

2020 ONION VARIETY TRIALS

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Introduction

Direct-seeded yellow, white, and red long-day onion varieties were evaluated in the field in 2020 for plant disease, thrips damage, maturity, bolting, and bulb single centers. Out of storage, the varieties were evaluated for yield, grade, and bulb decomposition. Ten early-season varieties were planted in March and harvested and graded in mid-August. Forty-three full-season varieties (29 yellow, 8 red, and 6 white) were planted in March, harvested in September, and graded out of storage in January 2021. Each year, growers and seed industry representatives have the opportunity to examine the varieties at our annual Onion Variety 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 (IYSV), bulb shape, bulb shape uniformity, flesh brightness, and skin color and retention.

Materials and Methods

Onions were grown in 2020 on a Greenleaf silt loam previously planted to wheat. After the wheat was harvested in 2019, the stubble was shredded and the field was irrigated to sprout unharvested wheat kernels and then the field was disked. A soil analysis taken in the fall of 2019 showed a pH of 8.2, 3.9% organic matter, 4 ppm nitrogen (N) as nitrate, 3 ppm N as ammonium, 33 ppm phosphorus (P), 887 ppm potassium (K), 40 ppm sulfur (S), 4557 ppm calcium, 424 ppm magnesium, 225 ppm sodium, 5.6 ppm zinc (Zn), 2 ppm manganese (Mn), 1.8 ppm copper (Cu), 8 ppm iron, and 0.2 ppm boron (B). Based on the soil analysis, 100 lb N/acre, 44 lb P/acre, 200 lb S/acre, 9 lb Mn/acre, and 2 lb B/acre were broadcast before plowing. In addition to the chemical fertilizer, 10 tons/acre of composted cattle feedlot manure were broadcast before plowing. After plowing and groundhogging, the field was fumigated with Vapam[®] at 15 gal/acre and bedded at 22 inches.

The varieties were planted in three adjacent trials based on bulb color (yellow, white, red). The experimental designs for each full-season trial and the early-maturing trial 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. All trials were planted on March 20 in plots 4 double rows wide and 27 ft long. The early-maturing trial had 10 varieties from 5 seed companies, the full-season yellow trial had 29 varieties from 8 seed companies, the full-season white trial had 6 varieties from 4 seed companies, and the full-season red trial had 8 varieties from 5 seed companies.

Seed was planted in double rows spaced 3 inches apart at 9 seeds/ft of single row. Two double rows were planted on beds spaced 22 inches apart on 44-inch beds. 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 (0.82 lb ai/acre)

over the seed rows for onion maggot control and the soil surface was cultipacked. Onion emergence started on April 11. On May 13, alleys 4 ft wide were cut between plots, leaving plots 23 ft long. The seedlings were hand thinned on May 15 and 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 double rows 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: glyphosate at 0.77 lb ai/acre (Roundup Power Max at 22 oz/acre) on April 8, sethoxydim at 0.28 lb ai/acre (Poast at 24 oz/acre) on May 8, 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 pendimethalin at 0.95 lb ai/acre (Prowl[®] H₂O at 2 pt/acre) on May 11, sethoxydim at 31 oz/acre, oxyfluorfen at 8 oz/acre, and bromoxynil at 24 oz/acre on June 10, and pendimethalin at 1 pint/acre on June 5.

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 on May 29 and June 5; cyantraniliprole at 0.13 lb ai/acre (Exirel at 20 oz/acre) on June 18 and June 26, spinetoram at 0.078 lb ai/acre (Radiant[®] at 8 oz/acre) on July 3 and July 14; and abamectin at 0.019 lb ai/acre (Agri-Mek[®] SC at 3.5 oz/acre) on July 22.

For fungal disease control, Luna Tranquility at 27 oz/acre (fluopyram, pyrimethanil) was applied by ground on June 26.

Starting on May 27, weekly root tissue and soil samples were taken from field borders (variety ‘Vaquero’) and analyzed for nutrients by Western Laboratories, Inc., Parma, Idaho (Tables 1 and 2). Root tissue was analyzed for nutrient concentration and soil samples were analyzed for concentrations of nutrients in the soil solution. Nutrients were applied only if both the root tissue and soil solution concentrations were simultaneously below the critical levels. (Table 3). Urea ammonium nitrate solution (URAN) was applied through the drip tape seven times from May 29 to June 19, supplying a total of 116 lb N/acre.

Table 1. Onion root tissue nutrient content in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Nutrient		27-May	3-Jun	10-Jun	18-Jun	24-Jun	6-Jul	9-Jul	15-Jul	22-Jul	3-Aug	10-Aug
NO ₃ -N (ppm)	Sufficiency range	8500	7667	6833	6000	5168	4338	3508	2678	1834	1000	1000
NO ₃ -N (ppm)		3788	4456	4515	5268	4406	5277	4504	3760	2847	2427	1909
P (%)	0.32 - 0.7	0.41	0.43	0.5	0.75	0.63	0.68	0.35	0.51	0.33	0.35	0.4
K (%)	2.7 - 6.0	2.96	3.16	3.87	4.34	4.29	5.13	4.81	4.6	3.83	3.72	3.69
S (%)	0.24 - 0.85	0.53	0.61	0.74	1.1	0.99	1.07	0.7	1.04	0.65	0.88	0.86
Ca (%)	0.4 - 1.2	0.39	0.35	0.44	0.52	0.64	0.78	0.66	0.72	0.63	0.72	0.88
Mg (%)	0.3 - 0.6	0.53	0.46	0.43	0.4	0.33	0.38	0.43	0.44	0.47	0.4	0.4
Zn (ppm)	25 - 50	59	44	52	60	48	56	54	46	43	32	37
Mn (ppm)	35 - 100	169	161	182	187	163	196	241	202	164	141	175
Cu (ppm)	6-20	14	10	12	10	8	7	9	7	8	8	10
B (ppm)	19 - 60	23	18	22	23	19	24	17	19	22	18	20

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, 2020.

Nutrient	Critical level	27-May	3-Jun	10-Jun	18-Jun	24-Jun	6-Jul	9-Jul	15-Jul	22-Jul	3-Aug	10-Aug
N	Critical levels	4	4	4	4	4	4	3.8	2.8	2	1.5	0.5
N		2	2.6	3.4	3.1	15.1	13.4	11.7	8.9	7.1	6	4.9
P	0.7 lb/acre	1.4	1.4	1	1.3	0.8	0.7	0.5	0.6	0.6	0.7	0.8
K	5 lb/acre	9	9.1	8.9	8.3	7.7	7.4	5.8	6	4.9	5.3	6.3
S	1 lb/acre	8.8	8.3	11.5	11	12.9	9.1	10.6	13.8	9.6	7.9	10.2
Ca	3 lb/acre	5.9	5.4	5.8	5.8	6.7	5.6	5.7	6.2	4.7	5.1	5.2
Mg	2 lb/acre	1.3	1.2	1.5	1.4	1.6	1.3	1.6	1.6	1.2	1.1	1.3
Zn	28 g/acre	348	315	291	327	288	264	321	294	267	288	261
Mn	28 g/acre	12	15	18	15	12	15	12	9	9	12	12
Cu	12 g/acre	78	81	81	75	63	69	66	66	54	54	60
B	21 g/acre	23	20	23	24	26	23	17	21	18	23	23

Table 3. Nutrients applied through the drip irrigation system in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Date	N, lb/ac
29-May	40
4-Jun	24
12-Jun	26
19-Jun	26
total	116

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 sensor model 200SS, Irrrometer Co. Inc., Riverside, CA) installed at 8-inch depth in the center of the double rows of onions. Sensors had been calibrated to SWT (Shock et al. 1998). The GMS were connected to the datalogger via multiplexers (AM16/32, Campbell Scientific, Logan, UT). The datalogger (CR1000, Campbell Scientific) read the sensors and recorded the SWT every hour. The datalogger automatically made irrigation decisions every 12 hours. The field was irrigated if the average 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 April 22 and irrigations ended on September 3.

Onions in the early-maturing trial were evaluated for maturity, severity of symptoms of IYSV, and bolting on August 3 and August 13. Onions in the full-season trial were evaluated for maturity on August 3, August 17, and September 1. On August 17, 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 percent dry leaves. For the IYSV evaluations, onions in each plot were given a subjective rating on a scale of 0 to 5 for severity of IYSV symptoms. The rating was 0 if there were no symptoms, 1 if 1 to 25% of foliage was diseased, 2 if 26 to 50% of foliage was diseased, 3 if 51 to 75% of foliage was diseased, 4 if 76 to 99% of foliage was diseased, and 5 if 100% of foliage was diseased. For thrips leaf-feeding damage, each plot was given a subjective severity rating on a scale of 0 to 10. 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 of ‘Red Angel’, ‘Elsye’, and ‘Redstone’ in the early-maturity trial were topped by hand, bagged, and graded on August 10. Onions from the middle two double rows in each plot of the remaining varieties in the early-maturity trial were topped by hand, bagged, and graded on August 17. 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 onion varieties matured before the yellow and white varieties. All red varieties were harvested on August 25, except ‘Cherry Mountain’. Cherry Mountain matured later and was harvested on August 31. At harvest, onions from the middle two rows in each plot of the red onion varieties were topped and bagged to cure in the field for a week, after which they were put in storage. The remaining yellow and white onions were lifted on September 11 to field cure. Onions from the middle two rows in each plot of the yellow and white varieties were topped by hand and bagged on September 19. The bags of white and yellow varieties were moved into storage on September 30. 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 in early January 2021.

After harvest, bulbs from one of the border rows in each plot of 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 external 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 super colossal (>4¼ inches). Bulb counts per 50 lb of super colossal onions were determined for each plot of every variety by weighing and counting all super colossal bulbs during grading. Marketable yield consisted of No.1 bulbs larger than 2¼ inches.

After grading, 50 No. 1 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. During the evaluation for internal defects in 2020, black sclerotia of white mold (*Sclerotinia sclerotiorum*) was observed on the surface of white varieties. The number of bulbs with white mold sclerotia was also evaluated.

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 2020 were close to the 26-year average (Figure 1). Precipitation in June was substantially higher (2.1 inches) than the 77-year average (0.8 inches). The automated irrigation system maintained the soil water tension at 8-inch depth close to the target of 20 cb, except on July 14, when irrigations were stopped to allow ground insecticide spraying (Figure 2). In 2020, the soil solution N went above the critical level in late June and the root nitrate level went above the critical level in early July. The total available soil N went above the critical level of 59 lb N/acre (Sullivan et al., 2001) also in late June, which has occurred most years (Table 4). Marginal Boron deficiencies occurred

during the season, but corrective measures were not attempted. A soil sample taken on July 8, showed very high levels of pink root (120 cfu).

Early-maturing Trial

Varieties ‘Red Angel’, ‘Elsye’, and ‘Redstone’ were harvested and graded on August 10. The other varieties were harvested and graded on August 17. On August 13, all varieties had at least 50% tops down, except ‘White Cloud’ (18% tops down) (Table 5). After 2 weeks of storage, bulb sprouting or decomposition was low, averaging 1.2%. All decomposition was external, except for ‘Scout’, which had 2.7% internal decomposition, possibly of bacterial origin. The percentage of onions that were functionally single centered averaged 43% and ranged from 11% for ‘Yosemite’ to 71% for ‘Avalon’ (Table 6). Total yield averaged 981 cwt/acre, ranging from 606 cwt/acre for Redstone to 1172 cwt/acre for Scout (Table 7).

Full-season Trials

Yellow varieties. On August 3, the percentage of tops down averaged 16% and ranged from 4% for ‘Sedona’, ‘Caliber’, and ‘Oloroso’ to 88% for ‘Traverse’ (Table 8). By August 17, the percentage of tops down averaged 65% and ranged from 18% for ‘Joaquin’ to 98% for Traverse. Onions were lifted on September 11 and harvested on September 19.

The severity of thrips leaf damage, on a scale from 0 to 10, averaged 3 and ranged from 1.4 for Joaquin to 4.6 for ‘Mondella’. Bolting averaged 1% and ranged from 0% for several varieties to 5% for Joaquin. Iris Yellow Spot Virus severity was low in this trial, with all varieties showing low intensity of symptoms with a rating of 1 (0–25% of foliage diseased).

The percentage of functionally single-centered bulbs averaged 75% and ranged from 22% for DPLD-14775 to 98% for ‘Anillo’ and Joaquin (Table 9).

Marketable yield out of storage in January 2021, averaged 928 cwt/acre and ranged from 290 cwt/acre for DPLD-14775 to 1,177 cwt/acre for ‘SV6672’ (Table 12). Number 2 bulbs (doubles) averaged 36 cwt/acre and ranged from 0 cwt/acre for Oloroso to 289 cwt/acre for DPLD-14775. Storage decomposition averaged 5.4% and ranged from 2% for ‘Arcero’ to 12% for ‘Caldwell’.

In December 2020, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 22% and ranged from 3.2% for ‘Jawbridge’ to 54% for ‘37-120’ (Table 11). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 1.5% and ranged from 0% for Oloroso to 3.6% for ‘37-118’ and Vaquero. In 2020, the percentage of bulbs with internal decomposition was low and was mainly caused by bacterial rot and neck rot (Table 12).

White varieties. The percentage of tops down averaged 6% on August 1, 56% on August 17, and 90% on September 1 (Table 13). Onions were lifted on September 11 and harvested on September 19.

The severity of thrips leaf damage, on a scale from 0 to 10, averaged 2.3 and ranged from 2 for ‘37-127’ to 2.8 for ‘Diamond Swan’. Bolting averaged 4.3% and ranged from 0.3% for ‘Rhea’ to 11% for ‘Cometa’. Iris Yellow Spot Virus severity was low in this trial, with all varieties showing low intensity of symptoms, with a rating of 1 (0–25% of foliage diseased).

The percentage of functionally single-centered bulbs averaged 88% and ranged from 63% for Diamond Swan to 98% for Cometa (Table 14).

Marketable yield in January 2021 averaged 701 cwt/acre and ranged from 310 cwt/acre for 37-127 to 849 cwt/acre for Cometa (Table 15). Storage decomposition averaged 37% and ranged from 25% for ‘Brundage’ to 73% for 37-127. There was no significant difference between varieties in the percentage of bulbs with white mold sclerotia on the bulb surface.

In December 2021, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 9% and ranged from 2.4% for Brundage to 16% for Rhea (Table 16). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 1.3%. In 2020, the internal decomposition was caused by bacterial rot and neck rot (Table 17).

Red varieties. On August 3, the percentage of tops down averaged 22% and ranged from 5% for ‘RW020’ and ‘Redwing’ to 72% for ‘TAS042’ (Table 18). On August 17, the percentage of tops down averaged 74% and ranged from 52% for Cherry Mountain to 95% for ‘Barolo’. All red varieties were harvested on August 25, except Cherry Mountain. Cherry Mountain matured later and was harvested on August 31.

The percentage of functionally single-centered bulbs averaged 63% and ranged from 23% for TAS042 to 91% for ‘Purple Haze’ (Table 19).

Marketable yield in December 2020 averaged 488 cwt/acre and ranged from 368 cwt/acre for ‘TAS040’ to 621 cwt/acre for Barolo (Table 20). Barolo had the highest marketable yield. Storage decomposition averaged 5% and ranged from 3.4% for TAS042 to 12% for Cherry Mountain.

In December 2020, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 38% and ranged from 12% for Barolo to 63% for TAS042 (Table 21). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 1.2% and ranged from 0% for RW020 to 2.8% for TAS042. In 2020, the percentage of bulbs with internal decomposition was low and was caused by bacterial rot, neck rot, and black mold (Table 22).

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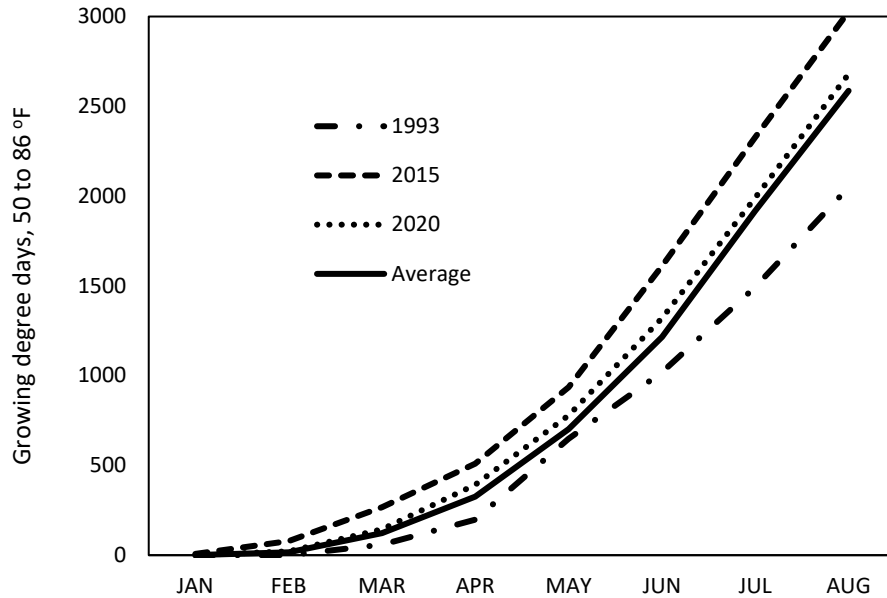


Figure 1. Cumulative growing degree-days (50–86°F) for selected years and 27-year average, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

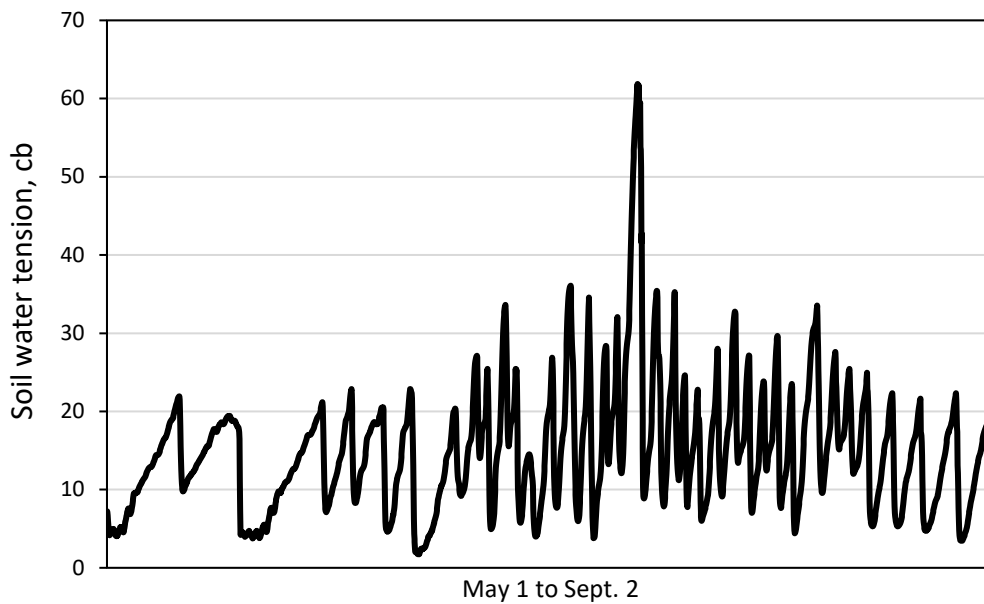


Figure 2. Soil water tension at 8-inch depth below the onion row, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Table 4. Soil-available N (as NO₃ + NH₄) in lb/acre in the top foot of soil by sampling date in the onion variety trials from 2014 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

2014		2015		2016		2017		2018		2019		2020	
		29-May	42			26-May	38					27-May	14
		8-Jun	48			12-Jun	32	8-Jun	14	11-Jun	12	3-Jun	18
		12-Jun	51	14-Jun	207	19-Jun	28	15-Jun	16	18-Jun	12	10-Jun	24
17-Jun	48	19-Jun	123	23-Jun	147	27-Jun	46	22-Jun	68	25-Jun	12	18-Jun	22
24-Jun	102	26-Jun	87	29-Jun	168	4-Jul	76	29-Jun	60	2-Jul	14	24-Jun	106
1-Jul	90	6-Jul	165	6-Jul	150	11-Jul	90	9-Jul	68	9-Jul	16	6-Jul	94
8-Jul	33	10-Jul	81	13-Jul	144	17-Jul	92	23-Jul	60	16-Jul	18	9-Jul	82
15-Jul	219	20-Jul	99	20-Jul	129	24-Jul	112	27-Jul	70	23-Jul	20	15-Jul	62
22-Jul	141	24-Jul	99	27-Jul	120	31-Jul	112	3-Aug	88	30-Jul	22	22-Jul	50
29-Jul	255	31-Jul	90	3-Aug	99	7-Aug	102	10-Aug	70	6-Aug	24	3-Aug	42
5-Aug	174	7-Aug	87							13-Aug	46	10-Aug	34
14-Aug	225	17-Aug	147										

Table 5. Maturity ratings and bulb quality for early-maturing onion varieties lifted and harvested in mid-August 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Maturity Aug. 3		Maturity Aug. 13		Bulb quality 2 weeks after harvest				
		Tops down	Leaf dryness	Tops down	Leaf dryness	Sprouted ----- % -----	External decomposition	Internal decomposition	Sprouted and decomposed	Total sprouted or decomposed
Bejo	Red Angel	78	7			0.0	1.6	0.0	0.0	1.6
Crookham	Avalon	9	1	79	10	0.0	0.8	0.0	0.0	0.8
	Scout	12	1	72	9	0.0	0.0	2.7	0.0	2.7
	White Cloud	6	1	18	5	0.8	0.0	0.0	0.0	0.8
Enza Zaden	Elsye	76	6			0.0	0.0	0.0	0.0	0.0
Hazera	Redstone	80	10			0.0	0.8	0.0	0.0	0.8
Sakata	Ovation	15	1	63	10	0.0	0.0	0.0	0.0	0.0
	Spanish Medallion	19	4	83	11	0.0	0.0	0.8	0.0	0.0
	Yosemite	26	5	83	12	1.6	0.8	0.0	0.0	2.4
	Great Western	16	4	58	11	0.8	1.6	0.0	0.0	2.4
	Average	34	4	65	10	0.3	0.6	0.0	0.0	1.2
LSD (0.05)		14.0	2.9	14.3	3.4	NS	NS	NS	NS	NS

Table 6. Single- and multiple-center bulb ratings for early-maturing onion varieties lifted and harvested in mid-August 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Multiple center			Single center	
		Large	Medium	Small	Functional*	Bullet
		----- % -----				
Bejo	Red Angel	38.8	30.6	20.1	30.6	10.5
Crookham	Avalon	3.2	25.6	10.4	71.2	60.8
	Scout	5.6	30.4	16.0	64.0	48.0
	White Cloud	4.8	48.0	13.6	47.2	33.6
Enza Zaden	Elsye	12.0	23.2	31.2	64.8	33.6
Hazera	Redstone	46.7	35.8	14.3	17.4	3.2
Sakata	Ovation	6.4	44.0	16.0	49.6	33.6
	Spanish Medallion	9.6	44.8	15.2	45.6	30.4
	Yosemite	33.6	55.2	8.8	11.2	2.4
	Great Western	29.6	40.8	12.8	29.6	16.8
	Average	19.0	37.8	15.8	43.1	27.3
LSD (0.05)		9.7	12.7	9.3	13.3	11.3

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

Table 7. Yield and grade performance of early-maturing onion varieties lifted and harvested in mid-August 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade								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	Bolting				
		----- cwt/acre -----								----- % -----			#/50 lb	
Bejo	Red Angel	783.9	752.8	5.7	80.2	617.9	49.0	17.0	6.8	0.0	1.0	0.0	1.0	36.8
Crookham	Avalon	1134.8	1118.6	139.8	527.4	436.5	14.9	11.2	1.0	0.8	0.3	0.2	0.1	29.9
	Scout	1171.6	1132.8	143.7	545.5	434.1	9.5	12.3	19.9	0.5	0.6	0.3	0.3	28.2
	White Cloud	976.2	926.2	31.9	339.3	534.8	20.2	10.8	31.3	0.1	0.8	0.3	0.5	33.2
Enza Zaden	Elsye	989.8	970.1	52.5	354.4	545.3	17.8	10.0	5.4	0.0	0.4	0.1	0.3	33.3
Hazera	Redstone	605.8	578.9	0.0	0.0	503.7	75.2	22.2	0.7	0.0	0.7	0.0	0.7	
Sakata	Ovation	1102.5	1061.4	80.8	483.8	477.4	19.5	15.1	21.8	0.0	0.4	0.2	0.1	31.0
	Spanish Medallion	1129.5	1081.1	202.9	468.7	388.4	21.1	10.2	35.0	0.1	0.3	0.0	0.3	24.0
	Yosemite	891.7	764.7	41.8	298.3	403.8	20.9	12.4	101.5	0.0	1.5	0.3	1.2	31.0
	Great Western	1019.4	957.3	104.9	353.5	472.4	26.5	16.3	30.9	0.0	1.5	1.2	0.3	30.4
	Average	980.5	934.4	80.4	345.1	481.4	27.5	13.8	25.4	0.2	0.8	0.3	0.5	30.9
LSD (0.05)		84.8	81.5	44.5	71.9	86.9	17.5	NS	23.6	0.5	NS	0.4	NS	NS

Table 8. Maturity, bolting, and thrips leaf damage ratings of full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Seed company	Variety	3-Aug		17-Aug		1-Sep		17-Aug	
		Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness	Bolting	Thrips leaf damage ^a
		----- % -----						0 - 10	
A. Takii	Grand Perfection	7.0	0.0	72.0	15.0	94.0	30.0	1.0	2.6
	Ridge Line	71.0	10.0	95.0	30.0	100.0	50.0	0.0	4.0
	Traverse	88.0	7.0	98.0	32.0	100.0	60.0	0.1	4.0
Bejo	Mondella	10.0	5.0	74.0	19.0	100.0	31.0	0.0	4.6
	Hamilton	6.0	1.0	46.0	11.0	91.0	20.0	0.5	3.6
	Legend	11.0	1.0	76.0	14.0	100.0	28.0	0.3	2.6
	Sedona	4.0	2.0	46.0	12.0	93.0	22.0	0.8	3.4
	Dawson	58.0	2.0	92.0	15.0	100.0	27.0	0.7	3.2
Crookham	Trident	15.0	0.0	81.0	17.0	94.0	29.0	0.7	3.8
	Caldwell	13.0	1.0	76.0	14.0	96.0	23.0	1.9	2.6
	Caliber	4.0	0.0	30.0	10.0	83.0	21.0	0.8	1.8
Hazera	37-118	42.0	7.0	88.0	22.0	100.0	39.0	0.3	3.8
	37-120	18.0	5.0	80.0	19.0	97.0	31.0	0.4	3.6
Nunhems	Anillo	6.0	0.0	24.0	9.0	83.0	25.0	0.2	2.6
	Arcero	6.0	1.0	36.0	14.0	93.0	25.0	0.1	2.8
	Granero	5.0	1.0	62.0	12.0	95.0	21.0	2.7	2.6
	Joaquin	5.0	0.0	18.0	9.0	71.0	14.0	5.1	1.4
	Montero	26.0	6.0	88.0	26.0	100.0	44.0	0.3	4.4
	Oloroso	4.0	0.0	42.0	12.0	92.0	24.0	0.0	2.6
	Pandero	5.0	0.0	24.0	10.0	78.0	17.0	2.3	2.2
	Vaquero	6.0	0.0	70.0	11.0	95.0	23.0	0.5	2.8
Sakata	Yukon	9.0	0.0	72.0	14.0	93.0	23.0	1.2	3.2
Seminis	Crusher	6.0	0.0	75.0	11.0	93.0	22.0	1.8	2.2
	Tucannon	8.0	0.0	76.0	13.0	95.0	24.0	0.2	2.4
	7716	9.0	0.0	74.0	11.0	95.0	21.0	4.4	2.4
	Jawbridge	5.0	0.0	62.0	9.0	98.0	20.0	1.1	2.2
	SV6672	8.0	2.0	64.0	13.0	96.0	23.0	2.0	2.4
D. Palmer	Saffron	8.0	2.0	68.0	14.0	89.0	31.0	0.1	2.8
	DPLD-14775	14.0	11.0	87.0	44.0	100.0	66.0	0.0	3.6
Average		16.4	2.2	65.4	15.9	93.6	28.8	1.0	3.0
LSD (0.05)		12.7	2.5	13.2	5.1	5.8	4.1	0.7	0.8

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

Table 9. Single- and multiple-center ratings for full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Seed company	Variety	Multiple center			Single center	
		Large	Medium	Small	Functional ^a	Bullet
		----- % -----				
A. Takii	Grand					
	Perfection	11.2	21.6	18.4	67.2	48.8
	Ridge Line	28.0	36.0	28.8	36.0	7.2
	Traverse	6.4	27.2	45.6	66.4	20.8
Bejo	Mondella	4.0	16.8	23.2	79.2	56.0
	Hamilton	4.4	19.8	18.6	75.8	57.2
	Legend	24.0	39.2	28.8	36.8	8.0
	Sedona	13.6	32.8	22.4	53.6	31.2
	Dawson	0.0	18.4	26.4	81.6	55.2
Crookham	Trident	0.0	4.0	3.2	96.0	92.8
	Caldwell	4.0	2.4	5.6	93.6	88.0
	Caliber	4.8	3.2	4.0	92.0	88.0
Hazera	37-118	26.6	25.8	21.8	47.6	25.7
	37-120	2.4	13.6	16.8	84.0	67.2
Nunhems	Anillo	0.8	1.6	4.0	97.6	93.6
	Arcero	0.8	2.4	2.4	96.8	94.4
	Granero	2.4	12.8	20.0	84.8	64.8
	Joaquin	0.0	2.4	12.0	97.6	85.6
	Montero	0.0	12.0	18.4	88.0	69.6
	Oloroso	0.0	4.0	4.0	96.0	92.0
	Pandero	7.2	13.6	16.8	79.2	62.4
	Vaquero	3.2	8.0	8.8	88.8	80.0
Sakata	Yukon	21.6	34.4	18.4	44.0	25.6
Seminis	Crusher	4.0	11.2	18.4	84.8	66.4
	Tucannon	1.6	10.4	12.0	88.0	76.0
	7716	4.8	9.6	10.4	85.6	75.2
	Jawbridge	3.2	7.2	17.6	89.6	72.0
	SV6672	3.6	15.8	9.8	80.6	70.8
D. Palmer	Saffron	20.2	39.5	18.6	40.3	21.7
	DPLD-14775	52.0	26.4	15.2	21.6	6.4
Average		8.8	16.3	16.2	74.9	58.7
LSD (0.05)		6.0	8.6	9.1	9.4	11.6

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

Table 10. Yield and grade of full-season experimental and commercial yellow onion varieties graded out of storage in January 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade						No. 2s	Bulb counts >4¼ in #/50 lb	Total rot	Neck rot	Plate rot	Black mold
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small						
		----- cwt/acre -----								--- % of total yield ---				
A. Takii	Grand Perfection	1123.8	1008.3	169.8	389.4	431.4	17.8	15.8	19.4	32.9	7.3	6.7	0.1	0.5
	Ridge Line	833.6	730.0	1.3	173.6	533.3	21.8	12.4	59.5	39.7	3.9	3.8	0.1	0.0
	Traverse	815.2	755.0	0.0	124.1	605.0	25.9	15.2	6.5		4.7	3.1	0.9	0.7
Bejo	Mondella	859.4	802.0	5.7	179.2	590.2	26.8	15.5	24.0	36.3	2.0	1.4	0.3	0.3
	Hamilton	1087.4	989.5	25.5	357.2	585.7	21.1	13.9	59.4	34.0	2.3	2.1	0.2	0.0
	Legend	961.8	826.0	40.4	294.4	474.0	17.2	9.6	50.6	35.0	7.7	6.4	1.2	0.1
	Sedona	1077.0	915.0	68.6	297.6	532.2	16.5	16.3	119.7	34.7	2.4	2.2	0.3	0.0
	Dawson	992.7	945.8	15.6	304.5	611.7	13.9	11.6	6.1	32.5	3.0	2.5	0.4	0.1
Crookham	Trident	931.8	866.3	23.7	230.9	591.3	20.5	10.4	2.0	34.8	5.7	3.6	0.9	1.2
	Caldwell	1108.6	963.9	109.8	398.1	440.9	15.1	12.9	2.0	31.6	11.9	9.2	0.4	2.2
	Caliber	1163.7	1039.4	243.4	490.7	288.4	16.9	12.0	1.9	31.1	9.5	5.6	0.9	3.0
Hazera	37-118	760.0	566.4	3.0	64.8	452.6	46.1	16.4	153.7	35.0	3.2	2.8	0.4	0.1
	37-120	848.5	757.4	13.3	159.4	540.1	44.6	21.2	20.6	36.0	6.0	5.6	0.2	0.2
Nunhems	Anillo	1072.9	1025.8	161.1	445.5	407.5	11.7	12.3	2.3	32.7	3.1	2.1	0.2	0.8
	Arcero	1155.7	1123.4	124.0	519.2	459.7	20.5	9.6	2.0	33.1	1.8	1.2	0.4	0.2
	Granero	1136.8	1056.9	159.9	483.3	400.1	13.5	7.7	17.6	32.4	4.8	4.1	0.3	0.4
	Joaquin	1269.8	1176.0	308.9	549.6	302.9	14.6	10.0	4.8	31.8	6.3	4.5	0.3	1.4
	Montero	940.9	887.8	25.2	321.3	525.1	16.2	9.4	2.3	34.8	4.5	3.9	0.3	0.3
	Oloroso	947.4	898.9	24.8	278.5	580.7	15.0	11.7	0.0	36.1	3.8	3.6	0.1	0.1
	Pandero	1127.6	1001.8	155.8	404.6	427.0	14.5	8.9	18.3	32.9	8.7	7.7	0.2	0.8
	Vaquero	1248.7	1130.6	222.5	480.4	411.4	16.4	11.0	7.7	31.6	7.9	7.4	0.3	0.2
Sakata	Yukon	1045.2	913.2	90.2	356.0	445.8	21.1	8.2	58.7	34.4	6.2	3.8	0.3	2.2
Seminis	Crusher	1190.1	1119.1	282.6	481.6	348.2	6.8	7.0	0.6	32.2	5.3	3.5	1.8	0.1
	Tucannon	1044.3	964.4	121.8	388.1	438.7	15.8	7.6	7.6	34.0	6.3	4.3	0.4	1.6
	7716	1273.9	1146.7	365.1	481.1	289.8	10.7	11.1	15.7	31.1	7.8	7.2	0.6	0.0
	Jawbridge	1203.3	1107.7	359.2	463.3	270.9	14.4	8.7	14.9	32.2	5.9	4.8	0.8	0.3
	SV6672	1299.1	1176.8	299.0	506.1	358.4	13.2	10.2	23.5	29.5	6.8	4.4	1.6	0.8
D. Palmer	Saffron	846.2	733.2	13.7	130.3	550.9	38.4	17.3	54.9	39.1	4.8	4.4	0.3	0.0
	DPLD-14775	629.1	289.7	1.6	12.4	219.5	56.2	31.8	288.6	31.6	3.1	3.0	0.1	0.0
Average		1034.3	928.2	118.5	336.7	452.2	20.8	12.6	36.0	33.7	5.4	4.3	0.5	0.6
LSD (0.05)		83.6	91.2	59.2	68.9	84.2	12.6	7.6	29.0	3.3	4.4	NS	0.9	1.7

Table 11. Internal defects of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2020, Malheur Experiment Station, Oregon State University, Ontario, OR

Seed company	Variety	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	91.6	0.4	92.0	7.6	0.4	8.0	100.0	0.4	0.0	0.4	0.4	0.0	0.4	0.8
	Ridge Line	68.8	0.8	69.6	25.5	4.9	30.4	100.0	0.4	0.0	0.4	1.2	0.8	2.0	2.4
	Traverse	66.4	0.0	66.4	32.4	1.2	33.6	100.0	0.0	0.0	0.0	0.8	0.0	0.8	0.8
Bejo	Mondella	72.4	0.0	72.4	26.4	1.2	27.6	100.0	0.8	0.0	0.8	0.0	0.0	0.0	0.8
	Hamilton	78.0	0.0	78.0	20.4	1.6	22.0	100.0	0.4	0.0	0.4	0.8	0.0	0.8	1.2
	Legend	88.0	0.0	88.0	10.8	1.2	12.0	100.0	1.6	0.0	1.6	0.0	0.4	0.4	2.0
	Sedona	82.7	0.0	82.7	15.7	1.6	17.3	100.0	0.0	0.0	0.0	0.4	0.4	0.8	0.8
	Dawson	83.6	1.6	85.2	14.0	0.8	14.8	100.0	0.8	0.0	0.8	0.0	0.0	0.0	0.8
Crookham	Trident	76.0	0.0	76.0	22.0	2.0	24.0	100.0	0.4	0.0	0.4	0.4	0.0	0.4	0.8
	Caldwell	87.3	0.0	87.3	11.9	0.8	12.7	100.0	0.4	0.0	0.4	0.0	0.0	0.0	0.4
	Caliber	92.2	0.0	92.2	7.4	0.4	7.8	100.0	0.4	0.0	0.4	0.0	0.0	0.0	0.4
Hazera	37-118	81.6	1.2	82.8	10.8	6.4	17.2	100.0	0.4	0.0	0.4	0.4	2.8	3.2	3.6
	37-120	46.4	0.0	46.4	46.8	6.8	53.6	100.0	1.2	0.0	1.2	0.4	0.8	1.2	2.4
Nunhems	Anillo	53.2	0.4	53.6	36.0	10.4	46.4	100.0	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	Arcero	77.2	0.0	77.2	16.0	6.8	22.8	100.0	2.0	0.0	2.0	0.0	0.8	0.8	2.8
	Granero	68.0	0.0	68.0	26.0	6.0	32.0	100.0	2.0	0.0	2.0	0.4	0.4	0.8	2.8
	Joaquin	81.6	0.4	82.0	16.4	1.6	18.0	100.0	0.8	0.0	0.8	1.2	0.4	1.6	2.4
	Montero	61.4	0.0	61.4	27.3	11.3	38.6	100.0	0.0	0.0	0.0	0.4	0.8	1.2	1.2
	Oloroso	71.4	0.0	71.4	26.1	2.5	28.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Pandero	79.6	0.0	79.6	18.4	2.0	20.4	100.0	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	Vaquero	84.8	0.0	84.8	8.8	6.4	15.2	100.0	0.4	0.0	0.4	0.0	0.0	0.0	0.4
Sakata	Yukon	82.1	0.0	82.1	14.7	3.2	17.9	100.0	2.0	0.0	2.0	0.4	1.2	1.6	3.6
Seminis	Crusher	89.0	0.4	89.4	9.0	1.6	10.6	100.0	2.5	0.0	2.5	0.0	0.0	0.0	2.5
	Tucannon	96.4	0.0	96.4	1.6	2.0	3.6	100.0	1.2	0.0	1.2	0.0	0.0	0.0	1.2
	7716	74.5	0.4	74.9	20.1	5.0	25.1	100.0	0.4	0.0	0.4	0.4	0.9	1.3	1.7
	Jawbridge	96.4	0.4	96.8	2.4	0.8	3.2	100.0	1.2	0.0	1.2	0.0	0.0	0.0	1.2
	SV6672	85.8	0.4	86.2	12.5	1.3	13.8	100.0	0.4	0.0	0.4	2.0	0.0	2.0	2.4
D. Palmer	Saffron	75.6	0.4	76.0	21.2	2.8	24.0	100.0	0.0	0.0	0.0	1.2	0.0	1.2	1.2
	DPLD-14775	56.8	0.8	57.6	33.2	9.2	42.4	100.0	0.8	0.0	0.8	0.4	0.0	0.4	1.2
	average	77.5	0.3	77.8	18.7	3.5	22.2	100.0	0.7	0.0	0.7	0.4	0.3	0.7	1.5
LSD (0.05)		10.1	NS	10.0	9.3	4.7	10.0		NS	NS	NS	NS	NS	NS	NS

Table 12. Internal decomposition by disease type of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
			----- % -----		
A. Takii	Grand Perfection	0.4	0.0	0.4	0.0
	Ridge Line	1.6	0.0	0.0	0.8
	Traverse	0.8	0.0	0.0	0.0
Bejo	Mondella	0.4	0.0	0.4	0.0
	Hamilton	0.8	0.0	0.4	0.0
	Legend	0.8	0.0	1.2	0.0
	Sedona	0.4	0.0	0.4	0.0
	Dawson	0.8	0.0	0.0	0.0
Crookham	Trident	0.4	0.4	0.0	0.0
	Caldwell	0.0	0.0	0.4	0.0
	Caliber	0.0	0.0	0.4	0.0
Hazera	37-118	2.0	0.0	0.4	1.2
	37-120	0.8	0.0	1.2	0.4
Nunhems	Anillo	0.4	0.0	0.0	0.0
	Arcero	1.2	0.0	0.4	1.2
	Granero	0.8	0.0	2.0	0.0
	Joaquin	0.4	0.0	2.0	0.0
	Montero	1.2	0.0	0.0	0.0
	Oloroso	0.0	0.0	0.0	0.0
	Pandero	0.0	0.0	0.4	0.0
Vaquero	0.0	0.0	0.4	0.0	
Sakata	Yukon	1.6	0.0	1.6	0.4
Seminis	Crusher	2.1	0.4	0.0	0.0
	Tucannon	0.4	0.0	0.8	0.0
	7716	1.7	0.0	0.0	0.0
	Jawbridge	0.0	0.0	1.2	0.0
	SV6672	0.0	0.0	2.4	0.0
D. Palmer	Saffron	0.0	0.0	1.2	0.0
	DPLD-14775	0.8	0.0	0.4	0.0
	average	0.7	0.0	0.6	0.1
LSD (0.05)		NS	NS	NS	NS

Table 13. Maturity, bolting, thrips leaf damage, and iris yellow spot virus symptoms ratings of full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Seed company	Variety	3-Aug		17-Aug		1-Sep		17-Aug	
		Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness	Bolting	Thrips leaf damage ^a
		----- % -----							0 - 10
Crookham	White Cap	9.0	2.0	78.0	12.0	92.0	21.0	3.1	2.4
	Brundage	5.0	0.0	62.0	13.0	93.0	21.0	3.5	2.4
Hazera	37-127	5.0	0.0	18.0	7.0	78.0	16.0	5.8	1.6
Nunhems	Cometa	4.0	0.0	64.0	9.0	91.0	18.0	11.0	2.2
	Rhea	9.0	0.0	80.0	11.0	97.0	21.0	0.3	2.2
D. Palmer	Diamond Swan	5.0	0.0	32.0	12.0	85.0	21.0	2.9	2.8
Average		6.2	0.3	55.7	10.7	89.3	19.7	4.43	2.3
LSD (0.05)		3.3	NS	16.7	3.4	8.2	3.7	2.30	0.5

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

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

Table 14. Single- and multiple-center ratings for full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Seed company	Variety	Multiple center			Single center	
		Large	Medium	Small	Functional ^a	Bullet
		----- % -----				
Crookham	White Cap	3.2	4.8	5.6	92.0	86.4
	Brundage	0.0	5.6	6.4	94.4	88.0
Hazera	37-127	0.8	12.0	9.6	87.2	77.6
Nunhems	Cometa	0.0	1.6	8.0	98.4	90.4
	Rhea	1.6	3.2	1.6	95.2	93.6
D. Palmer	Diamond Swan	20.8	16.0	28.0	63.2	35.2
Average		4.4	7.2	9.9	88.4	78.5
LSD (0.05)		5.0	7.5	10.0	9.9	9.6

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

Table 15. Yield and grade of full-season experimental and commercial white onion varieties graded out of storage in January 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade						No. 2s	Bulb counts >4¼ in	Total rot	Neck rot	Plate rot	Black mold	White mold
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small							
----- cwt/acre -----										#/50 lb	----- % of total yield -----				%
Crookham	White Cap	1107.9	755.5	119.4	252.1	364.5	19.5	14.9	3.4	32.0	29.6	29.6	0.0	0.0	0.8
	Brundage	1134.8	837.0	107.3	316.8	393.7	19.2	12.9	7.7	31.8	24.6	24.6	0.0	0.0	3.2
Hazera	37-127	1090.5	309.9	38.6	139.9	124.4	7.0	5.4	0.0	28.6	72.6	72.6	0.0	0.0	9.8
Nunhems	Cometa	1227.1	849.4	147.6	340.6	346.8	14.3	11.7	0.0	31.7	29.6	29.6	0.0	0.0	0.4
	Rhea	1206.6	840.0	110.8	373.2	340.6	15.4	18.9	0.0	30.3	28.7	28.6	0.1	0.0	2.4
D. Palmer	Diamond Swan	1077.2	616.1	70.7	227.0	301.9	16.5	14.2	77.9	31.9	33.9	33.9	0.0	0.0	2.0
	Average	1140.7	701.3	99.1	274.9	312.0	15.3	13.0	14.8	31.1	36.5	36.5	0.0	0.0	3.1
	LSD (0.05)	107.6	165.3	50.9	84.5	85.7	NS	6.4	20.2	NS	14.6	14.6	NS	NS	NS

Table 16. Internal defects of full-season experimental and commercial white onion varieties evaluated out of storage in December 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	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	
----- % -----															
Crookham	White Cap	97.6	0.0	97.6	1.6	0.8	2.4	100.0	0.4	0.0	0.4	0.0	0.4	0.4	0.8
	Brundage	92.8	0.0	92.8	5.2	2.0	7.2	100.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8
Hazera	37-127	89.6	0.0	89.6	8.5	1.9	10.4	100.0	0.5	0.0	0.5	0.0	1.1	1.1	1.6
Nunhems	Cometa	95.2	0.0	95.2	4.0	0.8	4.8	100.0	0.4	0.0	0.4	0.0	0.8	0.8	1.2
	Rhea	84.0	0.0	84.0	14.4	1.6	16.0	100.0	1.6	0.0	1.6	0.8	0.4	1.2	2.8
D. Palmer	Diamond Swan	86.4	0.0	86.4	13.2	0.4	13.6	100.0	0.4	0.0	0.4	0.0	0.4	0.4	0.8
	average	90.9	0.0	90.9	7.8	1.3	9.1	100.0	0.6	0.0	0.6	0.1	0.7	0.8	1.3
	LSD (0.05)	8.0	NS	NS	7.5	NS	8.0		NS	NS	NS	NS	NS	NS	NS

Table 17. Internal decomposition by disease type of full-season experimental and commercial white onion varieties evaluated out of storage in December 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
		----- % -----			
Crookham	White Cap	0.4	0.0	0.4	0.0
	Brundage	0.4	0.0	0.4	0.0
Hazera	37-127	0.4	0.0	1.2	0.0
Nunhems	Cometa	0.4	0.0	0.8	0.0
	Rhea	0.8	0.0	2.0	0.0
D. Palmer	Diamond Swan	0.8	0.0	0.0	0.0
	average	0.5	0.0	0.8	0.0
LSD (0.05)		NS	NS	NS	NS

Table 18. Maturity ratings of full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Seed company	Variety	3-Aug		17-Aug		24-Aug	
		Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness
		----- % -----					
Bejo	Redwing	5	11	58	34	86	42
Crookham	Purple Haze	7	8	58	28	76	32
	Red Beret	18	8	79	25	88	35
Enza Zaden	Barolo	42	6	95	29	97	37
New Zealand Onion	TAS040	20	12	75	34	83	44
	TAS042	72	11	94	38	100	54
	RW020	5	13	78	41	93	46
D. Palmer	Cherry Mountain	5	2	52	17	65	17
Average		22	9	74	31	86	38
LSD (0.05)		14	4	14	10	10	11

Table 19. Single- and multiple-center ratings for full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Seed company	Variety	Multiple center			Single center	
		Large	Medium	Small	Functional ^a	Bullet
		----- % -----				
Bejo	Redwing	6.4	14.4	26.4	79.2	52.8
Crookham	Purple Haze	0.8	8.0	16.8	91.2	74.4
	Red Beret	4.0	8.8	15.2	87.2	72.0
Enza Zaden	Barolo	36.0	29.6	28.0	34.4	6.4
New Zealand Onion	TAS040	24.0	25.6	27.2	50.4	23.2
	TAS042	40.8	36.0	14.4	23.2	8.8
	RW020	12.0	17.6	26.4	70.4	44.0
D. Palmer	Cherry Mountain	14.4	14.4	18.4	71.2	52.8
Average		17.3	19.3	21.6	63.4	41.8
LSD (0.05)		11.0	9.6	NS	12.5	12.0

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

Table 20. Yield and grade of full-season experimental and commercial red onion varieties graded out of storage in December 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade						No. 2s	Bulb counts >4¼ in	Total rot	Neck rot	Plate rot
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small					
			----- cwt/acre -----						#/50 lb	--- % of total yield ---			
Bejo	Redwing	566.2	506.6	0.0	1.6	418.5	86.5	24.4	7.9		4.8	3.7	1.1
Crookham	Purple Haze	600.8	540.2	0.0	6.7	446.3	87.2	25.4	4.3		5.3	4.4	0.9
	Red Beret	556.4	494.6	0.0	2.4	403.2	89.0	24.6	8.8		5.1	4.3	0.8
Enza Zaden	Barolo	709.2	620.9	0.0	7.3	559.6	54.0	14.3	49.6		3.5	2.3	1.2
New Zealand Onion	TAS040	493.6	368.3	0.0	30.2	265.9	72.2	24.0	81.2		4.1	3.5	0.6
	TAS042	614.0	480.7	0.0	15.8	412.1	52.8	14.7	97.4		3.4	2.3	1.1
	RW020	549.7	495.1	0.0	1.8	410.0	83.3	24.7	6.8		4.3	3.4	0.9
D. Palmer	Cherry Mountain	545.2	397.7	1.5	5.6	326.6	63.9	22.5	59.8	34.2	12.0	11.9	0.1
Average		579.4	488.0	0.2	8.9	405.3	73.6	21.8	39.5	34.2	5.3	4.5	0.8
LSD (0.05)		63.8	72.8	NS	9.1	88.3	NS	NS	19.9	NS	3.3	3.1	NS

Table 21. Internal defects of full-season experimental and commercial red onion varieties evaluated out of storage in December 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	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	
--- % ---															
Bejo	Redwing	50.2	0.0	50.2	38.9	10.8	49.8	100.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4
Crookham	Purple Haze	62.8	0.0	62.8	22.0	15.2	37.2	100.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8
	Red Beret	66.4	0.0	66.4	21.2	12.4	33.6	100.0	0.4	0.0	0.4	0.0	1.2	1.2	1.6
Enza Zaden	Barolo	87.6	0.0	87.6	11.6	0.8	12.4	100.0	0.4	0.0	0.4	0.4	0.4	0.8	1.2
New Zealand Onion	TAS040	61.6	0.0	61.6	26.4	12.0	38.4	100.0	0.0	0.0	0.0	0.0	2.4	2.4	2.4
	TAS042	37.4	0.0	37.4	42.7	19.9	62.6	100.0	0.0	0.0	0.0	0.0	2.8	2.8	2.8
	RW020	52.8	0.0	52.8	37.2	10.0	47.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Palmer	Cherry Mountain	77.1	0.0	77.1	18.5	4.4	22.9	100.0	0.0	0.0	0.0	0.4	0.0	0.4	0.4
average		62.0	0.0	62.0	27.3	10.7	38.0	100.0	0.1	0.0	0.1	0.1	1.0	1.1	1.2
LSD (0.05)		10.4	NS	10.4	11.2	7.1	10.4		NS	NS	NS	NS	1.9	NS	NS

Table 22. Internal decomposition by disease type of full-season experimental and commercial red onion varieties evaluated out of storage in December 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
			----- % -----		
Bejo	Redwing	0.0	0.0	0.0	0.4
Crookham	Purple Haze	0.4	0.0	0.4	0.0
	Red Beret	1.6	0.0	0.0	0.0
Enza Zaden	Barolo	0.8	0.0	0.4	0.0
New Zealand Onion	TAS040	1.6	0.0	0.4	0.4
	TAS042	2.4	0.0	0.0	0.4
	RW020	0.0	0.0	0.0	0.0
D. Palmer	Cherry Mountain	0.0	0.0	0.4	0.0
	average	0.8	0.0	0.2	0.1
LSD (0.05)		1.7	NS	NS	NS