

Variety Trials

Single-centered and Super Colossal Bulbs from Yellow Onion Cultivars

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SUMMARY. Onion (*Allium cepa*) cultivars for commercial production in eastern Oregon and southwestern Idaho are evaluated annually in replicated yield trials conducted at the Malheur Experiment Station, Oregon State University, Ontario. Market demand has progressively called for larger bulb size and bulbs with single centers. At harvest onions were evaluated for maturity, number of bolters, and single centeredness. Cultivars showed a wide range of bulbs with only one growing point or “bullet” single centers, ranging from 1% to 57% in 2000, from 7% to 70% in 2001, and from 1% to 74% in 2002. The percentages of bulbs functionally single-centered for processing uses ranged from

18% to 88% in 2000, from 24.7% to 91.3% in 2001, and from 14.4% to 92% in 2002. Bulb yield and market grade were evaluated out of storage. Marketable yield after 4 months of storage varied significantly by cultivar from 643 to 1196 cwt/acre (72.1 to 134.1 Mg·ha⁻¹) in 2000, from 538 to 980 cwt/acre (60.3 to 109.8 Mg·ha⁻¹) in 2001, and from 583 to 1119 cwt/acre (65.3 to 125.4 Mg·ha⁻¹) in 2002. Averaging over cultivars, super colossal bulb size averaged 26%, 14%, and 10% in 2000, 2001, and 2002, respectively.

Each year onion is produced on about 20,000 acres (8094 ha) in eastern Oregon and southwestern Idaho, with a total value of \$97 million, \$85 million, and \$94 million in 2000, 2001, and 2002, respectively [U.S. Department of Agriculture (USDA), 2003]. These onions are mostly yellow long-day cultivars and are marketed fresh in August and September and from storage through April (Shock et al., 2000). The onion production area is within a radius of 30 miles (48.3 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. The average onion bulb yield in the Treasure Valley was 625 cwt/acre (70.1 Mg·ha⁻¹) in 2000, 630 cwt/acre (70.6 Mg·ha⁻¹) in 2001, and 645 cwt/acre (72.3 Mg·ha⁻¹) in 2002 (USDA, 2003).

Seed companies are continually developing new cultivars that need to be evaluated across years and locations in order to determine which cultivars are best for any particular location. Since 1972, established cultivars and new onion lines for commercial production in eastern Oregon and south-

western Idaho have been evaluated in replicated yield trials conducted at the Malheur Experiment Station near Ontario, Ore. Characteristics that have been evaluated in these trials include bulb yield and size, maturity rating, potential for bolting, and susceptibility to neck rot (*Botrytis allii*) and plate rot (*Fusarium oxysporum*) diseases. Results of the 1996 and 1997 trials were reported (Shock et al., 2000). Starting in 2000, two additional cultivar characteristics were evaluated: super colossal size bulbs and bulb single centeredness.

Super colossal bulbs have become important for the restaurant industry. Appetizers made by deep-frying large onion bulbs increased in popularity in restaurants in the late 1990s. To meet the needs of this new market, in 1998 onion packers and shippers in southwestern Idaho and eastern Oregon adopted a new bulb size class called “super colossal.” Locally super colossal bulbs must be larger than 4¼ inches (108 mm) in diameter and are marketed with a count of 28–36 bulbs per 50-lb (22.7 kg) bag.

Single center is an important characteristic for restaurants and the manufacture of onion rings. Onion ring manufacturing efficiency is reduced when onion bulbs have multiple centers. McCain Snack Foods (Appleton, Wis.), a producer of frozen onion rings, has developed the protocol used here for measuring and classifying onion bulbs into four categories according to single centers. Bulbs with single centers (called “bullets”) or bulbs with a small multiple center [called a “small double” with multiple center diameters <1½ inches (38 mm)] are preferred. Together the bullets and small doubles are called “functionally single-centered” onions. Growers are contracted to deliver 75% “functionally single-centered” onions with overall bulb diameter of 3 to 4½ inches (76 to 114 mm). Incentives are paid for delivering onions that are more than 75% “functionally single-centered.” Onions with progressively larger multiple centers have fewer useable rings for processing.

Single centeredness is a heritable onion trait that allows for the development of cultivars with a high frequency of single centers (Gamie et al., 1995; Wall et al., 1996). The onset of lateral shoot development produces multiple centers in onions. The role of physi-

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ological stresses and their timing in the development of lateral shoot development is poorly understood. Our hypotheses for future research are that 1) stress to onions predisposes them to initiate lateral shoots (causing multiple centers) and 2) onion plants stressed early in development are more likely to express larger multiple centers at harvest than onions stressed during later phases of development.

Due to market demands for single centers and super colossal size bulbs, this paper presents bulb yield, size, and single centeredness evaluated after storage for cultivars of yellow onions from trials conducted at the Malheur Experiment Station in 2000, 2001, and 2002. In the discussion, both the established cultivars and the experimental lines on the verge of release are referred to as cultivars. Maturity ratings and the potential of all cultivars for bolting at harvest are also reported.

Materials and methods

Trials were conducted in 2000 on Greenleaf silt loam (fine-silty, mixed, mesic Xerollic Haplargids), and in 2001 and 2002 on Owyhee silt loam (coarse-silty, mixed, mesic Xerollic Camborthids) at the Malheur Experiment Station near Ontario, Ore. The fields each year had previously been planted to wheat (*Triticum aestivum*) and had 1.6%, 2.1%, and 2.4% organic matter and a water pH of 7.3, 7.2, and 7.5 in 2000, 2001, and 2002, respectively. The wheat stubble was shredded and the field deep-chiseled, disked, irrigated, moldboard-plowed, roller-harrowed, and bedded in the fall. Each year, before fall plowing, fertilizer was broadcast based on soil analyses and according to extension guidelines (Sullivan et al., 2001). In 2000, nitrogen (N) at 20 lb/acre (22.4 kg·ha⁻¹), phosphorus (P) at 44 lb/acre (49.3 kg·ha⁻¹), zinc (Zn) at 10 lb/acre (11.2 kg·ha⁻¹), and magnesium (Mg) at 30 lb/acre (33.6 kg·ha⁻¹) were broadcast. In 2001, N at 20 lb/acre, P at 87 lb/acre (97.5 kg·ha⁻¹), potassium (K) at 28 lb/acre (31.4 kg·ha⁻¹), sulfur (S) at 150 lb/acre (168.1 kg·ha⁻¹), Mg at 28 lb/acre, Zn at 10 lb/acre, and copper (Cu) at 5 lb/acre (5.6 kg·ha⁻¹) were broadcast. In 2002, P at 44 lb/acre, K at 100 lb/acre (112.1 kg·ha⁻¹), Mg at 50 lb/acre (56.0 kg·ha⁻¹), Zn at 10 lb/acre, Cu at 3 lb/acre (3.4

kg·ha⁻¹), and boron (B) at 1 lb/acre (1.1 kg·ha⁻¹), were broadcast. At bedding, the field was fumigated with 20 gal/acre (187.1 L·ha⁻¹) of Telone C-17 (77.9% 1,3-dichloropropene + 16.5% chloropicrin; Dow AgroSciences, Indianapolis) and left until spring without further tillage.

Beds were harrowed down the day prior to planting. Seeds were planted on 24 Mar. 2000, and on 22 Mar. 2001 and 2002. In 2000 and 2001, seed was planted in single rows on 22-inch (55.9 cm) beds. In 2002 seed was planted in double rows on 22-inch beds. The double rows were spaced 3 inches (7.6 cm) apart. In 2000 and 2001 the seeding rate was 18 seeds/ft of row (59.1 seeds/m). In 2002 the seeding rate was 9 seeds/ft (29.5 seeds/m) of single row. In 2000 and 2001, seed was planted using four ALMACO cone seeders (ALMACO, Nevada, Iowa) mounted on a John Deere Model 71 Flexi Planter (John Deere, Moline, Ill.) equipped with disc openers. In 2002, seed was planted with a new customized double row planter using John Deere Flexi Planter units equipped with disc openers. In 2002 the onion cultivar trials were improved by using a double row planter. The double rows more closely parallel grower practices. With the same plant population per unit area, double rows help avoid adjoining onions pressing against each other, developing slightly flattened sides. Consequently, the double row planter should promote a slightly higher percentage of marketable bulbs. For all years, each cultivar was planted in plots four rows wide and 27 ft (8.2 m) long with six replications. The experimental designs were randomized complete blocks.

Immediately after seeding, plots received 2 oz/acre (140 g·ha⁻¹) of chlorpyrifos, the soil surface was rolled, and the first furrow irrigation was applied to supply moisture for seed germination. Soon after germination the onion seedlings were hand thinned to a plant spacing of 3 inches between individual onion plants within rows [95,000 plants/acre (234,742 plants/ha)] in 2000 and 2001. In 2002 the onion seedlings were hand thinned to a plant spacing of 6 inches (15.2 cm) between individual onion plants within the single rows of the double rows (95,000 plants/acre). In late May, 4-ft-wide (1.2 m) alleys

were cut between plots, leaving plots 23 ft (7.0 m) long. In 2000 the field was sidedressed with N at 100 lb/acre as urea on 19 May and 16 June. In 2001 the field was sidedressed with N at 100 lb/acre as urea, Zn at 10 lb/acre, Cu at 1 lb/acre, and B at 1 lb/acre on 21 May. On 16 June 2001 N at 100 lb/acre was injected in the irrigation water as urea. In 2002 the field was sidedressed with N at 90 lb/acre (100.9 kg·ha⁻¹) as urea on 15 May and 11 June.

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 at labeled rates. Thrips (*Thrips tabaci*) were controlled with aerial applications of cyhalothrin and methomyl from June through early August at labeled rates. Four aerial applications for thrips control were made in 2000 and five were made in 2001 and 2002.

Onions were furrow irrigated when the soil water potential at 8 inches (20.3 cm) soil depth reached -20 cbar (kPa) (Shock et al., 1998). Soil water potential was monitored by six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrrometer Co., Riverside, Calif.) installed in mid-June below the onion row at 8 inches depth. Sensors were automatically read three times a day with an AM400 meter (Mike Hansen Co., East Wenatchee, Wash.) as previously described (Shock et al., 2002). The last irrigation of the season was in late August.

In early September, 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 (89 to 108 mm) were rated. The onions were cut equatorially through the bulb middle and, if multiple-centered, the long axis of the inside diameter of the first single ring was measured. These multiple-centered onions were ranked according to the diameter of the first single ring: "small double" had diameters <1½ inches (38 mm), "intermediate double" had diameters from 1½ to 2¼ inches (38 to 57 mm), and "blowout" had diameters >2¼ inches. Single-centered onions were classed as a "bullet." Onions were con-

Table 1. Single center rating (%) of onion cultivars evaluated at the Malheur Experiment Station, Ontario, Ore., in 2000. Diameter of the first single ring for multiple-centered onions: “small double” <1½ inches (38 mm), “intermediate double” 1½–2¼ inches (57 mm), and “blowout” >2¼ inches. Single-centered onions were termed “bullets.” Onions were considered “functionally single-centered” for processing if they were a “bullet” or “small double.” Cultivars are ranked by “bullet” single centers.

Cultivar	Seed co. ^z	Multiple-centered			Single-centered	Functionally single-centered
		Blowout	Intermediate double	Small double	bullet	(bullet + small double)
----- % -----						
Vaquero	Nunhems	2.0	10.0	31.3	56.7	88.0
Granero	Nunhems	1.3	19.2	23.8	55.7	79.5
Ranchero	Nunhems	4.0	18.7	36.0	41.3	77.3
Vision	Seminis	13.3	21.3	29.3	36.0	65.3
Ringstar	Rispens	19.3	23.3	22.7	34.7	57.3
Santa Fe	Seminis	14.0	22.1	30.0	33.9	63.9
Tequila	D. Palmer	17.9	23.3	25.8	33.0	58.8
Sabroso	Nunhems	4.0	20.7	42.7	32.7	75.3
Superstar	Rispens	12.7	30.0	25.3	32.0	57.3
Gunnison	Bejo	8.8	18.4	41.0	31.8	72.9
Vantage	Seminis	8.7	23.6	40.0	27.8	67.8
Zorro	Crookham	24.7	22.7	26.0	26.7	52.7
Harvest Moon	Dorsing	24.0	18.4	32.8	24.8	57.6
Cannon Ball	Seminis	27.1	31.2	17.8	23.8	41.7
XP15120	Seminis	21.3	33.3	24.7	20.7	45.3
Tradewind	Seminis	7.3	22.6	50.3	19.8	70.1
Mesquite	D. Palmer	22.0	31.3	27.3	19.3	46.7
XPH97H36	Crookham	25.8	27.3	27.7	19.2	46.9
XPH97H33	Crookham	34.0	24.7	22.7	18.7	41.3
Golden Security	Rispens	33.3	31.3	17.3	18.0	35.3
Quest	Seminis	18.0	31.3	33.3	17.3	50.7
Tesoro	Nunhems	22.7	28.0	34.0	15.3	49.3
Torero	Nunhems	10.0	38.0	37.3	14.7	52.0
Tioga	Seminis	22.0	33.3	30.7	14.0	44.7
Kodiak	D. Palmer	44.3	22.1	20.3	13.4	33.6
XP15113	Seminis	30.0	30.0	28.0	12.0	40.0
T-434	American Takii	49.3	20.7	18.7	11.3	30.0
T-441	American Takii	9.3	23.3	56.0	11.3	67.3
Pinnacle	Seminis	23.8	31.9	33.1	11.2	44.3
T-433	American Takii	41.3	30.7	19.3	8.7	28.0
T-439	American Takii	40.2	36.2	20.4	3.3	23.7
Delgado	Bejo	56.7	25.3	14.7	3.3	18.0
Legend	Bejo	35.3	36.0	26.0	2.7	28.7
Daytona	Bejo	42.2	33.3	21.8	2.6	24.4
Eagle	American Takii	28.0	42.0	28.7	1.3	30.0
Mean		22.8	26.7	29.1	21.4	50.5
LSD _(0.05) ^y		12.4	11.4	11.7	10.1	13.4

^zAmerican Takii, Salinas, Calif.; Bejo Seeds, Oceano, Calif.; Crookham Co., Caldwell, Idaho; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz.; Martin Rispens & Son, Beecher, Ill.; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^yLeast significant difference at 95% confidence.

sidered “functionally single-centered” for processing if they were a “bullet” or a “small double.”

Bulb maturity ratings for each cultivar were recorded in late August and early September as visual estimates of percent dry leaf material in each plot and percentage 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 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 from five replicates in late September and placed into burlap bags. The bags were placed into wooden bins [4 × 4 × 5 ft (1.2 × 1.2 × 1.5 m)], and the bins were moved into storage with

circulating ventilation. The storage was maintained as close to 34 °F (1.1 °C) and 70% relative humidity as possible using outdoor ambient air to cool the storage. The sixth replicate was used for demonstration at an annual grower field day.

Onion cultivars were compared based on bulb grade in January following 4 months of storage. During grading, bulbs were separated accord-

Table 2. Single center rating (%) of onion cultivars evaluated at the Malheur Experiment Station, Ontario, Ore., in 2001. Diameter of the first single ring for multiple centered onions: “small double” <1½ inches (38 mm), “intermediate double” 1½–2¼ inches (57 mm), and “blowout” >2¼ inches. Single-centered onions were termed “bullets.” Onions were considered functionally single-centered for processing if they were a “bullet” or “small double.” Cultivars are ranked by “bullet” single centers.

Cultivar	Seed co. ^z	Multiple-centered			Single-centered	Functionally single-centered
		Blowout	Intermediate double	Small double	bullet	(bullet + small double)
----- % -----						
Vaquero	Nunhems	8.7	8.0	13.3	70.0	83.3
Sabroso	Nunhems	1.3	7.3	30.0	61.3	91.3
Granero	Nunhems	8.0	12.0	25.3	54.7	80.0
Ranchero	Nunhems	8.0	20.7	22.0	49.3	71.3
Valiant	Nunhems	9.3	14.5	29.9	46.3	76.2
SWO 7102	Global Genetics	8.0	16.0	30.0	46.0	76.0
Gunnison	Bejo	6.0	15.3	35.3	43.3	78.7
Sweet Perfection	Crookham	13.8	23.7	21.0	41.5	62.5
Vision	Seminis	16.0	17.3	25.3	41.3	66.7
Tequila	D. Palmer	21.6	18.0	25.5	34.9	60.4
SWO 12028	Global Genetics	21.5	22.2	22.1	34.2	56.3
Santa Fe	Seminis	13.3	16.0	36.7	34.0	70.7
Zorro	Crookham	23.8	19.8	23.9	32.5	56.4
Superstar	Rispens	10.7	24.7	34.7	30.0	64.7
Quest	Seminis	19.3	24.0	28.0	28.7	56.7
Cannon Ball	Seminis	29.3	24.0	18.7	28.0	46.7
SWO 7254	Global Genetics	18.7	25.3	28.0	28.0	56.0
Torero	Nunhems	12.1	28.9	31.4	27.6	59.0
EX15120	Seminis	19.6	29.6	23.4	27.5	50.9
EX77031	Seminis	19.5	31.4	22.1	26.9	49.0
XPH97H33	Crookham	21.3	30.7	21.3	26.7	48.0
Raptor	Global Genetics	30.0	23.3	20.0	26.7	46.7
Ringstar	Rispens	25.3	29.3	19.3	26.0	45.3
Harvest Moon	Dorsing	22.9	28.6	23.4	25.1	48.6
T-441	American Takii	6.0	31.3	38.0	24.7	62.7
Pinnacle	Seminis	21.5	33.6	23.4	21.5	44.9
T-433	American Takii	31.4	30.5	17.4	20.7	38.1
Tioga	Seminis	21.3	34.0	26.0	18.7	44.7
T-439	American Takii	33.3	24.7	24.0	18.0	42.0
Tesoro	Nunhems	33.3	28.7	20.7	17.3	38.0
Golden Security	Rispens	37.5	27.6	18.1	16.8	34.8
Mesquite	D. Palmer	28.7	35.3	21.3	14.7	36.0
Pathfinder	Global Genetics	45.4	22.8	18.2	13.5	31.7
Daytona	Bejo	30.5	34.4	22.8	12.3	35.1
T-434	American Takii	49.3	26.0	14.0	10.7	24.7
Eagle	American Takii	18.8	34.3	36.9	10.1	47.0
XPH95345	Crookham	41.8	27.8	21.9	8.5	30.4
Legend	Bejo	38.0	34.7	19.4	7.9	27.3
Delgado	Bejo	42.0	30.0	21.3	6.7	28.0
Mean		22.2	24.8	24.5	28.5	53.0
LSD _(0.05) ^y		9.7	11.1	11.4	12.0	13.2

^zAmerican Takii, Salinas, Calif.; Bejo, Oceano, Calif.; Crookham Co., Caldwell, Idaho; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz.; Martin Rispens & Son, Beecher, Ill.; Global Genetics, Payette, Idaho; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^yLeast significant difference at 95% confidence.

ing to quality: marketable bulbs without blemishes (No. 1s); unmarketable split bulbs (No. 2s), neck rot (bulbs infected in the neck or side), and plate rot. The No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼ to 3 inches), jumbo (3 to 4 inches), colossal (4 to 4¼ inches), and super colossal (>4¼

inches). Bulb counts per 50 lb of super colossal onions were determined for each plot of every cultivar by weighing and counting all super colossal bulbs during grading.

Least significant differences at the 95% confidence level of cultivar performance, year effects, and cultivars by years were determined using analysis

of variance [NCSS 97 Statistical System for Windows; Number Cruncher Statistical Systems, Kaysville, Utah (Hintze, 2000)].

Results and discussion

The cultivars showed a wide range in the percentage of bulbs with “bul-

Table 3. Single center rating (%) of onion cultivars evaluated at the Malheur Experiment Station, Ontario, Ore., in 2002. Diameter of the first single ring for multiple-centered onions: “small double” <1½ inches (38 mm), “intermediate double” 1½–2¼ inches (57 mm), and “blowout” >2¼ inches. Single-centered onions were termed “bullets.” Onions were considered functionally single-centered for processing if they were a “bullet” or “small double.” Cultivars are ranked by “bullet” single centers.

Cultivar	Seed co. ^z	Multiple-centered			Single-centered bullet	Functionally single-centered (bullet + small double)
		Blowout	Intermediate double	Small double		
-----%-----						
Bandolero	Nunhems	1.6	6.4	18.0	74.0	92.0
Vaquero	Nunhems	5.6	10.4	28.0	56.0	84.0
Granero	Nunhems	8.8	16.8	21.6	52.8	74.4
Montero	Nunhems	3.2	7.2	44.0	45.6	89.6
Ranchero	Nunhems	17.6	8.0	32.8	41.6	74.4
Sabroso	Nunhems	11.8	17.9	28.8	41.5	70.3
SWO 6005	Global Genetics	17.6	21.6	23.2	37.6	60.8
Vision	Seminis	16.0	16.0	31.2	36.8	68.0
Sweet Perfection	Crookham	21.6	20.8	21.6	36.0	57.6
XPH01N3	Crookham	32.8	14.4	16.8	36.0	52.8
Mesquite	D. Palmer	24.0	15.4	25.2	35.4	60.6
Santa Fe	Seminis	20.8	22.4	23.2	33.6	56.8
SDX 2002	Seedex	28.7	7.3	32.2	31.8	64.0
DPSX 1171	D. Palmer	40.0	15.2	13.6	31.2	44.8
Super Chief	Seminis	18.4	28.0	23.2	30.4	53.6
Superstar	Rispens	26.5	18.6	25.0	29.9	54.9
Tequila	D. Palmer	28.8	16.3	25.6	29.3	54.9
Harvest Moon	Dorsing	30.4	21.6	21.6	26.4	48.0
Maverick	Global Genetics	18.4	28.8	28.0	24.8	52.8
Torero	Nunhems	21.6	21.6	33.6	23.2	56.8
Ringstar	Rispens	27.2	27.2	25.6	20.0	45.6
XPH97H24	Crookham	47.2	21.6	12.0	19.2	31.2
Daytona	Bejo	29.6	33.6	22.4	14.4	36.8
T-441	American Takii	25.8	22.3	38.9	13.0	51.9
T-433	American Takii	39.2	24.0	24.8	12.0	36.8
XPH95345	Crookham	46.4	24.0	17.6	12.0	29.6
T-439	American Takii	43.2	23.2	22.4	11.2	33.6
DPS 1172X	D. Palmer	52.0	18.4	20.0	9.6	29.6
T-467	American Takii	29.6	34.4	27.2	8.8	36.0
SWO 7074	Global Genetics	36.8	18.4	39.2	5.6	44.8
Aurora	Nunhems	62.4	23.2	11.2	3.2	14.4
Legend	Bejo	46.0	23.0	27.8	3.1	31.0
Condor	American Takii	48.8	33.6	15.2	2.4	17.6
Delgado	Bejo	53.6	26.4	19.2	0.8	20.0
Mean		28.9	20.2	24.7	26.2	50.9
LSD _(0.05) ^y		15.4	12.8	14.2	13.7	17.2

^zAmerican Takii, Salinas, Calif.; Bejo Seeds, Oceano, Calif.; Crookham Co., Caldwell, Idaho; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz.; Global Genetics, Payette, Idaho; Martin Rispens & Son, Beecher, Ill.; Seedex, Longmont, Colo.; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^yLeast significant difference at 95% confidence.

let” single centers each year (Tables 1–3). ‘Vaquero’, ‘Sabroso’, ‘Granero’, and ‘Ranchero’ had more than 70% of bulbs that were functionally single-centered every year. Averaged over the 3 years, ‘Vaquero’ and ‘Granero’ had more than 50% of bulbs with “bullet” single centers (Table 4). The rank for “bullet” single centers of the cultivars

remained fairly stable over the years (Table 4). Averaged over the cultivars each year, the percentage of “bullet” single centers was similar across years and did not show a year effect (Table 4). Although single centeredness is a cultivar attribute, single centeredness will probably increase over time as seed companies actively select single-cen-

tered onions in the inbred lines used to produce onion hybrids.

While there was no significant year effect on the proportion of “bullet” single centers or functionally single-centered bulbs, there was a year by cultivar effect on “bullets” (Table 4). Although the fields and years varied, fertility, irrigation, weed control, and

Table 4. Average single center rating (%) of onion cultivars evaluated in 2000, 2001, and 2002, and their ranking for “bullet” single centers in each year. Diameter of the first single ring for multiple-centered onions: “small double” [$<1\frac{1}{2}$ inches (38 mm)], “intermediate double” [$1\frac{1}{2}$ – $2\frac{1}{4}$ inches (57 mm)], and “blowout” ($>2\frac{1}{4}$ inches). Single-centered onions were termed “bullets.” Onions were considered “functionally single-centered” for processing if they were a “bullet” or “small double.” Cultivars are ranked by “bullet” single centers.

Cultivar	Seed co. ^z	Bullet (%)	Functionally single-centered (bullet + small double) (%)	2000	2001	2002
Vaquero	Nunhems	63.8	86.0	1	1	1
Granero	Nunhems	54.4	78.4	2	3	2
Sabroso	Nunhems	45.5	80.0	7	2	4
Ranchero	Nunhems	44.7	74.3	3	4	3
Vision	Seminis	38.0	66.8	4	5	5
Santa Fe	Seminis	34.0	65.8	5	7	7
Tequila	D. Palmer	32.9	58.6	6	6	9
Superstar	Rispens	30.5	59.5	8	8	8
Harvest Moon	Dorsing	26.0	52.6	9	10	10
Mesquite	D. Palmer	22.3	47.6	10	14	6
Torero	Nunhems	22.2	56.8	11	9	11
T-441	American Takii	16.5	61.6	12	11	13
T-433	American Takii	14.2	34.7	13	12	14
T-439	American Takii	10.8	33.3	14	13	15
Daytona	Bejo	9.2	32.1	17	15	12
Legend	Bejo	5.3	28.7	16	16	16
Delgado	Bejo	3.9	23.3	15	17	17
LSD _(0.05) ^y Cultivar (C)		6.4	6.9			
LSD _(0.05) Year (Y)		NS	NS			
LSD _(0.05) C × Y		11.5	NS			

^zAmerican Takii, Salinas, Calif.; Bejo Seeds, Oceano, Calif.; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz.; Martin Rispens & Son, Beecher, Ill.; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^yLeast significant difference at 95% confidence.

the timing of practices were as uniform as possible between years. The management variables, which were held as constant as possible, could be sources of variable stress with unknown effects on single centers.

Onion maturity was very different among cultivars (Tables 5–7). Significant differences in bolting were noted among cultivars in 2000 and 2001. Bolting was negligible in 2002. Cultivars with a propensity to bolt at any production site should be avoided.

Total yields out of storage averaged 1042, 917, and 1003 cwt/acre (116.8, 102.8, and 112.4 Mg·ha⁻¹) in 2000, 2001, and 2002, respectively (Tables 5–7). Averaged over the 3 years, total marketable yields ranged from 611 to 1062 cwt/acre (68.5 to 119.0 Mg·ha⁻¹, Table 8). ‘Ranchero’, ‘T-433’, ‘Torero’, and ‘Vaquero’ had more than 900 cwt/acre (100.9 Mg·ha⁻¹) marketable yield each year. For the 17 cultivars that were in the trials all 3 years, the percentage of bulbs that were super colossals averaged 26%, 14%, and 10% in 2000, 2001, and 2002, respectively. The super colossal

percentages of ‘Ranchero’ and ‘Quest’ were significantly greater than the other cultivars in 2000. ‘Quest’ had the highest percentage of super colossal bulbs in 2001. In 2002 six cultivars had 20% or more super colossal bulbs. In 2000, all cultivars had super colossal counts within the standard acceptable range for marketing [28–36 bulbs/50-lb bag (1.23 to 1.59 bulbs/kg)]. In 2001, ‘Daytona’, ‘Delgado’, ‘Legend’, ‘Sabroso’, and ‘Valiant’ had super colossal counts above the acceptable range (the bulb weight averaged too small, so the smaller super colossal bulbs would have to be removed prior to shipping). In 2002, only ‘Sabroso’ had super colossal counts above the acceptable range, so the largest bulbs would need to be removed. In contrast to the variable percentages of super colossal bulbs, the average percentage of colossal bulbs was fairly close across years, with no year effect. By year, the percentage of jumbo bulbs increased as the percentage of super colossals decreased. Averaging over only the 17 cultivars that were in the trials all 3 years, the percentage of bulbs that were jumbo averaged 23%, 37%,

and 47% in 2000, 2001, and 2002, respectively.

Onion losses to neck rot in storage averaged 5.1%, 7.7%, and 0.3% in 2000, 2001, and 2002, respectively. In 2000, ‘Tequila’, ‘Zorro’, and ‘T-434’ had more than 10% neck rot. In 2001, six cultivars had more than 10% neck rot. In 2002 neck rot was less than 2% for all cultivars. Plate rot was under 6% for all cultivars all years.

Conclusions

The percentage of “bullet” single centers was strongly dependent on cultivar. Of the 17 cultivars in the trials all 3 years, four averaged more than 74% that were functionally single-centered. Growers should be careful in selecting cultivars for single-centered onion contracts. There was no year effect on bulb single centeredness among trials receiving highly consistent management, so the extent of environmental influence on single centers needs further study. Of the 17 cultivars in the trials all 3 years, 11 averaged more than 20% of super colossal bulbs over the 3 years (Table 8). Averaged over 3 years both ‘Vaquero’ and ‘Granero’

Table 5. Bulb yield, bulb size, storage quality, and maturity rating of onion cultivars evaluated in 2000. Cultivars are ranked by total marketable yield.

Cultivar	Seed co. ^y	Total yield (cwt/acre ^x)	Marketable yield by grade ^z					Nonmarketable yield ^z				Maturity		
			Total (cwt/acre)	Super colossal	Colossal	Jumbo	Medium	Neck rot	Plate rot	No. 2s	Small	8 Aug.	29 Aug.	Bolters (no.)
------%-----														
Ranchero	Nunhems	1267	1196	54	29	10	1	2.3	1.3	1.2	0.2	6	62	0.6
Torero	Nunhems	1202	1096	37	40	13	1	3.8	1.6	0.9	0.5	2	53	0.6
Quest	Seminis	1264	1072	56	21	7	1	7.4	0.6	1.7	0.4	3	43	9.6
Granero	Nunhems	1128	1056	44	40	9	1	2.9	0.7	0.0	0.7	4	54	3.3
Vision	Seminis	1196	1028	36	34	13	3	7.5	3.2	1.2	0.7	8	53	2.6
Ringstar	Rispens	1234	1027	35	33	14	1	6.6	1.7	4.7	0.4	7	53	11.0
Vaquero	Nunhems	1144	1021	32	41	15	2	6.4	1.1	0.3	0.6	7	60	1.4
Mesquite	D. Palmer	1253	1003	27	37	14	2	6.7	0.9	5.8	0.8	2	44	11.5
T-433	Amer. Takii	1293	991	44	26	6	1	8.8	2.8	5.1	0.2	1	40	0.8
XP15113	Seminis	1099	973	20	39	25	4	1.9	1.5	3.5	0.9	16	65	1.5
T-439	Amer. Takii	998	943	20	49	23	2	2.3	1.0	1.5	0.6	31	78	1.4
XP15234	Seminis	1202	942	28	35	13	1	5.9	3.0	5.2	0.4	3	46	17.8
Golden														
Security	Rispens	1195	927	31	31	15	1	9.4	1.3	7.0	0.8	5	48	14.0
PS 663395	Seminis	953	913	16	42	34	4	0.1	1.2	0.6	0.7	25	67	1.8
Pinnacle	Seminis	1000	902	9	41	35	5	3.6	1.6	2.2	1.0	16	72	0.2
Santa Fe	Seminis	1061	892	28	35	18	3	5.7	2.5	3.5	0.8	16	63	4.2
Tesoro	Nunhems	950	888	21	41	29	2	2.1	0.5	2.5	0.7	34	65	3.3
XP1597H33	Crookham	1095	885	27	35	17	2	6.4	1.6	6.0	0.5	7	52	7.0
T-406	Amer. Takii	931	878	10	43	37	5	1.1	0.9	1.2	1.4	11	63	0.0
Superstar	Rispens	1161	877	33	29	13	2	9.0	1.3	6.3	0.6	2	46	5.4
XP15120	Seminis	979	864	15	39	31	3	1.5	1.6	2.9	0.9	14	67	1.2
Harvest														
Moon	Dorsing	957	832	37	21	23	6	4.5	0.8	5.7	1.1	15	59	2.6
XP1597H36	Crookham	1049	823	25	32	20	3	3.4	0.3	10.1	0.9	7	58	6.4
Vantage	Seminis	857	799	12	40	38	4	1.3	2.0	1.7	1.5	39	74	0.4
Zorro	Crookham	1112	793	33	26	11	2	14.7	1.2	7.7	0.3	7	52	12.8
Sabroso	Nunhems	805	779	3	39	50	5	1.0	1.0	0.3	0.8	11	72	0.0
Delgado	Bejo	928	766	6	34	38	5	6.2	0.8	7.2	0.7	4	65	0.2
Kodiak	D. Palmer	876	747	11	35	32	7	2.0	0.7	10.6	1.3	13	63	6.6
Daytona	Bejo	849	742	7	42	35	3	2.1	1.0	7.6	1.4	7	52	0.6
Tradewind	Seminis	775	736	5	31	49	9	2.1	0.8	0.5	1.5	53	81	3.0
BGS 157	Bejo	731	713	2	25	63	7	0.4	0.4	0.5	1.2	48	87	0.8
T-434	Amer. Takii	1264	683	27	18	8	2	12.0	1.7	23.8	0.7	3	50	1.3
T-441	Amer. Takii	704	662	0	18	63	13	0.8	1.4	0.6	2.5	51	89	0.0
Legend	Bejo	892	644	7	35	28	2	9.1	1.0	5.3	1.2	7	59	1.0
Tequila	D. Palmer	1083	643	20	23	14	2	17.7	1.5	4.7	0.5	3	47	6.6
Mean		1042	878	23	34	25	3	5.1	1.3	4.3	0.8	14	60	4.0
LSD _(0.05) ^w		126	159	10	9	9	3	8.0	NS	2.7	0.9	8	8	4.0

^zOnion cultivars were compared based on bulb grade in January following 4 months of storage. During grading, bulbs were separated according to quality: marketable bulbs without blemishes (No. 1s); unmarketable split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), and plate rot (bulbs infected with the fungus *Fusarium oxysporum*). The No. 1 bulbs were graded according to diameter: small [$<2\frac{1}{4}$ inches (57 mm)], medium [$2\frac{1}{4}$ –3 inches (57–76 mm)], jumbo [3–4 inches (76–102 mm)], colossal [4–4 $\frac{1}{4}$ inches (102–108 mm)], and super colossal ($>4\frac{1}{4}$ inches). Bulb counts per 50 lb (22.7 kg) of super colossal onions were determined for each plot of every cultivar by weighing and counting all super colossal bulbs during grading.

^yAmerican Takii (Amer. Takii), Salinas, Calif.; Bejo, Oceano, Calif.; Crookham Co., Caldwell, Idaho; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz.; Martin Rispens & Son, Beecher, Ill.; Global Genetics (Global Gen.), Payette, Idaho; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^wLeast significant difference at 95% confidence.

^x1 cwt/acre = 0.112 Mg·ha⁻¹.

^zLeast significant difference at 95% confidence.

Table 6. Bulb yield, bulb size, storage quality, and maturity rating of onion cultivars evaluated in 2001. Cultivars are ranked by marketable yield.

Cultivar	Seed co. ^y	Total yield (cwt/acre ^z)	Marketable yield by grade ^z					Nonmarketable yield ^z				Maturity		
			Total (cwt/acre)	Super colossal	Colossal	Jumbo	Medium	Neck rot	Plate rot	No. 2s	Small	20 Aug.	7 Sept.	Bolters (no.)
----- % -----														
T-433	Amer. Takii	1192	980	27	38	17	1	5.6	4.0	7.9	0.1	10	34	0.8
Quest	Seminis	1139	962	42	33	8	1	9.3	3.0	2.4	0.0	8	45	0.4
Torero	Nunhems	1067	930	20	45	21	1	7.4	2.7	2.3	0.2	14	61	0.0
Tioga	Seminis	975	915	6	40	47	1	2.6	2.2	0.9	0.3	34	66	0.2
Ranchero	Nunhems	998	915	18	42	30	1	3.7	2.1	2.4	0.2	21	63	0.2
Vaquero	Nunhems	981	909	13	46	32	1	5.2	1.1	0.4	0.1	17	59	0.0
Tequila	D. Palmer	1043	885	21	39	24	1	6.8	1.2	7.2	0.1	9	41	0.8
Superstar	Rispens	1059	881	22	39	22	1	8.2	1.6	6.9	0.1	10	45	1.4
Santa Fe	Seminis	1014	866	14	44	26	1	7.3	2.2	4.8	0.3	16	51	1.4
Granero	Nunhems	905	840	13	48	31	0	4.0	1.9	0.7	0.2	13	53	0.8
Vision	Seminis	987	837	20	39	25	1	8.6	3.2	3.3	0.2	19	56	0.2
Cannon Ball	Seminis	1036	825	19	38	22	1	9.6	2.8	7.7	0.2	9	44	2.2
Harvest Moon	Dorsing	1027	811	25	33	19	1	9.2	1.3	10.3	0.4	16	52	1.0
Zorro	Crookham	970	802	24	37	20	1	8.8	1.6	7.0	0.2	13	50	2.4
EX77031	Seminis	944	801	15	41	28	1	7.4	2.1	5.0	0.1	24	54	1.2
Ringstar	Rispens	995	786	22	35	21	1	10.7	1.3	8.8	0.2	13	47	0.
EX15120	Seminis	889	786	6	37	45	1	5.2	1.7	4.4	0.3	28	62	0.2
Legend	Bejo	867	770	2	23	61	2	3.7	1.4	5.0	1.0	23	67	0.0
Mesquite	D. Palmer	1009	767	21	32	22	1	15.6	1.9	6.1	0.2	8	37	1.6
XPH97H33	Crookham	966	755	16	38	23	1	10.5	2.1	9.2	0.1	18	49	0.6
Tesoro	Nunhems	888	747	2	26	54	2	7.3	0.9	6.7	0.8	39	74	0.6
SWO 7254	Global Gen.	883	741	12	37	33	1	7.5	2.0	6.0	0.4	22	56	0.2
Pinnacle	Seminis	878	735	4	34	45	1	8.6	2.6	5.0	0.3	41	75	0.0
T-439	Amer. Takii	893	733	9	42	30	1	4.4	4.5	8.7	0.3	52	88	0.6
Sweet Perfection	Crookham	983	727	24	34	15	1	20.0	2.5	3.0	0.1	16	53	1.0
XPH95345	Crookham	893	703	10	31	37	1	8.6	0.9	11.7	0.2	12	48	0.4
SWO 12028	Global Gen.	903	703	22	29	26	2	12.8	2.2	6.9	0.3	26	60	1.4
Delgado	Bejo	816	700	2	26	56	1	5.9	3.0	4.8	0.4	31	69	0.0
Raptor	Global Gen.	971	690	13	30	27	1	15.1	4.1	9.7	0.2	16	49	1.2
Daytona	Bejo	765	686	1	25	60	3	2.4	1.2	4.8	1.9	20	60	0.0
SWO 7102	Global Gen.	729	662	1	27	61	2	5.5	2.0	1.2	0.6	48	81	0.0
T-434	Amer. Takii	1132	646	12	27	17	1	6.7	1.6	33.7	0.1	12	52	0.0
Pathfinder	Global Gen.	815	636	2	24	51	1	10.2	1.1	10.5	0.2	49	74	0.4
Golden Security	Rispens	818	636	7	33	35	2	6.7	1.8	13.6	0.4	17	57	1.4
Eagle	Amer. Takii	732	636	2	32	51	1	7.1	1.9	4.0	0.2	26	71	0.0
Valiant	Nunhems	740	614	4	34	43	2	8.0	5.9	2.2	0.2	34	81	1.8
T-441	Amer. Takii	645	589	0	7	81	3	4.7	2.3	0.2	1.3	67	97	0.2
Gunnison	Bejo	619	568	0	4	83	4	3.6	3.3	0.4	0.9	71	99	0.0
Sabroso	Nunhems	597	538	0	11	75	3	5.1	2.6	0.9	1.4	34	79	0.0
Mean		917	762	13	33	37	1	7.7	2.3	6.1	0.4	25	60	0.6
LSD _(0.05) ^w		82	96	6	7	9	1	6.5	1.9	3.2	0.7	7	7	1.2

^zOnion cultivars were compared based on bulb grade in January following 4 months of storage. During grading, bulbs were separated according to quality: marketable bulbs without blemishes (No. 1s); unmarketable split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), and plate rot (bulbs infected with the fungus *Fusarium oxysporum*). The No. 1 bulbs were graded according to diameter: small [$< 2\frac{1}{4}$ inches (57 mm)], medium [$2\frac{1}{4}$ to 3 inches (57 to 76 mm)], jumbo [3 to 4 inches (76 to 102 mm)], colossal [4 to $4\frac{1}{4}$ inches (102 to 108 mm)], and super colossal ($>4\frac{1}{4}$ inches). Bulb counts per 50 lb (22.7 kg) of super colossal onions were determined for each plot of every cultivar by weighing and counting all super colossal bulbs during grading.

^yAmerican Takii (Amer. Takii), Salinas, Calif.; Bejo, Oceano, Calif.; Crookham Co., Caldwell, Idaho; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz.; Martin Rispens & Son, Beecher, Ill.; Global Genetics (Global Gen.), Payette, Idaho; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^z1 cwt/acre = 0.112 Mg·ha⁻¹.

^wLeast significant difference at 95% confidence.

Table 7. Bulb yield, bulb size, storage quality, and maturity rating of onion cultivars evaluated in 2002. Cultivars are ranked by marketable yield.

Cultivar	Seed co. ^y	Total yield (cwt/acre ^x)	Marketable yield by grade ^z					Nonmarketable yield ^z				Maturity	
			Total (cwt/acre)	Super colossal	Colossal	Jumbo	Medium	Neck rot	Plate rot	No. 2s	Small	20 Aug.	Bolters (no.)
----- % -----													
T-433	Amer. Takii	1208	1119	12	46	34	1	0.0	0.5	6.3	0.5	19	0.4
Vaquero	Nunhems	1130	1111	9	50	39	1	0.0	0.8	0.2	0.7	45	0.0
XPH97H24	Crookham	1218	1097	17	43	29	1	0.2	1.2	8.1	0.4	24	0.0
Sweet Perfection	Crookham	1154	1092	21	44	30	1	0.6	0.8	3.5	0.5	42	0.0
Maverick	Global Gen.	1159	1091	13	49	31	1	0.1	1.2	3.3	1.1	33	0.0
Ranchero	Nunhems	1090	1074	16	48	34	1	0.0	0.1	0.9	0.5	52	0.4
Torero	Nunhems	1084	1060	15	47	35	1	0.0	0.6	1.2	0.6	43	0.0
Tequila	D. Palmer	1134	1056	20	43	30	1	0.0	0.5	5.9	0.6	29	0.4
Ringstar	Rispens	1126	1054	21	45	27	1	0.2	0.8	4.7	0.6	36	0.8
Superstar	Rispens	1105	1050	22	47	26	1	0.1	0.8	3.3	0.7	27	0.4
XPH01N3	Crookham	1116	1046	18	44	31	1	0.4	1.2	4.1	0.4	44	1.2
Santa Fe	Seminis	1097	1039	18	49	26	1	0.0	1.3	3.6	0.3	31	0.0
Granero	Nunhems	1027	1009	6	40	51	2	0.1	0.3	0.6	0.8	41	0.2
Mesquite	D. Palmer	1081	1001	20	46	26	1	0.6	2.1	4.2	0.4	28	0.4
Vision	Seminis	1014	981	12	43	39	3	0.0	0.8	1.4	1.0	47	0.0
Super Chief	Seminis	1021	972	9	43	42	1	0.2	0.6	3.3	0.7	49	0.2
SWO 7074	Global Gen.	1050	951	7	33	49	2	0.4	2.0	6.7	0.5	62	0.0
SWO 6005	Global Gen.	977	949	9	40	47	1	0.0	1.2	1.0	0.6	37	0.0
Harvest Moon	Dorsing	1043	900	20	38	27	1	0.6	1.7	10.5	0.6	41	0.4
SDX 2002	Seedex	1047	896	8	37	40	1	0.0	1.0	12.5	0.7	66	0.5
SR 7002ON	Nunhems	919	894	6	36	53	1	0.1	2.0	0.2	0.7	74	0.0
DPS 1172X	D. Palmer	1025	880	6	31	46	2	0.1	0.9	13.0	0.5	49	0.2
DPSX 1171	D. Palmer	957	877	7	33	51	2	0.3	1.3	5.9	0.7	55	0.0
T-467	Amer. Takii	914	866	1	24	67	2	0.1	0.2	3.9	1.0	64	0.0
T-439	Amer. Takii	940	863	3	39	48	2	0.2	0.9	6.7	0.4	69	0.2
XPH95345	Crookham	973	853	5	31	50	2	1.7	0.9	8.9	0.9	38	0.2
Condor	Amer. Takii	892	848	2	30	61	2	0.0	0.4	3.6	0.9	74	0.0
Delgado	Bejo	855	820	1	19	74	2	0.6	0.3	2.2	1.0	59	0.2
Legend	Bejo	884	811	1	21	68	1	1.3	0.1	6.4	0.6	49	0.0
Sabroso	Nunhems	818	797	0	10	85	2	0.1	0.1	1.3	1.0	65	0.2
SX 7000ON	Nunhems	768	762	1	26	71	2	0.0	0.2	0.1	0.5	63	0.0
Daytona	Bejo	802	757	0	21	70	4	0.0	0.3	3.1	2.1	41	0.0
SX 4391ON	Nunhems	882	689	1	18	55	4	1.3	1.5	14.6	2.0	68	0.2
T-441	Amer. Takii	596	583	0	3	89	6	0.0	0.6	0.4	1.1	79	0.0
Mean		1003	937	10	36	47	2	0.3	0.9	4.6	0.8	48	0.2
LSD _(0.05) ^w		98	103	6	9	12	2	NS	NS	3.5	1.0	9	NS

^zOnion cultivars were compared based on bulb grade in January following 4 months of storage. During grading, bulbs were separated according to quality: marketable bulbs without blemishes (No. 1s); unmarketable split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), and plate rot (bulbs infected with the fungus *Fusarium oxysporum*). The No. 1 bulbs were graded according to diameter: small [$<2\frac{1}{4}$ inches (57 mm)], medium [$2\frac{1}{4}$ –3 inches (57–76 mm)], jumbo [3–4 inches (76–102 mm)], colossal [4–4 $\frac{1}{4}$ inches (102–108 mm)], and super colossal ($>4\frac{1}{4}$ inches). Bulb counts per 50 lb (22.7 kg) of super colossal onions were determined for each plot of every cultivar by weighing and counting all super colossal bulbs during grading.

^yAmerican Takii (Amer. Takii), Salinas, Calif.; Bejo, Oceano, Calif.; Crookham Co., Caldwell, Idaho; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz.; Martin Rispens & Son, Beecher, Ill.; Global Genetics (Global Gen.), Payette, Idaho; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^x1 cwt/acre = 0.112 Mg·ha⁻¹.

^wLeast significant difference at 95% confidence.

Table 8. Average bulb yield (cwt/acre) by market grade of onion cultivars evaluated in 2000, 2001, and 2002.

Cultivar	Seed co. ^y	2000–02 average marketable yield ^z				Marketable yield rank			
		Total marketable (cwt/acre ^x)	Super colossal	Colossal	Jumbo	Medium	2000	2001	2002
			-----%						
Ranchero	Nunhems	1062	29	40	25	1	1	3	3
T-433	American Takii	1030	27	37	19	0	7	1	1
Torero	Nunhems	1029	24	44	23	0	2	2	4
Vaquero	Nunhems	999	20	45	27	1	5	4	2
Granero	Nunhems	968	21	43	30	1	3	8	8
Vision	Seminis	948	22	39	26	2	4	9	10
Superstar	Rispens	936	25	39	20	0	10	6	6
Santa Fe	Seminis	925	20	42	23	2	6	12	9
Mesquite	D. Palmer	923	23	38	21	1	9	7	7
Tequila	D. Palmer	861	20	35	23	1	17	5	5
Harvest Moon	Dorsing	850	28	31	23	3	11	10	11
T-439	American Takii	846	11	43	34	2	8	13	12
Legend	Bejo	775	4	26	52	2	16	11	14
Delgado	Bejo	762	3	26	56	3	13	14	13
Daytona	Bejo	728	3	29	55	4	14	15	16
Sabroso	Nunhems	717	1	21	69	4	12	16	15
T-441	American Takii	611	0	9	78	7	15	17	17
LSD _(0.05) ^w Cultivar (C)		77	4	5	6	1			
LSD _(0.05) Year (Y)		25	2	NS	3	1			
LSD _(0.05) C × Y		101	8	8	10	3			

^zOnion cultivars were compared based on bulb grade in January following 4 months of storage. During grading, bulbs were separated according to quality: marketable bulbs without blemishes (No. 1s); unmarketable split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), and plate rot (bulbs infected with the fungus *Fusarium oxysporum*). The No. 1 bulbs were graded according to diameter: small [$<2\frac{1}{4}$ inches (57 mm)], medium [$2\frac{1}{4}$ –3 inches (57–76 mm)], jumbo [3–4 inches (76–102 mm)], colossal [4 to $4\frac{1}{4}$ inches (102–108 mm)], and super colossal ($>4\frac{1}{4}$ inches).

^yAmerican Takii, Salinas, Calif.; Bejo Seeds, Oceano, Calif.; Dorsing Seeds, Nyssa, Ore.; D. Palmer Seed Co., Yuma, Ariz; Martin Rispens & Son, Beecher, Ill.; Seminis, Oxnard, Calif.; Nunhems USA, Parma, Idaho.

^x1 cwt/acre = 0.112 Mg·ha⁻¹.

^wLeast significant difference at 95% confidence.

had both more than 20% super colossal bulbs and more than 75% functional single centers.

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