‘NuMex Radiance’ Onion

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

Origin

‘NuMex Radiance’ originates from NM 899, which was a germplasm released by the NMSU onion breeding program in 1992 (Corgan and Holland, 1992). NM 899 originated from several intercrosses between ‘Temprana’ and each of the following varieties: ‘Early Supreme’, ‘Southport White Globe’, ‘Ringmaster’, ‘White Creole’, and ‘New Mexico White Grano PRR’. The origin of NM 899 and the original six cultivars, that were used in its formation, was described in the release notice of ‘NuMex Mirage’ (Cramer and Corgan, 2007). ‘Temprana’ is a selection out of ‘New Mexico White Grano’ and was released by the New Mexico Agricultural Experiment Station in 1979 (Enzie and Corgan, 1979). ‘New Mexico White Grano’ was originally selected out of ‘New Mexico Early Grano’ in 1930 by the New Mexico Agricultural Experiment Station. ‘New Mexico White Grano’ produces high yields of large top-shaped white bulbs, is moderately pink root-resistant, and is susceptible to bolting. ‘Temprana’ is a short-day white onion that matures early when fall-planted in southern New Mexico (Enzie and Corgan, 1979). It is top-shaped and produces large bulbs with characteristics similar to ‘Texas Early Grano 502 PRR’. ‘Temprana’ is resistant to bolting but susceptible to pink

root. ‘Early Supreme’ is a short-day, F₁ hybrid white onion that was developed by Dessert Seed Co. in 1964 (Havey, 2007). ‘Early Supreme’ produces very large to jumbo-sized, pungent, flattened globe-shaped bulbs that have very good pink root resistance, intermediate fusarium basal rot resistance [causal agent, *Fusarium oxysporum* f. sp. *cepae* [(H.N. Hans.) W.C. Snyder & H.N. Hans]], and good bolting tolerance (Anonymous, 2007). ‘Early Supreme’ is not currently grown in New Mexico as a result of its poor adaptation. ‘Southport White Globe’ originated from the onion growing district in Southport, CT (Magruder et al., 1941). It is an intermediate-day white onion commonly grown in the northern United States for its firm to hard, medium-sized, slightly flattened to slightly oval-shaped bulbs that are relatively high in soluble solids and pungency and can be stored for long periods of time. ‘Southport White Globe’ is not adapted to southern New Mexico. ‘Ringmaster’ is a long-day white sweet spanish-type onion that matures late when spring-planted in southern New Mexico. It produces high yields of large globe bulbs and is moderately resistant to pink root. ‘White Creole’ is a short-day, open-pollinated cultivar that produces small, flat, hard bulbs that are strong in pungency and high in soluble solids (Magruder et al., 1941). It is often grown for the onion dehydration industry. ‘New Mexico White Grano PRR’ is a pink root-resistant selection of ‘New Mexico White Grano’ released in 1977 by the Dessert Seed Co. (Dessert, 1979).

From NM 899, a selection for deep (bulb height greater than bulb diameter) to round globe-shaped bulbs, earlier-maturing bulbs, bolting-resistant bulbs, pink root-resistant bulbs, hard bulbs, and bulbs that possessed a clean white dry scale color was made in 1990 (Fig. 1). Selections were made from fields in Las Cruces, NM, that contained high inoculum levels of *P. terrestris* and *F. oxysporum* f. sp. *cepae*. At bulb maturity, bulbs were rated for incidence of pink root. Only bulbs that possessed a healthy root system with minimal symptoms of pink root were selected. Sometimes at harvest, bulbs can possess some pink root symptoms but still have a large number of healthy roots. At bulb maturity, bulbs possessing fusarium basal rot (FBR) were not selected. During storage, bulbs that developed FBR were discarded. Selection for bolting resistance was done in field plantings that possessed 70% or more plants with scapes at harvest time. Seed was

planted approximately 1 Sept. to promote scape formation. This date is 2 to 3 weeks earlier than the earliest recommended planting date for fall-sown onions in southern New Mexico. Selection for bulb shape uniformity was for bulbs of the same size and those possessing the same desired shape.

These selection criteria were used for subsequent generations unless otherwise stated. Approximately 200 bulbs were selected from NM 899 and after storage until Sept. 1990, ≈100 bulbs remained. These bulbs were grouped together in a single cage, numbered 91–65. Crosses occurred between these bulb selections in May 1991. Seed from this cage was harvested in Aug. 1991 and sown for bulb selection in Sept. 1991. One hundred nineteen bulbs were selected in June 1992 from the 91–65 population using the selection criteria mentioned previously. The selected bulbs were stored until Sept. 1992. A large amount of variability existed between bulbs for a number of characters, so the selected bulbs were placed separately into individual cages for self-pollination to occur in the next year, May 1993. At this time, each cage received a new number designation. Seed from each cage was harvested in Aug. 1993 and sown for bulb selection in Sept. 1993.

Six and 19 bulbs were selected in June 1994 from the 93–116–1 and 93–154–1 populations, respectively, using the selection criteria mentioned previously. The selected bulbs were stored until Sept. 1994. The selected bulbs were placed separately into individual cages for self-pollination to occur in the next year, May 1995. At this time, each cage received a new number designation. Seed from each cage was harvested in Aug. 1995 and sown for bulb selection in Sept. 1995. One and three bulbs were selected in June 1996 from the 95–178–1 and 95–193–1 populations, respectively, using the selection criteria mentioned previously. The selected bulbs were stored until Sept. 1996. The selected bulbs were placed separately into individual cages for self-pollination to occur in the next year, May 1997. At this time, each cage received a new number designation. Seed from each cage was harvested in Aug. 1997 and sown for bulb selection in Sept. 1997. Three bulbs each were selected in June 1998 from the 97–252–1 and 97–243–1 populations using the selection criteria mentioned previously. The selected bulbs were stored until Sept. 1998. The selected bulbs from the 97–252–1 population were placed separately into individual cages for self-pollination, whereas the three selected bulbs from the 97–243–1 population were grouped together in a single cage for crosspollination to occur in the next year, May 1999. At this time, each cage received a new number designation. Seed from each cage was harvested in Aug. 1999 and sown for bulb selection in Sept. 1999.

Six and one bulbs were selected in June 2000 from the 99–248–1 and 99–288–1 populations, respectively, using the selection criteria mentioned previously. The selected bulbs were stored until Sept. 2000. After

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Fig. 1. Pedigree of 'NuMex Radiance'.

storage, only two bulbs selected from the 99-248-1 population were still alive. These two bulbs and the one bulb selected from the 99-288-1 population were placed together into an individual cage for crosspollination to occur in the next year, May 2001. Self-pollination of these bulbs was not done to prevent any further inbreeding depression and reduction in plant vigor and seed production. Seed was harvested in Aug. 2001 and sown for bulb selection in Sept. 2001. Twelve bulbs were selected in June 2002 from the 01-303-1 population using the selection criteria mentioned previously. The selected bulbs were stored until Sept. 2002. After storage, only five bulbs selected from the 01-303-1 population were still alive. Three bulbs were placed in a single cage, whereas the two remaining bulbs were placed a separate single cage. Crosspollination occurred in each cage between the selected bulbs in the next year, May 2003. Seed was harvested in Aug. 2003 and sown for bulb selection in Sept. 2003. Twenty-nine bulbs were selected in June 2004 from the 03-399-1 population and 21 bulbs were selected from the 03-400-1 population. The selected bulbs were stored until Sept. 2004. After storage, only four bulbs selected from the 03-399-1 population and nine bulbs selected from the 03-400-1 population were still alive.

The remaining bulbs from both populations were grouped together in a single crossing cage. Crosspollination occurred between the selected bulbs in the next year, May 2005. Seed was harvested in Aug. 2005 and sown for bulb selection in Sept. 2006. Forty-six bulbs were selected in June 2007 from the 05-11 population. The selected bulbs were stored until Sept. 2007. After storage, only 32 bulbs selected from the 05-11 population were still alive. The remaining bulbs were grouped together in a single crossing cage and crosspollination occurred between the selected bulbs in the next year, May 2008. Seed was harvested in Aug. 2008 and these seed are being released as 'NuMex Radiance'.

Beginning with the selection of bulbs from the 99-248-1 and 99-288-1 populations, selection criteria also included lack of bulb scale greening, lack of bulb scale discoloration, uniform bulb maturity, uniform bulb shape, and bulbs with a single growing point or multiple centers with a small diameter in the center of the bulb when cut transversely at the vertical center. Selection for bulb scale

color was based on the color of the dry outer bulb scales. Bulbs in which the outer scales tended to turn dirty white in color or in which the first fleshy scale layer tended to turn green were not selected. Selection for bulb shape and color was based on subjective visual observations. Selection for bulb maturity was based on a desired harvest date of the first week of June.

Evaluation Procedures

For the past 2 years, 'NuMex Radiance' has been compared with NM 899 and 'NuMex Mirage' in replicated trials grown in several locations. 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). To evaluate the bolting resistance of a promising breeding line as compared with a current commercial cultivar, an early September sowing date (5 to 10 Sept.) is often chosen for evaluation purposes. For each two-row plot, 1.5 g of seed was sown and plants were thinned later 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 design with four replications. Standard cultural practices were followed to produce fall-sown onions in southern New Mexico (Corgan et al., 2000). For Fields 1 and 3, diammonium phosphate (18N-20P-0K; Helena Chemical Co., Collierville, TN) at a rate of 170 kg-ha⁻¹ was applied as a band 10 cm below the soil surface before seeding. Field 1 was surface-irrigated, whereas Fields 2, 3, and 4 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 and 3, whereas a fish fertilizer (2.2N-4.4P-0.3K-0.2S; Neptune's Harvest Fertilizer, Gloucester, MA) was applied as needed to Fields 2 and 4.

All plots were harvested when 80% of the plant tops were lying down. The harvest date

was considered the maturity date, and the days from sowing until harvest was counted for each plot. The number of plants that produced 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 inoculum compared with farmers' fields. Two onion diseases, that are present at high levels in our evaluation fields, are pink root and FBR. 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 et al., 1998, 2000, 2001, 2002; Cramer and Muhyi, 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 level of FBR resistance in improved onion cultivars as compared with highly susceptible cultivars (Cramer and Corgan, 2003).

Immediately after harvest, the total bulb number was determined and 20 randomly 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).

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 high temperature and low humidity 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. 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.

Table 1. Bulb maturity, marketable yield, percentage of single centers, pink root severity rating, and fusarium basal rot severity rating and incidence of 'NuMex Radiance' as compared with NM 899 and 'NuMex Mirage' when grown on soil moderately infested with pink root and fusarium basal rot pathogens at the Fabian Garcia Research Center, Las Cruces, NM, from 2006 to 2008.

Entry	Maturity date (DAS) ^z	Marketable yield (t·ha ⁻¹) ^y	Single centers (%) ^x	Pink root severity rating ^w	Fusarium basal rot severity rating ^v	Fusarium basal rot incidence (%) ^u
2006–2007 Field 1 (25 Sept. 2006 seeding date) ^f						
NuMex Radiance	5 June (253)	51.0	51.0	2.5	1.8	41.8
NM 899	4 June (252)	51.8	29.0	3.3	1.8	38.8
NuMex Mirage	31 May (248)	52.7	16.0	3.2	1.6	28.8
Mean	3 June (251)	51.8	32.0	3.0	1.7	36.3
LSD (5%)	2 d**	NS	16.0**	0.6*	NS	NS
2006–2007 Field 2 (2 Oct. 2006 seeding date)						
NuMex Radiance	12 June (254)	40.9	34.0	2.2	1.1	8.8
NM 899	12 June (254)	45.0	7.0	2.5	1.3	23.8
NuMex Mirage	5 June (247)	33.6	10.0	2.0	1.3	25.0
Mean	10 June (252)	39.8	17.0	2.3	1.2	19.2
LSD (5%)	1 d***	8.5*	11.5**	NS	NS	NS
2006–2007 Field 3 (22 Sept. 2006 seeding date)						
NuMex Radiance	4 June (255)	52.2	76.0	2.8	1.8	46.3
NM 899	1 June (252)	38.6	32.0	3.1	1.8	53.8
NuMex Mirage	23 May (243)	36.8	50.0	2.8	1.2	20.0
Mean	30 May (250)	42.5	52.7	3.0	1.7	36.3
LSD (5%)	6 d**	3.3***	34.3*	NS	NS	NS
2007–2008 Field 1 (17 Sept. 2007 seeding date)						
NuMex Radiance	6 June (263)	65.2	83.0	2.8	1.9	43.8
NM 899	6 June (263)	49.5	30.0	3.0	1.6	27.5
NuMex Mirage	29 May (255)	62.0	39.0	3.4	1.8	43.8
Mean	3 June (260)	58.9	50.7	3.1	1.8	38.3
LSD (5%)	2 d***	12.6***	7.9***	NS	NS	NS
2007–2008 Field 4 (14 Sept. 2007 seeding date)						
NuMex Radiance	11 June (271)	51.8	91.0	2.8	2.5	47.5
NM 899	12 June (272)	23.4	44.5	3.0	2.5	44.1
NuMex Mirage	4 June (264)	49.2	40.0	2.8	1.9	28.8
Mean	9 June (269)	41.5	58.5	2.9	2.3	40.1
LSD (5%)	5 d**	10.7**	17.4**	NS	NS	NS

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

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

^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.

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

^vCut 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).

^uPercentage of bulbs with fusarium basal plate rot.

^fConventional vegetable cultural practices were used in Fields 1 and 3, whereas organic practices were used in Fields 2 and 4. Drip irrigation was used in Fields 2, 3, and 4, whereas furrow flood irrigation was used in Field 1.

NS, *, **, *** = Nonsignificant at $P = 0.05$, significant at $P = 0.05$, significant at $P = 0.01$, and significant at $P = 0.001$, respectively.

LSD = least significant difference.

Proc Means statement in the General Linear Models (GLM) procedure of the SAS statistical software (SAS Institute, Cary, NC; Version 9.2) was used for calculating the entry means across four replications. The Proc GLM statement analyzed entry differences for each trait. The mean separation was performed using Fisher's protected least significant difference among different entries at five percent level of significance.

Description and Performance

'NuMex Radiance' is a short-day, open-pollinated white, high-globe onion that matures from 4 June to 12 June when fall-sown in Las Cruces, NM (Table 1). Suggested planting dates at Las Cruces are 20 to 25 Sept. 'NuMex Radiance' matures at a similar time as NM 899 and 5 to 12 d later than 'NuMex Mirage' (Table 1). 'NuMex Radiance' produces a comparable or greater marketable bulb yield when compared with NM 899 (Table 1). For three of the five

growing environments tested, the yield of 'NuMex Radiance' was 3 to 17 t·ha⁻¹ greater than NM 899. 'NuMex Radiance' produces a moderate to high percentage of bulbs with a single growing point depending on the growing environment. In each growing environment tested in the past 2 years, 'NuMex Radiance' produced a greater percentage of bulbs with a single growing point than NM 899 (Table 1). 'NuMex Radiance' has excellent bolting resistance and will tolerate early seeding dates. When conditions that favor premature seedstalk formation are present, 'NuMex Radiance' has greater bolting resistance than NM 899. When both entries were grown in Field 3 during 2006 to 2007 and Field 4 during 2007 to 2008, 'NuMex Radiance' produced fewer seedstalks (0.0% and 3.5%, respectively) than NM 899 (1.7% and 17.8%, respectively) (data not shown).

'NuMex Radiance' is comparable to NM 899 with respect to pink root and FBR disease severity and incidence, average bulb size, and bulb firmness (Table 1). Based on the values

obtained for pink root and FBR severity, 'NuMex Radiance' would be considered moderately to highly resistant to pink root and highly resistant to FBR. Bulbs of 'NuMex Radiance' tend to be deeper than bulbs of NM 899. The bulb shape index, that is bulb height divided by bulb diameter, is greater for 'NuMex Radiance' (1.04) than NM 899 (0.98). Bulbs of 'NuMex Radiance' possess a bright white dry scale that seldom exhibits staining or greening.

Availability

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

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