

2013 ONION VARIETY TRIALS

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Introduction

The objectives of the onion variety trials were to evaluate yellow, white, and red onion varieties for disease, maturity, bolting, single centers, yield, and grade out of storage. Four early-season yellow varieties were planted in March and were harvested and graded in mid-August. Forty-nine full-season varieties (39 yellow, 3 red, and 7 white) were planted in March, harvested in September 2013, and graded out of storage in January 2014. Each year, growers and seed industry representatives have the opportunity to examine the varieties at our annual Onion Variety Field Day in late August and during onion grading in early January. Varieties are evaluated objectively for maturity, bolting, onion thrips, yield, grade, single centers, and storability. Varieties are evaluated subjectively for iris yellow spot virus, bulb shape, bulb shape uniformity, color, and skin retention.

Methods

Onions were grown on a Greenleaf silt loam with a pH of 7.4 and 1.8% organic matter, previously planted to wheat. In the fall of 2012, the wheat stubble was shredded and the field was irrigated. Based on a soil analysis, 49 lb of phosphorus/acre, 200 lbs of sulfur/acre, 3 lb zinc/acre, 5 lb manganese/acre, and 1 lb of boron/acre were broadcast. The field was then disked, moldboard plowed, groundhogged, fumigated with Vapam[®] (metham sodium) at 17 gal/acre and bedded at 22 inches.

The experimental designs for the full-season trial and the early-maturing trial were randomized complete blocks with five replicates. A sixth nonrandomized replicate was planted for demonstrating onion variety performance to growers and seed company representatives. The six replicates of the two trials were furrow irrigated. In addition to the six replicates, a seventh randomized replicate of the full-season trial was planted adjacent to the other replicates and was drip-irrigated. All trials were planted on March 14 in plots 4 double rows wide and 27 ft long. The early-maturing trial had 4 varieties from 3 seed companies and the full-season trial had 49 varieties from 8 seed companies.

Seed was planted in double rows spaced 3 inches apart at 9 seeds/ft of single row. Each double row was planted on beds spaced 22 inches apart. Planting was done with customized John Deere Flexi Planter units equipped with disc openers. Immediately after planting, the onions received a narrow band of Lorsban 15G[®] at 3.7 oz/1,000 ft of row (0.82 lb ai/acre), and the soil surface was rolled. Onion emergence started on April 4. On May 13, alleys 4 ft wide were cut between plots, leaving plots 23 ft long. On May 14, 15, 16, and 17, the seedlings were hand thinned to a spacing of 4.75 inches between individual onion plants in each single row, or 120,000 plants/acre.

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. For weed control, the following herbicides were applied. Roundup[®] at

1 lb ai/acre was broadcast on April 2 prior to onion emergence. On May 3, Goal Tender[®] at 0.06 lb ai/acre (4 oz/acre), Buctril[®] at 0.25 lb ai/acre (16 oz/acre), and clethodim at 0.19 lb ai/acre (12 oz/acre) were broadcast. On May 26, Prowl H₂O[®] at 0.83 lb ai/acre (2 pt/acre) was broadcast on the drip-irrigated area. On June 4, Prowl H₂O at 0.83 lb ai/acre (2 pt/acre) was broadcast on the furrow-irrigated area. On June 10, Goal Tender at 0.09 lb ai/acre (6 oz/acre), Buctril at 0.31 lb ai/acre (20 oz/acre), and clethodim at 0.25 lb ai/acre (16 oz/acre) were broadcast.

For thrips control, the following insecticides were applied: Movento[®] at 5 oz/acre on May 23 and 31 (ground applications), Agri-Mek[®] at 16 oz/acre on June 12 (ground application), Radiant[®] at 10 oz/acre on June 26 and July 14 (aerial applications) and Lannate[®] at 0.9 lb ai/acre on July 21 and July 31 (aerial applications). Thrips populations were measured every 2 weeks starting in early June. The total number of thrips (adults plus larvae) was determined in each of 10 plants in a border area of the field.

Urea treated with Nutrisphere[®] (SFP, LLC, Leawood, KS) at 120 lb nitrogen/acre was sidedressed to the furrow area on May 24. Uran at 32 lb nitrogen/acre was applied through the drip tape on May 24. Starting on June 7, root tissue samples from the drip and furrow areas were taken every 2 weeks and analyzed for nutrients (Table 1). Nutrients were applied based on the tissue analyses (Table 2). In the drip-irrigated area, nutrients were injected through the drip tape. In the furrow-irrigated area, nutrients were water-run during irrigations.

The trial was furrow irrigated when the soil water tension at 8-inch depth reached 25 cb (1 cb = 1 kPa) (Shock et al. 2013) and drip-irrigated when the soil water tension reached 20 cb (Shock et al. 2010). Starting in early June, soil water tension was monitored by six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrrometer Co. Inc., Riverside, CA) centered at 8-inch depth below the onion row in the drip- and furrow-irrigated areas. The sensors were automatically read three times a day with a datalogger (Irrrometer Monitor Model 950 R1). The last furrow irrigation was on August 29 and the last drip irrigation was on September 3.

The early-maturing trial was evaluated for maturity and for severity of symptoms of iris yellow spot virus (IYSV) on August 6 and 13. The full-season trial was evaluated for maturity and for severity of symptoms of IYSV on August 12 and 28. Onions in each plot were evaluated subjectively for maturity by visually rating the percentage of onions with the tops down and the percent dryness of the foliage. The number of bolted onion plants was counted in each plot. Each plot was given a subjective rating on a scale of 0 to 5 of increasing severity of IYSV symptoms. The rating was 0 if there were no symptoms, 1 if 1-25% of foliage was diseased, 2 if 26-50% of foliage was diseased, 3 if 51-75% of foliage was diseased, 4 if 76-99% of foliage was diseased, and 5 if 100% of foliage was diseased.

At harvest, bulbs from one of the border rows in each plot of both trials were rated for single centers. Twenty-five consecutive onions ranging in diameter from 3½ to 4¼ inches were rated. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the diameter of the first 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 or had a small multiple center.

Onions from the middle two double rows in each plot in the early-maturity trial were topped by hand, bagged, and graded on August 15.

The onions in the full-season trial were lifted on September 9 to field cure. Onions from the middle two rows in each plot of the full-season trial were topped by hand and bagged on September 17. The bags were put in storage on September 19. The storage shed was ventilated and the temperature was slowly decreased to maintain air temperature as close to 34°F as possible. Onions from the full-season trial were graded out of storage on January 7, 8, and 9, 2014.

During grading, bulbs were separated according to quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), plate rot (bulbs infected with the fungus *Fusarium oxysporum*), and black mold (bulbs infected with the fungus *Aspergillus niger*). The No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and supercolossal (>4¼ inches). Bulb counts per 50 lb of supercolossal onions were determined for each plot of every variety by weighing and counting all supercolossal bulbs during grading. Marketable yield consists of No.1 bulbs larger than 2¼ inches.

After grading, two replicates of each yellow and red variety from the furrow-irrigated plots were evaluated for subjective quality characteristics on January 10, 2014. The quality characteristics were evaluated by a consensus of 15-20 people without knowing the variety identities. Evaluators included Oregon State University and seed company employees. The characteristics evaluated were: bulb shape, skin color, bulb shape uniformity, firmness, skin retention, and flesh brightness.

Statistical analyses were conducted for the furrow-irrigated onions only. The data for the drip-irrigated onions are for demonstration, since only one replicate was planted. To compare the performance of the varieties under the two irrigation systems, regression analyses of the yield of the varieties under furrow irrigation against the yield of the varieties under drip irrigation were run. For the furrow-irrigated onions the average yield of each variety was used in the analysis.

Varietal differences for the furrow-irrigated onions were compared using analysis of variance. Means separation was determined using Fisher's least significant difference test at the 5% probability level, LSD (0.05). The varieties from each of the early-maturity and full-season trials were compared for yield, grade, internal quality, and disease expression. The least significant difference LSD (0.05) values in each table should be considered when comparisons are made between furrow-irrigated varieties for significant differences in performance characteristics. Differences between varieties equal to or greater than the LSD value for a characteristic should exist before any variety is considered different from any other variety in that characteristic. Variety performance will vary by year. Growers are encouraged to review performance over a number of years before choosing a variety to plant. In 2013, variety NUN 7202 was named 'Oloroso'.

Results

The rate of accumulation of growing degree-days (50-86°F) in 2013 was higher than the 23-year average (Fig. 1). Compared to 2011 and 2012, thrips pressure in 2013 was extremely high but lower than in 2012 and higher than in 2011 (Fig. 2). In 2013, the IYSV pressure was low and did not vary by variety (data not shown).

Compared with the nutrient sufficiency ranges used by Western Laboratories, Parma Idaho (Table 1), the onions required substantial nutrient amendments during the growing season (Table 2). It was difficult to maintain root nitrates sufficiently all season. It was difficult to maintain root phosphorus and potassium levels in the adequate range during July and August.

Early-maturing Trial

The proportion of single-centered bulbs averaged 47.8% and ranged from 42.4% for ‘Avalon’ to 57.6% for ‘Montero’ (Table 3). The percentage of onions that were functionally single centered averaged 57.9% and ranged from 48.7% for ‘Ovation’ to 66.2% for Montero. On August 6, all varieties had at least 40% tops down.

Total yield averaged 835.7 cwt/acre and ranged from 745.4 cwt/acre for Montero to 895.8 cwt/acre for ‘Scout’ (Table 4).

Full-season Trial

On August 12, most furrow-irrigated varieties had at least 10% tops down with an average of 28.7% tops down (Table 5). On August 12, most drip-irrigated varieties had at least 20% tops down with an average of 49.2% tops down. For the furrow-irrigated onions, bolting averaged 0.7% and ranged from 0 for many varieties to 3.1% for Scout and ‘Bello Blanco’. For the drip-irrigated onions, bolting averaged 1.5% and ranged from 0 for many varieties to 11.8% for ‘Dulce Reina’.

For the furrow-irrigated onions, the proportion of single-centered bulbs averaged 44.5% and ranged from 4% for DPLD 1504 to 88.8% for Oloroso (NUN7202) (Table 6). For the drip-irrigated onions, the proportion of single-centered bulbs averaged 57.6% and ranged from 8% for T-866 to 92% for ‘Brundage’ and NUN8003.

For the furrow-irrigated onions, marketable yield averaged 786.2 cwt/acre and ranged from 279.8 cwt/acre for ‘Countach’ to 1041 cwt/acre for SV6672 (Table 7). SV6672 was among the varieties with the highest marketable yield with XPO7716, ‘Ranchero’, ‘Vaquero’, Scout, ‘Maverick’, ‘Cometa’, and T-866 within the LSD (0.05) of SV6672.

For the drip-irrigated onions, marketable yield averaged 767.5 cwt/acre and ranged from 254.8 cwt/acre for ‘Marengo’ to 1217.4 cwt/acre for ‘Advantage’. In comparing the performance of the varieties under furrow and drip irrigation using regression analysis, the furrow-irrigated onions had slightly higher total yields than the drip-irrigated onions (Fig. 3). However, the drip-irrigated onions had slightly higher marketable yields and substantially higher colossal and supercolossal yields than the furrow-irrigated onions (Figs. 4 and 5).

Subjective Quality Evaluation

Subjective quality ratings can be found in Table 10 and explanation of the rating system can be found in Figure 6 and Tables 8 and 9. Significant variation was found between varieties in all subjective characteristics except bulb shape.

Acknowledgements

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References

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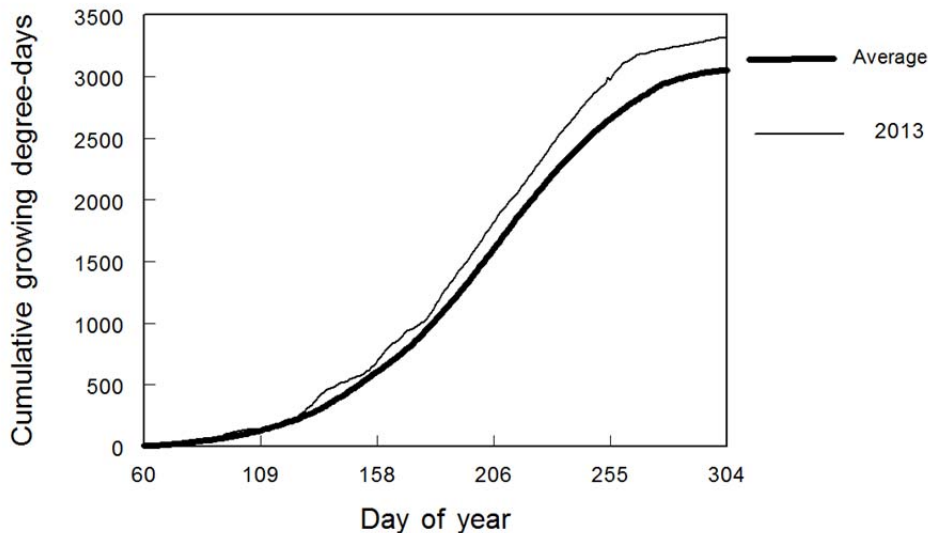


Figure 1. Cumulative growing degree-days (50-86°F) over time for 2013 and the 23-year average (1990-2012), Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

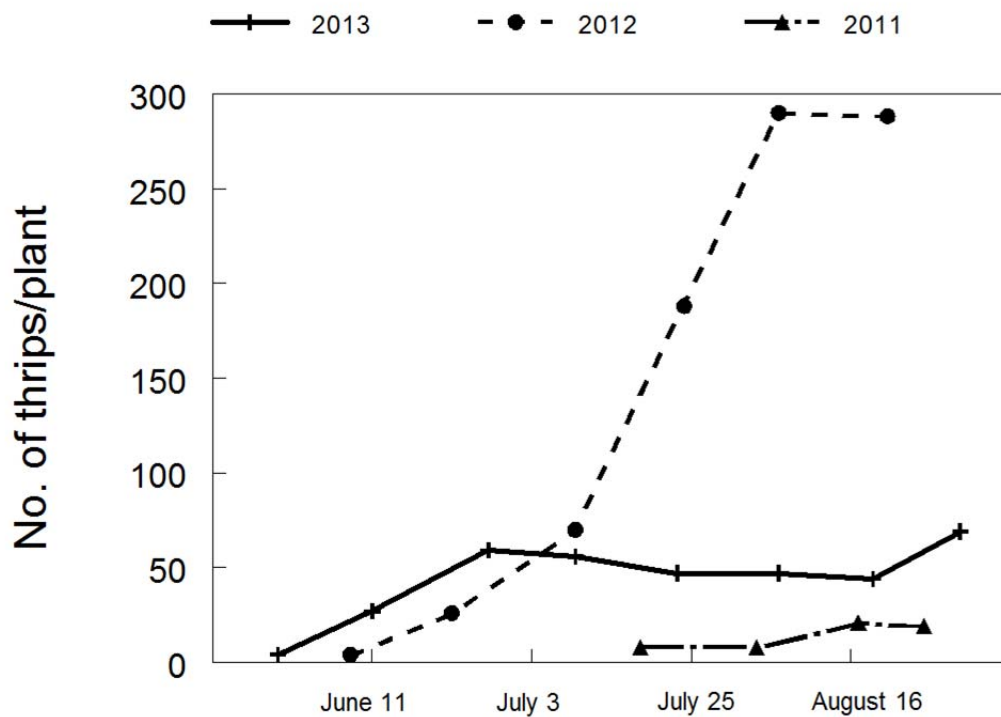


Figure 2. Average number of thrips per plant in the onion variety trial in 2011, 2012, and 2013, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Table 1. Onion root tissue analyses from drip- and furrow-irrigated areas, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Nutrient		7-Jun		19-Jun		2-Jul		16-Jul		30-Jul		13-Aug	
NO ₃ -N (ppm)	Sufficiency range	7978		6934		5803		4585		3367		2149	
		Furrow	Drip	Furrow	Drip	Furrow	Drip	Furrow	Drip	Furrow	Drip	Furrow	Drip
NO ₃ -N (ppm)		2764	365	3372	2729	3717	7384	4008	6848	1536	2790	1457	2454
P (%)	0.32 - 0.7	0.5	0.4	0.6	0.5	0.7	0.6	0.6	0.6	0.1	0.1	0.2	0.3
K (%)	2.7 - 6	2.9	2.1	2.7	2.6	2.5	2.2	2.2	2.2	0.4	0.3	0.7	0.7
S (%)	0.24 - 0.85	0.9	0.6	0.9	1.1	0.9	1.2	1.1	1.0	0.5	0.4	0.9	1.2
Ca (%)	0.4 - 1.2	0.5	0.5	0.5	0.5	0.4	0.7	0.6	0.8	0.6	1.1	1.1	1.7
Mg (%)	0.3 - 0.6	0.4	0.4	0.2	0.3	0.3	0.4	0.3	0.3	0.2	0.2	0.3	0.3
Zn (ppm)	25 - 50	51	45	34	36	30	32	24	22	10	12	30	50
Mn (ppm)	35 - 100	246	334	126	159	85	146	81	80	47	32	155	152
Cu (ppm)	6 - 20	14	17	7	8	10	12	9	10	7	6	15	12
Fe (ppm)	60 - 250	5507	9376	1250	1213	2126	2924	1181	1364	1245	855	4568	3891
B (ppm)	19 - 60	17	17	9	9	18	20	19	21	13	12	20	20

Table 2. Nutrients applied to drip- and furrow-irrigated onions, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Drip							
Date	N	P	K	B	Mg	Zn	Mn
	----- lbs/acre -----						
24-May	32						
7-Jun	32						
10-Jun			13	0.2			
21-Jun	20			0.2	5		
28-Jun		5	20				
3-Jul	20	5	20				
18-Jul			20			0.25	
31-Jul			20				
6-Aug		10		0.2	5	0.25	0.25
16-Aug		10	20				
Total	104	30	113	0.6	10	0.5	0.25

Furrow						
Date	N	P	K	B	Mg	Zn
	----- lbs/acre -----					
24-May	120*					
28-Jun	20	5	16	0.2	5	
3-Jul	20	5	16	0.2	5	
23-Jul	20	5	20		5	0.25
8-Aug	20	10	20	0.2	5	0.25
14-Aug		10	20			
Total	200	35	92	0.6	20	0.5

*sidedressed urea with Nutrisphere®

Table 3. Maturity and single- and multiple-center bulb ratings for early-maturing varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Seed company	Variety	Bulb color	Maturity Aug. 6		Multiple center			Single center	
			Tops down	Leaf dryness	large	medium	small	Functional*	bullet
----- % -----									
Nunhems	Montero	Y	42.0	20.0	17.9	15.8	8.6	66.2	57.6
Sakata	Ovation	Y	62.0	16.0	28.2	23.1	4.7	48.7	44.0
Crookham	Avalon	Y	70.0	12.0	20.9	19.9	16.9	59.2	42.4
	Scout	Y	40.0	10.0	22.7	20.0	10.2	57.3	47.1
Average			53.5	14.5	22.4	19.7	10.1	57.9	47.8
LSD (0.05)			NS	5.3	NS	NS	NS	NS	NS

*bullet single + small double

Table 4. Yield and grade performance of early-maturing varieties lifted and harvested August 15, 2013, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bulb color	Total yield	Marketable yield by grade						No. 2s	Bulb counts >4¼ in
				Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small		
----- cwt/acre -----											
Nunhems	Montero	Y	745.4	727.9	0.0	59.3	601.2	67.3	17.5	0.0	
Sakata	Ovation	Y	823.6	803.3	0.0	99.6	654.4	49.3	20.3	0.0	
Crookham	Avalon	Y	878.2	861.1	4.9	139.0	672.9	44.3	17.0	0.0	31.6
	Scout	Y	895.8	880.9	0.0	142.5	696.6	41.8	14.9	0.0	
Average			835.7	818.3	1.2	110.1	656.3	50.7	17.4	0.0	31.6
LSD (0.05)			63.1	66.7	NS	NS	33.6	NS	NS	NS	NS

Table 5. Maturity and bolting of furrow- and drip-irrigated full-season experimental and commercial onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Seed company	Variety	Bulb color	Maturity Aug. 12				Maturity Aug. 28				Bolting	
			Furrow		Drip		Furrow		Drip		Furrow	Drip
			Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness		
----- % -----												
A. Takii	TTA-747	Y	16.0	10.0	30.0	30.0	70.0	30.0	70.0	40.0	1.1	1.5
	T-866	Y	12.0	10.0	20.0	20.0	30.0	22.0	80.0	30.0	1.2	3.7
Bejo	Sedona	Y	16.0	18.0	30.0	20.0	82.0	36.0	90.0	40.0	0.9	1.3
	Calibra	Y	60.0	26.0	90.0	30.0	90.0	48.0	90.0	70.0	0.0	0.0
	Crockett	Y	14.0	14.0	20.0	30.0	46.0	34.0	80.0	50.0	0.1	0.2
	Legend	Y	30.0	14.0	40.0	40.0	76.0	36.0	90.0	70.0	0.0	0.0
	Delgado	Y	36.0	14.0	70.0	30.0	82.0	38.0	90.0	60.0	0.5	0.6
	Hamilton	Y	20.0	14.0	20.0	20.0	48.0	32.0	60.0	40.0	0.6	1.1
Crookham	Advantage	Y	16.0	14.0	30.0	20.0	66.0	30.0	80.0	30.0	0.4	5.6
	Avalon	Y	74.0	20.0	90.0	30.0	90.0	36.0	90.0	40.0	2.1	3.2
	Esteem	Y	26.0	24.0	50.0	40.0	80.0	48.0	90.0	50.0	0.3	0.4
	Morpheus	Y	50.0	12.0	70.0	30.0	90.0	30.0	90.0	40.0	0.1	0.6
	Oracle	Y	18.0	10.0	40.0	20.0	76.0	26.0	70.0	30.0	0.3	0.4
	Scout	Y	58.0	20.0	80.0	30.0	88.0	32.0	90.0	40.0	3.1	1.3
	Brundage	W	22.0	14.0	50.0	30.0	72.0	30.0	90.0	40.0	1.0	1.9
	Purple Haze	R	42.0	34.0	80.0	50.0	88.0	68.0	90.0	80.0	0.0	0.0
Hazera	Cruiser	Y	34.0	26.0	70.0	40.0	86.0	46.0	90.0	60.0	0.3	0.9
	Frontino	Y	12.0	14.0	20.0	20.0	48.0	38.0	50.0	40.0	0.1	0.6
	Maverick	Y	24.0	14.0	30.0	30.0	64.0	34.0	60.0	50.0	1.0	3.7
	Ventura	Y	48.0	26.0	80.0	40.0	90.0	48.0	90.0	60.0	0.8	0.2
Nunhems	Anillo	Y	26.0	16.0	40.0	30.0	78.0	38.0	90.0	50.0	0.4	0.9
	Arcero	Y	18.0	18.0	30.0	30.0	66.0	40.0	90.0	50.0	0.0	0.2
	Campero	Y	30.0	20.0	40.0	20.0	78.0	30.0	90.0	40.0	0.5	0.0
	Granero	Y	22.0	12.0	50.0	30.0	82.0	30.0	90.0	40.0	1.4	1.7
	Joaquin	Y	12.0	8.0	20.0	20.0	54.0	22.0	70.0	30.0	0.0	0.4
	Pandero	Y	14.0	10.0	20.0	10.0	64.0	26.0	70.0	40.0	0.2	0.6
	Ranchero	Y	34.0	16.0	40.0	30.0	88.0	32.0	90.0	40.0	0.6	0.6
	Vaquero	Y	24.0	14.0	50.0	30.0	84.0	34.0	90.0	60.0	0.5	1.1
	Oloroso (NUN7202)	Y	16.0	18.0	30.0	30.0	58.0	40.0	80.0	50.0	0.1	0.0
	Cometa	W	18.0	10.0	50.0	20.0	70.0	22.0	80.0	50.0	1.4	3.0
	NUN8003	W	32.0	14.0	90.0	20.0	90.0	24.0	90.0	40.0	0.0	0.0
	Countach	R	36.0	40.0	70.0	70.0	94.0	72.0	100.0	90.0	0.0	0.0
	Marengo	R	44.0	42.0	80.0	70.0	100.0	82.0	100.0	100.0	0.0	0.0
Sakata	Lasso (659Y)	Y	54.0	18.0	80.0	30.0	90.0	32.0	90.0	40.0	0.9	1.9
	Aruba	Y	50.0	20.0	80.0	30.0	88.0	36.0	90.0	50.0	1.2	1.5
	Dulce Reina	Y	36.0	14.0	50.0	30.0	78.0	32.0	80.0	40.0	1.5	11.8
	Bello Blanco	W	30.0	14.0	40.0	30.0	64.0	34.0	90.0	40.0	3.1	3.9
Seminis	Barbaro	Y	24.0	18.0	40.0	30.0	68.0	38.0	90.0	40.0	0.2	0.0
	Swale	Y	30.0	18.0	50.0	30.0	84.0	32.0	90.0	40.0	0.2	1.3
	SV6646	Y	14.0	14.0	40.0	30.0	78.0	30.0	90.0	40.0	0.1	0.0
	SV6672	Y	32.0	16.0	50.0	20.0	82.0	30.0	90.0	50.0	3.0	2.2
	XPO7716	Y	22.0	10.0	70.0	10.0	86.0	24.0	90.0	40.0	1.1	3.7
	SV4058	W	24.0	14.0	40.0	20.0	70.0	34.0	80.0	40.0	1.0	3.2
D. Palmer	DPLD 1473	Y	26.0	22.0	40.0	30.0	66.0	42.0	90.0	50.0	0.0	0.2
	DPLD 1477	Y	26.0	22.0	30.0	40.0	74.0	46.0	90.0	70.0	0.2	0.9
	DPLD1503	Y	8.0	8.0	20.0	20.0	34.0	16.0	50.0	40.0	0.6	2.6
	DPLD 1504	Y	12.0	12.0	30.0	20.0	36.0	20.0	60.0	30.0	0.6	0.6
	DPOW 2057	W	38.0	18.0	90.0	30.0	88.0	36.0	90.0	50.0	0.6	0.4
	DPLD 2066	W	24.0	12.0	40.0	30.0	56.0	30.0	80.0	50.0	1.5	1.5
	Average		28.7	17.1	49.2	29.4	73.7	35.6	83.7	48.0	0.7	1.5
	LSD (0.05)		9.1	5.6			9.2	6.4			0.8	

Table 6. Single- and multiple-centered bulb rating of furrow- and drip-irrigated full-season varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Continued on next page.

Seed company	Variety	Bulb color	Furrow					Drip				
			Multiple center			Single center		Multiple center			Single center	
			large	medium	small	functional ^a	single	large	medium	small	functional ^a	bullet
----- % -----												
A. Takii	TTA-747	Y	39.4	33.0	10.0	27.6	17.6	7.0	8.3	13.8	84.7	70.8
	T-866	Y	48.8	39.5	5.3	11.7	6.4	33.6	31.8	26.6	34.6	8.0
Bejo	Sedona	Y	26.9	24.1	14.6	49.0	34.4	21.0	19.3	13.8	59.7	45.8
	Calibra	Y	35.8	31.8	17.9	32.3	14.4	16.3	22.0	45.0	61.6	16.7
	Crockett	Y	34.0	28.5	8.6	37.6	28.9	13.4	18.0	36.5	68.5	32.0
	Legend	Y	46.5	37.9	6.4	15.6	9.2	15.1	17.7	28.7	67.2	38.5
	Delgado	Y	34.3	30.3	16.0	35.4	19.3	17.9	19.5	26.6	62.6	36.0
	Hamilton	Y	23.7	22.7	19.9	53.5	33.6	7.5	14.4	41.5	78.2	36.7
Crookham	Advantage	Y	11.6	10.8	8.0	77.6	69.6	6.7	6.0	3.3	87.3	84.0
	Avalon	Y	28.1	24.6	12.7	47.3	34.6	22.4	21.7	19.9	55.9	36.0
	Esteem	Y	16.6	15.2	10.6	68.2	57.6	4.5	5.6	10.0	90.0	80.0
	Morpheus	Y	17.5	15.4	8.0	67.2	59.2	9.0	11.8	23.2	79.2	56.0
	Oracle	Y	15.7	13.7	6.6	70.6	64.0	4.5	8.3	23.2	87.2	64.0
	Scout	Y	31.4	26.4	8.6	42.2	33.6	22.4	21.7	19.9	55.9	36.0
	Brundage	W	10.8	9.8	6.6	79.4	72.8	0.0	1.4	6.6	98.6	92.0
	Purple Haze	R	4.5	5.8	11.3	89.7	78.4	4.7	4.4	3.5	91.0	87.5
Hazera	Cruiser	Y	29.1	24.2	6.6	46.6	40.0	2.2	7.9	29.9	89.9	60.0
	Frontino	Y	15.2	12.5	2.7	72.3	69.6	6.7	6.0	3.3	87.3	84.0
	Maverick	Y	28.2	24.8	12.6	47.0	34.4	6.7	12.1	33.2	81.2	48.0
	Ventura	Y	15.7	15.7	16.6	68.6	52.0	7.7	11.3	25.8	80.9	55.2
Nunhems	Anillo	Y	8.5	7.5	4.0	84.0	80.0	2.2	4.5	13.3	93.3	80.0
	Arcero	Y	15.2	12.9	4.6	71.8	67.2	0.0	4.8	23.2	95.2	72.0
	Campero	Y	28.2	24.8	12.6	47.0	34.4	29.1	27.6	23.2	43.2	20.0
	Granero	Y	18.8	16.6	8.6	64.6	56.0	11.7	12.0	13.8	76.3	62.5
	Joaquin	Y	19.0	16.7	8.8	64.3	55.6	4.5	7.6	19.9	87.9	68.0
	Pandero	Y	25.1	22.2	12.0	52.8	40.8	9.0	10.4	16.6	80.6	64.0
	Ranchero	Y	20.2	17.9	10.0	62.0	52.0	4.5	6.9	16.6	88.6	72.0
	Vaquero	Y	25.0	20.7	5.4	54.3	48.8	6.7	8.7	16.6	84.6	68.0
	Oloroso (NUN7202)	Y	4.5	4.1	2.7	91.5	88.8	0.0	2.0	10.0	98.0	88.0
	Cometa	W	21.1	19.4	13.9	59.5	45.6	6.7	8.0	13.3	85.3	72.0
	NUN8003	W	13.4	11.5	4.6	75.0	70.4	0.0	1.4	6.6	98.6	92.0
	Countach	R	7.6	9.2	15.9	83.1	67.2	0.0	7.5	36.5	92.5	56.0
	Marengo	R	7.6	7.8	8.6	84.6	76.0	0.0	6.8	33.2	93.2	60.0

^a bullet single + small double

Table 6. Continued. Single- and multiple-centered bulb rating of furrow- and drip-irrigated full-season varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Seed company	Variety	Bulb color	Furrow					Drip				
			Multiple center			Single center		Multiple center			Single center	
			large	medium	small	functional ^a	single	large	medium	small	functional ^a	bullet
----- % -----												
Sakata	Lasso (659Y)	Y	25.9	22.0	8.0	52.0	44.1	11.2	12.9	19.9	75.9	56.0
	Aruba	Y	20.6	18.4	10.6	61.0	50.4	4.5	6.9	16.6	88.6	72.0
	Dulce Reina	Y	26.4	22.4	8.0	51.2	43.2	4.5	8.3	23.2	87.2	64.0
	Bello Blanco	W	16.4	16.3	16.5	67.3	50.7	11.7	12.0	13.8	76.3	62.5
Seminis	Barbaro	Y	25.5	22.2	10.6	52.2	41.6	11.2	11.5	13.3	77.3	64.0
	Swale	Y	20.2	18.6	13.3	61.3	48.0	2.2	4.5	13.3	93.3	80.0
	SV6646	Y	16.1	16.1	16.6	67.8	51.2	6.7	8.0	13.3	85.3	72.0
	SV6672	Y	24.8	20.2	3.4	55.1	51.7	9.0	10.4	16.6	80.6	64.0
	XPO7716	Y	30.0	24.7	5.3	45.3	40.0	6.7	6.6	6.6	86.6	80.0
	SV4058	W	14.8	14.5	13.9	70.7	56.8	6.7	7.3	10.0	86.0	76.0
D. Palmer	DPLD 1473	Y	33.2	28.9	13.9	37.9	24.0	29.2	27.4	21.7	43.4	21.7
	DPLD 1477	Y	33.6	29.3	14.0	37.1	23.1	28.0	27.0	24.2	45.0	20.8
	DPLD1503	Y	48.8	39.7	6.6	11.4	4.8	35.8	31.6	16.6	32.6	16.0
	DPLD 1504	Y	49.7	40.3	6.0	10.0	4.0	2.2	6.5	23.2	91.2	68.0
	DPOW 2057	W	26.9	25.3	20.6	47.8	27.2	6.7	12.8	36.5	80.5	44.0
	DPLD 2066	W	45.2	37.3	8.6	17.4	8.8	26.9	23.2	10.0	50.0	40.0
Average			24.2	21.1	10.2	54.7	44.5	10.3	12.1	19.5	77.5	58.0
LSD (0.05)			8.0	6.0	7.8	14.0	14.6					

^a bullet single + small double

Table 7. Yield and grade of full-season experimental and commercial furrow-irrigated onion varieties graded out of storage in January 2014. Data are the average of five replicates, Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

Seed company	Variety	Bulb color	Total yield	Marketable yield by grade							No. 2s	Small	Total rot	Neck rot	Plate rot	Black mold	Bulb counts >4¼ in
				Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	% of total yield								
				cwt/acre													
A. Takii	TTA-747	Y	955.8	924.8	19.3	255.9	607.9	41.7	4.0	13.5	1.4	1.2	0.2	0.0	32.4		
	T-866	Y	1040.5	954.1	30.9	301.2	595.7	26.4	65.6	14.6	0.6	0.4	0.3	0.0	33.5		
Bejo	Sedona	Y	760.7	733.9	0.0	48.6	631.9	53.4	0.9	20.3	0.7	0.4	0.3	0.0			
	Calibra	Y	663.6	629.5	4.0	35.6	518.0	72.0	0.0	22.5	1.8	0.3	1.5	0.0	26.0		
	Crockett	Y	686.3	658.1	0.0	26.0	560.3	71.8	5.9	21.3	0.1	0.0	0.1	0.0			
	Legend	Y	790.5	763.4	1.3	66.3	654.3	41.5	4.3	13.5	1.2	0.2	1.0	0.0	39.1		
	Delgado	Y	811.7	772.0	4.1	107.5	608.2	52.2	7.1	20.7	1.4	0.3	1.1	0.0	37.7		
	Hamilton	Y	769.8	748.0	0.0	24.7	654.6	68.7	2.6	16.4	0.3	0.1	0.2	0.0			
Crookham	Advantage	Y	904.8	880.9	17.7	194.2	624.5	44.5	1.9	16.2	0.6	0.4	0.2	0.0	34.5		
	Avalon	Y	1012.2	951.1	22.5	261.0	598.4	69.2	3.4	11.6	4.5	2.7	0.7	1.1	31.4		
	Esteem	Y	686.8	655.8	0.0	25.9	556.5	73.4	0.0	22.2	1.3	0.5	0.5	0.3			
	Morpheus	Y	955.4	939.0	17.1	263.4	624.3	34.2	0.7	11.6	0.4	0.2	0.3	0.0	33.2		
	Oracle	Y	948.1	922.5	28.6	242.7	616.6	34.6	0.0	14.7	1.1	0.9	0.2	0.0	34.7		
	Scout	Y	1022.4	979.3	19.4	239.7	681.9	38.3	3.4	17.0	2.2	1.8	0.1	0.3	29.2		
	Brundage	W	800.6	753.2	8.8	112.0	570.4	62.0	4.5	18.0	3.1	1.8	1.0	0.3	29.7		
	Purple Haze	R	388.5	335.3	0.0	0.0	159.0	176.3	0.0	49.1	1.0	0.4	0.6	0.0			
Hazera	Cruiser	Y	648.6	621.8	0.0	15.2	516.3	90.3	0.0	24.3	0.4	0.2	0.2	0.0			
	Frontino	Y	885.7	870.5	1.6	147.4	679.2	42.4	0.0	11.0	0.5	0.4	0.1	0.0	32.9		
	Maverick	Y	997.8	973.9	31.0	296.8	615.3	30.8	0.1	11.0	1.3	1.2	0.1	0.0	33.5		
	Ventura	Y	605.5	577.4	0.0	10.5	464.3	102.5	0.0	23.6	0.7	0.0	0.7	0.0			
Nunhems	Anillo	Y	844.7	824.9	4.5	119.5	645.4	55.4	0.4	15.7	0.5	0.3	0.1	0.0	35.2		
	Arcero	Y	928.1	913.0	7.0	184.6	683.9	37.4	0.0	11.3	0.4	0.2	0.2	0.0	36.2		
	Campero	Y	809.1	792.8	3.3	94.2	643.9	51.4	1.0	11.3	0.5	0.3	0.2	0.1	31.6		
	Granero	Y	899.0	866.3	7.4	137.3	676.0	45.6	2.1	12.5	1.9	1.4	0.5	0.0	34.5		
	Joaquin	Y	964.3	951.3	36.0	269.5	614.6	31.3	0.0	9.0	0.4	0.1	0.2	0.0	33.0		
	Pandero	Y	921.8	901.8	5.7	166.2	688.8	41.1	0.0	11.8	0.9	0.6	0.2	0.0	36.3		
	Ranchero	Y	1040.8	1012.5	49.0	302.2	628.3	32.9	2.8	13.6	1.2	1.1	0.0	0.0	30.1		
	Vaquero	Y	1013.6	990.8	28.5	276.3	657.3	28.7	0.7	11.8	1.0	0.8	0.1	0.1	30.8		
	Oloroso (NUN7202)	Y	780.6	746.6	0.0	67.1	619.8	59.8	16.8	14.7	0.3	0.2	0.1	0.0			
	Cometa	W	1007.5	957.9	20.2	209.6	692.2	35.8	2.3	16.1	3.1	1.2	0.9	1.1	32.4		
	NUN8003	W	860.1	822.5	8.0	128.6	652.5	33.4	2.8	22.1	1.5	0.9	0.6	0.0	32.2		
	Countach	R	337.9	279.8	0.0	0.0	118.4	161.4	0.7	56.4	0.3	0.3	0.0	0.0			
	Marenge	R	367.4	322.6	0.0	0.0	182.5	140.1	0.0	41.1	1.0	0.3	0.7	0.0			

Table 7. Continued. Yield and grade of full-season experimental and commercial furrow-irrigated onion varieties graded out of storage in January 2014. Data are the average of five replicates, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bulb color	Total yield	Marketable yield by grade					No. 2s	Small	Total rot	Neck rot	Plate rot	Black mold	Bulb counts >4¼ in
				Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in							
				cwt/acre							% of total yield				#/50 lb
Sakata	Lasso (659Y)	Y	962.8	942.1	12.2	239.4	655.6	34.9	0.0	13.2	0.8	0.7	0.1	0.0	33.8
	Aruba	Y	942.7	920.0	30.4	225.8	619.4	44.5	0.6	11.6	1.1	0.8	0.3	0.0	31.9
	Dulce Reina	Y	948.2	919.4	44.6	256.4	582.4	35.9	0.0	13.0	1.7	1.5	0.1	0.2	34.3
	Bello Blanco	W	879.9	786.0	12.2	195.1	528.1	50.6	3.7	17.8	8.1	5.7	1.6	0.8	29.9
Seminis	Barbaro	Y	846.3	816.3	8.1	164.6	582.6	61.0	4.0	22.8	0.4	0.2	0.1	0.0	32.7
	Swale	Y	901.7	862.5	1.7	79.1	730.9	50.8	2.2	18.2	2.0	1.0	1.0	0.0	29.8
	SV6646	Y	960.8	945.3	21.3	250.8	646.6	26.5	0.0	8.2	0.7	0.3	0.5	0.0	33.4
	SV6672	Y	1072.5	1041.0	16.1	313.2	686.5	25.2	9.6	7.8	1.3	1.3	0.0	0.0	32.8
	XPO7716	Y	1044.6	1015.5	123.0	382.4	483.1	27.0	3.0	8.6	1.7	1.1	0.5	0.0	32.1
	SV4058	W	875.1	797.7	11.8	154.7	590.4	40.7	8.8	12.4	6.4	4.4	1.0	1.0	29.7
D. Palmer	DPLD 1473	Y	611.5	561.1	1.4	20.2	460.9	78.6	17.6	26.4	1.1	0.8	0.3	0.0	35.7
	DPLD 1477	Y	450.9	400.7	0.0	0.0	262.8	137.9	9.8	34.4	1.2	0.8	0.4	0.0	
	DPLD1503	Y	886.8	712.7	0.0	81.3	570.8	60.6	162.6	11.5	0.0	0.0	0.0	0.0	
	DPLD 1504	Y	817.2	612.5	1.7	61.1	491.6	58.1	182.7	14.9	0.9	0.0	0.1	0.8	31.3
	DPOW 2057	W	665.6	612.3	1.7	21.3	485.0	104.3	2.7	25.5	3.8	2.8	0.8	0.2	29.8
	DPLD 2066	W	761.6	552.4	4.4	76.3	428.8	43.0	162.5	18.5	3.7	2.0	1.7	0.0	35.6
	average		831.4	786.2	13.6	145.9	568.3	58.4	14.4	18.1	1.5	0.9	0.4	0.1	32.8
LSD (0.05)			86.8	89.6	19.0	67.4	83.1	27.3	18.7	10.1	2.2	1.9	NS	NS	NS

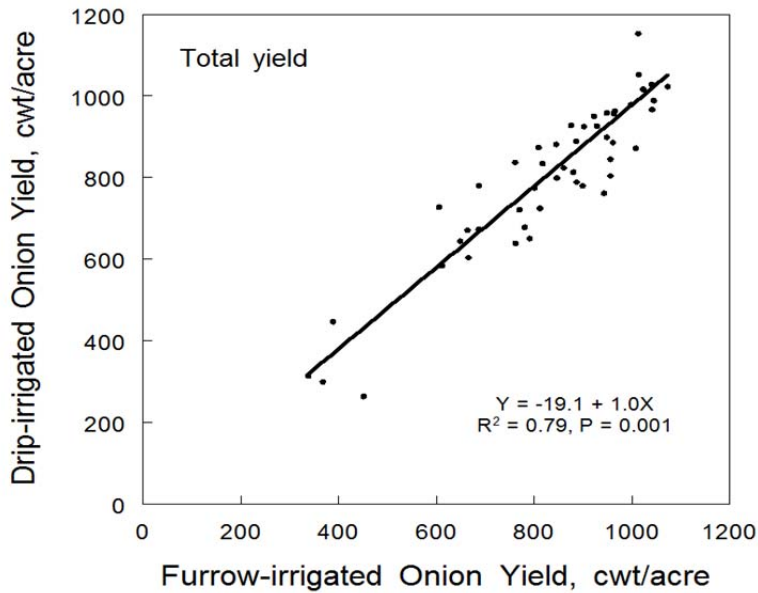


Figure 3. Relationship between yield of furrow-irrigated and drip-irrigated onions. Each data point represents 1 of 49 varieties. Yield for furrow-irrigated onions is the average of 5 replicates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

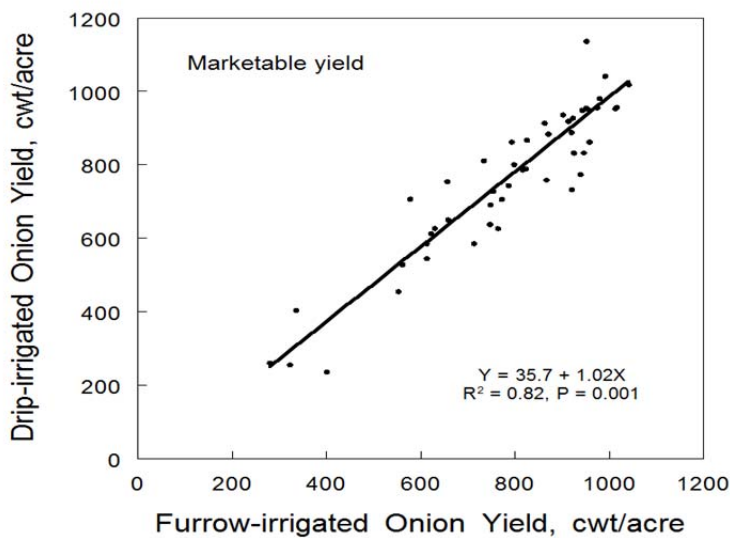


Figure 4. Relationship between yield of furrow-irrigated and drip-irrigated onions. Each data point represents 1 of 49 varieties. Yield for furrow-irrigated onions is the average of 5 replicates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

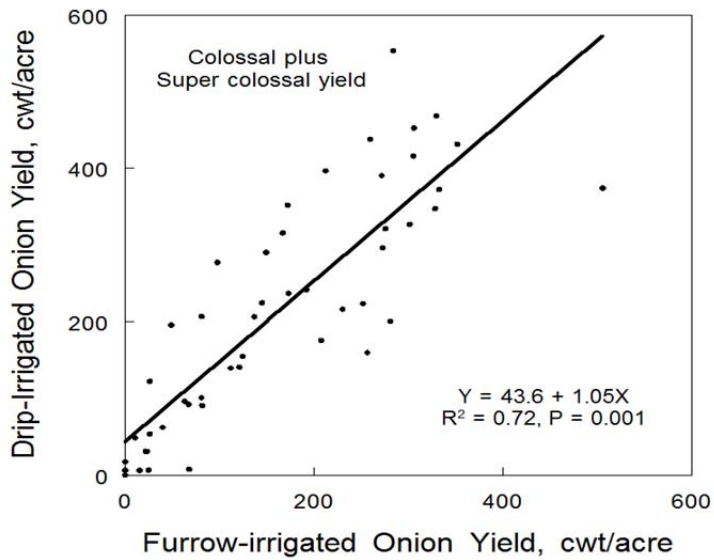


Figure 5. Relationship between yield of furrow-irrigated and drip-irrigated onions. Each data point represents 1 of 49 varieties. Yield for furrow-irrigated onions is the average of 5 replicates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

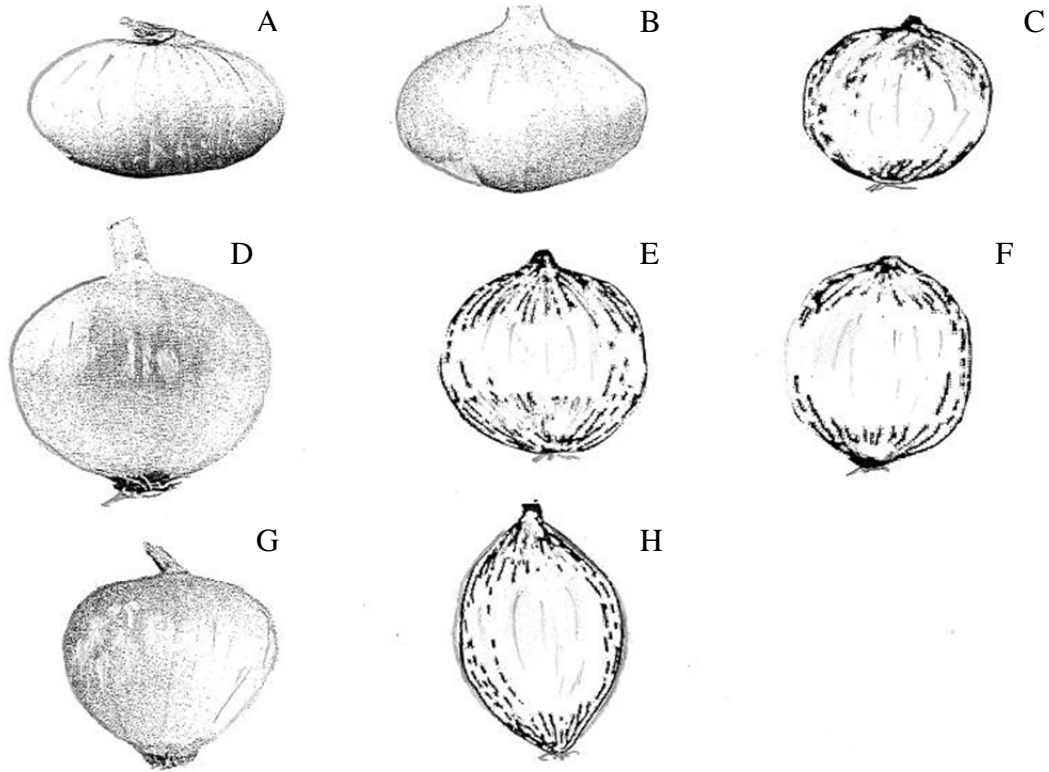


Figure 6. Onion bulb shape rating system, Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 8. Description of bulb shapes.

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

Table 9. Onion variety subjective quality evaluation rating system.

Characteristic	Scale	description
Bulb shape	A-H	see Fig. 1
Skin color	1-5	1 = light, 5 = dark
Bulb shape uniformity	1-5	1 = nonuniform shape, 5 = uniform shape
Firmness	1-5	1 = soft, 5 = hard
Skin retention	1-5	1 = bald, 5 = no cracks
Flesh brightness	1-5	yellow varieties: 1 = yellow, 5 = white red varieties: 1 = dark red, 5 = pale red white varieties: 1 = less white, 5 = very white

Table 10. Onion variety subjective quality evaluation on January 10, 2014, Malheur Experiment Station, Oregon State University, Ontario, OR. Continued on next page.

Company	Variety	Color	Bulb shape ^a	Skin color ^b	Bulb shape uniformity ^b	Firmness ^b	Scale retention ^b	Flesh brightness ^b
						----- 1 - 5 -----		
A. Takii	TTA-747	Y	d	3.7	4.0	4.3	4.7	3.0
	T-866	Y	e	3.7	4.0	4.0	4.7	2.7
Bejo	Sedona	Y	e	3.5	3.0	4.0	4.0	3.0
	Calibra	Y	e	4.0	3.0	4.0	3.0	2.0
	Crockett	Y	d	4.0	4.5	5.0	5.0	3.5
	Legend	Y	d	4.5	3.5	4.5	4.5	3.5
	Delgado	Y	d	3.5	4.0	5.0	4.5	3.0
	Hamilton	Y	d	4.7	4.0	5.0	5.0	3.3
Crookham	Advantage	Y	f	3.0	4.0	3.0	3.5	3.5
	Avalon	Y	d	2.0	3.0	3.0	2.0	4.0
	Esteem	Y	d	3.0	2.5	4.5	3.5	4.0
	Morpheus	Y	e	2.0	3.0	3.5	3.5	3.5
	Oracle	Y	f	4.0	4.0	4.0	5.0	3.0
	Scout	Y	d	1.0	3.0	2.5	1.5	3.5
	Brundage	W	d	2.5	3.0	4.0	2.0	1.5
	Purple Haze	R	c	2.5	3.5	3.5	3.5	3.0
Hazera	Cruiser	Y	d	3.0	4.0	4.5	4.0	3.0
	Frontino	Y	e	3.0	3.0	4.0	4.0	3.0
	Maverick	Y	e	3.0	4.5	4.0	4.0	4.0
	Ventura	Y	f	4.0	3.0	4.5	5.0	2.5

Table 10. Continued. Onion variety subjective quality evaluation on January 10, 2014, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Color	Bulb shape ^a	Skin color ^b	Bulb shape uniformity ^b	Firmness ^b	Scale retention ^b	Flesh brightness ^b
						----- 1 - 5 -----		
Nunhems	Anillo	Y	d	4.0	4.0	4.0	4.0	4.0
	Arcero	Y	e	3.5	4.0	4.0	4.0	4.0
	Campero	Y	d	4.5	3.5	5.0	5.0	3.0
	Granero	Y	d	5.0	4.0	5.0	5.0	2.0
	Joaquin	Y	d	4.0	4.0	5.0	5.0	3.5
	Pandero	Y	d	4.0	4.0	5.0	4.0	3.0
	Ranchero	Y	d	2.0	3.5	3.0	3.5	3.5
	Vaquero	Y	d	3.0	3.0	4.0	3.0	3.0
	Oloroso (NUN7202)	Y	d	4.5	4.5	5.0	5.0	4.0
	Cometa	W	e	3.5	3.3	4.5	1.3	2.0
	NUN8003	W	e	4.0	3.8	5.0	2.5	1.5
	Countach	R	e	1.5	3.0	3.0	3.0	1.0
	Marengo	R	c	2.0	3.5	2.5	3.0	2.0
	Sakata	Lasso (659Y)	Y	d	2.0	2.5	3.0	3.0
Bello Blanco		W	e	2.0	2.0	5.0	3.0	3.0
Aruba		Y	e	2.5	3.5	4.0	3.5	4.5
Dulce Reina		Y	e	3.0	3.0	3.0	3.0	4.3
Seminis	Barbaro	Y	d	3.0	3.0	3.0	3.0	4.0
	Swale	Y	d	4.0	4.0	5.0	4.0	2.5
	SV6646	Y	d	4.0	4.0	4.0	4.0	4.0
	SV6672	Y	d	3.5	4.0	4.5	4.0	3.5
	XPO7716	Y	e	2.5	3.5	3.5	3.5	4.5
	SV4058	W	d	2.5	2.5	5.0	3.0	1.8
D. Palmer	DPLD 1473	Y	d	4.0	2.0	4.5	5.0	3.5
	DPLD 1477	Y	d	5.0	3.5	5.0	5.0	2.0
	DPLD1503	Y	d	4.7	1.7	4.7	4.7	2.0
	DPLD 1504	Y	d	5.0	2.0	3.5	4.5	2.5
	DPOW 2057	W	e	2.0	3.3	4.0	3.3	3.0
	DPLD 2066	W	e	2.0	2.8	4.3	3.0	1.8
Average			d	3.4	3.4	4.1	3.8	3.1
LSD (0.05)			NS	0.9	1.9	1.0	1.0	1.3

^aBulb shape: see Figure 6. ^bSubjective ratings are described in Table 9.