‘NuMex Serenade’ Onion

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Additional index words. *Allium cepa*, bolting resistance, fusarium basal rot, *Fusarium oxysporum* f. sp. *cepae*, *Phoma terrestris*, pink root

The New Mexico State Univ. Agricultural Experiment Station announces the release of ‘NuMex Serenade’ onion (*Allium cepa* L.). ‘NuMex Serenade’ is an open-pollinated, bolting-resistant, pink-root-resistant [causal agent, *Phoma terrestris* (Hansen)], short-day, yellow skin onion cultivar for fall sowing in southern New Mexico and similar environments. ‘NuMex Serenade’ matures in late May to early June when fall-sown in Las Cruces, NM.

Origin

‘NuMex Serenade’ originates from ‘NuMex Starlite’ (Fig. 1), which was a cultivar released by the New Mexico State Univ. onion breeding program in 1990 (Corgan and Holland, 1990). In 1990, a selection of bolting-resistant bulbs was made from a seed-to-seed production cage of ‘NuMex Starlite’ in which 90% of the plants in the crossing cage had bolted. These bolting-resistant bulbs were placed together in a crossing cage that was numbered 91-23. Seed from this crossing cage was harvested and sown in 1991. Two additional selections were made using phenotypic recurrent selection. Bulbs were selected for increased bulb firmness, increased bolting resistance, a more round bulb shape, increased pink root [causal organism, *Phoma terrestris* (Hansen)] resistance, and for the visual appearance of a single vegetative meristem. The fields, used for onion bulb production, have been used for the last few decades and may have higher incidence levels of pink root as compared with farmers’ fields. The bulbs from the second selection cycle were placed in a crossing cage that was numbered 95-9. Seed from this crossing cage was harvested and sown in 1995.

In 1991, bulbs from ‘NuMex Starlite’ were self-pollinated and seed from those self-pollinations were sown. The next year, individual bulbs from these self-pollinations were selected for their increased bulb firmness, increased bolting resistance, and later bulb maturity when compared with ‘NuMex

Starlite’. The selected bulbs were placed together in a crossing cage that was numbered 93-20. Seed was harvested from this cage and sown in 1993. The next year, bulbs were selected for increased bulb firmness, increased bolting resistance, and for the visual appearance of a single vegetative meristem. The selected bulbs were placed in a crossing cage that was numbered 95-10. Seed from this crossing cage was harvested and sown in 1995.

In 1996, bulbs were selected from the 95-9 and 95-10 populations. The selection criteria used were increased bolting resistance, increased bulb firmness, a more round bulb shape, and improved dry outer scale qualities. After 3 months of storage, bulbs were cut transversely at the vertical center to observe the number of growing points within the center of the bulb. Only those bulbs that possessed a single growing point in the center of the bulb were selected. This selection pressure was used because onion cultivars that produce a high percentage of single-centered bulbs are desired by onion ring processors and their suppliers. Selected bulbs from both populations were placed in a crossing cage that was numbered 97-10. Seed from this crossing cage was harvested and sown in 1997. Bulbs were selected from this population using the same criteria as used for the previous selection. After bulbs were cut transversely, they were separated into two groups: those bulbs that possessed a single growing point (single-centered) and those bulbs that possessed two growing points. From those bulbs that possessed two growing points, only bulbs in which the two growing points occupied an internal diameter of 2.5 cm or less were retained, whereas the other bulbs were discarded. The two bulb selections were placed in a single crossing cage as separate entries that were numbered 99-18-1 for the single-centered bulb selection and 99-18-2 for the double-centered bulb selection. Within the single crossing cage, the two entries were allowed to intercross. Seed was harvested from each entry, kept separate, and sown in 1999. Four additional phenotypic recurrent selections were conducted in 2000, 2002, 2004, and 2007 on both breeding lines using the selection criteria mentioned previously except for the selection of single-centered bulbs. A single-centered bulb selection was made for each breeding line at each selection cycle. Any multiple-centered bulbs were discarded from the respective bulb selection. Bulbs that were selected from the

populations, 05-18-1 and 05-18-2 were placed in a crossing cage as separate entries. The two entries were numbered 08-18-1 and 08-18-2, respectively. The next year, seed was harvested from both entries and seed harvested from 08-18-1 became ‘NuMex Serenade’.

Evaluation Procedures

For the past 3 years, ‘NuMex Serenade’ has been compared with ‘NuMex Starlite’ in replicated trials grown in several field plots (Table 1). Seeds were sown ≈1 to 2 cm deep in two rows 6 cm apart from mid-September to early October depending on field location and year (Table 1). An early sowing date in September often results in a higher bolting percentage than a late September or early October sowing (Cramer, 2003). For each two-row plot, 1.5 g of seed was sown and plants were thinned to 10 cm between plants within the row. Each plot was 2.4 m long and 1 m wide and separated by an alley of 0.6 m from the next plot on the same bed. The trials were conducted in randomized complete block designs with four replications. Standard cultural practices were followed to produce fall-sown onions in southern New Mexico (Walker et al., 2009). For Fields 1, 2, 4, 6, and 7, diammonium phosphate (18N–20P–0K; Helena Chemical Co., Collierville, TN) was applied at a rate of 170 kg·ha⁻¹ before seeding as a band 10 cm below the soil surface. Fields 1 and 2 were surface-irrigated, whereas the other five fields were drip-irrigated. Subsurface drip irrigation lines (T Tape; T-Systems International, San Diego, CA), that had emitters every 20 cm, were placed 10 cm deep in the center of each bed. Irrigation was applied as needed. A urea-based liquid fertilizer (26N–0P–0K–6S; Western Blend, Inc., Las Cruces, NM) was applied as needed to Fields 1, 2, 4, 6, and 7, whereas a fish fertilizer (2.2N–4.4P–0.3K–0.2S; Neptune’s Harvest Fertilizer, Gloucester, MA) was applied as needed to Fields 3, 5, and 7.

All plots were harvested when 80% of the plants in the plot had lodged. The harvest date was considered the maturity date, and the days from sowing until harvest were counted for each plot. The number of plants that producing seed stalks was counted for each plot. The seed stalk percentage, a measure of bolting, was calculated by dividing the number of plants with seed stalks by the total plant number per plot. These fields have been used for onion production for the last few decades and may have higher levels of disease-causing, pathogen inoculum as compared with farmers’ fields. Two onion diseases that are present at high levels in our evaluation fields are pink root and fusarium basal rot (FBR) [causal agent, *Fusarium oxysporum* f. sp. *cepae* (H.N. Hans.) W.C. Snyder & H.N. Hans.]. Replicated variety trials over the past 10 to 12 years have evaluated germplasm for their resistance/tolerance to the pathogens that cause these two diseases (Cramer, 2001; Cramer and

Received for publication 22 Jan. 2010. Accepted for publication 25 Feb. 2010.

This research was funded by the New Mexico Agricultural Experiment Station and the New Mexico Dry Onion Commission.

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Fig. 1. Pedigree of 'NuMex Serenade'.

Table 1. Bulb maturity, bulb firmness rating, and percentage of single centers of 'NuMex Serenade' as compared with 'NuMex Starlite' when sown at the Fabian Garcia Science Center in Las Cruces, NM, from 2006 to 2009.

Entry	Maturity date (DAS) ^z	Firmness rating ^y	Single centers (%) ^x
<i>2006–2007 Field 1 (25 Sept. 2006 seeding date)^w</i>			
NuMex Serenade	31 May (248)	7.5	61.3
NuMex Starlite	5 June (253)	6.7	3.8
	**	+	**
<i>2006–2007 Field 2 (13 Sept. 2006 seeding date)</i>			
NuMex Serenade	26 May (255)	7.1	53.8
NuMex Starlite	15 June (275)	5.7	1.3
	**	**	**
<i>2006–2007 Field 3 (2 Oct. 2006 seeding date)</i>			
NuMex Serenade	5 June (247)	6.8	51.3
NuMex Starlite	12 June (254)	5.8	1.3
	**	+	**
<i>2006–2007 Field 4 (22 Sept. 2006 seeding date)</i>			
NuMex Serenade	28 May (248)	7.2	68.8
NuMex Starlite	4 June (255)	6.6	7.5
	NS	+	**
<i>2007–2008 Field 1 (17 Sept. 2007 seeding date)</i>			
NuMex Serenade	4 June (261)	7.2	72.5
NuMex Starlite	10 June (267)	7.0	16.3
	+	NS	**
<i>2007–2008 Field 5 (14 Sept. 2007 seeding date)</i>			
NuMex Serenade	1 June (261)	7.5	88.4
NuMex Starlite	9 June (269)	6.4	50.0
	+	*	*
<i>2007–2008 Field 6 (20 Sept. 2007 seeding date)</i>			
NuMex Serenade	11 June (269)	7.2	82.5
NuMex Starlite	14 June (272)	6.3	21.3
	NS	***	**
<i>2008–2009 Field 7 (30 Sept. 2008 seeding date)</i>			
NuMex Serenade	27 May (244)	6.0	36.0
NuMex Starlite	1 June (249)	4.4	1.0
	+	**	**

^zA plot was considered mature when 80% of the tops were down and was harvested at that time. DAS = days after sowing.

^yBulbs were rated on a scale of 1 (soft) to 9 (hard) when they were squeezed by hand at two separate points at the vertical center. For the first 2 years of testing, bulbs were rated 4 d after harvest. For the last year, bulbs were rated 4 weeks after harvest.

^xThe percentage of bulbs with single centers (single growing points) was determined by cutting each bulb transversely at the vertical center and measuring the number of growing points that extended 1.3 cm beyond the bulb's center. For the first 2 years of testing, bulbs were cut 4 d after harvest. For the last year, bulbs were cut 4 weeks after harvest.

^wConventional vegetable cultural practices were used in Fields 1, 2, 4, 6, and 7, whereas organic practices were used in Fields 3 and 5. Drip irrigation was used in Fields 3, 4, 5, 6, and 7, whereas furrow flood irrigation was used in Fields 1 and 2. In the 2006–2007 and 2007–2008 test years, 'NuMex Serenade' was tested as NMSU 05-18-1, whereas in the 2008–2009 test year, 'NuMex Serenade' was tested as NMSU 08-18-1.

NS, +, *, **, ***Nonsignificant at $P = 0.10$, significant at $P = 0.10$, significant at $P = 0.05$, significant at $P = 0.01$, and significant at $P = 0.001$, respectively. Test was conducted at $\alpha = 0.05$.

Muhyi, 2002; Cramer et al., 1998, 2000, 2001, 2002; Saxena and Cramer, 2008). In addition, our research program has focused on developing FBR resistance in onions and obtaining a better understanding of the disease (Cramer, 2000, 2006; Cramer and Gutierrez, 2005; Gutierrez et al., 2006; Lopez, 2003; Lopez and Cramer, 2001, 2002, 2004; Saxena, 2007). In our research and breeding efforts, we have been able to increase the FBR resistance level of onion cultivars released from the program (Cramer and Corgan, 2003).

Immediately after harvest, the total bulb number was determined and 20 arbitrarily selected bulbs per plot were rated for pink root severity using a subjective rating of 1 (no pink root) to 9 (heavily infected roots). The percent incidence of pink root disease was calculated by counting bulbs having a rating of more than 1 and divided it by 20. Later, bulb tops and roots were clipped, and the basal plate of 20 randomly selected bulbs was cut transversely to observe fusarium basal plate rot severity and incidence as described by Lopez (2003). For the first 2 years of testing, bulbs were cut 4 d after harvest. For the last year, bulbs were cut 4 weeks after harvest.

After harvest, bulbs were placed in mesh sacks and, on the same day, transferred indoors to an onion shed. Bulbs were cured for 3 to 4 d under ambient conditions to reduce storage losses and decay. After curing, the total bulb fresh weight was measured for each plot. Bulbs were graded to remove culls (diseased bulbs, bulbs under 3.8 cm in diameter, split- and double bulbs). The number of culls was subtracted from the total bulb number to obtain the marketable bulb number per plot. After bulbs were graded, they were weighed again to obtain marketable bulb weight per plot. The marketable yield percentage was calculated by dividing the marketable bulb weight per plot by the total weight per plot. The average bulb weight was calculated by dividing marketable bulb weight by marketable bulb number. To determine bulb firmness, 20 bulbs from each plot were squeezed by hand at two separate

points at the vertical center. Bulbs were rated on a scale of 1 (soft) to 9 (hard). For the first 2 years of testing, bulbs were rated 4 d after

Fig. 2. Mature, dry bulbs of 'NuMex Serenade' onion.

harvest. For the last year, bulbs were rated 4 weeks after harvest. Later, 25 bulbs were cut transversely at the widest point on the vertical axis to determine the percent of bulbs possessing a single growing point. If a bulb possessed a single growing point or multiple growing points within 1.3 cm of the bulb center, then the bulb was considered single-centered. For the first 2 years of testing, bulbs were cut 4 d after harvest. For the last year, bulbs were cut 4 weeks after harvest. For the last four environments tested, the bulb height and diameter of five bulbs per plot were measured for each cultivar. The bulb shape index, which is bulb height divided by bulb diameter, was calculated for each cultivar.

The General Linear Models procedure of the SAS statistical software (Version 9.2; SAS Institute, Cary, NC) was used to determine entry differences for each trait. The Proc Means statement was used to calculate the entry means across four replications.

Description and Performance

'NuMex Serenade' is a short-day, open-pollinated, yellow, globe onion (Fig. 2) that matures from 26 May to 11 June when fall-sown in Las Cruces, NM (Table 1). Suggested planting dates at Las Cruces are 20 to 25 Sept. In six of eight of the environments tested, bulbs of 'NuMex Serenade' matured

Table 2. Bolting percentage, pink root, and fusarium basal rot severity rating and incidence, percent, and total marketable bulb yield, and average bulb weight of 'NuMex Serenade' as compared with 'NuMex Starlite' when grown in soil moderately infested with pink root and fusarium basal rot pathogens at the Fabian Garcia Science Center and the Leyendecker Plant Science Research Center in Las Cruces, NM, from 2006 to 2009.

Entry	Bolting (%) ^z	Pink root		Fusarium basal rot		Marketable bulb yield		Avg bulb wt (g) ^s
		Severity rating ^y	Incidence (%) ^x	Severity rating ^w	Incidence (%) ^v	(%) ^u	(t·ha ⁻¹) ^t	
2006–2007 Field 1 (25 Sept. 2006 seeding date) ^r								
NuMex Serenade	0.0	3.4	100.0	1.2	16.3	95	64.7	309
NuMex Starlite	0.0	3.4	100.0	1.3	21.3	95	65.0	263
	NS	NS	NS	NS	NS	NS	NS	NS
2006–2007 Field 2 (13 Sept. 2006 seeding date)								
NuMex Serenade	0.5	1.1	8.8	1.3	53.2	97	52.5	241
NuMex Starlite	0.0	1.2	17.5	1.1	54.3	94	52.5	274
	NS	NS	NS	NS	NS	NS	NS	NS
2006–2007 Field 3 (2 Oct. 2006 seeding date)								
NuMex Serenade	0.0	2.0	95.0	1.2	13.8	97	50.0	257
NuMex Starlite	0.0	2.6	100.0	1.1	10.0	97	50.5	294
	NS	NS	NS	NS	NS	NS	NS	NS
2006–2007 Field 4 (22 Sept. 2006 seeding date)								
NuMex Serenade	0.0	2.9	100.0	1.5	46.3	97	66.3	265
NuMex Starlite	0.0	3.9	100.0	1.4	27.5	93	52.3	253
	NS	NS	NS	NS	***	NS	NS	NS
2007–2008 Field 1 (17 Sept. 2007 seeding date)								
NuMex Serenade	0.0	3.6	100.0	1.5	22.5	98	67.5	323
NuMex Starlite	0.4	3.8	100.0	1.9	33.8	98	68.0	317
	NS	NS	NS	NS	NS	NS	NS	NS
2007–2008 Field 5 (14 Sept. 2007 seeding date)								
NuMex Serenade	4.4	2.7	100.0	1.8	28.8	98	68.0	294
NuMex Starlite	7.1	3.5	100.0	1.8	22.5	97	57.4	275
	NS	NS	NS	NS	*	NS	NS	NS
2007–2008 Field 6 (20 Sept. 2007 seeding date)								
NuMex Serenade	0.0	4.6	100.0	3.1	35.0	87	32.7	197
NuMex Starlite	0.0	4.4	100.0	2.4	28.0	91	33.9	191
	NS	NS	NS	NS	NS	NS	NS	NS
2008–2009 Field 7 (30 Sept. 2008 seeding date)								
NuMex Serenade	0.5	1.7	53.8	3.3	40.0	98	76.0	390
NuMex Starlite	0.0	2.1	77.5	2.2	22.5	95	74.5	359
	NS	+	*	NS	NS	*	NS	NS

^zThe bolting percentage was determined at harvest and calculated by dividing the number of plants with scapes by the total number of plants per plot and multiply by one hundred.

^yRoot systems of 20 bulbs per plot were rated based on a scale of 1 (no infected roots) to 9 (completely infected roots).

^xPercentage of bulbs with pink root.

^wTransversely cut basal plates of 20 bulbs per plot were rated based on a scale of 1 (no disease tissue) to 9 (70% or more of basal plate decayed).

^vPercentage of bulbs with fusarium basal rot.

^uPercentage of marketable yield was calculated by dividing marketable bulb weight by total bulb weight.

^tMarketable bulb yield (t·ha⁻¹) was calculated by weighing the marketable bulbs per plot and adjusting the plot size to 1 ha.

^sAverage bulb weight was calculated by dividing the marketable bulb weight by the number of marketable bulbs.

^rConventional vegetable cultural practices were used in Fields 1, 2, 4, 6, and 7, whereas organic practices were used in Fields 3 and 5. Drip irrigation was used in Fields 3, 4, 5, 6, and 7, whereas furrow flood irrigation was used in Fields 1 and 2. In the 2006–2007 and 2007–2008 test years, 'NuMex Serenade' was tested as NMSU 05-18-1, whereas in the 2008–2009 test year, 'NuMex Serenade' was tested as NMSU 08-18-1.

NS, +, *, ***, Nonsignificant at $P = 0.10$, significant at $P = 0.10$, significant at $P = 0.05$, and significant at $P = 0.001$, respectively. Test was conducted at $\alpha = 0.05$.

earlier than bulbs of 'NuMex Starlite' (Table 1). This difference in maturity ranged from 3 to 20 d depending on the environment. When bulbs were squeezed and rated for firmness, 'NuMex Serenade' produced harder bulbs than 'NuMex Starlite' in seven of the eight tested environments (Table 1). The bulb firmness of 'NuMex Serenade' ranged from 6.0 to 7.5, whereas the bulb firmness of 'NuMex Starlite' ranged from 4.4 to 7.0. As mechanical harvesting becomes more widely adopted in New Mexico, bulb firmness will become an important trait to consider when selecting a cultivar for cultivation. 'NuMex Serenade' would be better suited for mechanical harvesting than 'NuMex Starlite'. In addition to bulb firmness, the percentage of single-centered bulbs produced by a cultivar is an important bulb quality trait to consider when selecting a cultivar for propagation because many onions are processed into onion rings in the United States. Onion ring processors request a high percentage of single-centered bulbs when purchasing onion bulb shipments for processing. 'NuMex Serenade' would be a better cultivar for ring processing than 'NuMex Starlite'. In each of the environments tested, 'NuMex Serenade' produced a higher percentage of single-centered bulbs than 'NuMex Starlite' (Table 1). The percentage of single-centered bulbs for 'NuMex Serenade' ranged from 36.0 to 88.4, whereas the percentage for 'NuMex Starlite' ranged from 1.0 to 50.0. Bulbs of 'NuMex Serenade' tend to have greater height than bulbs of 'NuMex Starlite'. The bulb shape index is greater for 'NuMex Serenade' (1.00) than 'NuMex Starlite' (0.91) when bulb measurements were averaged over four environments (data not shown). Cultivars that produce globe-shaped bulbs are more desirable by commercial buyers than cultivars that produce flatter bulbs.

'NuMex Serenade' is most comparable to 'NuMex Starlite' with respect to bolting percentage, pink root, and FBR disease severity and incidence, percentage marketable

bulb yield, marketable bulb yield, and average bulb size (Table 2). 'NuMex Serenade' has excellent bolting resistance and will tolerate earlier seeding dates than bolting-susceptible cultivars. Across the eight environments in which 'NuMex Serenade' was grown, the bolting percentage ranged from 0.0 to 4.4 with no bolting being observed in five of those environments (Table 2). Based on the values obtained for pink root (1.1 to 4.6) and FBR (1.2 to 3.3) severity, 'NuMex Serenade' would be considered moderately to highly resistant to pink root and highly resistant to FBR (Table 2) (Cramer and Gutierrez, 2005).

Availability

Currently, 'NuMex Serenade' is being produced, marketed, and sold exclusively by DP Seeds of Yuma, AZ. An application for Plant Variety Protection will be filed.

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