

2022 ONION VARIETY TRIALS

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Introduction

Direct-seeded yellow, white, and red long-day onion varieties were evaluated in the field in 2022 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-eight full-season varieties (28 yellow, 11 red, and 9 white) were planted in March, harvested in September, and graded out of storage in winter 2022–2023. 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 2022 on Owyhee silt loam previously planted to wheat. After the wheat was harvested in 2021, the stubble was shredded, the field was irrigated to sprout unharvested wheat kernels, and then the field was disced and plowed. A soil analysis taken in the fall of 2021 showed a pH of 7.4, 1.6% organic matter, 8 ppm nitrogen (N) as nitrate, 3 ppm N as ammonium, 27 ppm phosphorus (P), 348 ppm potassium (K), 13 ppm sulfur as sulfate (S), 2626 ppm calcium, 497 ppm magnesium, 216 ppm sodium, 3.3 ppm zinc (Zn), 2 ppm manganese (Mn), 1.5 ppm copper (Cu), 11 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 23 in plots 4 double rows wide and 27 ft long. The early-maturing trial had 10 yellow varieties, from 4 seed companies; the full-season yellow trial had 28 varieties from 6 seed companies; the full-season white trial had 9 varieties from 6 seed companies, and the full-season red trial had 11 varieties from 6 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 Flex Planter units equipped with disc openers.

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 12. On May 13, alleys 4 ft wide were cut between plots, leaving plots 23 ft long. The seedlings were hand-thinned on May 17 and 18 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 7; Avatar (clethodim) at 10 oz/acre, GoalTender (oxyfluorfen) at 4 oz/acre, Brox 2EC (bromoxynil) at 16 oz/acre and Prowl H2O (pendimethalin) at 2 pints/acre on May 25.

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 3; Movento HL (spirotetramat) at 2.5 oz/acre and Aza-Direct at 12 oz/acre on June 10; Movento HL at 2.5 oz/acre on June 17; Agri-Mek SC (abamectin) at 3.5 oz/acre on June 24 and July 1; Radiant (spinetoram) at 8 oz/acre on July 12 and July 19; and Exirel (cyantraniliprole) at 20 oz/acre on July 26 and August 4.

Starting on June 6, weekly root tissue and soil samples were taken from field borders (variety ‘Vaquero’) and analyzed for nutrients by Western Laboratories, Inc., Parma, Idaho. 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 1). 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 7 to July 5, supplying a total of 100 lb N/acre.

Table 1. Nitrogen applied through the drip tape in 2022. Malheur Experiment Station, Oregon State University, Ontario, OR.

Date	N, lb/acre
7-Jun	30
16-Jun	30
20-Jun	30
5-Jul	10
total	100

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 May 23, and irrigations ended on August 27 for the full season varieties. Irrigations for the early maturing varieties ended August 23.

Onions in the early-maturing and red variety trials were evaluated for maturity and bolting on August 1, August 8, and August 15. Onions in the yellow and white variety trials were evaluated for maturity and bolting on August 1 and August 15. 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 yellow and white variety trials were evaluated for IYSV severity on August 15. For the IYSV evaluations, ten consecutive onions in one of the middle two 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. On August 15, onions in the yellow and white variety trials 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 varieties ‘Frontier’, ‘Highlander’, ‘Outlander’, and ‘Switchback’ in the early-maturity trial were topped by hand, bagged, and stored on August 9. Onions from the middle two double rows of the other varieties in the early-maturity trial were topped by hand, bagged, and stored on August 24. The early maturing onions were graded on September 12.

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 ‘Tannat’, which was harvested on September 5. 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 8 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 16. The bags of white and yellow varieties were moved into storage on September 21. 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 2 and December 5. Yellow onions from the full-season trial were graded out of storage in early January 2023. 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 9, 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.

On January 10, 2023, a sample of each variety was evaluated for bulb shape, bulb shape uniformity, firmness, skin color, skin retention, and flesh brightness (Tables 5 and 6, Figure 1). The quality characteristics were evaluated by a group of 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 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.

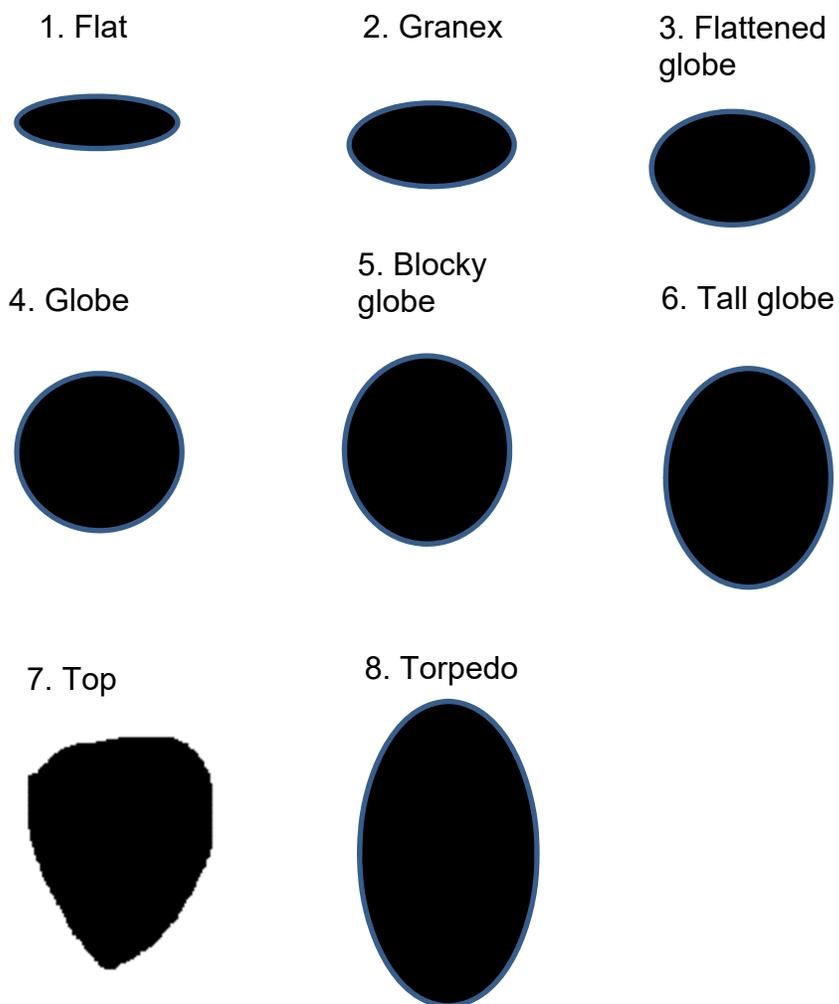


Figure 1. Onion bulb shape rating system. Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 2. 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 = 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 (5 = more desirable)
	1-5	red varieties: 1 = pale red, 5 = dark red (5 = more desirable)
	1-5	white varieties: 1 = less white, 5 = very white (5 = more desirable)

Results

In 2022, the months of April and May were cooler than average and the months of July and August were hotter than average (Table 3). Both maximum and minimum air temperature were above average from mid-July through August (Figures 2 and 3).

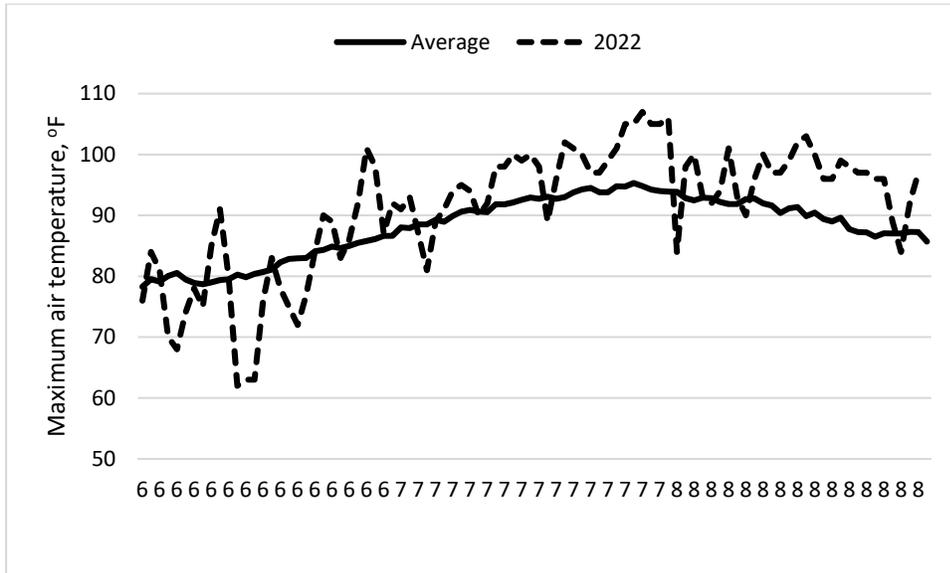


Figure 2. Maximum daily air temperature for June, July, and August in 2022 and the 79-year average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

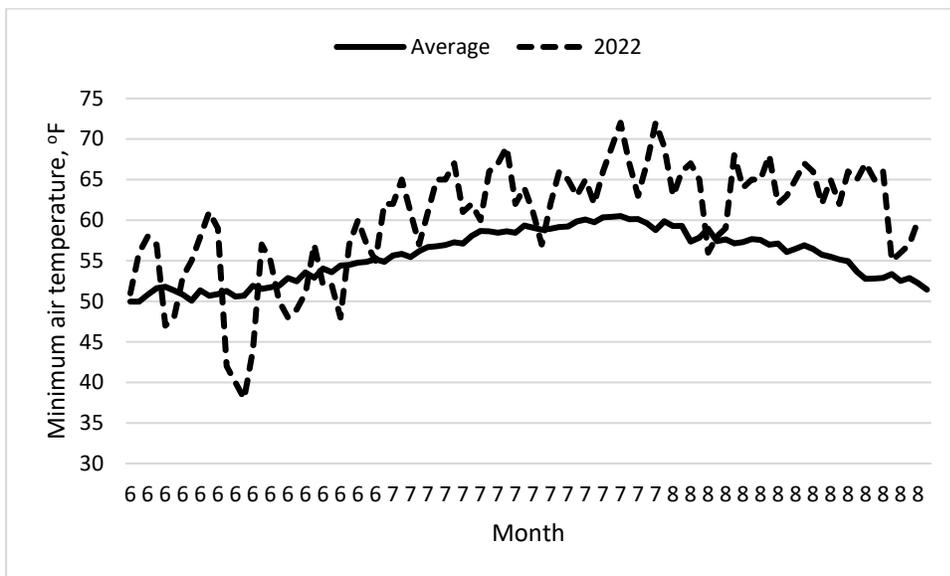


Figure 3. Minimum daily air temperature for June, July, and August in 2022 and the 79-year average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Table 3. Monthly average maximum and minimum air temperature (°F) in 2022 and the 79-year averages. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

		Apr	May	Jun	Jul	Aug
Maximum	2022	60.0	68.7	79.6	96.3	96.4
	Average	64.3	73.5	81.8	91.9	90.1
Minimum	2022	31.3	42.5	51.9	63.9	63.7
	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 2022, both the soil solution N and the root nitrate concentration went above the critical level in mid-June (Figures 5 and 6). The soil solution level showed a gradual increase up to the last sampling on August 11.

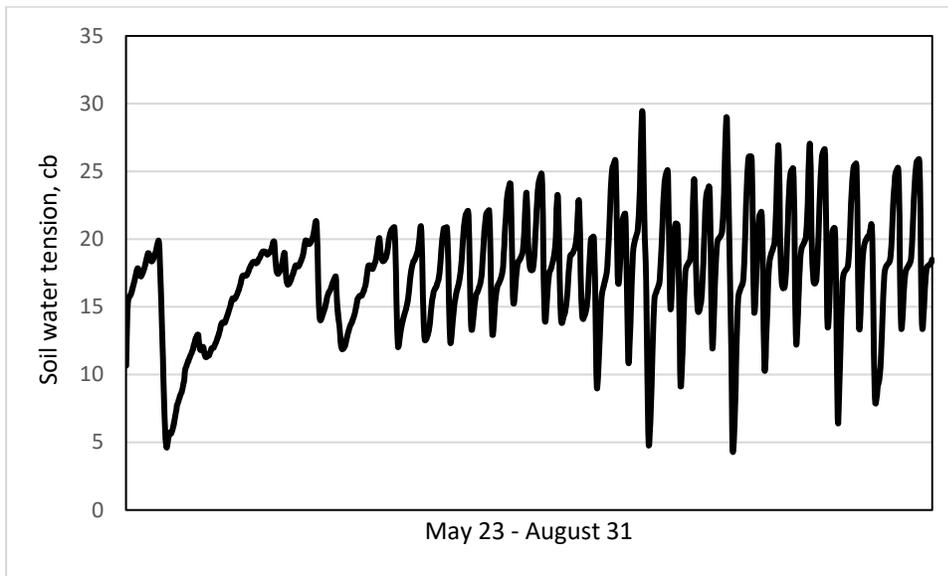


Figure 4. Soil water tension at 8-inch depth. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

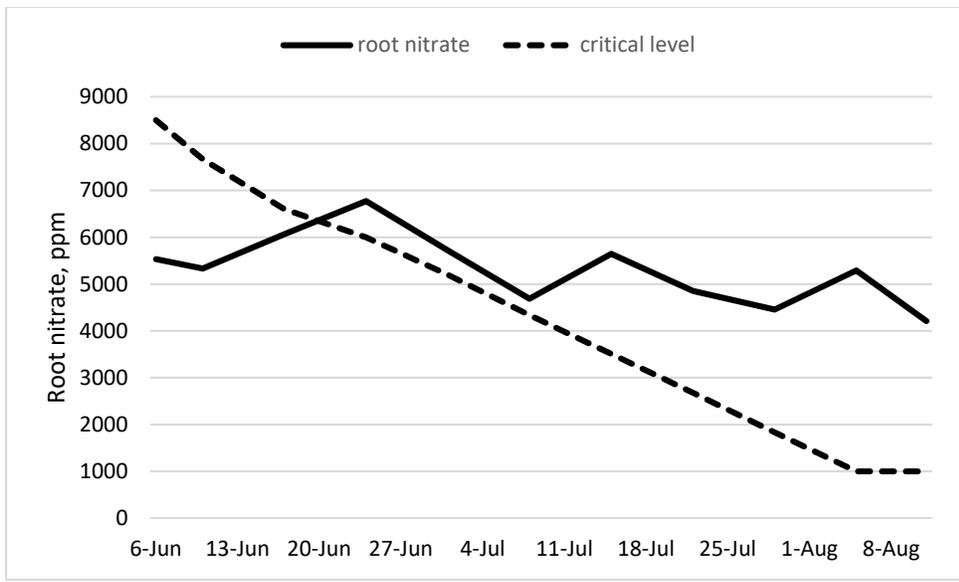


Figure 5. Root nitrate over time. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

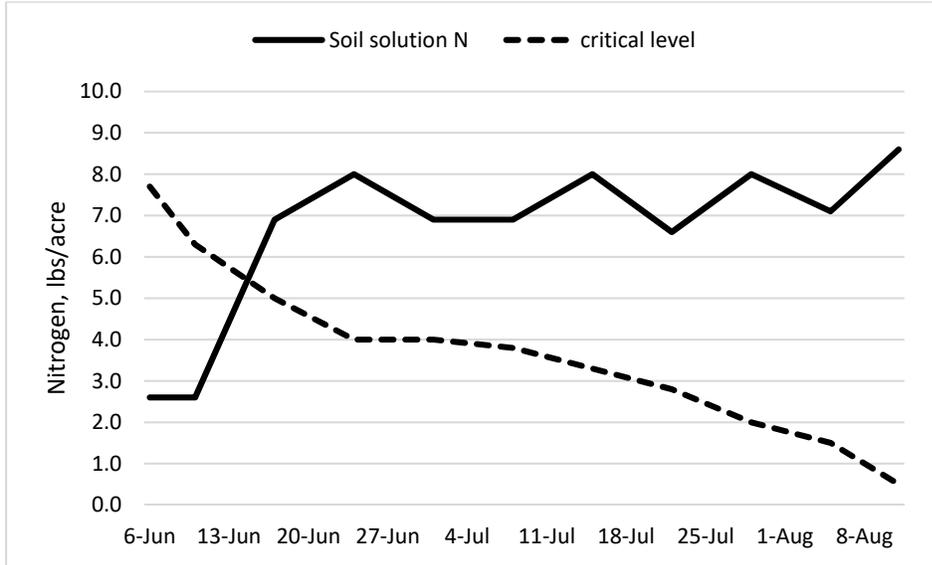


Figure 6. Soil solution N over time. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Early-maturing Trial

On August 1, varieties ‘Highlander’, ‘Outlander’, and ‘Switchback’ had 80% or more tops down (Table 4). On August 8, ‘Highlander’, ‘Outlander’, ‘Frontier’ and ‘Switchback’ had 60% or more tops down and 20% or higher leaf dryness. On August 8, the other varieties had 19% or more tops down, but only 3% or less leaf dryness.

The percentage of onions that were functionally single centered averaged 42% and ranged from 14% for ‘Outlander’ to 78% for ‘Avalon’ (Table 5). Total yield averaged 911 cwt/acre, ranging from 485 cwt/acre for ‘Outlander’ to 1259 cwt/acre for ‘Scout’ (Table 6). After 19 days of storage, bulb decomposition ranged from 0.2% for ‘Switchback’ to 15.8% for ‘Elsye’ (Table 6).

Full-season Trials

Yellow varieties. On August 15, the percentage of tops down averaged 48% and ranged from 12% for ‘Caliber’ to 90% for ‘Traverse’ (Table 7).

The severity of thrips leaf damage, on a scale from 0 to 10, averaged 1.5 and ranged from 1.0 for several varieties to 2.2 for ‘Traverse’, ‘Mondella’, and ‘Montero’ (Table 7). Bolting was very low in 2022, not exceeding 0.1% of bulbs, with most varieties having no bolting. The incidence of IYSV averaged 33% of plants infected and ranged from 10% for ‘Almanzoro’ to 54% for ‘Mondella’. Iris yellow spot virus severity was low in this trial, with an average rating of 1 (0–25% of foliage diseased).

The percentage of functionally single-centered bulbs averaged 80% and ranged from 33% for ‘TTA-782’ to 98% for ‘Arcero’ and ‘Vaquero’ (Table 8).

Total yield out of storage in January 2023 averaged 1083 cwt/acre and ranged from 749 cwt/acre for ‘Thunderstone’ to 1258 cwt/acre for ‘Joaquin’ (Table 9). Marketable yield out of storage in January 2023 averaged 1047 cwt/acre and ranged from 716 cwt/acre for ‘Thunderstone’ to 1237 cwt/acre for ‘Joaquin’.

In December 2022, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 19% and ranged from 2% for ‘Almanzoro’ to 36% for ‘Montero’ (Table 10). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 4% and ranged from 0.4% for ‘Almanzoro’ to 10% for ‘Anillo’. In 2022, internal decomposition was mainly caused by *Fusarium proliferatum* (Table 11).

Results of the subjective evaluation can be found in table 12.

White varieties. The percentage of tops down averaged 38% on August (Table 13).

The severity of thrips leaf damage, on a scale from 0 to 10, was low, averaging 1.1 (Table 13). 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 very low in 2022, not exceeding 0.1% of bulbs, with most varieties having no bolting. The percentage of functionally single-centered bulbs averaged 80% and ranged from 32% for ‘Bridewhite’ to 100% for ‘Rhea’ (Table 14).

Total yield in December 2022 averaged 1083 cwt/acre and ranged from 831 cwt/acre for ‘Diamond Swan’ to 1249 cwt/acre for ‘37-127’ (Table 15). Marketable yield in December 2022 averaged 934 cwt/acre and ranged from 561 cwt/acre for ‘Diamond Swan’ to 1131 cwt/acre for ‘Rhea’. Storage decomposition averaged 13% and ranged from 3% for ‘Rhea’ to 33% for ‘White Cloud’.

In December 2022, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 22% and ranged from 9% for ‘White Cloud’ to 38% for ‘37-127’ (Table 16). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales,

averaged 16% and ranged from 7% for ‘White Cap’ to 27% for ‘Diamond Swan’. In 2022, the internal decomposition was mainly caused by *Fusarium proliferatum* (Table 17).

Results of the subjective evaluation can be found in table 18.

Red varieties. The percentage of tops down averaged 4% on August 1, 29% on August 8, and 59% on August 15 (Table 19).

The percentage of functionally single-centered bulbs averaged 66% and ranged from 19% for ‘Barolo’ to 90% for ‘Purple Haze’ (Table 20).

Total yield in December 2022 averaged 627 cwt/acre and ranged from 488 cwt/acre for ‘8104’ to 916 cwt/acre for ‘Tannat’ (Table 21). Marketable yield in December 2022 averaged 545 cwt/acre and ranged from 353 cwt/acre for ‘37-128’ to 870 cwt/acre for ‘Tannat’. Storage decomposition averaged 6% and ranged from 2% for ‘Tannat’ to 10% for ‘Marengo’, ‘SV4643NT’, and ‘8104’.

In December 2022, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 23% and ranged from 14% for ‘Barolo’ to 40% for ‘Marengo’ (Table 22). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 2% and ranged from 0% for ‘Barolo’ and ‘SV 4643NT’ to 9% for ‘Marengo’. In 2022, the internal decomposition was mainly caused by bacteria (Table 23).

Results of the subjective evaluation can be found in table 24.

Acknowledgements

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Table 4. Maturity ratings for early-maturing onion varieties lifted and harvested in August 2022*, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	1-Aug		8-Aug		15-Aug	
		Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness
		----- % -----					
A. Takii	Frontier	7	10	68	20		
	Highlander	88	5	100	23		
	Outlander	100	10	100	35		
	Switchback	91	12	100	26		
Crookham	Avalon	4	0	26	0	70	9
	Scout	25	1	28	3	74	8
Enza Zaden	Elsye	22	0	84	1	94	9
Sakata	Ovation	8	0	19	1	54	7
	Spanish Medallion	6	0	22	2	46	11
	Yosemite	9	0	62	2	90	9
Average		36	4	61	11	71	9
LSD (0.05)		16	3	13	6	9	NS

*Varieties Frontier, Highlander, Outlander, and Switchback were harvested on August 8. The other varieties were harvested on August 24.

Table 5. Single- and multiple-center bulb ratings for early-maturing onion varieties lifted and harvested in August 2022, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
		----- % -----				
A. Takii	Frontier	11.9	41.1	29.4	46.9	17.5
	Highlander	42.7	26.7	4.0	30.7	26.7
	Outlander	26.0	60.0	8.0	14.0	6.0
	Switchback	14.4	51.2	24.0	34.4	10.4
Crookham	Avalon	0.8	21.6	20.0	77.6	57.6
	Scout	4.8	22.4	21.6	72.8	51.2
Enza Zaden	Elsye	22.4	46.4	22.4	31.2	8.8
Sakata	Ovation	13.6	48.8	18.4	37.6	19.2
	Spanish Medallion	10.4	39.2	14.4	50.4	36.0
	Yosemite	27.2	53.6	12.0	19.2	7.2
Average		17.4	41.1	17.4	41.5	24.1
LSD (0.05)		11.9	16.1	11.1	20.4	19.1

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

Table 6. Yield and grade performance of early-maturing onion varieties lifted and harvested in August 2022*, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Total yield	Marketable yield by grade							Total Rot ^a	Black mold	Plate rot	Flat 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	526.9	478.1	0.0	0.0	143.9	334.2	43.9	1.7	0.6	0.5	0.0	0.1	
	Highlander	555.7	505.6	0.0	24.1	358.7	122.8	30.0	8.9	2.2	2.2	0.0	0.0	
	Outlander	484.9	427.7	0.0	0.0	235.7	191.9	32.4	12.6	2.4	2.4	0.0	0.0	
	Switchback	581.8	544.0	0.0	2.3	287.9	253.9	36.4	0.0	0.2	0.2	0.0	0.0	
Crookham	Avalon	1188.0	1100.6	170.4	400.8	487.2	42.2	11.8	0.0	6.4	5.2	0.4	0.8	33.8
	Scout	1259.2	1188.8	163.1	421.0	570.8	34.0	16.5	0.0	4.3	2.6	0.2	1.5	32.9
Enza Zaden	Elsye	1180.9	966.0	123.2	343.2	451.8	47.7	13.5	7.0	16.2	15.8	0.3	0.1	31.5
Sakata	Ovation	1250.7	1147.3	198.3	472.6	441.5	34.9	12.5	6.6	6.8	6.2	0.0	0.6	33.8
	Spanish Medallion	1038.8	906.0	210.0	387.8	282.5	25.8	6.8	7.8	11.4	10.7	0.3	0.4	32.1
	Yosemite	1040.7	942.7	61.1	268.7	541.3	71.6	7.9	13.6	7.4	7.0	0.0	0.3	34.4
	Average	910.8	820.7	92.6	232.0	380.1	115.9	21.2	5.8	5.8	5.3	0.1	0.4	33.1
LSD (0.05)		61.1	75.4	43.1	40.2	54.5	26.4	9.1	7.3	4.6	4.8	NS	0.9	2.3

*Varieties Frontier, Highlander, Outlander, and Switchback were harvested on August 8. The other varieties were harvested on August 24.

^aAfter 19 days of storage.

Table 7. Maturity, IYSV ratings, thrips leaf damage on August 15, and number of leaves per plant of full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Seed company	Variety	Tops down	Leaf dryness	IYSV severity ^a	IYSV incidence ^b	Thrips damage ^c	Number of leaves	
							24-Jun	2-Aug
		----- % -----		0 - 5	%	0-10		
A. Takii	Traverse	90	14	1.0	52	2.2	7.9	9.7
	TTA-782	80	7	0.8	16	1.6	7.6	11.1
Bejo	Mondella	54	10	1.1	54	2.2	7.4	9.7
	Hamilton	17	3	1.0	28	1.6	7.6	10.9
	Legend	78	8	1.1	34	1.6	7.5	10.4
	Sedona	15	3	1.0	32	1.8	7.6	10.8
Crookham	Trident	72	11	1.0	36	2.0	7.7	10.5
	Caldwell	56	4	1.0	32	1.2	7.1	10.2
	Caliber	12	1	1.1	30	1.0	7.2	11.0
	Epic	84	10	1.0	48	2.0	6.6	9.5
	Defender	24	4	1.0	34	1.0	7.2	10.8
Hazera	Thunderstone	82	9	1.0	28	1.8	7.3	10.5
	37-126	52	10	0.9	32	1.6	6.8	11.0
Nunhems	Anillo	28	3	1.0	44	1.6	7.1	10.6
	Arcero	16	7	1.0	50	2.0	7.0	10.0
	Campero	36	6	1.0	18	1.0	7.4	10.5
	Granero	46	6	1.0	42	1.2	7.4	11.0
	Joaquin	16	2	1.0	36	1.0	7.6	11.5
	Montero	86	11	1.0	46	2.2	7.5	10.1
	Oloroso	23	4	1.0	50	1.4	7.1	10.4
	Pandero	18	1	1.0	24	1.0	7.2	11.1
	Vaquero	40	7	1.0	34	1.4	7.5	11.0
Seminis	Crusher	70	1	1.0	20	1.0	7.4	10.9
	Tucannon	73	5	1.0	28	1.2	7.4	11.0
	Jawbridge	55	2	1.0	26	1.2	6.7	11.8
	Almanzoro	44	2	0.6	10	1.0	7.3	11.0
	16000	66	2	1.0	20	1.0	6.9	11.3
	Hatchet	15	3	1.0	26	1.2	8.0	11.2
Average		48	6	1.0	33	1.5	7.3	10.7
LSD (0.05)		15	4	NS	23	0.5	0.6	0.6

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

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

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

Table 8. Single- and multiple-center ratings for full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
		----- % -----				
A. Takii	Traverse	0.8	30.7	33.1	68.5	35.4
	TTA-782	3.2	64.0	19.2	32.8	13.6
Bejo	Mondella	2.4	24.8	17.6	72.8	55.2
	Hamilton	6.4	22.4	17.6	71.2	53.6
	Legend	12.8	52.8	28.8	34.4	5.6
	Sedona	10.4	39.2	22.4	50.4	28.0
Crookham	Trident	0.8	4.8	10.4	94.4	84.0
	Caldwell	0.8	3.2	4.8	96.0	91.2
	Caliber	0.0	4.8	5.6	95.2	89.6
	Epic	1.6	8.8	17.6	89.6	72.0
	Defender	0.8	6.4	6.4	92.8	86.4
Hazera	Thunderstone	3.2	15.2	19.2	81.6	62.4
	37-126	3.2	38.4	31.2	58.4	27.2
Nunhems	Anillo	0.0	3.2	2.4	96.8	94.4
	Arcero	0.0	2.4	9.6	97.6	88.0
	Campero	4.0	43.6	23.3	52.4	29.1
	Granero	0.8	15.1	11.9	84.1	72.2
	Joaquin	0.8	7.2	5.6	92.0	86.4
	Montero	0.0	10.4	16.0	89.6	73.6
	Oloroso	1.6	3.2	2.4	95.2	92.8
	Pandero	1.6	18.4	15.2	80.0	64.8
	Vaquero	0.0	2.4	12.0	97.6	85.6
Seminis	Crusher	1.6	12.0	11.2	86.4	75.2
	Tucannon	2.4	13.6	20.8	84.0	63.2
	Jawbridge	0.8	13.6	6.4	85.6	79.2
	Almanzoro	4.7	20.5	20.5	74.8	54.3
	16000	1.6	8.0	10.4	90.4	80.0
	Hatchet	0.0	8.8	13.6	91.2	77.6
Average		2.4	17.8	14.8	79.8	65.0
LSD (0.05)		4.1	10.1	9.7	10.7	12.6

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

Table 9. Yield and grade of full-season experimental and commercial yellow onion varieties graded out of storage in January 2023, 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	909	867	0.0	75.6	723.5	67.8	11.9	0.0		3.28	0.75	0.17	2.36
	TTA-782	1167	1129	70.6	371.9	653.1	33.0	8.3	4.4	34	2.24	0.38	0.40	1.45
Bejo	Mondella	922	893	13.6	147.9	657.9	73.2	15.7	7.4	41	0.69	0.36	0.24	0.09
	Hamilton	1069	1047	36.0	293.9	666.0	51.2	7.5	4.5	38	0.90	0.54	0.03	0.33
	Legend	987	941	8.3	187.5	663.3	82.3	16.2	17.1	37	1.28	0.72	0.30	0.27
	Sedona	1118	1091	53.3	311.8	676.7	49.4	9.8	11.9	36	0.47	0.13	0.34	0.00
Crookham	Trident	932	901	17.4	137.8	660.2	85.5	16.5	0.0	36	1.59	0.61	0.10	0.88
	Caldwell	1105	1081	80.2	338.1	615.0	47.5	10.3	2.2	35	1.06	0.24	0.33	0.49
	Caliber	1176	1126	222.1	452.7	405.4	45.7	8.8	1.8	34	3.23	1.68	0.46	1.09
	Epic	947	818	13.2	94.6	635.5	75.1	13.0	0.0	35	12.05	2.56	0.16	9.33
	Defender	1122	1034	90.1	327.8	574.3	41.8	7.9	2.4	36	6.89	0.94	0.06	5.88
Hazera	Thunderstone	749	716	13.3	113.4	466.0	123.2	19.4	0.0	36	1.84	0.60	0.15	1.08
	37-126	973	933	39.6	218.0	627.1	48.1	12.7	1.7	35	2.74	1.63	0.02	1.09
Nunhems	Anillo	1133	1114	69.8	367.7	645.0	31.7	9.2	0.2	37	0.83	0.22	0.36	0.26
	Arcero	1102	1082	73.5	346.1	632.5	30.3	9.2	1.2	40	0.85	0.31	0.23	0.31
	Campero	1153	1103	74.8	386.0	605.9	35.9	7.9	6.0	37	3.13	0.51	0.00	2.61
	Granero	1126	1106	90.6	356.6	621.3	37.0	10.7	2.8	35	0.66	0.36	0.07	0.23
	Joaquin	1258	1237	179.0	483.8	539.0	35.7	8.7	0.8	35	0.88	0.25	0.23	0.40
	Montero	1026	962	61.0	273.0	573.3	55.0	12.1	0.7	34	4.92	3.04	0.29	1.59
	Oloroso	994	970	20.5	230.2	673.6	45.6	9.9	0.0	36	1.50	0.36	0.00	1.15
	Pandero	1104	1069	123.2	389.8	519.4	36.7	10.7	1.1	34	2.02	0.67	0.38	0.98
	Vaquero	1222	1206	171.1	429.4	566.0	39.0	8.7	0.5	35	0.58	0.45	0.12	0.00
Seminis	Crusher	1206	1182	153.4	427.0	576.4	25.1	10.6	1.0	35	1.00	0.37	0.06	0.57
	Tucannon	1052	1021	81.8	285.5	607.2	46.4	11.7	2.9	37	1.55	0.12	0.12	1.30
	Jawbridge	1176	1162	182.2	425.5	529.1	25.5	7.9	0.9	35	0.40	0.18	0.22	0.00
	Almanzoro	1141	1117	96.9	321.1	664.9	34.2	11.7	7.4	37	0.44	0.00	0.00	0.44
	16000	1231	1205	229.8	412.7	532.1	30.8	9.6	3.3	35	1.04	0.62	0.42	0.00
	Hatchet	1234	1212	146.5	430.7	590.6	44.5	9.9	3.1	36	0.72	0.52	0.20	0.00
Average		1083	1047	86.1	308.4	603.6	49.2	10.9	3.1	36	2.10	0.68	0.19	1.22
LSD (0.05)		74	75	54.1	76.4	80.2	21.3	6.6	5.1	3	2.20	1.50	NS	1.80

Table 10. Internal defects of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2022, 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	66.8	0.4	67.2	28.0	4.8	32.8	100	0.4	0.0	0.4	0.8	0.0	0.8	1.2
	TTA-782	95.2	0.8	96.0	3.2	0.8	4.0	100	0.0	0.0	0.0	0.8	0.4	1.2	1.2
Bejo	Mondella	69.6	1.2	70.8	19.6	9.6	29.2	100	1.6	0.8	2.4	0.4	2.4	2.8	5.2
	Hamilton	83.2	2.8	86.0	9.6	4.4	14.0	100	0.8	1.6	2.4	3.2	2.8	6.0	8.4
	Legend	80.8	0.4	81.2	16.0	2.8	18.8	100	0.4	0.4	0.8	0.8	1.2	2.0	2.8
	Sedona	91.7	0.7	92.5	4.7	2.8	7.5	100	0.4	0.7	1.1	0.0	0.8	0.8	1.9
Crookham	Trident	70.0	0.8	70.8	19.2	10.0	29.2	100	0.8	0.4	1.2	0.4	2.0	2.4	3.6
	Caldwell	87.0	0.5	87.5	11.0	1.5	12.5	100	1.5	0.5	2.0	1.0	1.5	2.5	4.5
	Caliber	88.1	2.4	90.5	7.4	2.2	9.5	100	2.9	0.8	3.7	2.9	1.3	4.2	7.9
	Epic	70.0	0.0	70.0	28.4	1.6	30.0	100	0.8	0.0	0.8	0.4	0.4	0.8	1.6
	Defender	88.4	1.2	89.6	6.4	4.0	10.4	100	1.2	0.4	1.6	0.4	0.8	1.2	2.8
Hazera	Thunderstone	67.6	0.0	67.6	26.4	6.0	32.4	100	0.0	0.0	0.0	0.4	1.2	1.6	1.6
	37-126	80.4	1.2	81.6	12.4	6.0	18.4	100	0.8	0.4	1.2	2.0	3.6	5.6	6.8
Nunhems	Anillo	75.6	3.2	78.8	11.6	9.6	21.2	100	0.8	1.2	2.0	3.2	5.2	8.4	10.4
	Arcero	77.6	2.4	80.0	11.2	8.8	20.0	100	1.2	0.8	2.0	0.0	4.4	4.4	6.4
	Campero	76.4	0.8	77.2	16.0	6.8	22.8	100	0.4	0.4	0.8	0.4	4.4	4.8	5.6
	Granero	84.8	1.2	86.0	8.4	5.6	14.0	100	0.0	0.8	0.8	1.2	2.0	3.2	4.0
	Joaquin	81.1	0.8	81.9	7.6	10.4	18.1	100	0.0	0.0	0.0	0.8	2.8	3.6	3.6
	Montero	64.0	0.4	64.4	22.4	13.2	35.6	100	0.0	0.4	0.4	0.8	0.4	1.2	1.6
	Oloroso	74.0	0.4	74.4	11.2	14.4	25.6	100	1.2	0.0	1.2	1.2	4.0	5.2	6.4
	Pandero	75.6	0.8	76.4	9.2	14.4	23.6	100	0.4	0.0	0.4	1.2	5.2	6.4	6.8
	Vaquero	77.7	1.7	79.4	14.2	6.4	20.6	100	1.4	0.8	2.2	0.5	2.8	3.3	5.5
Seminis	Crusher	87.2	0.4	87.6	4.4	7.9	12.4	100	0.4	0.4	0.8	0.4	1.2	1.6	2.4
	Tucannon	88.7	0.8	89.5	4.0	6.5	10.5	100	0.4	0.4	0.8	0.8	1.6	2.4	3.2
	Jawbridge	88.8	0.8	89.6	4.4	6.0	10.4	100	1.6	0.0	1.6	0.8	2.0	2.8	4.4
	Almanzoro	96.8	0.8	97.6	1.2	1.2	2.4	100	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	16000	84.0	1.6	85.6	11.2	3.2	14.4	100	0.4	0.8	1.2	0.8	1.2	2.0	3.2
	Hatchet	74.8	2.4	77.2	13.6	9.2	22.8	100	0.4	0.4	0.8	2.0	3.2	5.2	6.0
	average	80.2	1.1	81.3	12.3	6.4	18.7	100	0.7	0.4	1.2	1.0	2.1	3.1	4.3
LSD (0.05)		12.9	NS	13.6	10.5	8.4	13.6		NS	NS	1.9	NS	NS	4.0	4.2

Table 11. Internal decomposition by disease type of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2022, 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	0.4	0.0	0.8
	TTA-782	0.0	0.8	0.0	0.4
Bejo	Mondella	1.6	2.4	0.0	1.2
	Hamilton	3.2	4.0	0.0	1.2
	Legend	1.6	1.2	0.0	0.0
	Sedona	0.4	1.1	0.4	0.0
Crookham	Trident	2.4	0.8	0.0	0.4
	Caldwell	1.0	2.5	0.5	0.5
	Caliber	2.9	4.2	0.0	0.8
	Epic	1.2	0.4	0.0	0.0
	Defender	0.8	0.8	0.0	1.2
Hazera	Thunderstone	0.0	1.6	0.0	0.0
	37-126	3.2	3.6	0.0	0.0
Nunhems	Anillo	1.2	8.8	0.0	0.4
	Arcero	2.8	3.6	0.0	0.0
	Campero	0.8	3.6	0.0	1.2
	Granero	1.6	2.0	0.0	0.4
	Joaquin	0.4	3.2	0.0	0.0
	Montero	0.8	0.8	0.0	0.0
	Oloroso	0.0	5.2	0.0	1.2
	Pandero	2.0	4.8	0.0	0.0
	Vaquero	1.6	3.9	0.0	0.0
Seminis	Crusher	0.8	1.6	0.0	0.0
	Tucannon	0.8	2.4	0.0	0.0
	Jawbridge	1.6	2.8	0.0	0.0
	Almanzoro	0.0	0.4	0.0	0.0
	16000	0.8	2.4	0.0	0.0
	Hatchet	0.8	5.2	0.0	0.0
	average	1.2	2.7	0.0	0.3
LSD (0.05)		NS	3.3	NS	1.0

Table 12. Subjective evaluation of bulb characteristics for yellow onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

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	3.0	4.0	3.5	2.5	3.0	3.5
	TTA-782	3.5	4.0	4.0	4.5	4.0	3.5
Bejo	Mondella	3.5	3.0	3.0	3.5	3.5	3.0
	Hamilton	3.5	4.0	5.0	5.0	4.0	3.0
	Legend	4.0	4.0	4.0	5.0	3.5	3.0
	Sedona	4.0	2.0	4.0	4.0	3.0	3.0
Crookham	Trident	4.0	2.0	2.5	3.0	3.0	3.5
	Caldwell	4.0	3.5	3.0	3.0	3.0	3.5
	Caliber	3.0	2.0	3.0	3.0	2.0	4.0
	Epic	3.0	4.0	3.0	2.5	3.0	4.0
	Defender	5.0	3.5	4.0	4.0	3.5	3.0
Hazera	Thunderstone	4.0	3.5	3.0	4.0	4.0	3.0
	37-126	4.0	3.0	4.0	5.0	4.5	4.5
Nunhems	Anillo	4.0	3.0	3.5	3.5	4.0	4.0
	Arcero	4.0	3.5	4.0	4.0	4.0	4.5
	Campero	4.0	3.5	3.5	4.0	4.5	3.5
	Granero	5.0	4.0	4.0	3.5	3.5	3.0
	Joaquin	6.0	3.5	4.0	3.5	3.5	4.0
	Montero	4.0	3.0	2.5	3.0	3.0	4.0
	Oloroso	4.0	3.5	4.0	3.5	3.5	3.0
	Pandero	4.0	4.0	4.0	4.0	3.5	3.5
Seminis	Vaquero	4.0	3.5	3.0	3.5	3.5	3.0
	Crusher	6.0	4.0	4.0	4.0	3.5	4.0
	Tucannon	4.0	3.0	4.0	4.0	4.5	3.0
	Jawbridge	6.0	3.0	3.5	3.5	3.5	3.5
	Almanzoro	5.0	4.0	4.0	4.0	3.5	4.0
	16000	4.0	3.5	3.0	3.5	3.5	2.5
Hatchet	4.0	4.0	3.5	3.5	3.0	3.5	
Average		4.2	3.4	3.6	3.7	3.5	3.5

^aBulb shape: see Fig. 1.

^bSubjective ratings are described in Table 4: 1 = worst, 5 = best.

Table 13. Maturity, bolting, thrips leaf damage, and IYSV ratings of full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Seed company	Variety	August 15					Number of leaves	
		Tops down	Leaf dryness %	Thrips leaf damage ^a 0 - 10	IYSV severity ^b 0 - 5	IYSV Incidence ^c %	24-Jun	2-Aug
Bejo	Bridewhite	14	1	1.0	1.0	60	7.7	11.7
Crookham	Brundage	32	2	1.0	1.0	30	7.0	11.4
	White Cap	65	7	1.0	1.0	42	6.9	10.6
	White Cloud	54	3	1.0	0.8	26	7.5	10.2
Hazera	37-127	11	3	1.0	1.0	46	7.0	11.4
Nunhems	Cometa	64	3	1.6	1.0	28	6.8	11.2
	Rhea	80	0	1.0	1.0	44	7.3	10.9
Seminis	Tacana	15	7	1.3	1.0	43	6.6	10.9
D. Palmer	Diamond Swan	5	5	1.0	1.0	36	6.4	11.2
Average		38	3	1.1	1.0	39	7.0	11.0
LSD (0.05)		15	4	0.3	NS	NS	NS	0.7

^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

Table 14. Single- and multiple-center ratings for full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
Bejo	Bridewhite	2.4	65.6	20.0	32.0	12.0
Crookham	Brundage	0.8	4.0	5.6	95.2	89.5
	White Cap	0.0	8.8	12.8	91.2	78.4
	White Cloud	8.8	46.4	18.4	44.8	26.4
Hazera	37-127	0.8	8.0	6.4	91.2	84.8
Nunhems	Cometa	0.8	2.4	8.0	96.8	88.8
	Rhea	0.0	0.0	3.2	100.0	96.8
Seminis	Tacana	1.3	4.0	12.0	94.7	82.7
D. Palmer	Diamond Swan	8.0	20.0	36.0	72.0	36.0
Average		2.5	17.7	13.6	79.8	66.2
LSD (0.05)		3.5	9.0	6.4	7.8	8.9

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

Table 15. Yield and grade of full-season experimental and commercial white onion varieties graded out of storage in December 2022, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Marketable yield by grade											
		Total yield	Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	No. 2s	Bulb counts >4¼ in	Total rot	Neck rot	Plate rot
		cwt/acre							#/50 lb		--- % of total yield ---		
Bejo	Bridewhite	1026	927	9.4	228.1	619.2	70.5	13.9	0.0	37.2	8.3	7.5	0.7
Crookham	Brundage	1090	1010	74.2	300.7	585.2	50.2	10.2	0.3	36.0	6.4	6.2	0.2
	White Cap	1048	982	62.6	280.0	575.6	63.8	12.1	0.9	35.6	5.1	5.1	0.0
	White Cloud	1237	825	63.0	334.4	387.7	40.1	11.1	0.0	33.0	32.6	32.6	0.0
Hazera	37-127	1249	1125	126.1	472.9	500.6	25.8	5.2	2.2	34.8	9.3	9.3	0.0
Nunhems	Cometa	1153	1113	82.6	380.9	608.2	41.2	14.0	0.0	35.4	2.3	2.3	0.0
	Rhea	1185	1131	73.7	413.5	594.8	49.0	13.7	0.0	35.0	3.4	3.4	0.0
Seminis	Tacana	927	731	26.0	251.6	418.0	35.2	2.8	0.0	33.0	21.0	21.0	0.0
D. Palmer	Diamond Swan	831	561	109.4	240.1	197.7	13.6	4.9	41.3	35.4	27.0	27.0	0.0
Average		1083	934	69.7	322.5	498.6	43.3	9.8	5.0	35.0	12.8	12.7	0.1
LSD (0.05)		57	86	41.0	55.6	91.2	18.6	5.5	1.8	NS	5.2	5.2	NS

Table 16. Internal defects of full-season experimental and commercial white onion varieties evaluated out of storage in December 2022, 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	76.5	0.5	77.0	5.8	17.2	23.0	100	0.0	0.0	0.0	2.0	17.2	19.2	19.2
Crookham	Brundage	79.6	0.0	79.6	1.6	18.8	20.4	100	0.4	0.0	0.4	0.8	15.6	16.4	16.8
	White Cap	89.2	0.0	89.2	1.2	9.6	10.8	100	1.2	0.0	1.2	0.0	6.0	6.0	7.2
	White Cloud	88.2	2.9	91.1	0.0	8.9	8.9	100	0.0	1.3	1.3	0.0	7.2	7.2	8.5
Hazera	37-127	60.0	1.7	61.7	8.9	29.3	38.3	100	0.8	0.9	1.7	1.7	19.7	21.4	23.1
Nunhems	Cometa	82.0	0.0	82.0	0.4	17.6	18.0	100	0.4	0.0	0.4	0.4	14.0	14.4	14.8
	Rhea	69.6	3.6	73.2	5.6	21.2	26.8	100	0.4	0.8	1.2	0.0	13.2	13.2	14.4
Seminis	Tacana	80.0	1.3	81.3	2.7	16.0	18.7	100	0.0	0.7	0.7	1.3	8.0	9.3	10.0
D. Palmer	Diamond Swan	68.8	0.0	68.8	0.0	31.3	31.3	100	0.0	0.0	0.0	0.0	27.1	27.1	27.1
average		77.1	1.1	78.2	2.9	18.9	21.8	100.0	0.4	0.4	0.8	0.7	14.2	14.9	15.7
LSD (0.05)		10.9	NS	10.9	3.1	10.3	10.9		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 2022, 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	17.2	0.0	0.0
Crookham	Brundage	2.0	14.8	0.0	0.0
	White Cap	0.4	6.0	0.4	0.4
	White Cloud	0.8	7.2	0.0	0.4
Hazera	37-127	3.2	20.0	0.0	0.0
Nunhems	Cometa	0.8	14.0	0.0	0.0
	Rhea	5.2	8.8	0.4	0.0
Seminis	Tacana	0.7	8.7	0.0	0.7
	Diamond				
D. Palmer	Swan	10.4	16.7	0.0	0.0
average		2.8	12.6	0.1	0.2
LSD (0.05)		NS	NS	NS	NS

Table 18. Subjective evaluation of bulb characteristics for white onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Company	Variety	Bulb shape ^a	Bulb shape uniformity ^b	Firmness ^b	Scale retention ^b	Skin color ^b	Flesh brightness ^b
		----- 1 - 5 -----					
Bejo	Bridewhite	3.0	4.0	3.5	4.0	4.0	4.0
Crookham	Brundage	4.0	2.5	4.0	3.5	3.5	4.0
	White Cap	6.0	3.0	3.5	4.0	4.0	4.0
	White Cloud	4.0	3.0	3.0	3.5	3.0	4.5
Hazera	37-127	3.0	4.0	3.0	4.0	4.5	4.0
Nunhems	Cometa	6.0	4.0	3.5	4.0	4.0	4.0
	Rhea	4.0	4.0	3.5	4.0	4.5	4.0
Seminis	Tacana	3.0	4.0	4.0	3.5	3.0	3.0
D. Palmer	Diamond Swan	4.0	2.0	3.5	3.5	3.0	3.5
Average		4.1	3.4	3.5	3.8	3.7	3.9

^aBulb shape: see Fig. 1.

^bSubjective ratings are described in Table 4: 1 = worst, 5 = best.

Table 19. Maturity ratings and number of leaves per plant of full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Company	Variety	August 1		August 8		August 15		Number of leaves	
		Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness	24-Jun	2-Aug
----- % -----									
Bejo	Red Bull	2	2	18	10	61	19	7.2	9.0
	Red Carpet	1	0	7	8	34	18	6.8	9.0
	Redwing	0	0	3	9	28	18	6.9	9.2
Crookham	Purple Haze	1	0	23	6	65	14	7.2	10.3
	Red Beret	7	0	46	6	84	14	7.1	10.1
Enza Zaden	Barolo	11	0	63	7	91	14	7.5	9.0
	Tannat	0	0	15	1	56	8	7.6	10.9
Nunhems	Marengo	0	0	8	3	25	13	6.7	9.7
Seminis	SV 4643NT	16	0	82	9	88	19	7.4	8.9
Hazera	37-128	3	1	33	10	64	20	7.3	8.5
	8104	0	0	23	8	50	15	7.6	9.1
Average		4	0	29	7	59	16	7.2	9.4
LSD (0.05)		6	NS	13	3	14	4	NS	0.7

Table 20. Single- and multiple-center ratings for full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

Seed company	Variety	Multiple center			Single center	
		large	medium	small	functional ^a	bullet
----- % -----						
Bejo	Red Bull	6.4	24.8	22.4	68.8	46.4
	Red Carpet	4.0	18.4	23.2	77.6	54.4
	Redwing	8.0	13.6	18.4	78.4	60.0
Crookham	Purple Haze	1.6	8.8	12.8	89.6	76.8
	Red Beret	4.8	12.8	17.6	82.4	64.8
Enza Zaden	Barolo	36.8	44.0	14.4	19.2	4.8
	Tannat	5.6	20.8	26.4	73.6	47.2
Nunhems	Marengo	4.0	16.0	14.0	80.0	66.0
Seminis	SV 4643NT	28.8	18.4	15.2	52.8	37.6
Hazera	37-128	26.4	40.8	17.6	32.8	15.2
	8104	13.3	16.0	16.0	70.7	54.7
Average		12.7	21.3	18.0	66.0	48.0
LSD (0.05)		8.0	10.3	NS	12.7	14.5

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

Table 21. Yield and grade of full-season experimental and commercial red onion varieties graded out of storage in December 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 -----			
Bejo	Red Bull	565	487	0.0	1.2	216.1	270.0	45.3	2.3		5.5	2.4	3.0	0.1
	Red Carpet	576	511	0.0	0.0	230.9	280.4	44.8	2.2		3.0	1.5	1.4	0.1
	Redwing	572	498	0.0	0.0	202.2	296.1	52.8	0.0		3.6	1.7	1.5	0.5
Crookham	Purple Haze	652	578	0.0	5.0	345.6	227.2	29.6	1.6		6.6	5.4	1.2	0.0
	Red Beret	655	577	0.0	2.7	326.4	248.0	36.1	1.1		6.3	4.6	1.4	0.4
Enza Zaden	Barolo	740	671	0.0	4.3	445.4	221.6	24.9	21.9		2.9	1.1	1.7	0.1
	Tannat	916	870	1.6	89.8	715.8	62.7	10.8	18.3	32.1	1.8	1.4	0.4	0.0
Nunhems	Marengo	572	470	0.0	15.9	373.1	80.6	19.8	24.7		10.0	1.4	8.7	0.0
Seminis	SV 4643NT	671	563	0.0	17.2	394.7	151.3	25.6	14.2		10.0	5.7	4.2	0.1
Hazera	37-128	490	353	0.0	0.0	65.5	287.7	78.5	48.3		2.2	1.1	1.1	0.0
	8104	488	420	0.0	7.1	272.6	140.7	15.9	1.0		10.3	5.8	3.5	1.0
Average		627	545	0.0	13.0	326.2	206.0	34.9	12.3		5.7	2.9	2.5	0.2
LSD (0.05)		54	58	NS	10.5	58.9	45.1	15.7	9.8		4.0	3.1	2.0	NS

Table 22. Internal defects of full-season experimental and commercial red onion varieties evaluated out of storage in December 2022, 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	Red Bull	84.8	0.4	85.2	11.2	3.6	14.8	100.0	0.0	0.0	0.0	0.8	0.4	1.2	1.2
	Red Carpet	81.6	1.2	82.8	11.6	5.6	17.2	100.0	0.4	0.4	0.8	0.0	0.8	0.8	1.6
	Redwing	73.6	0.4	74.0	18.4	7.6	26.0	100.0	0.4	0.0	0.4	0.0	2.0	2.0	2.4
Crookham	Purple Haze	65.6	0.0	65.6	20.4	14.0	34.4	100.0	0.4	0.0	0.4	0.0	2.8	2.8	3.2
	Red Beret	81.6	0.8	82.4	9.2	8.4	17.6	100.0	0.0	0.4	0.4	0.0	1.6	1.6	2.0
Enza Zaden	Barolo	86.0	0.0	86.0	12.8	1.2	14.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tannat	59.6	2.0	61.6	19.6	18.8	38.4	100.0	0.0	0.8	0.8	0.0	2.0	2.0	2.8
Nunhems	Marengo	60.0	0.0	60.0	20.0	20.0	40.0	100.0	0.0	0.0	0.0	0.0	9.0	9.0	9.0
Seminis	SV 4643NT	84.8	0.4	85.2	10.4	4.4	14.8	100.0	0.0	0.0	0.0	0.4	0.0	0.4	0.4
Hazera	37-128	82.4	1.6	84.0	11.6	4.4	16.0	100.0	0.0	0.4	0.4	0.4	1.2	1.6	2.0
	8104	79.2	0.0	79.2	11.3	9.5	20.8	100.0	0.0	0.0	0.0	0.0	2.2	2.2	2.2
	average	76.3	0.6	76.9	14.2	8.9	23.1	100.0	0.1	0.2	0.3	0.1	2.0	2.1	2.4
LSD (0.05)		15.9	NS	16.7	NS	10.5	16.7		NS	NS	NS	NS	2.8	2.9	2.9

Table 23. Internal decomposition by disease type of full-season experimental and commercial white onion varieties evaluated out of storage in December 2022, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bacterial rot	<i>Fusarium proliferatum</i>	Neck rot	Black mold
----- % -----					
Bejo	Red Bull	1.2	0.0	0.0	0.0
	Red Carpet	1.2	0.4	0.0	0.0
	Redwing	1.6	0.4	0.0	0.4
Crookham	Purple Haze	0.4	2.4	0.4	0.0
	Red Beret	1.6	0.4	0.0	0.0
Enza Zaden	Barolo	0.0	0.0	0.0	0.0
	Tannat	2.4	0.4	0.0	0.0
Nunhems	Marengo	3.0	0.0	6.0	0.0
Seminis	SV 4643NT	0.4	0.0	0.0	0.0
Hazera	37-128	0.8	0.4	0.8	0.0
	8104	0.0	1.3	0.8	0.0
	average	1.1	0.5	0.7	0.0
LSD (0.05)		NS	NS	1.9	NS

Table 24. Subjective evaluation of bulb characteristics for red onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2022.

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	7.0	3.0	3.5	3.5	4.0	3.5
	Red Carpet	3.0	2.0	3.5	4.5	4.0	4.5
	Redwing	4.0	3.0	4.0	4.0	4.0	4.5
Crookham	Purple Haze	4.0	2.0	3.0	3.0	3.5	3.5
	Red Beret	4.0	1.5	3.0	3.5	3.0	4.0
Enza Zaden	Barolo	3.0	3.5	3.0	3.5	4.0	3.5
	Tannat	3.0	4.0	3.5	4.5	4.5	4.0
Nunhems	Marengo	4.0	2.0	3.0	4.0	4.0	3.5
Seminis	SV 4643NT	7.0	3.0	3.0	2.0	3.0	2.5
Hazera	37-128	3.5	4.0	4.0	4.0	4.0	3.5
	8104	4.0	3.0	3.5	3.5	3.0	3.5
Average		4.2	2.8	3.4	3.6	3.7	3.7

^aBulb shape: see Fig. 1.

^bSubjective ratings are described in Table 4: 1 = worst, 5 = best.