

2021 ONION VARIETY TRIALS

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Introduction

Direct-seeded yellow, white, and red long-day onion varieties were evaluated in the field in 2021 for plant disease, thrips damage, maturity, bolting, and bulb single centers. Out of storage, the varieties were evaluated for yield, grade, and bulb decomposition. Eleven early-season varieties were planted in March and harvested and graded in mid-August. Forty-four full-season varieties (26 yellow, 11 red, and 7 white) were planted in March, harvested in September, and graded out of storage in winter 2021–2022. 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 2021 on Owyhee silt loam previously planted to wheat. After the wheat was harvested in 2020, the stubble was shredded, and the field was irrigated to sprout unharvested wheat kernels, and then the field was disked and plowed. A soil analysis taken in the fall of 2020 showed a pH of 7.4, 3.5% organic matter, 2 ppm nitrogen (N) as nitrate, 3 ppm N as ammonium, 32 ppm phosphorus (P), 437 ppm potassium (K), 29 ppm sulfur as sulfate (S), 2796 ppm calcium, 614 ppm magnesium, 274 ppm sodium, 3.3 ppm zinc (Zn), 3 ppm manganese (Mn), 1 ppm copper (Cu), 7 ppm iron, and 1 ppm boron (B). Based on the soil analysis, 50 lb N/acre, 44 lb P/acre, 83 lb K/acre, 200 lb S/acre, 11 lb Mn/acre, 2 lb Cu/acre, and 1 lb B/acre were broadcast after plowing. In addition to the chemical fertilizer, 10 tons/acre of composted cattle feedlot manure were broadcast after plowing. After the fertilizer and compost were broadcast, the field was groundhogged, fumigated with K-Pam[®] (metam potassium) 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 non-randomized 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 30 in plots 4 double rows wide and 27 ft long. The early-maturing trial had 11 varieties, including 9 yellow, 1 red, and 1 white, from 4 seed companies; the full-season yellow trial had 26 varieties from 6 seed companies; the full-season white trial had 7 varieties from 5 seed companies, and the full-season red trial had 11 varieties from 7 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 44-inch beds, with the middles of the double rows 20 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 (0.82 lb ai/acre) over the seed rows for onion maggot control and the soil surface was rolled.

The field had drip tape laid at 4-inch depth between pairs of double rows during planting. The drip tape had emitters spaced 8 inches apart and an emitter flow rate of 0.09 gallons per hour (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 10 inches.

Onion emergence started on April 17. On May 13, alleys 4 ft wide were cut between plots, leaving plots 23 ft long. The seedlings were hand-thinned on May 18 and 19 to a target spacing of 4.25 inches between individual onion plants in each single row, or 134,174 plants/acre.

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: Roundup PowerMax® (glyphosate) at 22 oz/acre on April 12; Poast® (sethoxydim) at 24 oz/acre, GoalTender® (oxyfluorfen) at 4 oz/acre, and Brox® 2EC (bromoxynil) at 16 oz/acre on May 13; Prowl® H₂O (pendimethalin) at 2 pints/acre on May 25; Poast at 24 oz/acre, GoalTender at 8 oz/acre, and Brox 2EC at 24 oz/acre on June 7.

For thrips control, the following insecticides were applied by ground: Aza-Direct® (azadirachtin) at 12 oz/acre and M-Pede® (potassium salts of fatty acids) at 123 oz/acre on June 1; Movento® HL (spirotetramat) at 2.5 oz/acre and Aza-Direct at 12 oz/acre on June 14 and June 24; Exirel (cyantraniliprole) at 20 oz/acre on July 2 and July 12, and Agri-Mek® SC (abamectin) at 3.5 oz/acre on July 21.

For fungal disease control, Bravo® WS (chlorothalonil) at 3 pints/acre was applied by ground on July 23.

Starting on June 3, 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). Nitrogen was the only nutrient that was needed to be applied. Urea ammonium nitrate solution (URAN) was applied through the drip tape four times from June 4 to June 25, supplying a total of 80 lb N/acre.

Table 1. Onion root tissue nutrient content in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Nutrient	Critical level	3-Jun	10-Jun	17-Jun	24-Jun	1-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	12-Aug
NO ₃ -N critical level (ppm)		8500	7667	6833	6000	5168	4338	3508	2678	1834	1000	1000
NO ₃ -N (ppm)		4055	4229	5137	5796	7012	5734	4745	4469	4296	3984	4928
P (%)	0.7	0.59	0.53	0.47	0.58	0.68	0.95	0.63	0.43	0.54	0.35	0.29
K (%)	2.7	2.75	2.09	2.39	2.60	3.17	3.90	4.12	3.76	2.99	2.29	2.40
S (%)	0.24	0.58	0.5	0.45	0.51	0.75	0.87	1.12	1.06	1.28	1.47	1.04
Ca (%)	0.4	0.33	0.25	0.32	0.38	0.43	0.47	0.50	0.51	0.59	0.76	0.80
Mg (%)	0.3	0.25	0.22	0.20	0.26	0.32	0.34	0.40	0.31	0.31	0.35	0.33
Zn (ppm)	25	33	28	23	28	36	46	38	30	31	36	42
Mn (ppm)	35	58	60	51	58	62	73	85	94	73	82	85
Cu (ppm)	6	15	11	12	14	16	18	15	13	10	10	11
B (ppm)	19	13	11	14	17	22	21	26	22	24	30	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, 2021.

Nutrient	Critical level	3-Jun	10-Jun	17-Jun	24-Jun	1-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	12-Aug
N critical level		4	4	4	4	4	4	3.8	2.8	2	1.5	0.5
N lb/acre		6.0	5.1	4.9	5.1	5.4	6.0	6.9	7.7	10.0	10.3	11.1
P lb/acre	0.7	2.3	2.2	3.0	3.6	2.6	2.1	2.0	1.8	1.7	2.5	2.3
K lb/acre	5	7.9	7.7	8.7	9.5	7.5	9.0	6.9	6.2	4.9	5.2	6.1
S lb/acre	1.5	8.3	7.9	11.3	15.8	10.4	12.9	16.2	15.2	16.6	18.7	19.3
Ca lb/acre	3	6.0	5.3	6.9	4.9	6.3	6.1	5.9	4.9	6.0	5.8	6.7
Mg lb/acre	0.6	1.2	1.1	1.4	1.5	1.2	1.1	1.3	1.2	1.4	1.1	1.2
Zn oz/acre	22	339	297	321	279	240	276	240	225	198	219	279
Mn oz/acre	28	12	9	9	9	15	15	12	15	18	18	15
Cu oz/acre	12	78	99	81	72	57	51	63	69	60	45	51
B g/acre	21	30	35	38	32	29	32	29	35	26		

Table 3. Nutrients applied through the drip irrigation system in the onion variety trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Date	N, lb/acre
June 4	20
June 14	20
June 18	20
June 25	20
Total	80

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 minutes, 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 28, and irrigations ended on August 27 for the full season yellow and white varieties. Irrigations for the early maturing varieties ended August 15 and irrigations for the red varieties ended August 18.

Onions in the early-maturing and full season trials were evaluated for maturity and bolting on July 26 and August 9. Onions in each plot were evaluated subjectively for maturity by visually rating the percentage of onions with the tops down and percent dry leaves. Onions in the early-maturing and full season trials were evaluated for IYSV severity on July 27. For the IYSV evaluations, ten consecutive onions in one of the middle 2 rows 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. The number of dead plants out of the 10 evaluated was also recorded. On August 9, onions in the full-season trial were also evaluated for thrips damage severity. 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 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 19. 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 yellow and white onions were lifted on September 7 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 14. The bags of white and yellow varieties were moved into storage on September 16. The ambient-air storage shed was ventilated, and the temperature was slowly decreased to maintain air temperature as close to 34°F as possible.

After harvest, bulbs from one of the border rows in each plot 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.

Red and white onions from the full-season trial were graded out of storage on December 1. Yellow onions from the full-season trial were graded out of storage in early January 2022. 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.

From December 6 to December 10, fifty No. 1 bulbs from each plot of the yellow, red, and white varieties 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.

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 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.

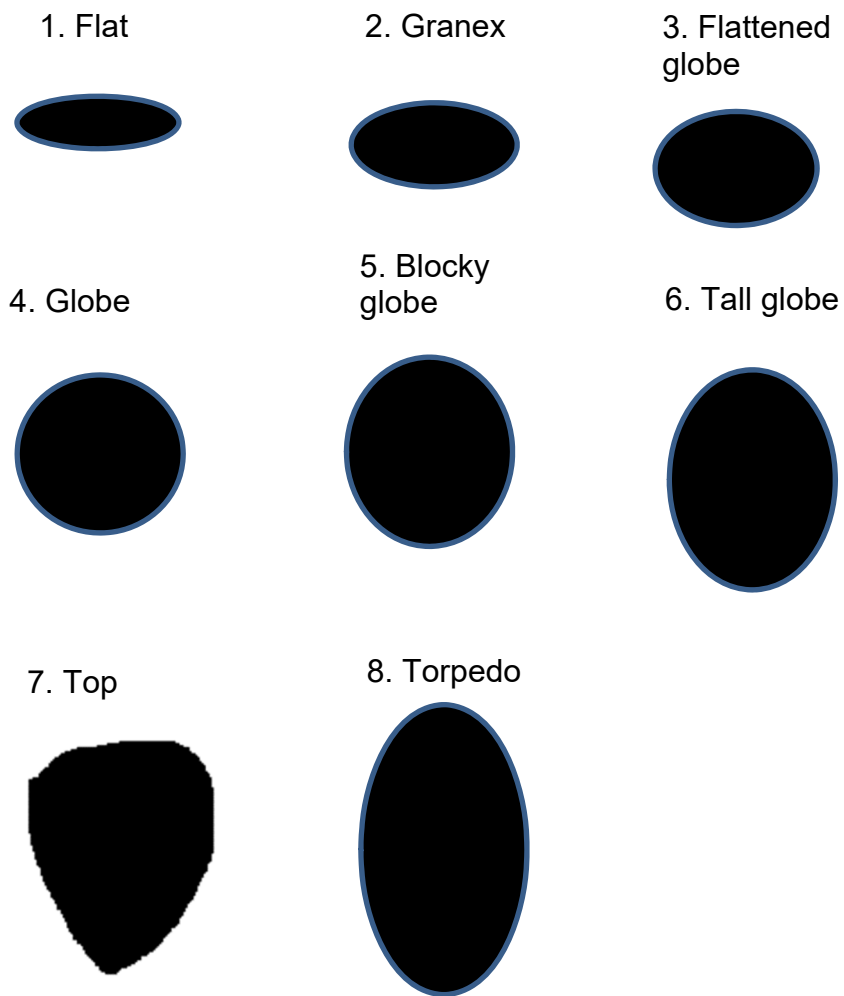


Figure 1. Onion bulb shape rating system. Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 4. Onion variety subjective quality evaluation rating system.

Characteristic	Scale	Description
Bulb shape	1-8	see Fig. 1
Skin color	1-5	1 = light, 5 = dark, white varieties: 1=dark, 5=white
Bulb shape uniformity	1-5	1 = non uniform 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 (5 = more desirable) red varieties: 1 = pale red, 5 = dark red (5 = less desirable) white varieties: 1 = less white, 5 = very white (5 = more desirable)

Results

In 2021, the months of June and July were unusually hot. Above average air temperature occurred for prolonged periods in June and July (Figures 2 and 3). The average maximum air temperature for July was the highest since records began at the Malheur Experiment Station in 1943 (Table 5). The average low temperatures for June and July were the highest since 1943. The hot weather resulted in earlier onion maturity. By August 9, the average percentage of tops down in the full season yellow variety trial was 71%.

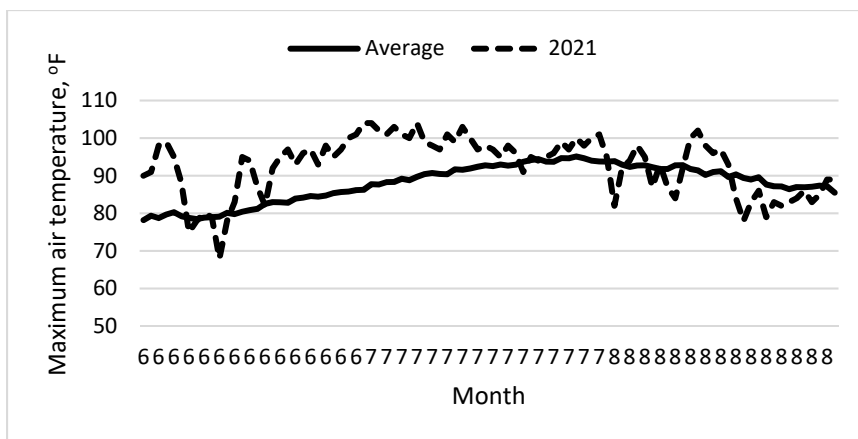


Figure 2. Maximum daily air temperature for June, July, and August in 2021 and the 79-year average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

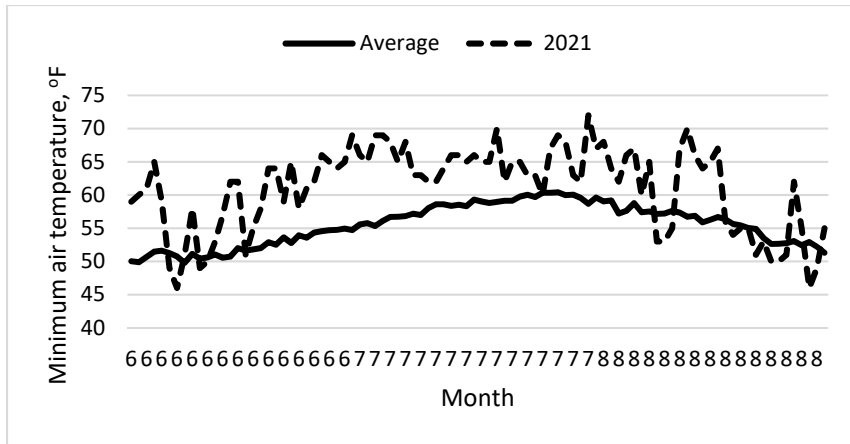


Figure 3. Minimum daily air temperature for June, July, and August in 2021 and the 79-year average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Table 5. Monthly average maximum and minimum air temperature (° F) in 2021 and the 79-year averages. Malheur Experiment Station, Oregon State University, Ontario, OR.

		Apr	May	Jun	Jul	Aug
Maximum	2021	66.7	73.5	90.6	98.7	89
	Average	64.3	73.5	81.8	91.9	90.1
Minimum	2021	35.2	47.0	58.9	65.4	58.7
	Average	37.3	45.2	52.1	58.3	55.8

The automated irrigation system maintained the soil water tension at 8-inch depth close to the target of 20 cb (Figure 4). In 2021, the soil solution N remained above the critical level all season and showed a gradual increase up to the last sampling on August 11 (Figure 6). The root nitrate level went above the critical level in early July (Figure 5) prompting the termination of N fertilization in late June. The total available soil N went above the critical level of 59 lb N/acre (Sullivan et al., 2001) in late July, later than most years (Table 6). A soil sample taken on August 27 showed high levels of pink root (25 cfu).

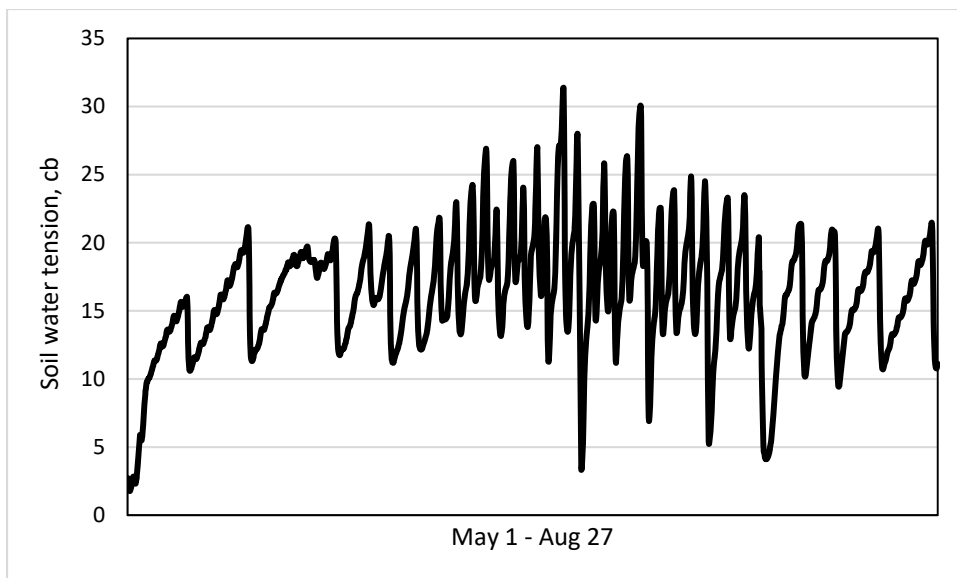


Figure 4. Soil water tension at 8-inch depth. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

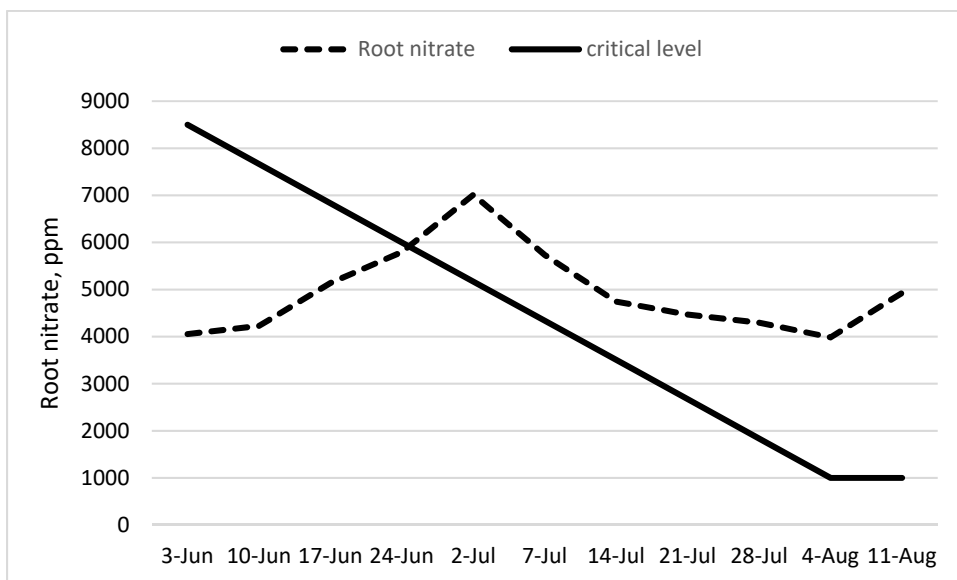


Figure 5. Root nitrate over time. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

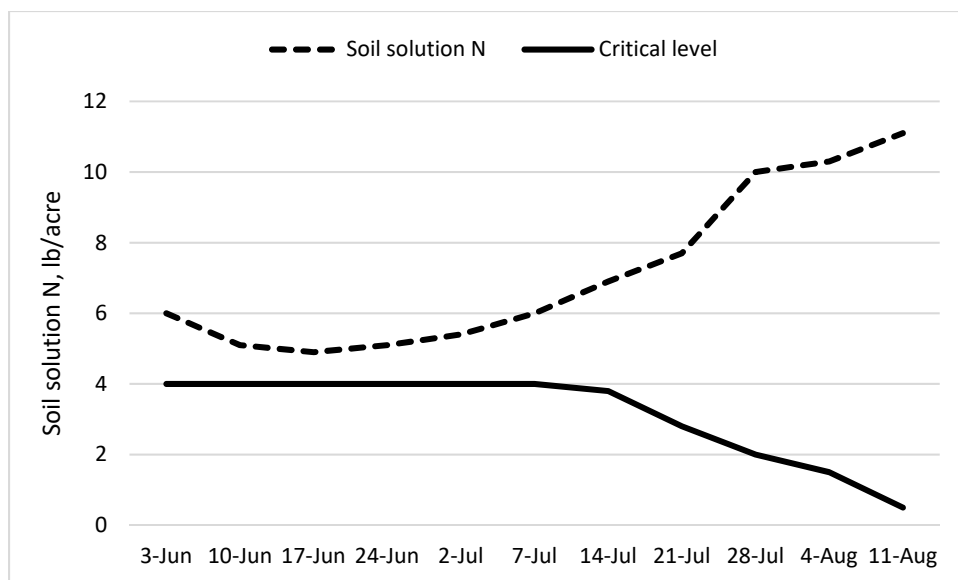


Figure 6. Soil solution N over time. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Table 6. 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 2021, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

2014	2015	2016	2017	2018	2019	2020	2021
	29-May 42		26-May 38			27-May 14	
	8-Jun 48		12-Jun 32	8-Jun 14	11-Jun 12	3-Jun 18	3-Jun 42
	12-Jun 51	14-Jun 207	19-Jun 28	15-Jun 16	18-Jun 12	10-Jun 24	10-Jun 36
17-Jun 48	19-Jun 123	23-Jun 147	27-Jun 46	22-Jun 68	25-Jun 12	18-Jun 22	17-Jun 34
24-Jun 102	26-Jun 87	29-Jun 168	4-Jul 76	29-Jun 60	2-Jul 14	24-Jun 106	24-Jun 36
1-Jul 90	6-Jul 165	6-Jul 150	11-Jul 90	9-Jul 68	9-Jul 16	6-Jul 94	1-Jul 38
8-Jul 33	10-Jul 81	13-Jul 144	17-Jul 92	23-Jul 60	16-Jul 18	9-Jul 82	8-Jul 42
15-Jul 219	20-Jul 99	20-Jul 129	24-Jul 112	27-Jul 70	23-Jul 20	15-Jul 62	15-Jul 48
22-Jul 141	24-Jul 99	27-Jul 120	31-Jul 112	3-Aug 88	30-Jul 22	22-Jul 50	22-Jul 54
29-Jul 255	31-Jul 90	3-Aug 99	7-Aug 102	10-Aug 70	6-Aug 24	3-Aug 42	29-Jul 70
5-Aug 174	7-Aug 87				13-Aug 46	10-Aug 34	5-Aug 72
14-Aug 225	17-Aug 147						12-Aug 78

Early-maturing Trial

On July 26, varieties ‘Highlander’, ‘Outlander’, and ‘T-832’ had 80% or more tops down (Table 7). ‘Red Angel’ had 41% tops down and the other varieties had less than 30% tops down on July 26. Two weeks later, on August 9, all varieties had 78% or more tops down. No bolting was observed in any plot in 2021. The incidence of IYSV (% of plants infected) ranged from 20% for ‘Ovation’ to 88% for ‘Frontier’ (Table 7). The severity of IYSV was low for all varieties (1.4 or

less). The percentage of onions that were functionally single centered averaged 71% and ranged from 38% for ‘Yosemite’ to 89% for ‘Avalon’ (Table 8). Total yield averaged 674 cwt/acre, ranging from 302 cwt/acre for Outlander to 935 cwt/acre for ‘Spanish Medallion’ (Table 9). After 2 weeks of storage, bulb sprouting or decomposition was low, averaging 2% (Table 10).

Full-season Trials

Yellow varieties. On July 26, the percentage of tops down averaged 10% and ranged from 2% for ‘TTA-795’ to 19% for ‘Montero’ (Table 11). By August 9, the percentage of tops down averaged 71% and ranged from 24% for ‘Hamilton’ to 94% for ‘Traverse’. Onions were lifted on September 7 and harvested on September 14.

The severity of thrips leaf damage, on a scale from 0 to 10, averaged 3 and ranged from 1.4 for ‘Caliber’ to 4.8 for ‘Scorpion’ (Table 11). Bolting did not occur in any variety in 2021. Iris yellow spot virus severity was low in this trial, with an average rating of 0.8 (0–25% of foliage diseased).

The percentage of functionally single-centered bulbs averaged 92% and ranged from 74% for TTA-795 to 99% for Montero (Table 12).

Total yield out of storage in January 2022 averaged 748 cwt/acre and ranged from 455 cwt/acre for ‘Thunderstone’ to 950 cwt/acre for ‘Vaquero’ (Table 13). Marketable yield out of storage in January 2022 averaged 702 cwt/acre and ranged from 371 cwt/acre for Thunderstone to 932 cwt/acre for Vaquero.

In December 2021, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 38% and ranged from 2% for ‘Jawbridge’ to 68% for ‘Mondella’ (Table 14). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 5% and ranged from 2% for ‘Joaquin’ and ‘Crusher’ to 14% for ‘Anillo’. In 2021, internal decomposition was mainly caused by *Fusarium proliferatum* and black mold (Table 15).

Results of the subjective evaluation can be found in table 16.

White varieties. The percentage of tops down averaged 8% on July 26 and 67% on August 9 (Table 17). Onions were lifted on September 7 and harvested on September 14.

The severity of thrips leaf damage, on a scale from 0 to 10, averaged 2.5 and ranged from 2 for ‘37-127’ to 3.2 for ‘Diamond Swan’ (Table 17). 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) or less. Bolting was not observed in any variety.

The percentage of functionally single-centered bulbs averaged 92% and ranged from 78% for Diamond Swan to 100% for ‘Rhea’ (Table 18).

Total yield in January 2022 averaged 741 cwt/acre and ranged from 645 cwt/acre for Diamond Swan to 951 cwt/acre for 37-127 (Table 19). Marketable yield in January 2022 averaged 607 cwt/acre and ranged from 458 cwt/acre for Diamond Swan to 852 cwt/acre for 37-127. Storage decomposition averaged 16% and ranged from 6% for Rhea to 22% for Diamond Swan.

In December 2021, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 40% and ranged from 22% for ‘White Cap’ to 62% for Diamond Swan (Table 20). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales,

averaged 14% and ranged from 4% for ‘37-127’ to 26% for ‘Bridewhite’. In 2021, the internal decomposition was mainly caused by *Fusarium proliferatum* (Table 21).

Results of the subjective evaluation can be found in table 22.

Red varieties. On July 26, the percentage of tops down averaged 25% and ranged from 9% for ‘Tannat’ to 97% for ‘Chianti’ (Table 23). On August 9, the percentage of tops down averaged 87% and ranged from 75% for ‘Cherry Mountain’ to 100% for Chianti.

The percentage of functionally single-centered bulbs averaged 83% and ranged from 70% for TAS042 and ‘37-128’ to 95% for ‘Purple Haze’ and ‘Red Beret’ (Table 24).

Total yield in December 2021 averaged 377 cwt/acre and ranged from 84 cwt/acre for Chianti to 673 cwt/acre for Tannat (Table 25). Marketable yield in December 2021 averaged 265 cwt/acre and ranged from 0 cwt/acre for Chianti to 640 cwt/acre for Tannat. Storage decomposition averaged 6% and ranged from 1% for ‘TAS042’ to 19% for ‘Red Nugent’.

Results of the subjective evaluation can be found in table 26.

Acknowledgements

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Table 7. Maturity ratings and IYSV rating for early-maturing onion varieties lifted and harvested on August 17, 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Color	26-Jul		9-Aug		July 29		
			Tops down	Leaf dryness	Tops down	Leaf dryness	IYSV severity ^a	IYSV incidence ^b	Dead plants ^c
			----- % -----				0 - 5	%	%
A. Takii	Frontier	Y	16	23	97	64	1.1	88	18
	Highlander	Y	91	21	100	82			
	Outlander	Y	93	22	100	86			
	T-832	Y	80	18	100	66			
Bejo	Red Angel	R	41	8	95	27	1.1	60	10
Crookham	Avalon	Y	12	2	89	19	1.0	40	2
	Scout	Y	14	4	88	21	1.0	32	0
	White Cloud	W	11	0	80	18	1.1	28	0
Sakata	Ovation	Y	14	3	78	20	1.0	20	0
	Spanish Medallion	Y	28	6	92	21	1.4	24	0
	Yosemite	Y	21	4	92	22	1.1	34	0
Average			38	10	92	41	1.1	41	4
LSD (0.05)			9	4	5	7	NS	24	5

^aIYSV severity: 0= no disease, 5=100% of foliage diseased

^bIYSV incidence: percentage of the 10 plants evaluated having at least one lesion

^cDead plants: percentage of the 10 plants evaluated that had completely dead foliage from undetermined causes.

Table 8. Single- and multiple-center bulb ratings for early-maturing onion varieties lifted and harvested on August 17, 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Color	Multiple center			Single center	
			large	medium	small	functional*	bullet
			----- % -----				
A. Takii	Frontier	Y	2.4	18.4	42.4	79.2	36.8
	Highlander	Y	11.2	33.6	36.0	55.2	19.2
	Outlander	Y	7.2	21.6	48.8	71.2	22.4
	T-832	Y	0.8	20.0	40.0	79.2	39.2
Bejo	Red Angel	R	8.8	23.2	45.6	68.0	22.4
Crookham	Avalon	Y	1.6	9.6	37.6	88.8	51.2
	Scout	Y	7.2	11.2	13.6	81.6	68.0
	White Cloud	W	2.4	15.2	38.4	82.4	44.0
Sakata	Ovation	Y	4.8	26.4	25.6	68.8	43.2
	Spanish Medallion	Y	8.8	20.0	21.6	71.2	49.6
	Yosemite	Y	25.8	36.3	24.1	37.9	13.8
Average			7.4	21.4	34.0	71.2	37.3
LSD (0.05)			9.2	13.1	14.3	14.9	15.1

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

Table 9. Yield and grade performance of early-maturing onion varieties lifted and harvested on August 17, 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Color	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				
----- cwt/acre -----														#/50 lb
A. Takii	Frontier	Y	335.9	221.7	0.0	0.0	35.2	186.6	113.6	0.3	0.1	0.0	0.1	
	Highlander	Y	400.6	303.2	0.0	0.0	121.9	181.3	93.5	3.7	0.1	0.0	0.1	
	Outlander	Y	302.4	166.2	0.0	0.0	20.3	145.9	135.6	0.2	0.1	0.0	0.1	
	T-832	Y	333.8	239.2	0.0	4.8	75.8	158.6	94.6	0.0	0.0	0.0	0.0	
Bejo	Red Angel	R	653.1	587.5	1.4	6.1	440.6	139.4	59.9	4.6	0.2	0.0	0.2	37.9
Crookham	Avalon	Y	928.7	904.2	12.2	142.8	696.2	52.9	20.3	0.0	0.5	0.5	0.0	35.5
	Scout	Y	931.4	911.5	5.5	101.1	749.2	55.7	19.0	0.0	0.1	0.0	0.1	37.7
	White Cloud	W	917.2	808.9	0.0	35.0	697.8	76.1	99.7	4.9	0.5	0.0	0.5	
Sakata	Ovation	Y	931.9	918.4	4.5	141.6	718.5	53.9	11.5	2.0	0.0	0.0	0.0	35.3
	Spanish Medallion	Y	934.8	911.8	11.7	171.5	687.2	41.3	18.4	3.2	0.2	0.0	0.2	33.4
	Yosemite	Y	746.5	703.3	4.3	50.0	565.0	84.0	29.5	10.9	0.4	0.0	0.4	35.5
	Average		674.2	606.9	3.6	59.4	437.1	106.9	63.2	2.7	0.2	0.0	0.1	35.9
LSD (0.05)			99.6	79.3	NS	36.6	67.6	25.0	67.7	5.4	NS	NS	0.3	NS

Table 10. Bulb decomposition and sprouting after two weeks of storage of early-maturing onion varieties lifted and harvested on August 17, 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Color	Bulb quality 2 weeks after harvest				
			external decomposition	internal decomposition	total sprouted or decomposed	external decomposition	internal decomposition
			----- % -----				
A. Takii	Frontier	Y	0.0	1.6	0.0	0.0	1.6
	Highlander	Y	0.0	0.0	0.0	0.0	0.0
	Outlander	Y	0.0	0.8	0.0	0.0	0.8
	T-832	Y	0.0	0.8	0.0	0.0	0.8
Bejo	Red Angel	R	0.0	1.6	0.8	0.0	2.4
Crookham	Avalon	Y	0.0	2.4	0.0	0.0	2.4
	Scout	Y	0.0	0.8	0.0	0.0	0.8
	White Cloud	W	0.0	4.0	0.0	0.0	4.0
Sakata	Ovation	Y	0.0	4.0	0.0	0.0	4.0
	Spanish Medallion	Y	0.0	3.9	0.0	0.0	3.9
	Yosemite	Y	0.0	2.4	0.8	0.0	3.2
Average			0.0	2.0	0.0	0.0	2.0
LSD (0.05)			NS	NS	NS	NS	NS

Table 11. Maturity, thrips leaf damage, and IYSV ratings of full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Seed company	Variety	July 26		August 9			July 29		
		Tops down	Leaf dryness	Tops down	Leaf dryness	Thrips leaf damage ^a	IYSV severity ^b	IYSV incidence ^c	Dead plants ^d
		----- %		----- %		0 - 10	0 - 5	%	%
A. Takii	Traverse	16	11	94	31	4.4	0.8	24	0
	TTA-795	2	2	84	22	4.2	1.1	36	0
Bejo	Mondella	7	5	73	21	4.0	0.8	18	5
	Hamilton	4	0	24	12	3.6	0.8	24	0
	Legend	13	4	80	20	3.0	0.9	18	4
Crookham	Trident	15	4	80	25	3.8	0.8	18	6
	Caldwell	11	4	73	21	3.0	1.0	24	8
	Caliber	3	0	25	9	1.4	0.9	18	0
	Scorpion	17	5	80	24	4.8	0.6	14	0
	Defender	5	2	62	18	2.8	0.6	10	0
Hazera	Thunderstone	18	8	87	25	3.8	0.8	20	12
	37-126	10	5	73	21	3.0	0.8	18	0
Nunhems	Anillo	10	0	64	17	3.2	0.8	18	2
	Arcero	6	1	44	19	3.0	0.8	26	0
	Granero	12	1	78	17	2.8	1.3	28	2
	Joaquin	7	0	71	13	2.0	0.8	14	0
	Montero	19	6	91	29	4.2	0.8	16	2
	Oloroso	7	0	68	19	3.2	1.0	40	0
	Pandero	6	0	51	12	1.6	0.8	20	0
	Vaquero	9	0	74	19	3.0	1.0	40	0
Seminis	Crusher	9	1	79	17	2.8	0.8	14	0
	Tucannon	9	1	81	16	2.4	0.2	6	2
	Jawbridge	6	0	84	16	2.4	0.8	12	2
	SV6672	7	1	63	19	2.8	0.8	12	2
	16000	10	0	83	19	2.6	0.4	8	2
	SV6646NW	9	1	74	17	2.4	0.4	10	2
Average		10	2	71	19	3	0.8	19	2
LSD (0.05)		4	3	11	4	0.6	NS	18	6

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

^bIYSV severity: 0= no disease, 5=100% of foliage diseased

^cIYSV incidence: percentage of the 10 plants evaluated having at least one lesion

^dDead plants: percentage of the 10 plants evaluated that had completely dead foliage from undetermined causes (possibly pink root or plate rot).

Table 12. Single- and multiple-center ratings for full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
		%				
A. Takii	Traverse	0.8	5.6	16.0	93.6	77.6
	TTA-795	4.8	21.6	45.6	73.6	28.0
Bejo	Mondella	2.4	5.6	7.2	92.0	84.8
	Hamilton	12.8	8.8	12.0	78.4	66.4
	Legend	4.0	12.0	34.4	84.0	49.6
Crookham	Trident	0.8	3.2	7.2	96.0	88.8
	Caldwell	0.0	2.4	8.8	97.6	88.8
	Caliber	0.0	2.4	4.8	97.6	92.8
	Scorpion	0.8	2.4	3.2	96.8	93.6
	Defender	0.8	2.4	6.4	96.8	90.4
Hazera	Thunderstone	3.2	8.0	22.4	88.8	66.4
	37-126	4.0	11.2	16.0	84.8	68.8
Nunhems	Anillo	1.6	2.4	1.6	96.0	94.4
	Arcero	0.0	3.2	5.6	96.8	91.2
	Granero	3.2	2.4	8.8	94.4	85.6
	Joaquin	0.8	2.4	10.4	96.8	86.4
	Montero	0.0	0.8	5.6	99.2	93.6
	Oloroso	1.6	2.4	2.4	96.0	93.6
	Pandero	3.2	10.4	27.2	86.4	59.2
	Vaquero	1.6	0.8	9.6	97.6	88.0
Seminis	Crusher	0.8	4.0	6.4	95.2	88.8
	Tucannon	4.7	1.6	7.2	93.7	86.5
	Jawbridge	0.8	7.2	22.2	92.0	69.9
	SV6672	4.8	13.6	15.2	81.6	66.4
	16000	2.4	5.6	15.2	92.0	76.8
	SV6646NW	0.8	6.4	11.2	92.8	81.6
Average		2.3	5.7	12.8	91.9	79.2
LSD (0.05)		4.0	5.4	8.1	6.4	9.9

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

Table 13. Yield and grade of full-season experimental and commercial yellow onion varieties graded out of storage in January 2022, 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
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small						
		----- cwt/acre -----						#/50 lb	----- % of total yield -----					
A. Takii	Traverse	470.5	404.7	0.0	0.0	268.5	136.2	59.9	0.9		1.1	0.4	0.3	0.4
	TTA-795	572.2	518.0	0.0	1.7	402.8	113.6	27.5	6.6		3.6	1.0	0.2	2.4
Bejo	Mondella	627.4	573.5	0.0	5.1	466.1	102.3	38.0	1.8		2.2	1.3	0.9	0.0
	Hamilton	810.7	768.1	0.0	37.6	696.9	33.5	7.0	24.4		1.4	1.1	0.3	0.0
	Legend	686.3	643.1	1.6	9.7	541.6	90.2	24.7	6.4	33.3	1.8	1.1	0.3	0.4
Crookham	Trident	580.8	500.3	0.0	17.5	385.1	97.8	49.8	0.0		5.3	4.3	0.7	0.3
	Caldwell	715.2	671.4	1.5	40.4	548.9	80.6	25.6	0.3	33.8	2.5	1.8	0.5	0.2
	Caliber	893.5	848.1	9.5	143.5	640.0	55.1	18.9	0.8	32.6	3.1	1.8	0.6	0.6
	Scorpion	571.2	526.7	0.0	3.6	392.9	130.3	36.1	0.5		1.4	1.1	0.3	0.0
	Defender	761.9	677.6	0.0	47.4	553.9	76.3	32.9	0.0		6.5	3.5	0.4	2.7
Hazera	Thunderstone	454.5	371.3	0.0	9.6	262.9	98.8	72.1	4.3		1.5	1.2	0.3	0.0
	37-126	718.8	660.7	0.0	45.2	535.6	79.9	32.2	2.0		3.6	2.8	0.1	0.7
Nunhems	Anillo	756.2	733.1	1.2	45.0	633.0	53.8	15.9	0.0	41.7	1.0	0.4	0.6	0.0
	Arcero	857.9	823.9	0.0	66.4	717.9	39.6	11.5	0.0		2.6	1.6	0.8	0.2
	Granero	851.5	826.1	0.0	90.1	690.7	45.2	16.7	0.0		1.0	0.5	0.5	0.0
	Joaquin	945.4	918.5	8.5	188.2	673.6	48.2	17.7	0.0	36.9	0.9	0.8	0.2	0.0
	Montero	601.1	534.2	0.0	3.9	434.1	96.2	42.1	0.0		4.2	3.8	0.1	0.3
	Oloroso	754.3	724.5	0.0	20.2	621.7	82.6	21.6	0.0		1.1	0.7	0.1	0.3
	Pandero	902.6	872.8	9.4	101.2	710.0	52.1	16.2	0.4	32.7	1.5	0.6	0.7	0.2
	Vaquero	949.7	931.8	1.5	147.6	752.3	30.4	13.4	0.0	33.8	0.5	0.1	0.2	0.1
Seminis	Crusher	826.1	794.5	7.4	126.6	612.9	47.7	12.3	3.0	35.1	2.0	1.2	0.7	0.1
	Tucannon	784.9	726.9	3.0	54.9	605.6	63.4	26.0	0.8	34.4	4.1	1.7	1.0	1.4
	Jawbridge	813.1	770.7	4.4	77.7	627.8	60.8	20.5	7.1	35.3	1.9	1.3	0.5	0.1
	SV6672	925.4	889.2	4.7	193.4	649.9	41.1	15.4	5.2	32.8	1.7	1.2	0.5	0.0
	16000	764.9	711.2	5.8	96.7	561.4	47.3	24.9	3.9	35.6	3.3	2.2	1.1	0.1
	SV6646NW	849.7	820.5	2.9	100.6	673.6	43.4	8.1	1.2	36.2	2.4	1.5	0.7	0.1
Average		747.9	701.6	2.4	64.4	563.8	71.0	26.4	2.7	34.9	2.4	1.5	0.5	0.4
LSD (0.05)		90.5	100.8	NS	53.2	95.3	31.2	14.2	4.7	NS	2.1	1.9	0.6	0.9

Table 14. Internal defects of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2021, 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	Traverse	38	0	38	58	3	62	100	2	0	2	2	2	4	6
	TTA-795	70	0	70	29	1	30	100	0	0	0	3	0	3	4
Bejo	Mondella	32	0	32	62	6	68	100	1	0	1	3	1	4	5
	Hamilton	54	0	54	42	4	46	100	1	0	1	2	1	3	4
	Legend	39	0	39	58	4	61	100	0	0	0	3	1	4	4
Crookham	Trident	54	0	54	43	2	46	100	2	0	2	7	1	8	10
	Caldwell	65	0	65	33	2	35	100	1	0	1	4	0	4	6
	Caliber	70	0	71	28	1	29	100	1	0	1	3	0	3	4
	Scorpion	48	3	52	42	6	48	100	2	3	5	5	2	6	12
	Defender	74	0	74	23	2	26	100	3	0	3	2	1	3	6
Hazera	Thunderstone	48	0	48	43	8	52	100	0	0	0	3	2	6	6
	37-126	67	0	67	31	1	33	100	1	0	1	3	0	3	4
Nunhems	Anillo	52	0	52	47	1	48	100	4	0	4	10	0	10	14
	Arcero	73	0	73	23	4	27	100	0	0	0	1	1	2	3
	Granero	82	0	82	16	1	18	100	4	0	4	2	0	2	6
	Joaquin	79	0	79	17	4	21	100	1	0	1	0	0	0	2
	Montero	45	0	45	44	11	55	100	0	0	0	8	1	10	10
	Oloroso	48	0	48	45	7	52	100	0	0	0	7	1	8	8
	Pandero	56	0	56	40	4	44	100	2	0	2	3	0	3	5
	Vaquero	77	0	77	16	7	23	100	0	0	0	2	1	3	4
Seminis	Crusher	82	2	85	14	1	15	100	1	0	1	0	0	1	2
	Tucannon	76	0	76	18	6	24	100	3	0	3	1	1	2	6
	Jawbridge	98	0	98	2	0	2	100	2	0	2	1	0	1	3
	SV6672	69	0	69	30	2	31	100	0	0	0	4	1	4	4
	16000	58	0	58	36	6	42	100	1	0	1	2	1	3	4
	SV6646NW	53	0	53	40	7	47	100	2	0	2	1	0	1	3
	average	62	0	62	34	4	38	100	1	0	2	3	1	4	5
LSD (0.05)		15	1	15	15	5	15		NS	1	3	4	NS	4	5

Table 15. Internal decomposition by disease type of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
		----- % -----			
A. Takii	Traverse	0.0	0.0	0.0	6.0
	TTA-795	0.4	0.4	0.0	2.8
Bejo	Mondella	0.4	0.0	0.0	4.4
	Hamilton	0.0	2.8	0.0	0.8
	Legend	0.0	1.2	0.0	2.4
Crookham	Trident	1.2	4.4	0.0	4.4
	Caldwell	0.8	2.4	0.0	2.4
	Caliber	0.0	2.0	0.4	2.0
	Scorpion	0.4	1.2	0.0	10.0
	Defender	0.8	2.4	0.0	2.4
Hazera	Thunderstone	0.4	3.2	0.0	2.4
	37-126	0.0	2.0	0.0	1.6
Nunhems	Anillo	2.4	10.4	0.0	0.8
	Arcero	0.8	1.2	0.0	0.8
	Granero	3.2	2.8	0.4	0.0
	Joaquin	0.0	1.2	0.0	0.4
	Montero	0.4	0.8	0.4	8.0
	Oloroso	0.4	2.8	0.0	4.8
	Pandero	0.0	4.4	0.0	0.8
	Vaquero	0.4	2.4	0.0	0.8
Seminis	Crusher	0.0	1.6	0.0	0.4
	Tucannon	0.8	3.6	0.0	1.2
	Jawbridge	0.8	2.0	0.4	0.0
	SV6672	0.5	2.0	0.0	1.5
	16000	0.4	1.6	0.0	2.0
	SV6646NW	0.4	1.2	0.0	1.6
	average	0.6	2.3	0.1	2.5
LSD (0.05)		NS	3.1	NS	3.2

Table 16. Subjective evaluation of bulb characteristics for yellow onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Company	Variety	Bulb shape ^a	Bulb shape uniformity ^b	Firmness ^b	Scale retention ^b	Skin color ^b	Flesh brightness ^b
----- 1 - 5 -----							
A. Takii	Traverse	4	4	3	3	3	3
	TTA-795	5	4	4	4	4	3
Bejo	Mondella	3	3	4	4	3	4
	Hamilton	5	4	4	5	5	4
	Legend	6	3	4	5	4	4
Crookham	Trident	4	2	3	4	3	3
	Caldwell	4	3	3	4	3	4
	Caliber	5	3	4	4	3	4
	Scorpion	5	2	3	3	3	3
	Defender	5	3	3	4	4	4
Hazera	Thunderstone	4	3	4	5	4	3
	37-126	4	3	4	4	4	4
Nunhems	Anillo	6	4	4	5	4	4
	Arcero	5	4	4	4	4	5
	Granero	6	4	4	5	4	3
	Joaquin	5	4	4	5	4	4
	Montero	4	3	2	4	3	4
	Oloroso	5	4	4	5	4	4
	Pandero	6	4	4	5	4	4
	Vaquero	5	3	4	4	3	4
Seminis	Crusher	6	4	4	4	4	3
	Tucannon	6	4	4	5	4	4
	Jawbridge	6	4	3	4	3	4
	SV6672	4	3	4	3	3	4
	16000	5	3	3	4	3	4
	SV6646NW	5	4	4	4	4	4
Average		5	3	3	4	4	4
LSD (0.05)		2	1	1	1	1	NS

^aBulb shape: see Fig. 1. ^b Subjective ratings are described in Table 4. 1=worst, 5=best

Table 17. Maturity, bolting, thrips leaf damage, and IYSV ratings of full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Seed company	Variety	July 26		August 9			July 29			
		Tops down	Leaf dryness	Tops down	Leaf dryness	Thrips leaf damage ^a	IYSV severity ^b	IYSV incidence ^c	Dead plants ^d	
		----- % -----		----- % -----			0 - 10	0 - 5	%	%
Bejo	Bridewhite	5	0	76	17	2.8	1.0	20	0.0	
Crookham	White Cap	11	2	75	19	2.6	0.8	18	0.0	
	Brundage	7	1	70	19	2.4	0.4	8	0.0	
Hazera	37-127	6	2	26	11	1.8	0.6	20	0.0	
Nunhems	Cometa	8	0	75	18	2.6	0.4	10	0.0	
	Rhea	12	0	80	16	2.0	0.6	10	0.0	
D. Palmer	Diamond Swan	8	3	64	22	3.2	0.4	16	1.8	
Average		8	1	67	17	2.5	0.6	15	0.3	
LSD (0.05)		3	NS	12	4	0.7	NS	NS	NS	

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

^bIYSV severity: 0= no disease, 5=100% of foliage diseased

^cIYSV incidence: percentage of the 10 plants evaluated having at least one lesion

^dDead plants: percentage of the 10 plants evaluated that had completely dead foliage from undetermined causes (possibly pink root or plate rot).

Table 18. Single- and multiple-center ratings for full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
		----- % -----				
Bejo	Bridewhite	0.8	14.4	27.2	84.8	57.6
Crookham	White Cap	0.0	3.2	15.2	96.8	81.6
	Brundage	1.6	3.2	9.6	95.2	85.6
Hazera	37-127	2.4	2.4	16.8	95.2	78.4
Nunhems	Cometa	4.0	0.8	3.2	95.2	92.0
	Rhea	0.0	0.0	4.0	100.0	96.0
D. Palmer	Diamond Swan	10.4	11.2	24.8	78.4	53.6
Average		2.7	5.0	14.4	92.2	77.8
LSD (0.05)		4.7	5.7	7.8	6.6	11.4

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

Table 19. Yield and grade of full-season experimental and commercial white onion varieties graded out of storage in December 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
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small						
		----- cwt/acre -----						#/50 lb		----- % of total yield -----				
Bejo	Bridewhite	670.2	500.5	0.0	5.8	423.1	71.7	27.4	1.0		21.1	19.5	0.0	1.6
Crookham	White Cap	678.8	532.1	1.4	49.6	424.9	56.2	27.2	0.7	35.7	17.4	15.3	0.5	1.6
	Brundage	685.7	541.3	0.0	25.3	449.7	66.2	23.4	0.0		17.8	16.4	0.3	1.1
Hazera	37-127	950.7	852.2	3.0	242.2	592.5	14.4	6.7	1.3	34.3	9.6	8.7	0.3	0.6
Nunhems	Cometa	747.6	621.2	0.0	29.3	539.3	52.6	15.0	1.3		15.0	14.3	0.3	0.3
	Rhea	810.2	746.3	0.0	54.0	641.8	50.5	17.0	0.0		5.8	4.7	1.0	0.1
D. Palmer	Diamond Swan	644.5	458.4	3.0	30.7	365.6	59.1	32.1	14.0	34.0	21.8	19.7	0.9	1.2
Average		741.1	607.4	1.1	62.4	491.0	53.0	21.3	2.6	34.7	15.5	14.1	0.5	0.9
LSD (0.05)		63.8	83.1	NS	34.7	84.8	16.6	9.3	2.9	NS	5.1	5.4	0.5	NS

Table 20. Internal defects of full-season experimental and commercial white onion varieties evaluated out of storage in December 2021, 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	Bridewhite	51	1	52	48	1	48	100	1	0	1	24	0	25	26
Crookham	White Cap	77	1	78	18	4	22	100	2	0	2	8	2	10	11
	Brundage	71	0	71	27	2	29	100	2	0	2	11	0	11	13
Hazera	37-127	58	0	58	36	6	42	100	0	0	0	4	0	4	4
Nunhems	Cometa	54	1	55	37	8	45	100	1	0	1	15	1	16	17
	Rhea	70	0	70	28	2	30	100	1	0	1	7	0	8	8
D. Palmer	Diamond Swan	37	1	38	56	6	62	100	3	0	3	18	0	18	21
average		60	1	60	36	4	40	100	1	0	1	12	1	13	14
LSD (0.05)		10	NS	10	9	4	10		NS	NS	NS	8	NS	8	8

Table 21. Internal decomposition by disease type of full-season experimental and commercial white onion varieties evaluated out of storage in December 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
		----- % -----			
Bejo	Bridewhite	2.0	19.6	0.4	3.6
Crookham	White Cap	0.4	9.2	0.0	1.6
	Brundage	0.8	10.4	0.0	1.6
Hazera	37-127	0.4	3.6	0.0	0.0
Nunhems	Cometa	0.0	14.8	0.0	2.0
	Rhea	0.0	7.6	0.0	0.8
D. Palmer	Diamond Swan	2.0	16.4	0.0	2.4
	average	0.8	11.7	0.1	1.7
LSD (0.05)		NS	7.2	NS	NS

Table 22. Subjective evaluation of bulb characteristics for white onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Company	Variety	Bulb shape ^a	Bulb shape uniformity ^b	Firmness ^b	Scale retention ^b	Skin color ^b	Flesh brightness ^b
		----- 1 - 5 -----					
Bejo	Bridewhite	5	4	3	4	4	4
Crookham	White Cap	6	3	3	3	3	4
	Brundage	6	3	4	4	4	4
Hazera	37-127	4	4	3	4	4	4
Nunhems	Cometa	6	4	3	3	3	4
	Rhea	5	4	4	4	4	3
D. Palmer	Diamond Swan	5	3	3	3	3	3
	Average	5	3	3	3	3	4
LSD (0.05)		NS	NS	1	1	NS	0

^aBulb shape: see Fig. 1. ^b Subjective ratings are described in Table 4. 1=worst, 5=best

Table 23. Maturity ratings and IYSV ratings of full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Seed company	Variety	July 26		August 9		July 29		
		Tops down	Leaf dryness	Tops down	Leaf dryness	IYSV severity ^a	IYSV incidence ^b	Dead plants ^c
		----- % -----		----- % -----		0 - 5	%	%
Bejo	Red Bull	11	17	85	41	1.1	38	10.9
Crookham	Purple Haze	10	10	77	29	1.0	16	1.8
	Red Beret	13	11	82	37	1.0	24	1.8
Enza Zaden	Tannat	9	2	90	21	1.1	24	0.0
New Zealand Onion	TAS042	39	14	94	43	1.1	24	10.9
	8229	18	16	87	40	1.1	32	8.8
Seminis	Red Nugent	24	10	89	33	1.0	24	7.0
	SV 4643NT	31	11	94	37	0.8	28	8.5
D. Palmer	Cherry Mountain	12	7	75	34	0.8	22	0.0
	Chianti	97	91	100	100			
Hazera	37-128	12	19	84	50	1.0	30	22.5
Average		25	19	87	42	1.0	26	7.2
LSD (0.05)		6.2	4.5	5.8	6.6	NS	NS	9.5

^aIYSV severity: 0= no disease, 5=100% of foliage diseased

^bIYSV incidence: percentage of the 10 plants evaluated having at least one lesion

^cDead plants: percentage of the 10 plants evaluated that had completely dead foliage from undetermined causes (possibly pink root or plate rot).

Table 24. Single- and multiple-center ratings for full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
		----- % -----			----- % -----	
Bejo	Red Bull	1.6	13.6	8.8	84.8	76.0
Crookham	Purple Haze	1.6	3.2	5.6	95.2	89.6
	Red Beret	0.0	4.8	8.0	95.2	87.2
Enza Zaden	Tannat	6.4	9.6	5.6	84.0	78.4
New Zealand Onion	TAS042	4.0	25.6	46.4	70.4	24.0
	8229	4.8	11.9	35.7	83.4	47.6
Seminis	Red Nugent	9.6	12.8	18.4	77.6	59.2
	SV 4643NT	7.2	12.0	8.0	80.8	72.8
D. Palmer	Cherry Mountain	3.2	8.8	8.0	88.0	80.0
	Chianti	1.3	12.0	26.7	86.7	60.0
Hazera	37-128	9.6	20.0	25.6	70.4	44.8
Average		4.5	12.2	17.9	83.3	65.4
LSD (0.05)		5.7	7.1	10.8	9.1	12.7

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

Table 25. Yield and grade of full-season experimental and commercial red onion varieties graded out of storage in December 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade							No. 2s	Total rot	Neck rot	Plate rot
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	----- cwt/acre -----				
Bejo	Red Bull	348.1	245.8	0.0	0.0	113.7	132.1	94.0	0.8	2.1	2.0	0.1	
Crookham	Purple Haze	436.3	314.5	0.0	0.0	153.2	161.3	81.1	1.6	9.0	8.7	0.3	
	Red Beret	382.1	273.2	0.0	0.0	121.5	151.7	83.0	0.3	6.7	6.4	0.3	
Enza Zaden	Tannat	673.0	640.1	0.0	3.3	548.8	88.0	23.0	0.9	1.3	0.8	0.5	
New Zealand Onion	TAS042	384.2	261.8	0.0	0.0	72.9	188.8	117.3	1.6	0.9	0.5	0.4	
	8229	320.5	190.5	0.0	0.0	74.7	115.7	117.7	2.3	3.2	2.6	0.6	
Seminis	Red Nugent	479.0	318.7	0.0	0.8	213.5	104.3	55.8	14.5	19.0	18.6	0.4	
	SV 4643NT	434.5	315.6	0.0	0.0	194.9	120.7	74.2	10.3	7.9	7.7	0.2	
D. Palmer	Cherry Mountain	349.4	235.6	0.0	0.0	114.9	120.7	84.3	9.1	5.8	4.1	1.7	
	Chianti	83.9	0.0	0.0	0.0	0.0	0.0	75.2	0.0	10.2	10.2	0.0	
Hazera	37-128	254.4	118.6	0.0	0.0	15.7	102.9	122.4	7.6	2.3	2.2	0.1	
Average		376.9	264.9	0.0	0.4	147.6	116.9	84.4	4.4	6.2	5.8	0.4	
LSD (0.05)		49.0	54.8		NS	46.4	22.9	14.0	6.2	6.7	6.8	NS	

Table 26. Subjective evaluation of bulb characteristics for red onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Company	Variety	Bulb shape ^a	Bulb shape uniformity ^b	Firmness ^b	Scale retention ^b	Skin color ^b	Flesh brightness ^b
----- 1 - 5 -----							
Bejo	Red Bull	6	4	3	4	4	4
Crookham	Purple Haze	5	3	3	4	4	4
	Red Beret	6	4	3	4	3	3
Enza Zaden	Tannat	4	4	4	4	5	5
New Zealand Onion	TAS042	3	4	4	4	3	3
	8229	3	3	4	3	3	4
Seminis	Red Nugent	7	3	3	3	3	3
	SV 4643NT	6	3	3	3	3	3
D. Palmer	Cherry Mountain	4	3	4	4	4	5
	Chianti						
Hazera	37-128	7	3	4	4	4	5
Average		5	3	3	4	3	4
LSD (0.05)		2	1	1	NS	1	1

^aBulb shape: see Fig. 1. ^b Subjective ratings are described in Table 4. 1=worst, 5=best