

# Variety Trials

## Yield of Yellow Onion Cultivars in Eastern Oregon and Southwestern Idaho

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SUMMARY. Potential new onion (*Allium cepa* L.) cultivars for commercial production in eastern Oregon and southwestern Idaho are evaluated annually in yield trials conducted at the Malheur Experiment Station, Oregon State University, Ontario, Ore. Bulb yield and market grade were determined in field trials for 63 yellow onion cultivars and lines in

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1996 and for 49 cultivars and lines in 1997. Marketable yield out of storage in January ranged from 478 to 1131 cwt/acre (54 to 127 Mg·ha<sup>-1</sup>) in 1996, and from 383 to 912 cwt/acre (43 to 102 Mg·ha<sup>-1</sup>) in 1997. Marketable yields of '9003C', 'Seville', 'El Charro', 'Sunre 1430', 'El Padre', 'Golden Security', 'Bravo', and 'X 202' were greater than 1000 cwt/acre (112 Mg·ha<sup>-1</sup>) in 1996. In 1997, marketable yields of 'Seville', 'Bravo', 'Quest', 'T-433', '9003C', 'Goldstar', 'Superstar', 'RNX-10020', 'Vision', and 'Sweet Perfection' were greater than 850 cwt/acre (95 Mg·ha<sup>-1</sup>). Of the 30 cultivars evaluated both years, the average marketable yields of 'Seville', '9003C', 'Bravo', 'Quest', and 'Sweet Perfection' were among the highest. Many others showed potential for high yields and merit further evaluation. In both years, most bulbs of all selections graded jumbo [3 to 4 inch (7.6 to 10.2 cm) diameter] and colossal [>4 inch (10.2 cm) diameter], and only a few cultivars had more than 2% medium-size [2.25 to 3 inch (5.7 to 7.6 cm) diameter] bulbs. Infection by neck rot (*Botrytis allii* Munn.) and plate rot [*Fusarium oxysporum* f. sp. *cepa* (H. N. Hans.) W.C. Snyder & H.N. Hans.] during storage was more severe in 1996 than in 1997, but in general, most cultivars showed relatively low levels of these diseases in both years. Averaged across all cultivars, bolting was evident in less than 1% of bulbs in both years.

**B**ulb onion is produced on more than 150,000 acres (60,700 ha) annually in the United States (USDA, 1999). The United States bulb onion production areas consist of fall planted (spring harvested) and spring planted (summer harvested) regions. The crop is fall planted and spring harvested primarily in southern California, Georgia, and Texas, with smaller acreages in Arizona, southeastern states, and elsewhere. These onions are short-day cultivars and are marketed from April to August. Onion is planted in the spring in the Pacific northwest U.S. (Idaho, Oregon, and Washington), with additional acreage in Colorado, New York, Michigan, Minnesota, Wisconsin, central California, Utah, and Nevada. These onions are mostly long-day cultivars and are marketed from August to April from storage [Idaho Eastern-Oregon Onion Committee (IEOOC), 1999]. The Pacific north-

west U.S. has a small percentage of fall-planted, spring-harvested onions.

The Pacific northwestern U.S. is a major onion producing region in the U.S. In 1997 and 1998, onion was produced on about 20,000 acres (8,090 ha) in southeastern Oregon and southwestern Idaho alone, with a total value of about \$100 million in 1997 and \$122 million in 1998 (Table 1) (USDA, 1999). The onion production area is within a radius of 30 miles (50 km) of Ontario, Ore, on the Snake River plain and along the tributaries of the Snake River, a region frequently referred to as the Treasure Valley. In general, onion bulb yield in the Treasure Valley is greater than in any other onion producing area; the average onion bulb yield in the Treasure Valley was 648 cwt/acre (72.6 Mg·ha<sup>-1</sup>) in 1997 and 538 cwt/acre (60.2 Mg·ha<sup>-1</sup>) in 1998 (Table 1) (USDA, 1999).

Most onions produced in the Treasure Valley are yellow sweet Spanish cultivars, whereas white and red cultivars made up 6.5% of the crop during the 1998-99 marketing season (IEOOC, 1999). The onions produced in the region have a long-standing reputation for high quality. The onions are marketed fresh from August through October, and then out of storage from November through April. Onions are sold out of a few refrigerated storages after April. The primary markets for onions produced in the Treasure Valley are the northern midwest and northeast of the United States (USDA, 1997). Shippers export to off shore markets in the far east.

These spring-planted long-day cultivars are commonly furrow irrigated with 44.4 acre-inches/acre (1128 mm) (Jensen and Simko, 1991) yet onion evapotranspiration at Ontario is about 27.5 acre-inches/acre (700 mm) (Shock et al., 2000a). Optimum irrigation criteria for furrow irrigated onion on silt loam soil in the Treasure Valley have been determined (Shock et al., 1998). Subsurface drip irrigation (SDI) can be used to increase onion yield and grade on Treasure Valley sites that are difficult to irrigate (Feibert et al., 1995). Subsurface drip irrigation criteria have been determined to help assure high yields of storable sweet spanish onions (Shock et al., 2000a, 2000b).

Many onion cultivars are grown commercially in the Treasure Valley. Open pollinated yellow sweet spanish

varieties were the standard in the region, but hybrid cultivars have gained popularity during the last 2 decades. Currently most of the cultivars grown in the region are hybrids, which are generally more uniform and higher yielding. Seed companies are continually developing new cultivars. Besides bulb yield, many other characteristics of these cultivars need to be evaluated across years and locations in order to know which cultivars are best for any particular location. Important characteristics include maturity rating, potential for bolting, bulb size, and susceptibility to neck rot and plate rot diseases.

Bolting (flowering) is induced by exposure to cold temperatures (Brewster, 1994). Bolting is a highly undesirable cultivar characteristic in bulb production. Neck rot and plate rot are the most important onion diseases in the Treasure Valley, and losses of greater than 50% of bulb yield can occur for some cultivars from individual fields in a few years. Infection by both fungi occurs in the field, with loss

from decay occurring during storage.

Since 1972, established cultivars and new onion lines for commercial production in eastern Oregon and Idaho have been evaluated in replicated yield trials conducted at the Malheur Experiment Station near Ontario, Ore. This paper presents bulb yield evaluated after storage for cultivars of yellow onions from variety yield trials conducted at Malheur Experiment Station in 1996 and 1997. For simplicity of the discussion, both the established cultivars and the experimental lines on the verge of release are referred to as cultivars. Maturity rating and the potential of all cultivars for bolting is reported. Bulb yield and market grade, as determined out of storage in January following each harvest, are presented. Cultivar susceptibility to neck rot and plate rot during storage is evaluated.

Materials and methods

The trials were conducted on Owyhee silt loam (coarse-silty, mixed, mesic Xerollic Camborthid) near On-

tario, Ore. Fields in both years had previously been planted to wheat, and had 1.5% organic matter and a pH of 7.4. Before fall plowing, 100 lb/acre (112 kg·ha<sup>-1</sup>) of P<sub>2</sub>O<sub>5</sub>, and 20 to 50 lb/acre (22 to 50 kg·ha<sup>-1</sup>) N were broadcast. The wheat stubble was shredded and the field deep-chiseled, disked, irrigated, moldboard-plowed, roller-harrowed, and bedded in the fall. At bedding, the field was fumigated with 18 gal/acre (168 L·ha<sup>-1</sup>) of Telone C-17 (Dow Chemical Co., Midland, Mich.) (77.9% 1,3-dichloropropene + 16.5% chloropicrin + inert ingredients) and left until spring without further tillage.

In March of each year, the beds were harrowed down and sprayed with 3 lb/acre (3.3 kg·ha<sup>-1</sup>) a.i. of DCPA banded 11-inch (28-cm) wide along the top of the beds. The DCPA was incorporated the next day with a bed harrow. Onion seeds used were of 63 cultivars from 14 companies in 1996, and of 49 cultivars from 15 companies in 1997. Seeds were planted in mid-April on 22-inch (56-cm) single-row

**Table 1. The top ten states and areas for onion bulb yield (all types-all seasons), land harvested, and total value in 1977 and 1978.<sup>z</sup>**

State or area	Land harvested (acre) <sup>y</sup>	State or area	Avg bulb yield (cwt/acre) <sup>x</sup>	State or area	Total value (\$1000)
			1997		
California	36,200	Treasure Valley <sup>w</sup>	648	California	143,869
Treasure Valley <sup>w</sup>	20,200	Nevada	540	Treasure Valley <sup>w</sup>	100,444
Georgia	15,800	Washington	520	Georgia	88,990
Colorado	15,300	Utah	485	Washington	61,594
Washington	14,400	New Mexico	470	Colorado	49,289
New York	12,200	Oregon (west)	450	New Mexico	43,315
Texas	11,800	California	441	Texas	41,539
Oregon (west)	7,400	Ohio	415	New York	39,276
New Mexico	6,400	Wisconsin	390	Oregon (west)	28,603
Michigan	6,100	Arizona	355	Michigan	13,840
Total	145,800	Mean	471	Total	610,759
			1998		
California	36,800	Treasure Valley <sup>w</sup>	538	California	170,902
Washington	20,350	Washington	492	Treasure Valley <sup>w</sup>	122,540
Treasure Valley <sup>w</sup>	20,000	Arizona	470	Washington	108,738
Colorado	16,000	New Mexico	460	Texas	90,226
Texas	15,400	California	440	New York	77,844
Georgia	13,900	Oregon (west)	440	New Mexico	68,722
New York	12,500	Utah	440	Oregon (west)	51,638
Oregon (west)	7,500	Nevada	440	Georgia	43,056
New Mexico	7,200	Wisconsin	380	Michigan	39,485
Michigan	4,500	Ohio	310	Utah	10,692
Total	154,150	Mean	441	Total	783,843

<sup>z</sup>Based on USDA (1999). Several areas do not rank in the top 10 in all categories.

<sup>y</sup>1 acre = 0.405 ha.

<sup>x</sup>1 cwt/acre = 100 lb/acre = 112.09 kg·ha<sup>-1</sup>.

<sup>w</sup>The onion production area referred to as the Treasure Valley is in southeastern Oregon and southwestern Idaho within a radius of 30 miles (50 km) of Ontario, Ore., on the Snake River plain and along the tributaries of the Snake River.

beds in plots four rows wide and 27 feet (8.3 m) long. Each variety was planted with five replications. Seeding rate was 12 viable seeds per foot of row (39/m). Seed was planted using four cone seeders (ALMACO, Nevada, Iowa) mounted on a flexi-planter (model 71; Deere & Co., Moline, Ill.) equipped with disc openers.

Immediately after seeding, plots received 0.123 lb/acre (138 g·ha<sup>-1</sup>) a.i. of chlorpyrifos, the soil surface was rolled, and the first furrow irrigation was applied to supply moisture for seed germination. Soon after germination the seedling onion plants were hand thinned to a plant spacing of 4 inches (10.2 cm) between individual onion plants within rows [95,000 plants/acre (235,000 plants/ha)]. In late May, 4 ft (1.22 m) wide alleys were cut between plots, leaving plots 23 ft (7 m) long. In early June and then again in late June, 90 lb/acre (101 kg·ha<sup>-1</sup>) of N as urea was sidedressed along both sides of every row [total of 180 lb/acre (202 kg·ha<sup>-1</sup>) of N].

Weeds were controlled with cultivations and low rate herbicide applications as needed until early July, when onion foliage growth precluded further tractor traffic. Herbicides included bromoxynil, oxyfluorfen, sethoxydim, and pendimethalin. Thrips were controlled with four aerial applications of cyhalothrin from June through August. Methomyl was added to the cyhalothrin application in July to control mites. Methomyl was also applied aerially in August. Downy mildew

[*Peronospora destructor* (Berk.) Casp. in Berk.] was controlled with metalaxyl applied once in July and twice in August.

The last irrigation of the season was in late August. Bulb maturity ratings for each plot were recorded in late August and early September as visual estimates of percent dry leaf material in each plot and percent of bulbs with necks collapsed and leaves on the ground. Those percentages for each date were averaged for maturity ratings. Bolted onions were counted in September and recorded as the number of bulbs in the entire four-row plot.

Onion bulbs were lifted in September to field-dry. Onions were hand-topped from the middle two rows of every plot in late September and placed into slatted wooden crates. The crates were placed into wooden bins [4 × 4 × 5 ft (1.22 × 1.22 × 1.52 m)], and the bins were moved into a storage with circulating ventilation. The storage was maintained as close to 34 °F (1 °C) and 70% relative humidity as possible using outdoor ambient air to cool the storage. Onion cultivars were compared based on bulb grade out of storage the following January. Bulbs infected with botrytis neck rot in the neck or side and bulbs infected with plate rot were separated manually and weighed before the sound bulbs were graded by size. Split double bulbs were graded as No. 2s. The percentages of loss were calculated. Bulbs without blemishes or signs of decomposition (No. 1s)

were graded according to their diameter. Size categories were small, <2.25 inches (5.7 cm) in diameter; medium, 2.25 to 3 inches (5.7 to 7.6 cm); jumbo, 3 to 4 inches (7.6 to 10.2 cm); and colossal, >4 inches (10.2 cm). Variety differences were compared using analysis of variance and least significant differences at the 5% probability level.

## Results

In 1996, April and May were wetter and cooler than the 50 year mean, and fewer degree days were accumulated through spring months than average (Table 2). In contrast, more growing degree days were accumulated through June in 1997 than the 50 year mean. Consequently, growth and maturity were prolonged in 1996 compared to 1997. Averaged across all cultivars, the percentage of plants that matured by 22 Aug., 30 Aug., and 6 Sept. were 15, 23, and 37% in 1996 (Table 3), and 37, 47, and 62% in 1997 (Table 4), respectively.

In 1996, bulb yield out of storage ranged from 564 to 1317 cwt/acre (63 to 148 Mg·ha<sup>-1</sup>), and marketable yield ranged from 478 to 1131 cwt/acre (54 to 127 Mg·ha<sup>-1</sup>) (Table 3). Marketable bulb yield of eight cultivars tested in 1996 was greater than 1000 cwt/acre. Averaged across all cultivars, total yield out of storage in 1996 was 952 cwt/acre (107 Mg·ha<sup>-1</sup>) and marketable yield out of storage was 832 cwt/acre (93 Mg·ha<sup>-1</sup>). The

**Table 2. Monthly weather information for the Malheur Experiment Station near Ontario, Ore.**

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation (inches) <sup>z</sup>												
1996	0.96	0.90	1.10	1.34	2.54	0.11	0.28	0.29	0.68	1.13	1.32	2.85
1997	2.13	0.17	0.25	0.66	0.67	0.86	1.40	0.28	0.40	0.43	1.02	0.94
50-yr mean	1.32	0.94	0.97	0.80	1.00	0.82	0.22	0.43	0.50	0.71	1.20	1.33
Mean air temp (°F) <sup>y</sup>												
1996	32	34	44	50	57	66	76	71	60	50	40	32
1997	31	36	44	49	62	67	72	72	65	50	40	31
50-yr mean	27	34	42	51	60	67	74	72	63	51	38	30
Cumulative degree days (lower threshold = 50 °F, upper threshold = 85 °F) <sup>y</sup>												
1996	0	0	58	193	436	929	1687	2345	2709	2903	2921	2923
1997	0	0	85	202	621	1130	1791	2497	2977	3134	3154	3154
11-year mean	0	0	62	229	559	1067	1775	2440	2868	3041	3051	3052
Pan evaporation (inches) <sup>z</sup>												
1996				5.59	8.19	9.61	11.61	10.67	7.03	4.08		
1997				6.17	8.66	10.43	11.06	10.82	7.32	5.38		
50-year mean				5.54	7.61	8.81	11.09	9.51	6.19	3.09		

<sup>z</sup>1 inch = 25.4 mm.

<sup>y</sup>1 °F = 1.8 °C + 32.

**Table 3. Bulb yield, bulb size, susceptibility to neck rot and plate rot, and maturity rating of onion cultivars evaluated in 1996. Cultivars are presented in order of their total marketable yield.**

Cultivar	Seed co.	Bulb yield at harvest (cwt/acre) <sup>x</sup>	Marketable yield (%) <sup>z</sup>				Nonmarketable yield (%)				Mature plants <sup>y</sup>			Bolters <sup>w</sup> (no.)
			in January after storage				Neck rot	Plate rot	No. 2s	Total	22 Aug.	30 Aug.	6 Sept.	
			Total	Colossal	Jumbo	Medium								
9003C	American Takii	1317	1131	55	45	0	5	3	6	14	0	3	19	1.1
Seville	Aristogenes	1178	1093	45	55	0	4	2	1	7	6	12	30	1.9
El Charro	Aristogenes	1203	1071	44	55	1	6	5	1	11	4	9	21	1.5
SXO 1430														
(Sunre 1430)	Sunseeds	1098	1061	42	57	1	1	2	1	3	16	36	46	0.2
EL Padre	Aristogenes	1115	1040	46	53	0	2	3	1	7	1	3	16	1.5
Golden Security	Rispen Seeds	1134	1022	46	54	0	4	2	5	10	2	3	17	1.1
Bravo	Aristogenes	1148	1015	45	55	0	4	5	3	12	6	10	21	1.9
X 202	Waldo Seeds	1191	1004	38	62	0	10	4	2	16	1	2	12	1.6
Vaquero	Sunseeds	1054	996	34	66	0	3	2	0	6	3	6	27	0.3
Sweet Amber	Crookham	1126	990	35	64	0	5	4	4	12	13	27	42	0.8
9003	American Takii	1189	988	39	60	1	9	3	4	17	0	1	5	0.3
Celebrity	Crookham	1118	985	43	56	0	4	4	4	12	1	6	18	1.6
Victory	Rispen Seeds	1107	982	45	55	0	3	4	4	11	8	19	33	0.2
Sweet Perfection	Crookham	1091	970	45	54	0	3	4	4	11	12	18	30	0.8
X 201	Waldo Seeds	1195	949	43	57	0	12	5	4	21	2	9	19	1.6
Quest	Petoseed	1107	939	62	38	0	5	9	2	15	2	5	20	0.6
Atlas	Petoseed	1135	925	68	32	0	5	9	4	19	6	17	31	0.8
Vision	Petoseed	1066	917	47	53	0	4	7	3	14	2	5	21	0.6
Maritime	Aristogenes	1022	910	22	78	0	3	7	1	11	25	40	53	0.8
Great Scott	Scottseed	1043	900	45	55	0	4	3	7	14	3	8	25	0.2
ATX 5-96	American Takii	972	893	35	64	1	2	4	3	8	2	6	16	0.2
FMX 2074	Ferry Morse	986	886	36	64	0	3	6	1	10	7	22	35	1.0
Viper	Asgrow	1023	885	27	72	0	6	5	3	14	29	40	50	2.2
Caesar	Ferry Morse	962	885	26	73	0	3	4	1	8	3	11	32	0.8
Envoy	Aristogenes	990	881	28	71	0	3	5	3	11	33	43	52	0.9
ATX 5-89	American Takii	981	869	41	59	0	3	5	3	11	2	3	13	0.8
Oro Grande	Ferry Morse	939	857	31	68	1	3	5	1	9	5	11	30	1.0
Pinnacle	Petoseed	918	855	22	78	0	1	5	0	7	6	15	40	0.0
6077	Rio Colorado Seeds	1004	851	33	67	0	2	5	8	15	13	23	36	0.6
Challenge	Rio Colorado Seeds	986	846	31	69	0	4	6	5	14	14	22	40	1.0
Augustus	Ferry Morse	931	838	30	70	0	5	3	2	10	2	6	14	1.2
Bullring	Sunseeds	980	834	20	80	0	6	8	1	15	33	49	54	3.5
Fabius	Ferry Morse	939	830	21	79	0	3	7	2	12	22	36	52	2.1
Apex	Petoseed	887	828	19	81	0	1	3	2	7	3	6	24	0.0
Condor	American Takii	977	818	28	72	0	4	10	2	16	14	22	44	0.4
Viceroy	Asgrow	873	807	19	80	0	2	3	2	8	22	38	52	0.0
Rio Seco	Rio Colorado Seeds	937	801	14	86	0	5	8	2	15	50	53	55	0.2
Eagle	American Takii	888	800	22	78	0	2	5	3	10	3	6	24	1.3
SSC 1992	Shamrock	909	788	21	78	1	3	5	5	13	8	18	28	0.3
Wrangler	Rispen Seeds	864	786	21	75	4	2	4	3	9	3	12	29	0.2
Winner	Sunseeds	1079	779	50	50	0	9	17	1	28	19	33	42	2.8
Teton	Petoseed	913	778	24	76	0	4	9	2	15	15	27	48	1.9
Regiment	Asgrow	924	775	31	69	1	4	10	2	16	37	48	51	1.1
Tesoro	Sunseeds	817	764	20	80	0	2	3	2	7	15	27	45	1.0
Impala	Shamrock	924	751	14	85	1	5	4	10	19	47	52	57	0.0
Sabroso														
(Sunex 1433)	Sunseeds	838	744	13	86	1	2	7	2	11	6	22	46	0.0
Discovery	Rio Colorado Seeds	846	733	21	78	1	4	6	4	13	27	38	45	0.3
Valiant	Sunseeds	854	721	17	82	1	4	10	2	16	11	22	49	1.5
Sueno														
(XPH 93386)	Crookham	799	708	17	82	1	3	5	3	11	10	22	43	1.5
Altisimo														
(BGS 77 F1)	Bejo seeds	761	706	13	87	1	1	3	3	7	2	9	20	0.1
Daytona	Bejo seeds	774	704	13	86	1	1	5	3	9	2	5	11	0.3

Table 3. Continued.

Cultivar	Seed co.	Bulb yield at harvest (cwt/acre) <sup>x</sup>	Marketable yield (%) <sup>z</sup> in January				Nonmarketable yield (%)				Mature plants <sup>y</sup> (%)			Bolters <sup>w</sup> (no.)
			after storage				Neck rot	Plate rot	No. 2s	Total	22 Aug.	30 Aug.	6 Sept.	
			Total	Colossal	Jumbo	Medium								
T-432	American Takii	813	699	43	57	1	6	5	3	14	2	11	20	0.0
SSC 3359	Shamrock	802	697	21	79	0	4	3	7	13	14	26	38	0.0
Pathfinder	Rio Colorado Seeds	776	670	11	89	0	4	8	1	14	36	45	53	0.6
RCS 6171	Rio Colorado Seeds	843	655	17	82	1	6	10	6	22	44	47	52	0.6
Fury	Asgrow	764	638	16	84	1	2	8	6	17	27	35	50	0.0
SSC 9983	Shamrock	744	629	16	83	1	3	9	3	16	20	37	51	1.2
Tamara F1 (BGS 80)	Bejo seeds	702	609	3	97	0	4	9	0	13	23	47	60	0.0
Impact	Harris Moran	659	598	5	94	1	2	4	4	9	47	54	67	0.6
Santana F1 (BGS 65)	Bejo seeds	668	534	6	93	1	4	15	2	20	23	40	55	0.0
Frontier	American Takii	564	503	3	95	2	4	6	2	11	64	75	89	0.0
Squire	Harris Moran	596	478	9	90	1	5	11	3	20	35	49	57	0.0
Mean		952	832	29	70	1	4	6	3	13	15	23	37	1.0
LSD <sub>(0.05)</sub>		71	74	9	9	1	4	3	2	5	8	9	9	0.8

<sup>z</sup>Colossal = >4 inch, Jumbo = 3 to 4 inch, Medium = 2.25 to 3 inch.

<sup>y</sup>Average of the percent plant tops collapsed and percent of dry leaves.

<sup>x</sup>1 cwt/acre = 100 lb/acre = 112.09 kg·ha<sup>-1</sup>.

<sup>w</sup>Per plot [7 × 23 ft (2.1 × 7.0 m)].

majority of cultivars in 1996 produced only jumbo and colossal bulbs. Only 'Wrangler' and 'Frontier' had more than 1% medium size bulbs. In general, the higher the yield, the greater the percentage of colossal bulbs and the lower the percentage of jumbo bulbs. On the average, onion cultivars in 1996 produced 70% jumbo and 29% colossal bulbs.

From 1 to 12% of bulbs in 1996 showed symptoms of neck rot during storage, depending on cultivar. The percentage of bulbs with evidence of plate rot during storage ranged from 2% to 17% among cultivars. In general, all cultivars produced relatively few No. 2s and bolting onions (Table 3). By January, 28% of 'Winner' was not marketable, whereas only 3% of 'Sunre 1430' was not marketable. Averaged across all cultivars, 13% of the stored crop in 1996 was not marketable in January, which included 4% with neck rot, 6% with plate rot, and 3% U.S. No. 2s. Small onions consisted of less than 1% of yield in all cultivars, and were included in No. 2s. There were large variations among cultivars for maturity rating. By 9 Sept. 1996, only 5% of line 9003 was mature, whereas 89% of 'Frontier' was mature by that time.

In 1997, onion bulb total yield out of storage ranged from 395 to 933 cwt/acre (44 to 105 Mg·ha<sup>-1</sup>) and averaged 699 cwt/acre (78 Mg·ha<sup>-1</sup>) (Table 4). Marketable yield in January

1998, ranged from 383 to 912 cwt/acre (43 to 102 Mg·ha<sup>-1</sup>) and averaged 674 cwt/acre (76 Mg·ha<sup>-1</sup>). Marketable yields of 'Seville', 'Bravo', 'Quest', 'T-433', '9003C', 'Goldstar', 'Superstar', 'RNX-10020', 'Vision', and 'Sweet Perfection' were greater than 830 cwt/acre (93 Mg·ha<sup>-1</sup>). Averaged across all cultivars in 1997, marketable bulbs out of storage were 76% jumbo, 22% colossal, and only 2% medium.

Neck rot and plate rot during storage were not as evident in 1997 as in 1996. The incidence of neck rot ranged from 0% to 2.7% among cultivars and averaged 0.8%, and the incidence of plate rot ranged from 0% to 1.1% and averaged 0.4% (Table 4). Except for a few cultivars, number 2s consisted of only a small portion of bulbs produced in 1997. Total nonmarketable yield in 1997 ranged from 1% to 12%, and averaged 4%.

As in 1996, maturity rating varied significantly among cultivars in 1997 (Table 4). The earliest cultivar was 'Tenshin' with 97% of plants mature by 5 Sept., and the latest cultivar was 'Castillo' with only 7% of plants mature by that time.

Total marketable onion yield after storage, as well as percentage of the marketable yield that were colossal or jumbo size, was strongly correlated ( $P < 0.001$ ) with maturity ratings in both years (Fig. 1). Marketable yield and the portion of colossal onions decreased

as the cultivars matured earlier in the season, while the portion of jumbo onions increased. Bolting and the severity of neck rot and plate rot were not associated with maturity rating in either year.

## Discussion and conclusion

Onion yields in the range of 1000 cwt/acre (112 Mg·ha<sup>-1</sup>) are not uncommon in commercial fields of the Treasure Valley. Results of these trials show the potential of some new onion cultivars to exceed these yields with a large proportion of the largest size marketable bulbs.

Yield performance of the 30 cultivars evaluated in both 1996 and 1997 was consistent between years (Table 5). Of these cultivars and lines, 'Seville', '9003C', 'Bravo', 'Quest', and 'Sweet Perfection' ranked at the top for average marketable bulb yield. The new line 9003C showed excellent yield and quality performance, and merits further investigation. 'Celebrity', 'Vision', and 'Maritime' also performed well in both years. 'Bravo', 'Quest', 'Maritime', and 'Vision' were also included in 1996 and 1997 yield trials in eastern Washington, and were among the top yielding cultivars in that area (G.Q. Pelter, personal communication). These cultivars merit further evaluation in the region.

The reported values for defective onions due to neck rot and plate rot

**Table 4. Bulb yield, bulb size, susceptibility to neck rot and plate rot, and maturity rating of onion cultivars evaluated in 1997. Cultivars are presented in order of their total marketable yield.**

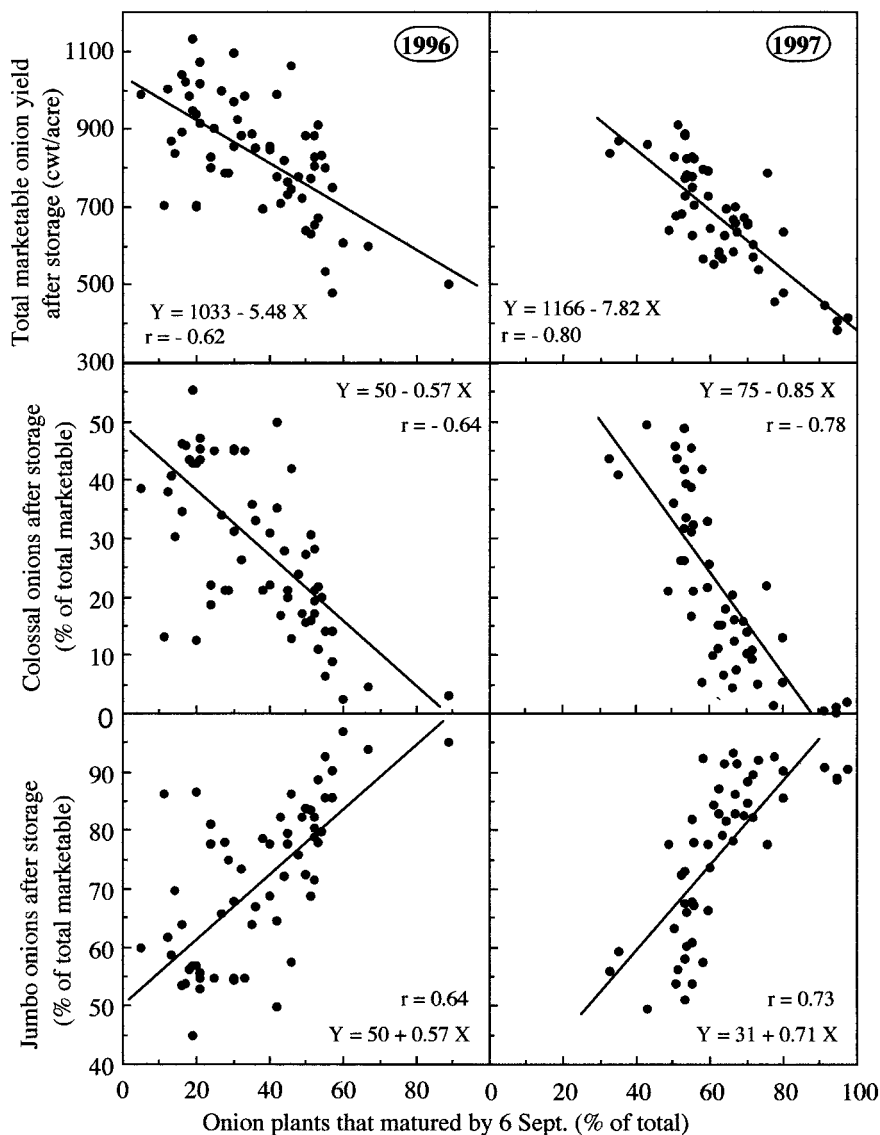
Cultivar	Seed co.	Bulb yield at harvest (cwt/acre) <sup>x</sup>	Marketable yield (%) <sup>z</sup> in January				Nonmarketable yield (%)				Mature plants <sup>v</sup> (%)			Bolters <sup>w</sup> (no.)
			Total	after storage			Neck rot	Plate rot	No. 2s	Total	22 Aug.	30 Aug.	6 Sept.	
				Colossal	Jumbo	Medium								
Seville	Aristogenes	933	912	43	56	0	1.0	0.4	1	2	24	39	51	8.0
Bravo	Aristogenes	931	888	42	58	0	1.9	0.1	3	5	28	46	53	6.8
Quest	Petoseed	895	884	49	51	0	0.5	0.6	0	1	41	47	53	2.2
T-433	American Takii	886	868	41	59	0	0.7	0.4	1	2	4	21	35	0.8
9003C	American Takii	944	861	49	50	1	0.7	0.0	8	9	6	21	43	0.0
Goldstar	Rispens Seed	872	839	44	56	1	1.1	0.1	3	4	4	16	33	7.6
Superstar	Rispens Seed	848	827	36	63	1	0.6	0.4	1	2	27	35	50	5.2
RNX-10020	Rio Colorado Seeds	860	827	38	61	1	0.9	0.5	2	4	33	50	55	6.4
Vision	Petoseed	839	826	33	66	1	0.7	0.4	0	2	25	35	54	0.6
Sweet Perfection	Crookham	846	824	32	67	1	0.6	0.2	2	3	39	48	56	0.4
Rio Rita	Rio Colorado Seeds	819	797	42	57	1	1.6	0.5	1	3	47	51	58	1.0
Vega	Asgrow	814	793	33	66	1	0.1	0.4	2	2	43	50	59	2.6
Maritime	Aristogenes	802	788	22	78	1	1.0	0.2	1	2	53	57	76	0.6
FMX 2031	Ferry-Morse	798	780	39	60	1	0.8	0.9	1	2	21	36	54	6.6
Raptor	Rio Colorado Seeds	803	776	45	54	1	1.1	0.2	2	3	29	44	55	2.0
Celebrity	Crookham	810	773	32	68	1	0.8	0.4	3	5	26	39	53	2.8
Great Scott	Scottseed	802	750	31	68	1	0.7	0.9	5	7	25	42	55	0.4
FMX 2015	Ferry-Morse	754	728	26	73	1	1.3	0.4	2	4	21	36	53	2.4
Vaquero	Sunseeds	738	727	21	78	1	0.7	0.1	0	1	44	52	60	0.8
Payette	Petoseed	716	704	21	78	1	0.9	0.2	1	2	46	48	56	0.0
Viper	Asgrow	718	702	16	83	1	1.5	0.4	0	2	52	55	67	0.6
Valiant	Sunseeds	700	696	18	82	1	0.0	0.4	0	1	44	56	65	1.4
Golden Security	Rispens Seed	735	681	26	73	2	2.2	0.3	5	7	23	37	52	0.4
RNX-10311	Rio Colorado Seeds	717	675	46	54	1	2.7	0.2	3	6	22	37	51	0.2
Mira	Asgrow	680	673	16	82	2	0.8	0.2	0	1	53	57	69	0.0
Viceroy	Asgrow	692	669	20	78	2	0.6	0.3	2	3	50	54	67	0.0
Pinnacle	Petoseed	670	660	10	88	1	0.2	0.9	0	1	46	54	70	0.0
Envoy	Aristogenes	679	659	12	86	2	0.6	1.1	1	3	51	57	67	0.0
Regiment	Asgrow	665	652	14	85	1	0.3	1.1	1	2	56	58	70	0.8
407B	American Takii	656	643	25	74	1	0.8	0.1	1	2	22	39	60	0.0
XPH 95345	Crookham	689	638	21	78	2	2.4	0.6	4	7	15	33	49	1.4
Eagle	American Takii	643	637	7	92	1	0.5	0.2	0	1	39	51	67	0.0
Condor	American Takii	651	634	13	86	1	0.1	1.1	1	3	54	61	80	0.2
Castillo	Bejo	716	631	19	81	1	0.5	0.0	11	12	0	3	7	0.4
Apex	Petoseed	655	625	16	82	2	1.7	0.3	2	4	25	39	55	0.2
Teton	Petoseed	633	624	6	91	2	0.1	1.0	0	1	45	53	64	0.0
Tesoro	Sunseeds	611	602	9	90	1	0.5	0.0	1	1	49	54	72	0.0
Santos	Vilmorin	652	587	15	83	2	0.2	0.4	9	10	38	47	62	0.0
Sabroso	Sunseeds	589	584	4	93	2	0.1	0.3	0	1	30	43	66	0.0
SSC 0377	Shamrock	627	574	11	87	2	0.4	0.2	8	9	50	55	62	0.0
Sueno	Crookham	583	569	11	82	7	0.8	0.6	1	2	46	54	72	0.4
Daytona	Bejo	587	568	5	92	3	0.5	0.1	3	3	20	40	58	0.0
Wrangler	Rispens Seed	585	567	15	79	6	0.2	0.2	3	3	29	47	63	0.0
Altisimo	Bejo	573	552	10	84	6	0.3	0.2	3	4	25	41	61	0.0
PX 67691	Petoseed	546	537	5	92	3	0.0	0.8	1	2	55	58	73	0.0
Fury	Asgrow	504	479	5	90	5	1.5	0.8	3	5	51	60	80	0.0
Lorenzo	Vilmorin	492	457	1	93	6	0.2	0.8	6	7	53	60	78	0.0
HMX 4633	Harris Moran	460	447	0	91	9	0.9	0.4	2	3	43	61	91	0.6
Tenshin	Seedex	422	415	2	91	8	0.2	0.5	1	2	73	89	97	0.0
Impact	Harris Moran	434	408	1	89	11	1.1	1.0	4	6	59	76	95	0.2
VDH 89573	Shamrock	395	383	0	89	11	0.1	0.5	2	3	64	74	94	0.0
Mean		699	674	22	76	2	0.8	0.4	2	4	36	47	62	1.3
LSD <sub>(0.05)</sub>		53	57	11	12	2	1.2	0.8	3	3	10	9	7	2.0

<sup>z</sup>Colossal = >4 inch, Jumbo = 3 to 4 inch, Medium = 2.25 to 3 inch.

<sup>v</sup>Average of the percent plant tops collapsed and percent of dry leaves.

<sup>x</sup>1 cwt/acre = 100 lb/acre = 112.09 kg·ha<sup>-1</sup>.

<sup>w</sup>Per plot [7 × 23 ft (2.1 × 7.0 m)].



**Fig. 1. Correlations between total marketable onion yield after storage, and the percentage of the marketable bulb yield after storage that were colossal [ $>4$  inch (10.2 cm) diameter] or jumbo [3 to 4 inch (7.6 to 10.2 cm) diameter] size, and maturity ratings of all cultivars tested in 1996 and 1997. Each data point represents a cultivar averaged across all replications. (1 cwt/acre = 100 lb/acre = 112.09 kg·ha<sup>-1</sup>).**

may be used as a preliminary ranking of cultivars for their susceptibility to these diseases. However, the severity of these diseases strongly depends on weather conditions during crop growth and harvest and subsequent storage conditions and management. The incidence and severity of both neck rot and plate rot was greater in 1996 than in 1997, which is attributed in part to delayed crop maturity in 1996, and more precipitation and cooler temperatures during September and October in 1996 than in 1997. Also, factors such as bruising or injury at harvest, inadequate curing, and improper storage conditions and management have a

strong effect on the incidence and severity of bulb infection by disease. The bulbs of all cultivars were treated the same in these trials; they were relatively unharmed at harvest, properly cured within limits of the climate, and adequately stored. Neck rot and plate rot can be controlled or prevented to some degree by crop sanitation and rotation, cultivar selection, sound cultural practices, fumigation, and the use of proper harvest and storage procedures. Fungicides have not been shown to be effective against these diseases in the Treasure Valley.

Cultivars varied considerably for their maturity ratings. In the present

**Table 5. Average marketable onion yield of all cultivars that were tested in both 1996 and 1997, and their ranking for marketable yield in each year.**

Cultivar	Seed co.	Marketable bulb yield			
		Avg 1996-97		1996	1997
		Yield (cwt/acre) <sup>z</sup>	Rank (no.)	rank (no.)	rank (no.)
Seville	Aristogenes	1002	1	2	1
9003C	American Takii	996	2	1	5
Bravo	Aristogenes	951	3	4	2
Quest	Petoseed	912	4	8	3
Sweet Perfection	Crookham	897	5	7	7
Celebrity	Crookham	879	6	6	9
Vision	Petoseed	871	7	9	6
Vaquero	Sunseeds	862	8	5	11
Golden Security	Rispen Seeds	851	9	3	14
Maritime	Aristogenes	849	10	10	8
Great Scott	Scottseed	825	11	11	10
Viper	Asgrow	793	12	12	12
T-432	American Takii	784	13	28	4
Envoy	Aristogenes	770	14	13	17
Pinnacle	Petoseed	758	15	14	16
Viceroy	Asgrow	738	16	17	15
Apex	Petoseed	727	17	15	21
Condor	American Takii	726	18	16	20
Eagle	American Takii	718	19	18	19
Regiment	Asgrow	714	20	21	18
Valiant	Sunseeds	708	21	24	13
Teton	Petoseed	701	22	20	22
Tesoro	Sunseeds	683	23	22	23
Wrangler	Rispen Seeds	676	24	19	27
Sabroso (Sunex 1433)	Sunseeds	664	25	23	24
Sueno (XPH 93386)	Crookham	638	26	25	25
Daytona	Bejo seeds	636	27	27	26
Altisimo (BGS 77 F1)	Bejo seeds	629	28	26	28
Fury	Asgrow	559	29	29	29
Impact	Harris Moran	503	30	30	30

<sup>z</sup>1 cwt/acre = 100 lb/acre = 112.09 kg·ha<sup>-1</sup>.

trial, late maturing cultivars had greater total yield and greater yields of the larger size bulbs, without increases in decomposition during storage. Early maturity can be strategically desirable because of facilitating early harvest, the possibility of realizing higher market value early in the season, and better curing before storage. Additional observations would be required to conclusively group cultivars into different maturity and disease resistance categories.

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