

2018 ONION VARIETY TRIALS

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

Introduction

Direct-seeded yellow, white, and red onion varieties were evaluated in the field in 2018 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 March and were harvested and graded in early August. Fifty-three full-season varieties (35 yellow, 12 red, and 6 white) were planted in March, harvested in September, and were graded out of storage in January 2019. 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 were evaluated objectively for bolting, yield, grade, single centers, and storability. Varieties were 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 2018 on a Greenleaf silt loam previously planted to wheat. A soil analysis taken in the fall of 2017 showed that the top foot of soil had a pH of 8.2, 3.4% organic matter, 7 ppm nitrate, 3 ppm ammonium, 22 ppm phosphorus (P), 386 ppm potassium (K), 20 ppm sulfur (S), 3218 ppm calcium (Ca), 533 ppm magnesium (Mg), 138 ppm sodium, 4.1 ppm zinc (Zn), 3 ppm manganese (Mn), 2.2 ppm copper (Cu), 16 ppm iron, and 0.5 ppm boron (B). In the fall of 2017, the wheat stubble was shredded and the field was irrigated. The field was then disked. Based on a soil analysis, 78 lb of P/acre, 81 lb of K/acre, 162 lb of S/acre, 9 lb of Mn/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 March 20 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 53 varieties from 11 seed companies. An additional trial with onion transplants is not reported here.

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 9. On May 10, alleys 4 ft wide

were cut between plots, leaving plots 23 ft long. On May 14-16, the seedlings were hand thinned to a target 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: oxyfluorfen at 0.13 lb ai/acre (GoalTender[®] at 4 oz/acre), bromoxynil at 0.25 lb ai/acre (Brox[®] 2EC at 16 oz/acre), and clethodim at 0.12 lb ai/acre (Shadow[®] 3EC at 5.3 oz/acre) on May 7; pendimethalin at 0.95 lb ai/acre (Prowl[®] H₂O at 2 pt/acre) on May 17; oxyfluorfen at 0.25 lb ai/acre (GoalTender[®] at 8 oz/acre), bromoxynil at 0.31 lb ai/acre (Brox[®] 2EC at 20 oz/acre), and clethodim at 0.12 lb ai/acre (Shadow[®] 3EC at 5.3 oz/acre) on May 25.

For thrips control, the following insecticides were applied by ground: spirotetramat at 0.078 lb ai/acre (Movento[®] at 5 oz/acre) and azadirachtin at 0.0093 lb ai/acre (Aza-Direct[®] at 12 oz/acre) on May 21 and June 3; abamectin at 0.019 lb ai/acre (Agri-Mek[®] SC at 3.5 oz/acre) on June 11. The following insecticides were applied by air: Abamectin at 0.019 lb ai/acre on June 27; spinetoram at 0.078 lb ai/acre (Radiant[®] at 10 oz/acre) on June 30 and July 7; methomyl at 0.9 lb ai/acre (Lannate[®] at 3 pt/acre) on July 14 and July 21; spinetoram at 0.078 lb ai/acre on July 28 and August 5.

Starting on June 8, root tissue and soil 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 based on the root tissue recommendations from Western Labs (Table 3). Urea ammonium nitrate solution (URAN) was applied through the drip tape six times from May 23 to June 25, supplying a total of 120 lb N/acre. Starting June 22, the soil solution nitrogen remained above the critical level for the rest of the season. Also starting June 22, the amount of total available soil N remained above the critical level of 60 lb N/acre for the rest of the season (Table 4, Sullivan et al. 2001). Phosphorus, K, Mg, and Cu were also applied 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, 2018.

Nutrient		8-Jun	15-Jun	22-Jun	29-Jun	9-Jul	23-Jul	27-Jul	3-Aug	10-Aug
NO ₃ -N (ppm)	Sufficiency range	8500	7667	6833	6000	5168	4338	3508	2678	1834
NO ₃ -N (ppm)		4772	3668	4105	4726	3903	4644	3616	3432	2871
P (%)	0.32 - 0.7	0.52	0.44	0.34	0.40	0.44	0.37	0.28	0.41	0.35
K (%)	2.7 - 6.0	3.67	3.31	3.13	4.49	4.18	3.21	2.75	2.51	2.16
S (%)	0.24 - 0.85	1.00	0.94	0.87	1.21	0.63	0.60	0.77	0.81	0.50
Ca (%)	0.4 - 1.2	0.59	0.66	0.79	0.79	0.74	0.87	0.93	1.16	0.96
Mg (%)	0.3 - 0.6	0.33	0.42	0.47	0.36	0.32	0.35	0.43	0.43	0.36
Zn (ppm)	25 - 50	67	47	56	47	39	46	51	40	30
Mn (ppm)	35 - 100	99	93	108	82	62	73	85	92	68
Cu (ppm)	6 - 20	20	15	10	8	7	6	7	6	7
B (ppm)	19 - 60	72	80	61	52	42	33	31	25	28

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. Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Nutrient	Critical level, lb/ac or g/ac	Critical level,								
		8-Jun	15-Jun	22-Jun	29-Jun	9-Jul	23-Jul	27-Jul	3-Aug	10-Aug
N	Critical levels	8.6	7.8	7	6.2	5.4	4.6	3.8	2.8	2.0
N		2.0	2.3	9.7	8.6	9.7	8.6	10.0	12.6	10.0
P	0.7 lb/acre	1.2	1.1	1.5	1.6	1.5	2.0	1.8	2.2	2.3
K	5 lb/acre	8.5	9.1	9.2	7.9	6.6	7.0	8.2	6.9	7.4
S	1 lb/acre	1.5	1.0	2.3	3.1	4.3	5.5	5.5	3.8	4.7
Ca	3 lb/acre	4.9	5.0	6.1	4.7	5.5	4.5	5.5	5.1	5.0
Mg	2 lb/acre	0.2	0.2	0.5	0.6	0.7	0.9	1.0	1.0	1.1
Zn	28 g/acre	75	69	78	57	66	57	63	45	45
Mn	28 g/acre	24	30	27	21	27	33	30	27	24
Cu	12 g/acre	36	42	33	27	21	24	27	24	30
B	21 g/acre	8	9	12	11	14	12	15	12	15

Table 3. Nutrients applied through the drip irrigation system in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Date	N	P	K	Mg	Cu
----- lb/acre -----					
23-May	20				
1-Jun	20				
11-Jun	20				
12-Jun	20				
19-Jun	20			2.5	
25-Jun	20			5	
6-Jul				5	
25-Jul					0.3
30-Jul		10			
7-Aug			10		
15-Aug			10		
total	120	10	20	12.5	0.3

Table 4. Soil available N (as NO₃ + NH₄) in the top foot of soil in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Date	Available soil N, lb/acre
8-Jun	14
15-Jun	16
22-Jun	68
29-Jun	60
9-Jul	68
23-Jul	60
27-Jul	70
3-Aug	88
10-Aug	70

Onions were irrigated automatically to maintain the soil water tension (SWT) at 8-inch depth 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 of onions. 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 at 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 16 and irrigations ended on August 31.

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 the IYSV evaluations, 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 and compared to the plant population.

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.

In the full-season trial, the red and white onion varieties matured before the yellow varieties. Onions from the middle two rows in each plot of the red and white onion varieties were topped and bagged on September 5 to cure in the field until September 10 when they were put in bins and stored outdoors. The remaining yellow onions were lifted on September 10 to field cure. Onions from the middle two rows in each plot of the yellow varieties were topped by hand and bagged on September 15. The bags of red, white, and yellow varieties were moved into storage on September 21. 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 7-11, 2019.

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.

In late December, 2018, 50 bulbs from border rows in 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.

After grading, two replicates of each variety were evaluated for bulb shape, bulb shape uniformity, firmness, skin color, skin retention, and flesh brightness on January 15, 2019. 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. Because variety performance varies by year, growers are encouraged to review variety performance data 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 2018 were close to the 24-year average, until May (Fig. 1), which had higher than average growing degree-days (Fig. 2). With regards to irrigation management, the SWT at 8-inch depth frequently exceeded the target of 20 cb by 5 to 10 cb during the season (Fig. 3).

Early-maturing Trial

On August 8, all varieties had at least 68% tops down (Table 5). After 2 weeks of storage, no bulb sprouting or decomposition was found. The percentage of onions that were functionally single centered averaged 65% and ranged from 44% for ‘Yosemite’ to 84% for ‘Spanish Medallion’ (Table 5). Total yield averaged 1120 cwt/acre, ranging from 995 cwt/acre for Yosemite to 1179 cwt/acre for Spanish Medallion (Table 6).

Full-season Trial

On August 1, the percentage of tops down averaged 35% and ranged from 8% for ‘Joaquin’ and ‘Barbaro’ to 89% for ‘Traverse’ and SV4643NT (Table 7). By August 15, the percentage of tops down averaged 83% and ranged from 27% for Joaquin to 100% for ‘Ridge Line’ and Traverse. The severity of thrips leaf damage, on a scale from 0 to 10, averaged 2.8 and ranged from 1.2 for ‘Oracle’, Joaquin, SV6672, and DPLD-17-34 to 5.4 for TAS016. Bolting averaged 0.3% and ranged from 0% for many varieties to 2.6% for ‘Dulce Reina’. Iris yellow spot virus severity was low in this trial, with most varieties showing low intensity of symptoms with a rating of 1 (0-25% of foliage diseased). Iris yellow spot virus severity averaged 1 and ranged from 1 for most varieties to 1.8 for 1029.

The percentage of functionally single-centered bulbs averaged 74% and ranged from 17.6% for 10284 to 99.2% for ‘Cometa’ (Table 8).

Marketable yield averaged 997 cwt/acre and ranged from 304 cwt/acre for variety 1029 to 1493 cwt/acre for SV6672 (Table 9). Variety SV6672 had the highest marketable yield followed by Barbaro, Vaquero, ‘Ranchero’, SV6646, and ‘Avalon’. Storage decomposition averaged 4% and ranged from 0.3% for Traverse to 27% for ‘Red Nugent’.

Subjective Quality Evaluation

Subjective bulb quality ratings can be found in Table 12 and explanation of the rating system can be found in Figure 4 and Tables 10 and 11. 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 28% for Cometa to 90% for 1029 (Table 13). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 0.4% and ranged from 0% for many varieties to 2.4% for TAS016. For most varieties, most of the internal

decomposition occurred in bulbs with incomplete scales. In 2018, the percentage of bulbs with internal decomposition was low and had bacteria, *Fusarium proliferatum*, neck rot, and black mold present (Table 14).

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. 2018-31100-06041 and 2018-31200-06041 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.
- Sullivan, D.M., B.D. Brown, C.C. Shock, D.A. Horneck, R.G. Stevens, G.Q. Pelter, and E.B.G. Feibert. 2001. Nutrient Management for Sweet Spanish Onions in the Pacific Northwest. Pacific Northwest Extension Publication PNW 546:1-26.

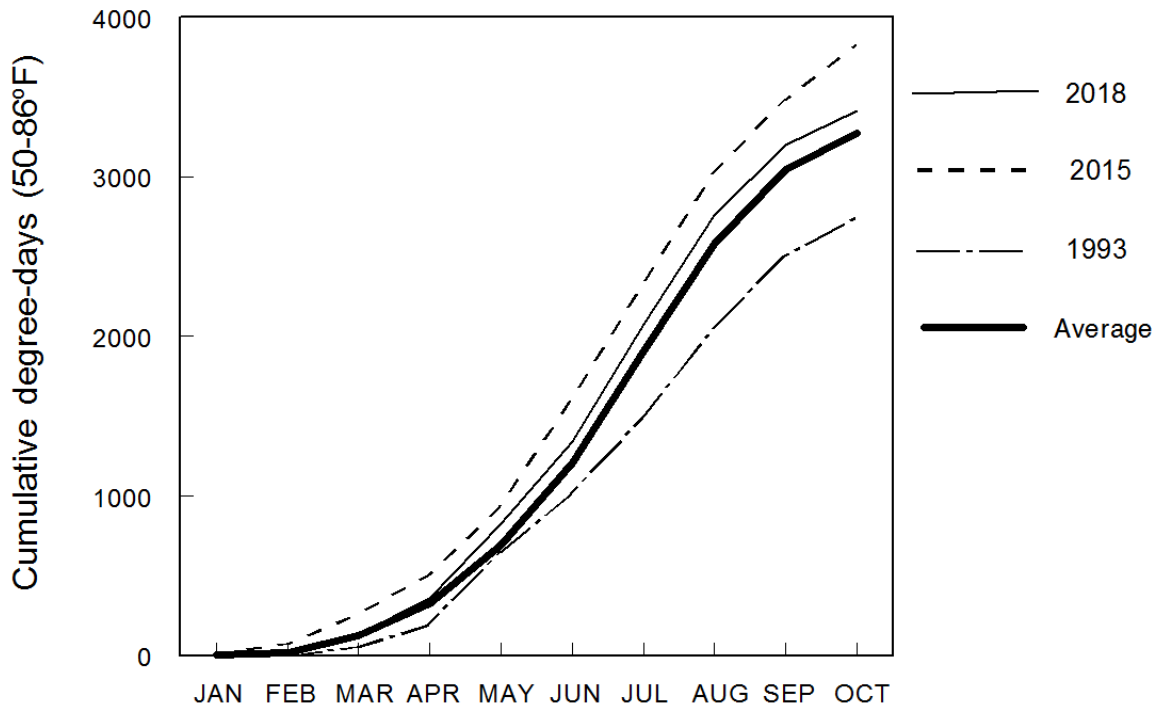


Figure 1. Cumulative growing degree-days (50-86°F) for selected years and 25-year average, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

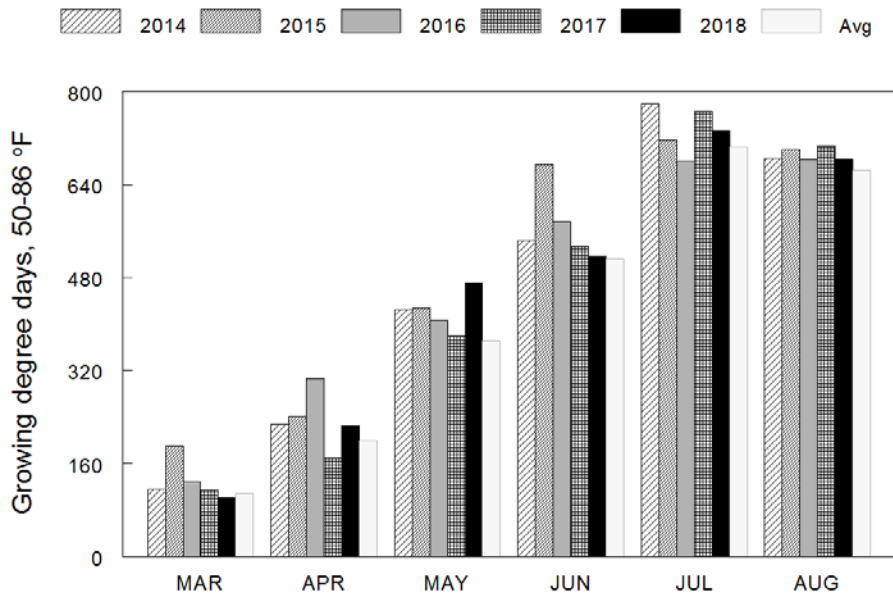


Figure 2. Monthly growing degree-days (50-86°F) for 2014-2018 and 25-year average, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

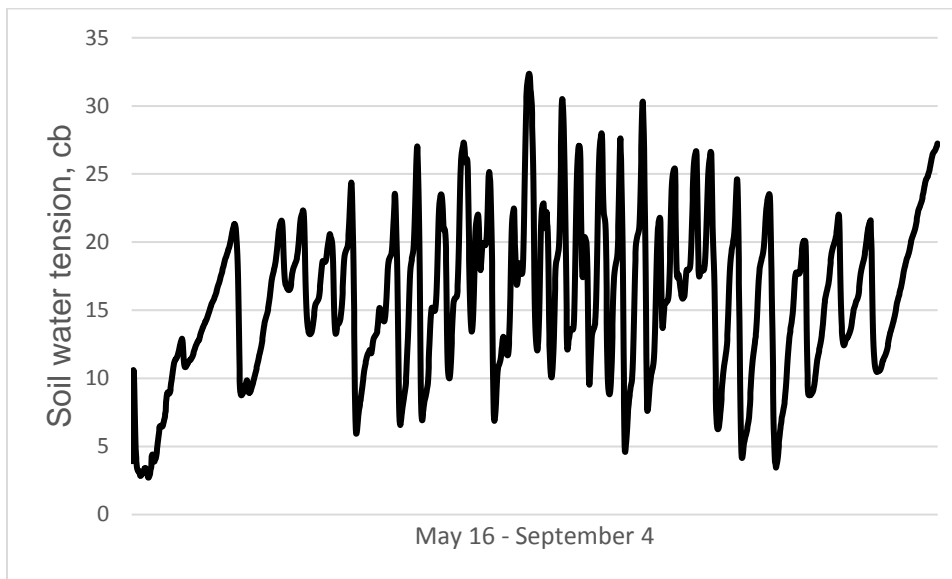


Figure 3. Soil water tension at 8-inch depth below the onion row. Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Table 5. Single- and multiple-center bulb ratings for early-maturing onion varieties lifted and harvested August 8, 2018, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Multiple center			Single center		Maturity Aug. 8		
		large	medium	small	functional*	bullet	tops down	leaf dryness	bolting
----- % -----									
Enza Zaden	10106	8.0	30.4	28.0	61.6	33.6	94.0	22.0	0.0
Sakata	Ovation	12.8	18.4	18.4	68.8	50.4	68.0	19.0	0.2
	Spanish Medallion	4.0	12.0	24.0	84.0	60.0	86.0	18.0	0.2
	Yosemite	29.6	26.4	28.0	44.0	16.0	90.0	21.0	0.0
	Average	13.6	21.8	24.6	64.6	40.0	84.5	20.0	0.1
LSD (0.05)		10.2	12.4	NS	13.3	18.0	9.4	NS	NS

*Functional single-centered bulbs are the small multiple-centered plus the bullet-centered onion.

Table 6. Yield and grade performance of early-maturing onion varieties lifted and harvested August 8, 2018, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade							Split root	Total rot	Black mold	Plate rot	Bulb counts >4¼ in
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	No. 2s					
----- cwt/acre -----														
----- % -----														
Enza Zaden	10106	1176.2	1149.4	308.4	463.4	361.9	15.7	11.6	6.4	1.4	0.6	0.5	0.1	30.9
Sakata	Ovation	1131.6	1115.2	153.6	510.6	438.7	12.3	5.3	0.0	11.1	0.0	0.0	0.0	31.7
	Spanish Medallion	1179.1	1166.1	240.2	490.7	424.5	10.6	12.1	0.0	0.0	0.1	0.0	0.1	31.1
	Yosemite	994.8	966.8	107.4	384.1	457.3	18.0	13.6	1.6	10.0	0.3	0.2	0.1	31.9
	Average	1120.4	1099.4	202.4	462.2	420.6	14.2	10.6	2.0	5.6	0.2	0.2	0.1	31.4
LSD (0.05)		33.9	37.2	75.8	66.3	NS	NS	4.9	NS	NS	NS	NS	NS	NS

Table 7. Maturity, bolting, thrips leaf damage, and iris yellow spot virus symptoms ratings of full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018. Continued on next page.

Seed company	Variety	Bulb color	1-Aug		15-Aug		Bolting	15-Aug	
			Tops down	Leaf dryness	Tops down	Leaf dryness		Thrips leaf damage ^a	IYSV ^b
			----- % -----				0 - 10	0 - 5	
A. Takii	Grand Perfection	Y	26.0	6.0	92.0	16.0	0.1	2.2	1
	Ridge Line	Y	91.0	22.0	100.0	41.0	0.0	4.0	1
	Traverse	Y	89.0	21.0	100.0	50.0	0.0	4.4	1
Bejo	Delgado	Y	26.0	6.0	90.0	17.0	0.0	2.4	1
	Hamilton	Y	18.0	5.0	81.0	14.0	0.2	2.0	1
	Legend	Y	30.0	8.0	91.0	18.0	0.0	2.8	1
	Sedona	Y	23.0	6.0	89.0	13.0	0.7	2.0	1
Crookham	Avalon	Y	48.0	7.0	93.0	16.0	0.3	1.8	1
	Scout	Y	56.0	8.0	90.0	17.0	0.2	2.0	1
	Oracle	Y	13.0	2.0	56.0	12.0	0.5	1.2	1
	OLYX08-640	Y	82.0	12.0	94.0	27.0	0.0	3.6	1
	Red Beret	R	54.0	16.0	92.0	42.0	0.0	4.2	1
	Purple Haze	R	21.0	17.0	84.0	40.0	0.0	5.0	1.2
	White Cloud	W	44.0	8.0	90.0	16.0	0.0	1.8	1
Dorsing	1029	R	23.0	26.0	82.0	66.0	0.0	5.0	1.8
Enza Zaden	10284	Y	30.0	6.0	87.0	13.0	0.7	1.8	1
Hazera	Rhino	Y	43.0	10.0	92.0	17.0	0.0	2.8	1
New Zealand Onion	TAS016	R	35.0	26.0	92.0	52.0	0.0	5.4	1.2
	TAS040	R	62.0	20.0	91.0	43.0	0.0	4.8	1
	TAS042	R	83.0	22.0	97.0	46.0	0.0	4.6	1
	NZRW-001	R	13.3	23.3	86.7	53.3	0.0	4.7	1

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

^bIYSV: 0 = no symptoms, 5 = 100% foliage diseased.

Table 7. (Continued.) Maturity, bolting, thrips leaf damage, and iris yellow spot virus symptoms ratings of full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Seed company	Variety	Bulb color	1-Aug		15-Aug		Bolting	15-Aug	IYSV ^b
			Tops down	Leaf dryness	Tops down	Leaf dryness		Thrips leaf damage ^a	
			----- % -----					0 - 10	0 - 5
Nunhems	Annillo	Y	17.0	7.0	74.0	15.0	0.0	2.2	1
	Arcero	Y	11.0	8.0	70.0	14.0	0.0	2.4	1
	Granero	Y	15.0	5.0	78.0	14.0	0.4	2.2	1
	Ranchero	Y	21.0	5.0	85.0	14.0	0.2	2.2	1
	Joaquin	Y	8.0	2.0	27.0	8.0	0.5	1.2	1
	Montero	Y	68.0	15.0	91.0	26.0	0.0	3.4	1.2
	Oloroso	Y	13.0	3.0	76.0	13.0	0.0	2.4	1
	Pandero	Y	12.0	1.0	67.0	12.0	1.0	1.4	1
	Vaquero	Y	18.0	5.0	80.0	14.0	0.0	2.2	1
	Cometa	W	25.0	3.0	86.0	12.0	2.3	2.2	1
Marengo	R	39.0	24.0	97.0	54.0	0.0	5.0	1	
Sakata	Aruba	Y	47.0	5.0	88.0	14.0	0.7	2.0	1
	Lasso	Y	36.0	6.0	87.0	16.0	0.5	1.8	1
	Dulce Reina	Y	20.0	5.0	70.0	12.0	2.6	2.0	1
	Yukon	Y	34.0	8.0	88.0	16.0	0.1	2.2	1
Seminis	Barbaro	Y	8.0	3.0	48.0	11.0	0.1	1.4	1
	Swale	Y	18.0	3.0	78.0	12.0	0.0	1.4	1
	Tucannon	Y	32.0	6.0	86.0	15.0	0.0	2.2	1
	16000	Y	41.0	7.0	92.0	14.0	0.2	1.6	1
	SV4058	W	17.0	7.0	74.0	15.0	0.0	2.0	1
	SV6646	Y	17.0	4.0	86.0	13.0	0.1	1.8	1
	SV6672	Y	26.0	5.0	88.0	11.0	0.7	1.2	1
	SV4643NT	R	89.0	26.0	99.0	62.0	0.0	5.2	1
	Red Nugent	R	86.0	29.0	98.0	66.0	0.0	4.4	1.2
D. Palmer	Saffron	Y	26.0	10.0	86.0	19.0	0.1	2.2	1
	Diamond Swan	W	14.0	5.0	68.0	14.0	1.2	2.0	1
	Cherry Mountain	R	19.0	15.0	82.0	28.0	0.0	4.4	1.2
	DPLD-17-34	Y	10.0	3.0	38.0	12.0	0.6	1.2	1
	DPLD-17-35	Y	31.0	7.0	91.0	18.0	0.3	2.6	1
	DPS-2056	W	18.0	6.0	78.0	14.0	0.6	2.2	1
	DPS-2075	W	72.0	14.0	92.0	30.0	0.0	3.4	1
	DPR-3088	R	17.0	14.0	80.0	28.0	0.0	4.2	1
Average			34.6	10.3	83.0	23.9	0.3	2.8	1.0
LSD (0.05)			12.7	4.1	8.8	5.8	0.4	0.8	0.2

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

^bIYSV: 0 = no symptoms, 5 = 100% foliage diseased.

Table 8. Single- and multiple-center ratings for full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018. Continued on next page.

Seed company	Variety	Bulb color	Multiple center			Single center	
			large	medium	small	functional ^a	bullet
			----- % -----				
A. Takii	Grand Perfection	Y	11.2	27.2	13.6	61.6	48.0
	Ridge Line	Y	28.6	26.2	17.4	45.2	27.8
	Traverse	Y	7.2	24.8	29.6	68.0	38.4
Bejo	Delgado	Y	30.2	21.9	26.9	47.9	21.0
	Hamilton	Y	9.6	11.2	8.8	79.2	70.4
	Legend	Y	30.6	26.4	25.5	43.0	17.5
	Sedona	Y	16.0	16.8	22.4	67.2	44.8
Crookham	Avalon	Y	12.0	18.4	20.0	69.6	49.6
	Scout	Y	15.5	20.1	17.1	64.4	47.3
	Oracle	Y	0.8	1.6	1.6	97.6	96.0
	OLYX08-640	Y	4.0	3.2	11.2	92.8	81.6
	Red Beret	R	8.0	11.2	13.6	80.8	67.2
	Purple Haze	R	3.2	5.6	12.8	91.2	78.4
	White Cloud	W	28.9	28.3	19.5	42.8	23.3
Dorsing	1029	R	12.0	14.4	19.2	73.6	54.4
Enza Zaden	10284	Y	48.8	33.6	5.6	17.6	12.0
Hazera	Rhino	Y	7.2	6.4	9.6	86.4	76.8
New Zealand Onion	TAS016	R	25.1	17.0	24.1	57.9	33.7
	TAS040	R	22.5	33.1	19.4	44.3	24.9
	TAS042	R	22.6	27.4	25.1	50.0	24.9
	NZRW-001	R	4.0	16.0	13.3	80.0	66.7

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

Table 8. (Continued.) Single- and multiple-center ratings for full-season onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Seed company	Variety	Bulb color	Multiple center			Single center	
			large	medium	small	functional ^a	bullet
			----- % -----				
Nunhems	Annillo	Y	1.6	4.0	4.0	94.4	90.4
	Arcero	Y	0.8	0.8	4.8	98.4	93.6
	Granero	Y	4.0	11.2	10.4	84.8	74.4
	Ranchero	Y	3.2	4.8	12.8	92.0	79.2
	Joaquin	Y	0.8	0.8	1.6	98.4	96.8
	Montero	Y	1.6	4.8	15.2	93.6	78.4
	Oloroso	Y	3.2	3.2	3.2	93.6	90.4
	Pandero	Y	6.4	17.6	12.8	76.0	63.2
	Vaquero	Y	1.6	8.8	11.2	89.6	78.4
	Cometa	W	0.0	0.8	1.6	99.2	97.6
	Marengo	R	4.0	7.2	18.4	88.8	70.4
Sakata	Aruba	Y	0.8	11.2	11.2	88.0	76.8
	Lasso	Y	8.8	16.0	17.6	75.2	57.6
	Dulce Reina	Y	4.8	8.8	9.6	86.4	76.8
	Yukon	Y	15.2	21.6	17.6	63.2	45.6
Seminis	Barbaro	Y	0.8	1.6	6.4	97.6	91.2
	Swale	Y	5.6	9.6	13.6	84.8	71.2
	Tucannon	Y	9.6	7.1	13.5	83.3	69.8
	16000	Y	4.8	4.0	8.0	91.2	83.2
	SV4058	W	6.4	13.6	9.6	80.0	70.4
	SV6646	Y	1.6	1.6	6.4	96.8	90.4
	SV6672	Y	8.0	11.2	5.6	80.8	75.2
	SV4643NT	R	24.5	14.4	7.9	61.2	53.3
	Red Nugent	R	20.8	14.4	6.4	64.8	58.4
D. Palmer	Saffron	Y	22.4	17.6	26.4	60.0	33.6
	Diamond Swan	W	24.0	21.6	20.8	54.4	33.6
	Cherry Mountain	R	12.0	22.4	20.0	65.6	45.6
	DPLD-17-34	Y	23.2	17.6	12.8	59.2	46.4
	DPLD-17-35	Y	22.4	20.0	16.0	57.6	41.6
	DPS-2056	W	7.2	15.2	14.4	77.6	63.2
	DPS-2075	W	49.6	15.2	10.4	35.2	24.8
	DPR-3088	R	15.2	12.0	12.0	72.8	60.8
Average			12.5	13.8	13.6	73.7	60.1
LSD (0.05)			8.6	9.5	7.8	12.3	14.6

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

Table 9. Yield and grade of full-season experimental and commercial onion varieties graded out of storage in January 2019, 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 #/50 lb	Total rot	Neck rot	Plate rot	Black mold	Split basal plate
				Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small							
				cwt/acre												
A. Takii	Grand Perfection	Y	1275	1239	373.1	492.1	358.9	14.7	6.3	7.8	30.5	1.0	0.9	0.1	0.0	0.8
	Ridge Line	Y	856	826	24.7	159.1	609.9	31.8	11.1	7.1	32.3	1.4	1.1	0.3	0.0	0.1
	Traverse	Y	901	887	4.6	108.5	744.3	29.4	11.3	0.0	33.8	0.3	0.1	0.2	0.0	0.0
Bejo	Delgado	Y	1123	1056	137.3	408.2	490.0	20.9	11.8	47.1	30.4	0.6	0.3	0.3	0.0	0.1
	Hamilton	Y	1214	1162	125.5	474.8	542.5	19.7	8.7	37.2	29.6	0.4	0.2	0.2	0.0	0.1
	Legend	Y	1063	1013	47.0	299.4	638.8	27.6	14.2	25.0	29.1	1.0	0.9	0.1	0.0	0.0
	Sedona	Y	1277	1204	175.5	513.7	497.4	17.8	9.9	52.6	30.7	0.8	0.7	0.0	0.0	0.0
Crookham	Avalon	Y	1506	1331	485.6	495.1	334.3	15.5	9.5	3.6	27.9	10.7	9.7	0.1	0.9	0.0
	Scout	Y	1394	1296	443.9	494.2	342.2	15.9	9.8	5.6	28.5	5.8	5.2	0.1	0.5	0.1
	Oracle	Y	1337	1277	394.2	471.7	392.4	18.9	11.2	2.2	30.8	3.4	3.3	0.1	0.0	0.0
	OLYX08-640	Y	921	883	18.1	202.6	629.7	32.7	14.3	3.7	31.4	2.2	1.8	0.3	0.1	0.0
	Red Beret	R	605	525	0.0	16.6	413.7	94.9	26.6	7.1		7.4	7.4	0.0	0.0	0.0
	Purple Haze	R	620	519	0.0	14.1	422.0	82.7	31.0	10.3		9.8	9.6	0.3	0.0	0.0
	White Cloud	W	1260	1094	208.6	422.1	447.3	15.5	8.5	27.1	29.2	9.8	8.6	0.4	0.9	0.6
Dorsing	1029	R	386	304	0.0	4.9	229.0	70.4	33.6	10.0		9.2	6.2	3.0	0.0	0.6
Enza Zaden	10284	Y	1494	1287	497.9	487.6	291.2	10.7	4.2	102.6	28.0	6.2	5.2	0.3	0.7	0.4
Hazera	Rhino	Y	1093	1043	189.4	408.3	417.4	27.9	8.9	9.8	30.9	2.8	2.6	0.2	0.0	0.0
New Zealand Onion	TAS016	R	460	358	0.0	0.0	181.9	176.3	57.3	34.8		1.8	1.4	0.4	0.0	0.3
	TAS040	R	585	477	0.0	30.8	376.1	70.4	36.1	47.0		2.8	2.7	0.1	0.0	1.4
	TAS042	R	676	598	4.9	41.7	488.0	63.8	21.5	35.9	32.7	2.8	2.4	0.4	0.0	0.1
	NZRW-001	R	479	448	0.0	13.2	349.4	85.2	19.1	4.8		1.4	0.7	0.5	0.2	0.2

Table 9. (Continued.) Yield and grade of full-season experimental and commercial onion varieties graded out of storage in January 2019, 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 #/50 lb	Total rot	Neck rot	Plate rot	Black mold	Split basal plate
				Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small							
				----- cwt/acre -----												
Nunhems	Annillo	Y	1254	1240	318.5	520.5	388.3	13.0	6.0	0.0	30.7	0.4	0.4	0.0	0.0	0.2
	Arcero	Y	1278	1257	263.5	548.8	432.2	12.9	10.0	1.7	31.0	0.7	0.5	0.2	0.0	0.0
	Granero	Y	1274	1247	259.8	560.6	410.5	16.2	8.6	1.1	30.8	1.2	1.0	0.1	0.1	0.1
	Ranchero	Y	1386	1347	466.2	505.3	353.0	22.5	12.1	8.7	28.9	1.3	1.3	0.0	0.0	0.0
	Joaquin	Y	1384	1300	379.6	548.9	355.2	16.7	9.2	6.6	30.0	5.0	4.9	0.1	0.0	0.2
	Montero	Y	1113	1096	174.3	404.1	503.1	14.9	9.7	1.4	31.4	0.4	0.3	0.1	0.0	0.1
	Oloroso	Y	1160	1131	104.2	487.6	519.1	19.7	8.8	6.0	32.9	1.1	1.0	0.0	0.2	0.1
	Pandero	Y	1287	1261	289.9	497.4	457.0	17.0	10.2	8.5	29.8	0.4	0.3	0.1	0.0	0.1
	Vaquero	Y	1382	1361	482.7	536.2	326.0	15.7	7.6	0.0	29.0	0.9	0.8	0.0	0.1	0.0
	Cometa	W	1207	1138	204.4	452.7	462.6	17.9	5.9	1.7	30.4	5.1	4.6	0.3	0.2	0.0
	Marengo	R	607	522	1.7	15.8	441.0	63.7	26.2	14.9	30.1	6.4	4.1	2.2	0.0	0.8
Sakata	Aruba	Y	1210	1166	297.2	437.0	411.6	19.9	8.9	6.2	30.0	2.4	2.0	0.4	0.0	0.0
	Lasso	Y	1202	1158	280.8	471.6	389.6	16.0	5.9	20.0	30.5	1.5	1.2	0.3	0.1	0.0
	Dulce Reina	Y	1329	1267	429.8	484.4	332.0	20.7	9.5	5.7	31.2	3.5	3.4	0.0	0.1	0.0
	Yukon	Y	1327	1271	354.8	502.6	392.0	21.4	10.4	24.2	29.3	1.5	0.6	0.5	0.4	0.1
Seminis	Barbaro	Y	1441	1369	599.2	469.0	287.9	13.2	11.4	4.2	28.9	3.3	3.0	0.3	0.0	0.5
	Swale	Y	1319	1273	263.4	513.3	483.0	12.9	7.3	10.9	30.7	1.0	0.9	0.1	0.0	1.1
	Tucannon	Y	1153	1119	216.8	412.8	463.0	26.8	11.7	10.7	30.3	0.9	0.8	0.1	0.0	0.0
	16000	Y	1274	1234	350.2	481.0	386.5	15.8	10.0	8.8	28.9	1.7	1.5	0.1	0.1	0.0
	SV4058	W	1213	1116	269.7	428.3	405.9	11.8	11.0	9.3	29.5	6.3	5.5	0.8	0.0	0.1
	SV6646	Y	1372	1337	427.9	544.3	352.1	12.7	7.5	7.9	29.6	1.4	1.3	0.1	0.0	0.1
	SV6672	Y	1531	1493	625.4	552.9	308.2	6.1	6.8	9.2	26.9	1.3	1.1	0.1	0.1	0.2
	SV4643NT	R	624	490	1.6	37.3	383.1	67.9	25.1	37.7	31.6	11.3	10.1	1.2	0.0	0.0
		Red Nugent	R	643	412	0.0	26.4	321.3	64.7	28.5	32.4		27.3	26.7	0.6	0.0
D. Palmer	Saffron	Y	896	803	26.0	167.7	554.4	54.5	19.3	62.8	31.4	1.1	1.1	0.0	0.0	0.0
	Diamond Swan	W	1124	953	114.2	328.3	485.0	26.0	11.3	95.5	29.8	5.1	4.3	0.5	0.3	0.5
	Cherry Mountain	R	559	432	0.0	22.5	340.6	68.9	24.6	63.1		6.6	5.5	1.1	0.0	0.4
	DPLD-17-34	Y	1311	1230	317.8	496.3	397.8	18.2	10.1	63.6	29.8	0.5	0.4	0.1	0.0	0.1
	DPLD-17-35	Y	1118	1037	140.1	389.6	485.4	22.0	7.9	55.3	30.0	1.5	0.9	0.2	0.3	0.1
	DPS-2056	W	1115	981	207.5	350.9	397.7	24.8	11.0	44.8	29.4	7.1	7.0	0.1	0.0	0.0
	DPS-2075	W	772	519	51.1	119.3	306.1	42.7	17.5	148.6	28.1	11.0	11.0	0.0	0.0	0.1
		DPR-3088	R	566	463	3.0	43.0	353.1	63.8	25.5	44.8	35.6	5.6	4.2	1.4	0.0
Average			1075	997	208.5	338.0	416.6	34.0	14.3	24.5	30.3	3.9	3.5	0.3	0.1	0.2
LSD (0.05)			69	81	71.7	64.6	79.1	13.4	7.3	18.7	1.9	4.3	4.3	1.0	0.4	0.3

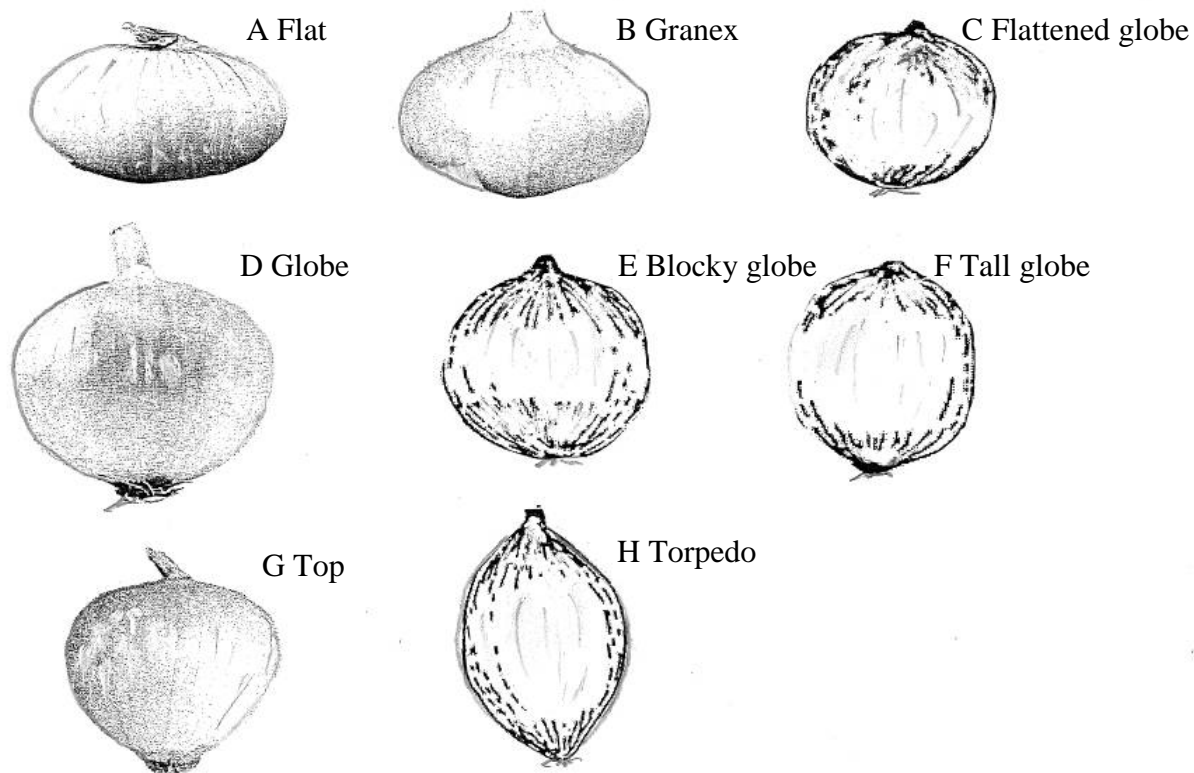


Figure 4. Onion bulb shape rating system (see Table 10). Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 10. Bulb shapes. For a 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 11. 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 12. Subjective evaluations of onion appearance and firmness by variety on January 15, 2019, 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	d	3.3	3.5	3.0	3.5	4.0
	Ridge Line	Y	d	3.0	3.5	3.0	2.0	4.5
	Traverse	Y	e	3.0	4.0	3.3	3.0	4.0
Bejo	Delgado	Y	d	3.5	4.0	3.8	3.5	3.8
	Hamilton	Y	d	3.5	3.5	4.8	4.8	4.0
	Legend	Y	d	4.0	3.5	4.3	4.5	4.0
	Sedona	Y	d	3.5	3.5	3.5	4.0	3.3
Crookham	Avalon	Y	d	2.0	2.5	2.3	2.5	4.8
	Scout	Y	e	2.3	2.8	3.5	3.0	4.3
	Oracle	Y	f	2.8	3.5	3.0	3.5	4.3
	OLYX08-640	Y	d	3.8	3.0	4.0	4.0	3.0
	Red Beret	R	d	3.0	2.3	2.8	3.0	3.8
	Purple Haze	R	f	3.3	2.3	3.0	3.0	2.5
	White Cloud	W	d	2.5	3.5	3.0	3.0	4.0
Dorsing	1029	R	c	3.0	2.5	2.8	3.0	2.0
Enza Zaden	10284	Y	c	2.0	3.0	2.0	2.5	3.8
Hazera	Rhino	Y	e	3.3	4.0	3.5	3.5	3.5
New Zealand Onion	TAS016	R	c	3.0	3.0	3.0	3.0	3.3
	TAS040	R	d	3.3	3.0	3.0	2.0	3.0
	TAS042	R	c	2.5	3.0	2.8	2.0	3.5
	NZRW-001	R	g	3.0	3.0	3.5	4.0	3.8
Nunhems	Annillo	Y	e	3.5	4.0	4.0	4.0	4.0
	Arcero	Y	d	3.5	4.0	4.0	3.8	4.5
	Granero	Y	d	3.5	3.5	4.0	4.0	3.0
	Ranchero	Y	e	2.8	4.0	3.5	4.0	3.5
	Joaquin	Y	f	3.0	4.0	4.0	4.0	4.0
	Montero	Y	d	2.8	3.5	3.0	3.8	5.0
	Oloroso	Y	d	4.0	4.0	4.0	5.0	3.8
	Pandero	Y	d	3.5	2.8	3.3	4.0	3.5
	Vaquero	Y	d	3.0	3.3	3.8	4.0	3.8
	Cometa	W	d	3.5	4.0	3.0	4.0	4.5
Marengo	R	e	4.0	3.8	3.0	3.0	3.3	
Sakata	Aruba	Y	d	2.3	3.5	3.5	3.0	4.8
	Lasso	Y	e	2.3	3.3	3.0	3.0	3.8
	Dulce Reina	Y	d	2.5	3.5	3.0	3.0	5.0
	Yukon	Y	d	2.0	3.0	3.0	3.0	3.5
Seminis	Barbaro	Y	f	3.0	3.5	3.5	3.3	4.5
	Swale	Y	d	3.5	4.0	3.3	4.5	3.3
	Tucannon	Y	d	3.8	3.0	3.8	4.0	3.5
	16000	Y	d	3.0	3.0	3.0	3.5	4.3
	SV4058	W	d	3.0	3.5	3.0	3.0	4.3
	SV6646	Y	d	3.0	3.5	3.0	3.0	4.3
	SV6672	Y	d	3.0	3.0	3.3	3.0	4.0
	SV4643NT	R	g	2.8	3.5	2.3	2.8	3.0
	Red Nugent	R	g	2.8	2.8	2.5	3.3	3.5
D. Palmer	Saffron	Y	d	4.0	2.8	3.8	4.5	3.3
	Diamond Swan	W	d	3.0	3.0	3.0	3.0	3.5
	Cherry Mountain	R	d	4.3	2.5	3.0	4.0	1.5
	DPLD-17-34	Y	e	3.0	3.0	3.3	4.0	3.5
	DPLD-17-35	Y	d	3.0	2.5	3.8	2.5	3.3
	DPS-2056	W	d	2.8	2.5	3.0	3.0	4.5
	DPS-2075	W	d	2.3	2.0	2.8	2.5	3.0
	DPR-3088	R	f	4.0	3.0	3.0	4.0	3.0
	Average			d	3.1	3.2	3.3	3.4
LSD (0.05)			1.5	0.7	NS	0.6	1.0	0.9

^aBulb shape: see Fig. 4. ^bSubjective ratings are described in Table 12.

Table 13. Internal defects of full-season experimental and commercial onion varieties evaluated out of storage in January 2019, 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	60.0	3.3	63.3	26.9	9.8	36.7	100	0.0	0.0	0.0	0.0	0.8	0.8	0.8
	Ridge Line	Y	13.6	0.0	13.6	41.6	44.8	86.4	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Traverse	Y	15.2	0.0	15.2	38.0	46.8	84.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bejo	Delgado	Y	62.1	1.2	63.3	24.7	12.0	36.7	100	0.4	0.4	0.8	0.4	0.0	0.4	1.2
	Hamilton	Y	49.0	5.2	54.1	27.1	18.7	45.9	100	0.0	0.0	0.0	0.8	0.0	0.8	0.8
	Legend	Y	48.4	12.0	60.4	17.2	22.4	39.6	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sedona	Y	41.3	4.8	46.2	34.9	18.9	53.8	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
Crookham	Avalon	Y	55.3	0.5	55.8	26.3	17.9	44.2	100	0.0	0.0	0.0	0.6	0.6	1.2	1.2
	Scout	Y	38.2	0.0	38.2	34.8	27.0	61.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Oracle	Y	61.7	1.2	62.9	21.1	16.0	37.1	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	OLYX08-640	Y	32.0	0.4	32.4	39.6	28.0	67.6	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Red Beret	R	25.2	1.6	26.8	14.4	58.8	73.2	100	0.4	0.0	0.4	0.0	0.0	0.0	0.4
	Purple Haze	R	13.1	0.0	13.1	26.7	60.1	86.9	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	White Cloud	W	59.6	0.4	60.0	25.6	14.4	40.0	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
Dorsing	1029	R	8.4	2.0	10.4	8.5	81.1	89.6	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Enza Zaden	10284	Y	44.4	0.8	45.2	33.7	21.1	54.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazera	Rhino	Y	29.6	2.8	32.4	26.4	41.2	67.6	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New Zealand Onion	TAS016	R	35.6	0.0	35.6	42.8	21.6	64.4	100	0.0	0.0	0.0	1.2	1.2	2.4	2.4
	TAS040	R	27.5	0.0	27.5	31.5	41.0	72.5	100	0.4	0.0	0.4	0.0	1.2	1.2	1.6
	TAS042	R	14.4	0.0	14.4	30.8	54.8	85.6	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	NZRW-001	R	11.7	7.9	19.6	12.4	67.9	80.4	100	0.0	0.0	0.0	0.0	1.3	1.3	1.3

Table 13. (Continued.) Internal defects of full-season experimental and commercial onion varieties evaluated out of storage in January 2019, 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	20.8	0.0	20.8	34.0	45.2	79.2	100	0.4	0.0	0.4	0.4	0.0	0.4	0.8
	Arcero	Y	51.2	6.0	57.2	20.8	22.0	42.8	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	Granero	Y	44.8	1.6	46.4	35.6	18.0	53.6	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Ranchero	Y	57.8	0.8	58.6	15.2	26.1	41.4	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Joaquin	Y	54.8	0.0	54.8	21.2	24.0	45.2	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	Montero	Y	22.4	4.8	27.2	22.8	50.0	72.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Oloroso	Y	33.8	4.8	38.6	30.6	30.8	61.4	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Pandero	Y	57.2	6.8	64.0	17.2	18.8	36.0	100	0.0	0.0	0.0	0.4	0.4	0.8	0.8
	Vaquero	Y	42.5	11.7	54.2	23.2	22.6	45.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cometa	W	70.8	1.6	72.4	11.6	16.0	27.6	100	0.0	0.0	0.0	0.4	0.4	0.8	0.8
Marengo	R	17.6	0.8	18.4	33.6	48.0	81.6	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sakata	Aruba	Y	44.9	4.9	49.8	29.6	20.7	50.2	100	0.0	0.0	0.0	0.8	0.0	0.8	0.8
	Lasso	Y	65.8	4.0	69.8	22.9	7.3	30.2	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dulce Reina	Y	66.7	2.5	69.2	17.2	13.6	30.8	100	0.0	0.0	0.0	0.8	0.0	0.8	0.8
	Yukon	Y	58.2	2.9	61.1	22.1	16.8	38.9	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Seminis	Barbaro	Y	61.8	2.6	64.4	22.8	12.8	35.6	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Swale	Y	61.6	1.6	63.2	22.0	14.8	36.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tucannon	Y	52.0	0.8	52.8	25.6	21.6	47.2	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	16000	Y	43.3	0.4	43.7	28.7	27.7	56.3	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SV4058	W	65.4	0.8	66.2	26.1	7.7	33.8	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	SV6646	Y	62.3	0.0	62.3	23.2	14.4	37.7	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	SV6672	Y	52.6	0.0	52.6	35.9	11.5	47.4	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SV4643NT	R	27.7	3.4	31.1	29.2	39.7	68.9	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	Red Nugent	R	12.8	0.4	13.2	33.6	53.2	86.8	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	D. Palmer	Saffron	Y	46.4	2.8	49.2	32.0	18.8	50.8	100	0.0	0.0	0.0	0.0	0.4	0.4
Diamond Swan		W	50.9	0.8	51.7	38.0	10.3	48.3	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
Cherry Mountain		R	22.8	2.0	24.8	21.6	53.6	75.2	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DPLD-17-34		Y	56.4	5.5	61.9	19.7	18.4	38.1	100	0.0	0.0	0.0	0.8	1.3	2.1	2.1
DPLD-17-35		Y	40.1	2.4	42.6	27.4	30.0	57.4	100	0.0	0.0	0.0	0.4	0.4	0.8	0.8
DPS-2056		W	66.4	0.8	67.2	17.6	15.2	32.8	100	0.0	0.0	0.0	0.0	0.4	0.4	0.4
DPS-2075		W	28.0	0.4	28.4	56.8	14.8	71.6	100	0.0	0.4	0.4	0.8	0.0	0.8	1.2
DPR-3088		R	25.6	4.4	29.9	20.4	49.7	70.1	100	0.4	0.0	0.4	0.0	0.0	0.0	0.4
average			42.1	2.4	44.5	26.9	28.7	55.5	100	0.0	0.0	0.1	0.2	0.2	0.4	0.4
LSD (0.05)		15.6	5.9	16.3	14.6	16.7	16.3		NS	NS	NS	NS	NS	NS	1.3	

Table 14. Internal decomposition by disease type of full-season experimental and commercial onion varieties evaluated out of storage in January 2019, 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	0.4	0.0
	Ridge Line	Y	0.0	0.0	0.0	0.0
	Traverse	Y	0.0	0.0	0.0	0.0
Bejo	Delgado	Y	0.0	0.8	0.4	0.0
	Hamilton	Y	0.0	0.4	0.4	0.0
	Legend	Y	0.0	0.0	0.0	0.0
	Sedona	Y	0.0	0.0	0.4	0.0
Crookham	Avalon	Y	1.1	0.0	0.0	0.0
	Scout	Y	0.0	0.0	0.0	0.0
	Oracle	Y	0.0	0.0	0.0	0.0
	OLYX08-640	Y	0.0	0.0	0.0	0.0
	Red Beret	R	0.4	0.0	0.0	0.0
	Purple Haze	R	0.0	0.0	0.0	0.4
	White Cloud	W	0.0	0.0	0.0	0.4
Dorsing	1029	R	0.0	0.0	0.0	0.0
Enza Zaden	10284	Y	0.0	0.0	0.0	0.0
Hazera	Rhino	Y	0.0	0.0	0.0	0.0
New Zealand Onion	TAS016	R	0.0	0.0	0.0	2.4
	TAS040	R	0.4	0.0	0.0	1.2
	TAS042	R	0.4	0.0	0.0	0.0
	NZRW-001	R	0.0	0.0	0.0	1.3

Table 14. (Continued.) Internal decomposition by disease type of full-season experimental and commercial onion varieties evaluated out of storage in January 2019, 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	0.0	0.0	0.4	0.4
	Arcero	Y	0.0	0.0	0.4	0.0
	Granero	Y	0.0	0.0	0.0	0.0
	Ranchero	Y	0.0	0.0	0.0	0.0
	Joaquin	Y	0.0	0.0	0.0	0.4
	Montero	Y	0.0	0.0	0.0	0.0
	Oloroso	Y	0.0	0.0	0.0	0.0
	Pandero	Y	0.0	0.4	0.4	0.0
	Vaquero	Y	0.0	0.0	0.0	0.0
	Cometa	W	0.4	0.0	0.4	0.0
Marengo	R	0.0	0.0	0.0	0.0	
Sakata	Aruba	Y	0.8	0.0	0.0	0.0
	Lasso	Y	0.0	0.0	0.0	0.0
	Dulce Reina	Y	0.0	0.0	0.8	0.0
	Yukon	Y	0.0	0.0	0.0	0.0
Seminis	Barbaro	Y	0.0	0.0	0.0	0.0
	Swale	Y	0.0	0.0	0.0	0.0
	Tucannon	Y	0.4	0.0	0.0	0.0
	16000	Y	0.0	0.0	0.0	0.0
	SV4058	W	0.4	0.0	0.0	0.0
	SV6646	Y	0.0	0.0	0.4	0.0
	SV6672	Y	0.0	0.0	0.0	0.0
	SV4643NT	R	0.0	0.0	0.0	0.4
	Red Nugent	R	0.0	0.0	0.0	0.0
D. Palmer	Saffron	Y	0.0	0.0	0.0	0.4
	Diamond Swan	W	0.0	0.4	0.0	0.0
	Cherry Mountain	R	0.0	0.0	0.0	0.0
	DPLD-17-34	Y	1.2	0.4	0.4	0.0
	DPLD-17-35	Y	0.8	0.0	0.0	0.0
	DPS-2056	W	0.0	0.0	0.0	0.4
	DPS-2075	W	0.0	0.4	0.4	0.4
	DPR-3088	R	0.0	0.0	0.4	0.0
	average			0.1	0.1	0.1
LSD (0.05)			NS	NS	NS	0.7