Harvest Date Affects Yield and Postharvest Quality of Nondried, Short-day Onions

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Abstract. Short-day onions (*Allium cepa* L.) grown under humid, subtropical conditions at two locations were evaluated for bulb size and yield at five harvest dates (H1 to H5) ranging from 94 to 132 days after transplanting (DAT) for 'Granex 33' and from 115 to 153 DAT for 'Texas Grano 1015Y'. Maximum yields were attained by H4 for both cultivars and were attributed to increased bulb size rather than differences in plant (bulb) population. Nondried, large bulbs (>7.6 cm diameter) from each harvest were trimmed and stored at 1 or 10 °C and 80% relative humidity (RH) for 2 weeks plus 2 weeks at 20 °C and 80% RH to simulate commercial storage and handling. Initial respiration rates of bulbs of both cultivars decreased >60% between H1 and H4. Bulbs also retained higher fresh weight during storage as harvest was delayed. Storage for 2 weeks at 1 °C suppressed sprouting of immature (H1) 'Texas Grano 1015Y' bulbs, but not of 'Granex 33' bulbs from one location. Storage at 10 °C did not suppress sprouting of either cultivar. Decay became more prevalent with delayed harvest, but 'Granex 33' was more resistant to decay than was 'Texas Grano 1015Y', which developed up to 40% decay after 2 weeks at 20 °C. Harvest at 115 and 132 DAT resulted in acceptable yields for 'Granex 33' and 'Texas Grano 1015', respectively, and satisfactory postharvest quality of nondried bulbs following 2 weeks of storage at 1 °C and 80% RH plus 2 weeks at 20 °C.

Onion growth, yield, and bulb quality are significantly affected by environmental factors, including temperature, photoperiod, and soil characteristics, and by cultural practices such as plant population, planting arrangement, fertilization, and irrigation (Brewster, 1977a). Mildly pungent, short-day onions bring higher returns than do the more pungent types, and the former are often marketed as gourmet items. A well-coordinated research and marketing program helped Georgia growers significantly increase production and sales of high-quality "sweet" *Vidalia* onions (Barton, 1992). However, production of these types in humid, subtropical regions has been quite limited, despite reported potential for

good yields and quality (Hayslip et al., 1987). Weather is a serious constraint to increased production in these areas because frequent and heavy rains during the growing season favor weed growth, high insect populations, and bulb decay, but delaying fall planting of short-day onions from early September to early October in Texas resulted in a linear decrease in total bulb yields (t·ha⁻¹) (Richwine, 1990). Lower yields have also been reported for onions harvested at earlier dates (Rickard and Wickens, 1977; Stoffella and Sonoda, 1982).

Another limitation to increased production of mildly pungent onions in humid areas is their relatively short postharvest life compared with the more pungent types. Harvest maturity affects postharvest life (Tucker and Drew, 1982) and carbohydrate content (Nilsson, 1980) of onion bulbs. Smittle and Maw (1988) harvested and dried two mild onion cultivars ('Granex 33', 'Sweet Georgia') at typical harvest maturity. Postharvest losses for bulbs from the first harvest were minimal during 1 month of storage at 22 to 25 °C. However, the percentage of marketable bulbs after storage decreased when bulbs

were harvested later. Wall and Corgan (1994) obtained similar results with dried, short-day onions; as harvest was delayed, the incidence of decay increased during 20 d of storage under ambient conditions. Kopsell and Randle (1997) found that short-day onions, when dried for 7 d under cover at 20 to 25 °C, sprouted after ≈2 months of storage at 5 °C, whereas more pungent, long-day cultivars remained dormant during storage for up to 8 months. Note that "drying" is the most accurate term for onions, since moisture is removed from the neck and outer scales of the bulb, serving as protective barriers during subsequent handling and storage. "Curing" is appropriate for crops such as potatoes (*Solanum tuberosum* L.) that undergo suberization in response to mechanical injuries.

Harvested bulbs are particularly susceptible to soft-rot bacteria (notably, *Erwinia* sp. and *Pseudomonas* sp.) and fungal species that infect the neck region and cuts (Snowden, 1992). Several postharvest handling methods have proven effective in reducing storage decay, including field and artificial drying (removal of 3% to 5% moisture) (Hoyle, 1948), drying in conjunction with refrigerated storage at 0 °C and 65% to 70% relative humidity (RH) (Hardenburg et al., 1986), application of maleic hydrazide prior to harvest and top rolling (Toledo et al., 1984), and controlled atmosphere storage (Isenberg, 1979). Short-day onions grown under subtropical conditions stored best when harvested at 10% to 20% fallen tops, followed by trimming of the tops to 2.5 to 5.0 cm prior to packing (Hayslip et al., 1978).

Field drying is considered unreliable in subtropical production areas because of the unpredictability of rains. The extra costs associated with purchase of drying equipment have discouraged many vegetable growers from growing short-day onions. However, many growers have access to refrigerated storage used to store other crops. If refrigerated storage of nondried, short-day onions provided sufficient postharvest life for commercial marketing, more vegetable growers could plant these high-value onion types.

In this study, two short-day onion cultivars were grown under humid, subtropical conditions at two locations. Bulb size and quality and yields were determined as a function of five harvest dates, and postharvest quality of nondried bulbs was studied during subsequent refrigerated storage.

Materials and Methods

Cultural practices. Experiments were conducted at two locations in southern Florida with similar conditions: the Indian River Research and Education Center at Fort Pierce (Atlantic Ocean coast) and the Gulf Coast Research and Education Center at Bradenton (Gulf of Mexico coast). Soils were characterized as an Oldsmar fine sand (sandy, siliceous, hyperthermic, Alfic Arenic Haplaquods) at Fort Pierce and an EauGalle fine sand (sandy, siliceous, hyperthermic Aeric Haplaquods) at Bradenton.

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Raised beds were constructed at both locations (0.15 m high $\times$ 1.1 m wide and 2.1 m apart at Fort Pierce, and 0.20 m high $\times$ 1.3 m wide and 1.5 m apart at Bradenton). Fertilizer was broadcast and soil-incorporated into the beds. At the Fort Pierce site, fertilizer (192N–70P–138K kg·ha⁻¹) was initially applied; following heavy rainfall (25.4 cm) in January and February, an additional application (83N–13P–36K kg·ha⁻¹) was broadcast onto the beds. At the Bradenton site, a single application (269N–98P–192K kg·ha⁻¹) was applied. Subsurface irrigation was used in both experiments. Pesticides were applied as needed to control insects, diseases, and weeds during production.

‘Texas Grano 1015Y’ and ‘Granex 33’ onion seedlings (7-week-old, Speedling® 080A plants) were transplanted in early December at both locations using a randomized complete-block design, with five treatments (harvest dates) replicated four times, for a total of 20 plots. Each plot was 3 m in length and contained three rows spaced 20 cm apart; transplants were spaced 10 cm apart within each row (total of 90 transplants/plot). Plant populations were equivalent to 56,007 and 78,408 plants/ha at the Fort Pierce and Bradenton sites, respectively.

Harvest dates. Treatments consisted of five harvest dates. ‘Granex 33’ is an early maturing cultivar (Hayslip et al., 1987); therefore the initial harvest was earlier than for ‘Texas Grano 1015Y’. Harvest maturity can be approximated using the number of days from transplanting for the cultivar. Harvest dates were 94, 104, 115, 124, and 132 d after transplanting (DAT) for ‘Granex 33’ and 115, 124, 132, 144, and 153 DAT for ‘Texas Grano 1015Y’. At the first harvest of each cultivar, shoot tips had senesced but <5% of the tops had fallen, whereas at the last harvest, nearly all tops had senesced and fallen.

Bulb size and yield measurements. A 2.4-m section of each plot was harvested on each assigned harvest date. Bulbs were graded as marketable or culls (misshapen, splits, doubles, etc.), counted, and weighed. Marketable bulbs were sized by equatorial diameter into small (<5 cm), medium (5.0 to 7.6 cm), and large (>7.6 cm) categories and weighed. Weights of the marketable categories were converted to percentage of total yield.

Postharvest treatments and measurements. For each location, cultivar, harvest date, and replicate (plot), the largest 15 bulbs (average = 330 g/bulb) were bagged and, within 24 h of harvest, transported at ambient temperature to Gainesville, Fla. Within 6 h of arrival, the bulbs were brushed to remove any adhering soil, stems were trimmed to 2.5 cm and roots were removed. The 15 bulbs from each plot were randomly distributed as follows: five bulbs each for storage quality determinations at 1 or 10 °C and 75% to 85% RH, two bulbs for determination of initial firmness, and three bulbs for determination of respiration rate during storage. Initial quality analyses were performed (see below), and the 10 bulbs for future evaluations were placed

in netted bags (five/bag) for 2 weeks of storage followed by transfer to 20 °C for an additional 2 weeks.

Firmness, fresh weight, and respiration rate were determined initially, after 2 weeks of storage at 1 and 10 °C (Week 2), and during subsequent storage at 20 °C (Weeks 3 and 4). Firmness was measured nondestructively using a modified version of the Cornell firmness tester (Gull et al., 1980). In this method, a static load of 9.8 N was applied for 5 s with a 15-mm convex probe at two locations on the equator of each bulb, and the deformation was measured in millimeters and averaged. Fresh weight was determined per bag of five bulbs. Throughout storage, individual bulbs were also inspected for incidence and severity of decay. At the end of the storage period, percentage of moisture content of each bulb was determined by weight difference after sliced quarters were dried at $\approx$ 50 °C for 48 h.

Respiration rates were determined by individually weighing bulbs and placing one bulb in each of three open-top jars ($\approx$ 3.8 L) at 20 °C. After an initial 24 h equilibration period, the jars were sealed for 1 h, and two samples (0.5 mL each) were withdrawn from the headspace for CO₂ analysis by gas chromatography (Fisher model 1200 Gas Partitioner; Fisher Scientific, Pittsburgh). The data were converted to mg CO₂·kg⁻¹·h⁻¹. Means for the three bulbs/plot were analyzed statistically.

Statistical analyses: Since each variety was harvested at different DAT, bulb size and yield data were subjected to analysis of variance (ANOVA) by variety for each location (SAS Institute, 1985). Percentage data were transformed to square root-arcsin prior to ANOVA. The main effects of harvest dates were partitioned into linear, quadratic, or cubic contrasts. The storage experiments were analyzed using a split-plot experimental design. Quality data for each field plot were averaged, with storage temperature as the main plot and harvest time as the subplot for each cultivar and location, and analyzed using ANOVA.

Results and Discussion

Bulb size and yield response. Bulbs grown at both locations were quite small at Harvest 1 (H1) and H2, and, in some cases, H3 (Table 1). Although transplanted on the same date, both cultivars from Bradenton were somewhat more mature at the five harvests than those from Ft. Pierce. Differences in growing conditions between locations, possibly because of nutrient leaching during a torrential rainfall at the Ft. Pierce site, may have delayed maturity. Percentage of top fall at H1 to H5 at Bradenton was about 0%, 5%, 20%, 50%, and 100%, respectively, for ‘Granex 33’, whereas that for ‘Texas Grano 1015Y’ was somewhat delayed, at about 0%, 0%, 5%, 25%, and 50% for the same respective harvests (data not shown). Percentage of top fall was generally less for both cultivars at Ft. Pierce.

Marketable bulb yields of ‘Granex 33’ and ‘Texas Grano 1015Y’ increased linearly or quadratically at each location as each harvest was delayed (Table 1). Stoffella and Sonoda (1982), Rickard and Wickens (1977), and Wall and Corgan (1994) all reported that delaying harvest increased onion yields. The increased marketable yields (Table 1) at the later harvests were attributed to a greater percentage of large bulbs (Table 2) for both cultivars at both sites.

Although bulb size generally increased with each successive harvest, the proportion of culls (percentage of total bulb weight) increased linearly for ‘Granex 33’ at both locations and for ‘Texas Grano 1015Y’ at the Ft. Pierce location (Table 1), with physiological disorders (splits, seconds, or misshapen bulbs) being the primary cause. Mean bulb weight increased linearly or quadratically with successive harvest dates for both cultivars at both locations (Table 1).

Harvest maturity and postharvest quality. Bulb maturity at harvest significantly affected several postharvest quality variables for both cultivars. The respiration rate at harvest was highest at H1, followed by a dramatic reduc-

Table 1. Onion yields as influenced by cultivar and harvest maturity.

Granex 33						Texas Grano 1015Y				
Harvest	DAT ^z	Marketable yield			Culls (%)	DAT	Marketable yield			Culls (%)
		t·ha ⁻¹	No. bulbs ^y	g/bulb			t·ha ⁻¹	No. bulbs ^y	g/bulb	
<i>Bradenton</i>										
1	94	24.6	174	143	0.0	115	19.1	171	112	0.0
2	104	35.6	173	206	0.9	124	31.9	166	192	1.2
3	115	42.8	167	255	2.1	132	39.7	176	227	2.6
4	124	45.0	164	273	6.3	144	43.1	180	240	2.7
5	132	41.9	147	285	8.7	153	41.8	167	247	3.4
Significance ^x		Q**	L*	Q**	L**		Q**	NS	Q**	NS
<i>Ft. Pierce</i>										
1	94	16.3	136	121	0.2	115	13.2	128	103	5.5
2	104	22.9	135	170	0.7	124	18.8	130	145	7.4
3	115	24.4	131	187	7.9	132	28.6	135	212	2.1
4	124	32.3	130	248	6.4	144	34.1	128	266	10.1
5	132	31.1	130	239	5.5	153	34.2	121	282	13.2
Significance		L**	NS	L**	L*		L**	Q**	L**	L*

^zDays after transplant.

^yThousand bulbs/ha.

^xLinear (L) or quadratic (Q).

NS, *, ** Nonsignificant or significant at $P \leq 0.05$ or 0.01.

Table 2. Onion bulb diameter (% distribution) as influenced by cultivar and harvest maturity.

Harvest	Granex 33				Texas Grano 1015Y			
	DAT ²	Small ³	Medium	Large	DAT	Small	Medium	Large
<i>Bradenton</i>								
1	94	27.1	44.0	28.9	115	51.4	32.2	16.3
2	104	22.5	19.5	58.0	126	30.8	26.4	42.8
3	115	18.0	7.6	74.4	132	19.5	28.2	52.3
4	124	19.6	12.1	68.3	144	23.7	34.5	41.7
5	132	18.6	7.2	74.2	153	13.1	25.6	61.3
Significance ^x		NS	C*	Q**		C*	C*	C**
<i>Ft. Pierce</i>								
1	94	32.6	52.2	15.2	115	58.7	35.3	6.0
2	104	16.9	38.3	44.8	124	28.3	56.7	15.0
3	115	8.8	37.8	53.4	132	12.0	47.8	40.2
4	124	3.7	18.1	78.8	144	4.8	31.4	63.8
5	132	2.2	20.6	77.1	153	2.3	34.4	63.3
Significance		L**	L**	L**		Q**	C**	C*

²Days after transplant.³Size categories: Small (<5 cm), Medium (5–7.6 cm), and Large (>7.6 cm).^xLinear (L), quadratic (Q), cubic (C).NS, *, ** Nonsignificant or significant at $P \leq 0.05$ or 0.01.

Fig. 1. Initial respiration rates for onion bulbs harvested at five maturities ('Granex 33': 94, 104, 115, 124, and 132 d after transplant; 'Texas Grano 1015Y': 115, 124, 132, 144, and 153 d after transplant) from two locations. (n = 4).

tion at subsequent harvests for both cultivars at both sites (24 to 32 mg·kg⁻¹·h⁻¹ of CO₂) (Fig. 1). The higher respiration rates at H1 and H2 at both sites indicated that the bulbs were still quite immature and actively growing, whereas the lower respiration rates for bulbs harvested later indicate that the bulbs had reached maturity, as reported by Hardenburg et al. (1986) for dried onions.

Bulbs of both cultivars from H1 generally sprouted more during storage than those from subsequent harvests, whereas virtually no sprouting was evident in H5 bulbs (Table 3). Storage for 2 weeks at 1 °C suppressed sprouting of 'Texas Grano 1015Y' bulbs from H1 at Bradenton; however, after 1 additional week at 20 °C, sprouting was similar to that of onions stored initially at 10 °C for both locations (Table 3). 'Granex 33' from the Bradenton location had <1% sprouting when stored at either temperature; however, those

grown in Ft. Pierce had significantly more sprouting when stored at 10 °C than at 1 °C after 2 and 3 weeks of storage. 'Texas Grano 1015Y' bulbs grown at both sites had significant harvest × temperature interactions for sprouting. Bulbs from H1 (Bradenton) stored for 2 weeks at 1 and 10 °C had 0% and 40% sprouting, respectively, while those from H2 had 0 and 10% for the same respective storage temperatures. The trend in sprouting of bulbs from H1 (Ft. Pierce) was similar, although at higher incidence. Storage at 1 °C suppressed sprouting of harvested immature bulbs, although, once warmed to 20 °C, the bulbs sprouted similarly to those initially stored at 10 °C.

Following 2 weeks of storage at 1 °C plus 2 weeks at 20 °C, 'Texas Grano 1015Y' bulbs from H1 had sprouted an average of 3.7 cm (Bradenton) and 5.9 cm (Ft. Pierce), respectively, whereas sprouting on for 'Granex 33'

averaged 0.1 cm and 6.6 cm, respectively (data not shown). Sprouts for bulbs from H2 grew significantly less during storage, and by H3, the bulbs did not sprout during the extended storage period, indicating that they were dormant.

The occurrence of storage decay was cultivar-related and attributed primarily to bacterial soft rot. There was no appreciable decay in 'Granex 33' after 4 weeks of storage, irrespective of harvest maturity, location or storage temperature (data not shown). 'Texas Grano 1015Y' from Bradenton had no decay after 2 weeks storage at either 1 or 10 °C, although following 2 additional weeks at 20 °C, 12.5% (H4), and 5% (H5) of the bulbs were severely decayed (lesions extending from the cut stem into the bulb). Bulbs from H5 (Ft. Pierce) stored at 1 °C for 2 weeks had less decay than those stored at 10 °C (15% and 30% mild decay ratings, respectively, where mild decay consisted of apparent, but superficial lesions). However, following 2 weeks of storage at 20 °C, the severity rating for bulbs stored at these respective temperatures increased to 40% and 30% severe decay.

Drying reduces the potential for bulb infection by decay pathogens during postharvest handling and storage. In this study, decay occurred at moist, cut stems or sites of mechanical injury. Lesions given a slight decay rating following 2 weeks of storage under refrigerated conditions actually dried and became quiescent during subsequent storage for 2 weeks at 20 °C. The storage decay prevalent in 'Texas Grano 1015Y' bulbs from H4 and H5 may have resulted from latent infection from the field at these later harvests. Smittle and Maw (1988) reported that the incidence of storage decay for 'Granex 33' increased as harvest maturity increased, which they attributed to mechanical injury during commercial harvest. In that study, storage decay was lowest at the early harvest stage when the necks were soft and the crop had <6% fallen tops. Wall and Corgan (1994) also reported increased storage decay as harvest was delayed. Morphology also may have been a factor in resistance or susceptibility to decay. 'Texas Grano 1015Y' had a noticeably thicker stem than did 'Granex 33', resulting in a larger wound after the tops were trimmed.

For onions from H1 to H5, moisture content (MC) after storage for 2 weeks at 1 or 10 °C plus 2 weeks at 20 °C ranged from 92.0% to 93.5%, respectively (data not shown). There were no trends for cultivar or location. Smittle and Maw (1988) reported that dried 'Granex 33' stored for 4 weeks at 25 to 28 °C had similar MC, ranging from 93.8% to 94.9%. Bulb firmness was determined throughout storage; however, onions from all treatments remained very firm, with average deformations of only 1.0 and 1.3 mm, respectively, for 'Granex 33' and 'Texas Grano 1015Y' after 4 weeks of storage (data not shown).

Cumulative weight loss for both cultivars declined as harvest date for both cultivars was delayed. Bulbs from H1 had the greatest weight loss following 2 weeks of storage at either 1 or

Table 3. Percentage of incidence of sprouting during storage of onion bulbs as influenced by cultivar and harvest maturity.

		Bradenton			Ft. Pierce		
		Storage time (weeks) ^z			Storage time (weeks)		
Variable		2	3	4	2	3	4
<i>Texas Grano 1015Y</i>							
Harvest	DAT ^y						
1	115	20.0	35.0	35.0	35.0	65.0	65.0
2	124	5.0	7.5	7.5	10.0	22.5	22.5
3	132	0.0	2.5	2.5	0.0	2.5	2.5
4	144	0.0	5.0	5.0	0.0	0.0	0.0
5	153	0.0	0.0	0.0	0.0	0.0	5.0
Significance ^x		**	**	**	**	**	**
Initial storage temperature (°C)							
1		0.0	9.0	9.0	0.0	17.0	17.0
10		10.0	11.0	11.0	18.0	19.0	21.0
Significance		**	NS	NS	**	NS	NS
Harvest × temperature							
Significance		**	NS	NS	**	NS	NS
<i>Granex 33</i>							
Harvest	DAT ^y						
1	94	2.5	2.5	2.5	72.5	72.5	72.5
2	104	0.0	2.5	2.5	0.0	5.0	7.5
3	115	0.0	0.0	0.0	2.5	2.5	2.5
4	124	0.0	0.0	0.0	0.0	0.0	2.5
5	132	0.0	0.0	0.0	0.0	0.0	2.5
Significance		NS	NS	NS	**	**	**
Initial storage temperature (°C)							
1		1.0	1.0	1.0	12.0	12.0	14.0
10		0.0	1.0	1.0	18.0	20.0	21.0
Significance		NS	NS	NS	**	*	NS
Harvest × temperature							
Significance		NS	NS	NS	**	NS	NS

^zBulbs were stored for 2 weeks (Week 2) at either 1 or 10 °C followed by 2 weeks at 20 °C (Weeks 3, 4) (n = 4).

^yDays after transplant.

NS, *, ** Nonsignificant or significant at $P \leq 0.05$ or 0.01.

Table 4. Cumulative weight loss (%) during storage of onion bulbs at five harvest maturities.

		Bradenton			Ft. Pierce		
		Storage time (weeks) ^z			Storage time (weeks)		
Variable		2	3	4	2	3	4
<i>Texas Grano 1015Y</i>							
Harvest	DAT ^y						
1	115	2.6	5.0	6.1	4.2	8.3	10.3
2	124	1.6	1.6	4.4	2.4	5.0	6.0
3	132	1.5	1.5	3.9	2.2	4.1	5.2
4	144	0.5	0.5	3.0	1.5	3.5	4.6
5	153	1.2	1.2	4.2	2.4	4.3	5.5
Significance ^x		**	**	**	**	**	**
Initial storage temperature (°C)							
1		1.4	3.5	4.5	2.4	5.2	6.6
10		1.5	3.2	4.1	2.7	5.0	6.1
Significance		NS	NS	*	*	*	*
Harvest × temperature							
Significance		NS	NS	*	*	NS	*
<i>Granex 33</i>							
Harvest	DAT ^y						
1	94	2.7	5.1	6.0	4.5	8.1	9.7
2	104	2.3	4.2	5.1	3.0	5.2	6.4
3	115	1.8	3.4	4.1	2.3	4.2	5.1
4	124	1.2	2.8	3.6	1.4	3.3	4.0
5	132	1.6	3.4	4.8	2.0	3.6	4.8
Significance		**	**	**	**	**	**
Initial storage temperature (°C)							
1		1.8	3.8	4.8	2.4	4.9	6.1
10		2.1	3.7	4.6	2.9	4.9	5.9
Significance		**	NS	NS	*	NS	NS
Harvest × temperature							
Significance		NS	NS	NS	NS	NS	NS

^zBulbs were stored for 2 weeks (Week 2) at either 1 or 10 °C followed by 2 weeks at 20 °C (Weeks 3, 4) (n = 4).

^yDays after transplant.

NS, *, ** Nonsignificant or significant at $P \leq 0.05$ or 0.01.

10 °C (Table 4). They continued to lose weight during subsequent storage at 20 °C (weeks 3 and 4 of storage), although at lower rates. 'Texas Grano 1015Y' bulbs from both locations that were initially stored at 1 °C lost more weight after 4 weeks of storage than did those initially stored at 10 °C. There was less surface desiccation during the initial 2 weeks storage at 1 °C. Bulbs from H2 to H5 generally lost less than did those from H1.

Delayed harvest (H4, H5) resulted in significant increases in total yield and the proportion of large (>7.6 cm diameter) bulbs, weight, and decreases in the respiration rate, sprouting, and weight loss, all consistent with more mature bulbs. However, for onions grown under humid, subtropical conditions, storage decay increased with later harvests. Considering the above quality parameters, recommended harvest times for 'Granex 33' and 'Texas Grano 1015' are 115 and 132 DAT, respectively (H3). At this maturity ≈20% and 5% of the tops had fallen for these respective cultivars. Nondried bulbs harvested at this maturity could be stored for 2 weeks at 1 °C and 80% RH plus 2 weeks at 20 °C, allowing sufficient time for shipment to distant markets and retailing. Storage of bulbs from H3 at 10 °C and 80% RH resulted in unacceptable rates of decay after an additional 2 weeks storage at 20 °C.

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