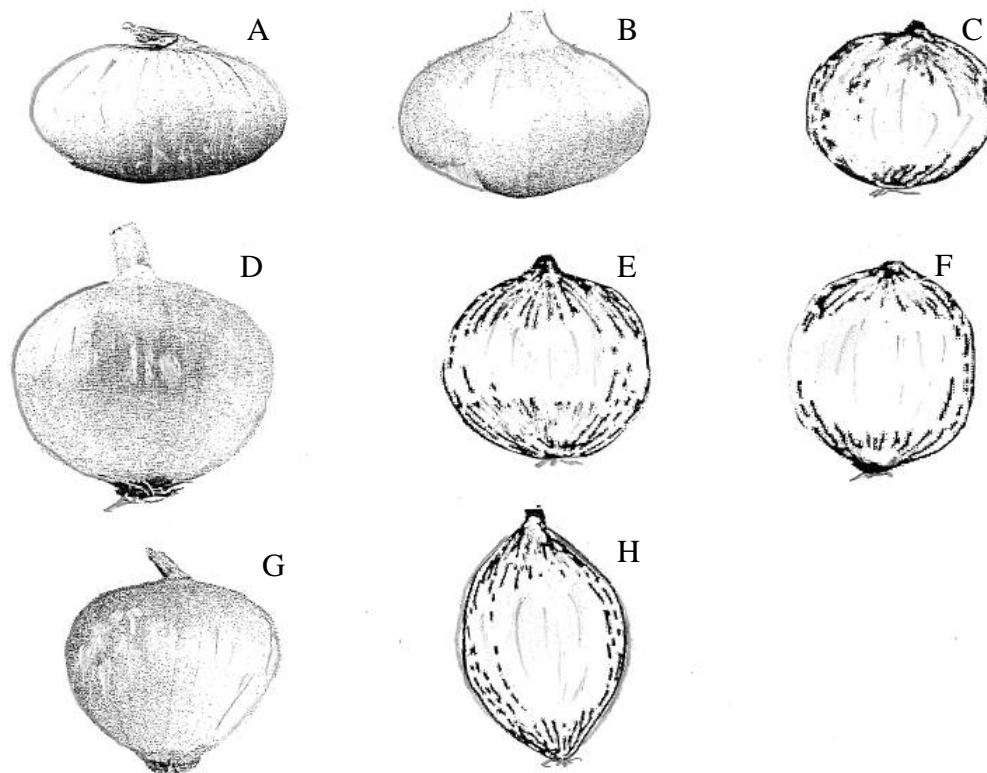


Figure 4. Onion bulb shape rating system (see Table 11). Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 11. Description of bulb shapes, see Fig. 4.

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

Table 12. Onion variety subjective quality evaluation rating system.

Characteristic	Scale	Description
Bulb shape	A-H	see Fig. 4
Skin color	1-5	1 = light, 5 = dark
Bulb shape uniformity	1-5	1 = nonuniform 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 13. Subjective evaluations of onion appearance and firmness by variety on January 16, 2018, 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
						----- 1 - 5 -----		
A. Takii	Grand Perfection	Y	e	3.0	3.8	4.5	3.5	4.0
Bejo	Dawson	Y	d	3.0	4.0	3.8	4.0	3.3
	Delgado	Y	d	3.8	4.0	3.5	4.5	3.5
	Hamilton	Y	d	4.0	4.0	5.0	5.0	4.0
	Legend	Y	d	3.3	3.8	4.0	4.0	3.3
	Sedona	Y	d	3.3	4.0	4.0	4.0	3.5
Crookham	Avalon	Y	c	2.0	2.5	1.5	2.5	4.0
	Scout	Y	d	1.5	2.5	2.3	2.0	3.8
	Morpheus	Y	d	2.3	3.5	3.3	3.5	4.8
	Advantage	Y	e	2.8	3.5	3.0	3.5	3.5
	OLYX08-640	Y	d	4.0	4.0	5.0	5.0	4.0
	Red Devil	R	d	3.0	3.4	3.0	3.0	2.8
	Red Beret	R	d	3.0	3.0	3.0	3.5	2.8
	Purple Haze	R	d	3.0	3.0	3.5	4.0	3.0
	White Cloud	W	d	3.8	4.0	3.0	3.0	3.0
Enza Zaden	Caoba	Y	d	4.0	4.0	4.5	3.8	3.5
	10043	Y	d	3.3	3.5	3.3	3.8	3.3
	Monastrell	R	c	4.0	4.0	3.0	3.0	2.0
	10058	R	a	3.0	4.0	3.0	2.0	3.0
Hazera	Rhino	Y	d	3.5	3.5	3.5	4.0	3.8
New Zealand Onion	TAS016	R	c	3.0	4.0	3.5	4.0	3.0
	TAS018	R	c	2.0	4.0	4.0	2.0	3.0
	TAS027	R	c	3.0	3.0	3.0	2.0	3.0
	ROL221-222	R	d	4.0	4.0	4.0	4.0	3.0
	ROM223-224	R	c	4.0	2.0	3.0	4.0	2.5
Nunhems	Annillo	Y	d	3.5	3.8	4.3	4.3	4.3
	Arcero	Y	d	3.5	4.5	4.0	3.5	4.0
	Granero	Y	d	3.3	4.0	4.1	3.5	3.3
	Ranchero	Y	d	3.0	3.0	3.0	2.8	3.5
	Joaquin	Y	e	3.5	4.0	3.8	4.3	4.0
	Montero	Y	d	3.0	3.0	3.0	3.3	3.6
	Oloroso	Y	d	4.0	4.0	4.0	4.0	4.3
	Pandero	Y	d	3.8	4.0	4.5	4.5	3.5
	Vaquero	Y	d	3.0	4.0	3.5	3.5	3.8
	Salsa	R	d	3.0	3.0	3.0	3.0	3.0
Marengo	R	d	4.0	3.5	3.0	3.0	2.0	
Sakata	Aruba	Y	d	2.0	2.8	2.5	3.0	4.4
	Lasso	Y	d	2.0	3.0	2.0	2.5	4.5
	Dulce Reina	Y	e	2.0	3.0	3.0	3.3	3.8
	Yukon	Y	e	2.5	3.0	2.5	3.5	4.3
Seminis	Barbaro	Y	d	3.0	4.0	3.8	4.0	4.0
	Swale	Y	d	2.5	3.3	3.5	3.5	4.0
	Tucannon	Y	d	4.0	2.0	4.0	4.0	4.5
	16000	Y	e	2.5	3.8	3.8	3.3	4.5
	SV4058	W	d	2.5	3.5	3.3	3.5	4.0
	SV6646	Y	d	3.0	4.0	4.0	4.0	3.5
	SV6672	Y	f	3.0	3.0	3.0	3.0	3.5
	SV4643NT	R	d	4.0	4.0	4.3	4.0	3.0
D. Palmer	Saffron	Y	f	4.3	2.8	5.0	5.0	3.0
	Diamond Swan	W	d	2.5	4.0	4.0	4.0	3.0
	Cherry Mountain	R	d	2.0	3.0	2.0	4.0	4.0
Average			d	3.1	3.5	3.5	3.6	3.5
LSD (0.05)			0.9 ^c	0.6	NS	0.6	0.7 ^c	0.7

^aBulb shape: see Fig. 4. ^bSubjective ratings are described in Table 12. ^cLSD (0.10)

Table 14. Internal defects of full-season experimental and commercial onion varieties evaluated out of storage in January 2018, Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

Seed company	Variety	Bulb color	All bulbs							Diseased bulbs						
			Complete scales			Incomplete scales			Total	Complete scales			Incomplete scales			Total
			no dry scale	dry scale	total	no dry scale	dry scale	total		no dry scale	dry scale	total	no dry scale	dry scale	total	
----- % -----																
A. Takii	Grand Perfection	Y	68.4	0.4	68.8	26.8	4.4	31.2	100	0.0	0.0	0.0	0.0	1.2	1.2	1.2
Bejo	Dawson	Y	43.6	0.0	43.6	46.8	9.6	56.4	100	0.0	0.0	0.0	0.0	0.8	0.8	0.8
	Delgado	Y	54.8	0.0	54.8	38.0	7.2	45.2	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Hamilton	Y	49.2	1.2	50.4	32.0	17.6	49.6	100	0.0	0.0	0.0	0.8	0.8	1.6	1.6
	Legend	Y	33.2	0.4	33.6	54.8	11.6	66.4	100	0.4	0.0	0.4	0.0	1.2	1.2	1.6
	Sedona	Y	66.0	0.4	66.4	23.6	10.0	33.6	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
Crookham	Avalon	Y	57.4	0.4	57.8	35.6	6.6	42.2	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Scout	Y	45.5	1.2	46.7	43.7	9.6	53.3	100	0.0	0.0	0.0	0.8	0.0	0.8	0.8
	Morpheus	Y	60.0	0.4	60.4	29.6	10.0	39.6	100	2.0	0.0	2.0	0.0	0.0	0.0	2.0
	Advantage	Y	86.4	0.0	86.4	11.5	2.1	13.6	100	1.8	0.0	1.8	0.0	0.0	0.0	1.8
	OLYX08-640	Y	33.9	0.4	34.3	45.6	20.0	65.7	100	0.0	0.0	0.0	1.6	0.0	1.6	1.6
	Red Devil	R	22.8	0.4	23.2	56.0	20.8	76.8	100	0.0	0.0	0.0	1.2	0.0	1.2	1.2
	Red Beret	R	39.2	0.0	39.2	46.4	14.4	60.8	100	0.0	0.0	0.0	0.0	1.2	1.2	1.2
	Purple Haze	R	21.2	0.0	21.2	65.6	13.2	78.8	100	0.4	0.0	0.4	0.0	2.0	2.0	2.4
White Cloud	W	51.1	0.4	51.5	42.5	6.0	48.5	100	0.0	0.0	0.0	0.4	0.8	1.2	1.2	
Enza Zaden	Caoba	Y	54.4	0.8	55.2	37.6	7.2	44.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10043	Y	87.6	0.0	87.6	11.2	1.2	12.4	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Monastrell	R	11.6	0.4	12.0	77.6	10.4	88.0	100	0.8	0.0	0.8	0.0	0.0	0.0	0.8
	10058	R	7.2	0.0	7.2	90.0	2.8	92.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazera	Rhino	Y	27.6	0.0	27.6	52.0	20.4	72.4	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
N. Zealand Onion	TAS016	R	46.4	0.0	46.4	41.6	12.0	53.6	100	0.0	0.0	0.0	0.4	3.6	4.0	4.0
	TAS018	R	19.7	0.0	19.7	77.1	3.2	80.3	100	0.0	0.0	0.0	0.4	0.8	1.2	1.2
	TAS027	R	16.8	0.0	16.8	73.2	10.0	83.2	100	0.0	0.0	0.0	0.4	1.2	1.6	1.6
	ROL221-222	R	34.8	0.0	34.8	38.4	26.8	65.2	100	0.0	0.0	0.0	0.0	11.2	11.2	11.2
	ROM223-224	R	39.5	0.0	39.5	35.0	25.5	60.5	100	0.0	0.0	0.0	0.0	12.0	12.0	12.0

Table 14. (Continued) Internal defects of full-season experimental and commercial onion varieties evaluated out of storage in January 2018, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bulb color	All bulbs							Diseased bulbs						
			Complete scales			Incomplete scales			Total	Complete scales			Incomplete scales			Total
			no dry scale	dry scale	total	no dry scale	dry scale	total		no dry scale	dry scale	total	no dry scale	dry scale	total	
----- % -----																
Nunhems	Annillo	Y	18.0	0.0	18.0	54.4	27.6	82.0	100	0.8	0.0	0.8	1.2	1.6	2.8	3.6
	Arcero	Y	37.6	0.8	38.4	38.4	23.2	61.6	100	0.8	0.0	0.8	0.0	0.8	0.8	1.6
	Granero	Y	42.4	0.4	42.8	45.6	11.6	57.2	100	0.4	0.0	0.4	0.8	0.0	0.8	1.2
	Ranchero	Y	64.0	1.6	65.6	28.0	6.4	34.4	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	Joaquin	Y	66.8	1.7	68.5	25.1	6.4	31.5	100	0.0	0.0	0.0	0.4	0.4	0.8	0.8
	Montero	Y	18.8	0.8	19.6	46.8	33.6	80.4	100	0.0	0.0	0.0	0.4	1.6	2.0	2.0
	Oloroso	Y	34.4	0.0	34.4	47.2	18.4	65.6	100	0.0	0.0	0.0	0.4	2.4	2.8	2.8
	Pandero	Y	40.0	0.4	40.4	39.2	20.4	59.6	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	Vaquero	Y	36.0	4.0	40.0	48.0	12.0	60.0	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	Salsa	R	18.8	0.0	18.8	69.6	11.6	81.2	100	0.4	0.0	0.4	0.4	3.6	4.0	4.4
	Marenge	R	3.2	0.0	3.2	73.6	23.2	96.8	100	0.4	0.0	0.4	2.4	1.2	3.6	4.0
Sakata	Aruba	Y	43.6	0.8	44.4	34.0	21.6	55.6	100	0.4	0.0	0.4	0.0	0.4	0.4	0.8
	Lasso	Y	48.8	0.0	48.8	30.8	20.4	51.2	100	0.4	0.0	0.4	0.0	0.0	0.0	0.4
	Dulce Reina	Y	66.0	0.0	66.0	28.0	6.0	34.0	100	0.0	0.0	0.0	0.4	0.4	0.8	0.8
	Yukon	Y	56.0	0.0	56.0	31.6	12.4	44.0	100	5.6	0.0	5.6	0.0	0.4	0.4	6.0
Seminis	Barbaro	Y	56.4	1.2	57.6	36.0	6.4	42.4	100	0.0	0.0	0.0	1.2	0.8	2.0	2.0
	Swale	Y	56.0	0.4	56.4	34.4	9.2	43.6	100	0.4	0.0	0.4	0.0	0.0	0.0	0.4
	Tucannon	Y	62.4	1.6	64.0	24.4	11.6	36.0	100	0.8	0.0	0.8	0.0	0.8	0.8	1.6
	16000	Y	60.0	0.4	60.4	27.6	12.0	39.6	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	SV4058	W	55.6	0.4	56.0	32.0	12.0	44.0	100	2.8	0.0	2.8	1.2	5.2	6.4	9.2
	SV6646	Y	55.8	0.0	55.8	35.3	8.9	44.2	100	0.4	0.0	0.4	0.4	0.0	0.4	0.8
	SV6672	Y	56.0	0.0	56.0	36.0	8.0	44.0	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	SV4643NT	R	10.4	0.0	10.4	76.0	13.6	89.6	100	0.0	0.0	0.0	1.2	1.6	2.8	2.8
D. Palmer	Saffron	Y	29.2	0.4	29.6	38.0	32.4	70.4	100	0.0	0.0	0.0	0.4	0.4	0.8	0.8
	Diamond Swan	W	63.2	1.2	64.4	29.2	6.4	35.6	100	0.0	0.0	0.0	0.0	1.6	1.6	1.6
	Cherry Mountain	R	20.4	0.8	21.2	47.2	31.6	78.8	100	0.4	0.0	0.4	0.0	0.8	0.8	1.2
	average		43.1	0.5	43.6	42.9	13.5	56.4	100	0.4	0.0	0.4	0.4	1.2	1.6	2.0
LSD (0.05)			17.5	1.6	17.7	16.0	11.6	17.7		NS	NS	NS	1.2	2.4	2.4	3.4

Table 15. Internal decomposition by disease type of full-season experimental and commercial onion varieties evaluated out of storage in January 2018, Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

Seed company	Variety	Bulb color	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
			----- % -----			
A. Takii	Grand Perfection	Y	0.4	0.0	0.0	0.8
Bejo	Dawson	Y	0.0	0.0	0.0	0.8
	Delgado	Y	0.0	0.0	0.0	0.0
	Hamilton	Y	0.0	0.4	0.0	1.2
	Legend	Y	0.4	0.0	0.0	1.2
	Sedona	Y	0.0	0.4	0.0	0.0
Crookham	Avalon	Y	0.0	0.0	0.0	0.0
	Scout	Y	0.0	0.0	0.8	0.0
	Morpheus	Y	0.0	0.0	0.8	1.2
	Advantage	Y	0.0	0.0	1.4	0.4
	OLYX08-640	Y	0.0	0.4	0.4	0.8
	Red Devil	R	0.0	0.8	0.0	0.4
	Red Beret	R	0.0	0.0	0.0	1.2
	Purple Haze	R	0.8	0.4	0.0	1.2
	White Cloud	W	0.4	0.4	0.0	0.4
Enza Zaden	Caoba	Y	0.0	0.0	0.0	0.0
	10043	Y	0.0	0.0	0.0	0.0
	Monastrell	R	0.4	0.0	0.4	0.0
	10058	R	0.0	0.0	0.0	0.0
Hazera	Rhino	Y	0.4	0.0	0.0	0.0
New Zealand Onion	TAS016	R	0.0	0.0	0.0	4.0
	TAS018	R	0.4	0.0	0.0	0.8
	TAS027	R	0.8	0.0	0.4	0.4
	ROL221-222	R	0.0	0.0	0.0	11.2
	ROM223-224	R	1.5	0.0	0.0	10.5

Table 15. (Continued) Internal decomposition by disease type of full-season experimental and commercial onion varieties evaluated out of storage in January 2018, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bulb color	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
			----- % -----			
Nunhems	Annillo	Y	0.4	0.8	1.2	1.2
	Arcero	Y	0.8	0.0	0.0	0.8
	Granero	Y	0.0	0.4	0.4	0.4
	Ranchero	Y	0.0	0.4	0.0	0.0
	Joaquin	Y	0.0	0.0	0.4	0.4
	Montero	Y	0.4	0.0	0.0	1.6
	Oloroso	Y	0.0	0.4	0.0	2.4
	Pandero	Y	0.0	0.0	0.4	0.0
	Vaquero	Y	0.0	0.0	0.0	0.4
	Salsa	R	0.4	0.0	0.4	3.6
	Marengo	R	0.0	0.0	0.8	3.2
Sakata	Aruba	Y	0.0	0.4	0.4	0.0
	Lasso	Y	0.4	0.0	0.0	0.0
	Dulce Reina	Y	0.4	0.0	0.0	0.4
	Yukon	Y	5.6	0.4	0.0	0.0
Seminis	Barbaro	Y	1.6	0.0	0.0	0.4
	Swale	Y	0.4	0.0	0.0	0.0
	Tucannon	Y	1.2	0.0	0.0	0.4
	16000	Y	0.0	0.4	0.0	0.0
	SV4058	W	8.4	0.8	0.0	0.0
	SV6646	Y	0.8	0.0	0.0	0.0
	SV6672	Y	0.4	0.0	0.0	0.0
	SV4643NT	R	0.4	0.0	0.0	2.4
D. Palmer	Saffron	Y	0.0	0.0	0.0	0.8
	Diamond Swan	W	1.2	0.0	0.0	0.4
	Cherry Mountain	R	0.0	0.0	0.4	0.8
average			0.6	0.1	0.2	1.1
LSD (0.05)			2.4	NS	NS	2.1