

# Evaluation of Forty-seven Cultivars of *Lisianthus* as Cut Flowers

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**SUMMARY.** *Lisianthus* [*Eustoma grandiflorum* (Raf.) Shinn.] is emerging as an important cut flower in the United States while in European and Asian markets it is already listed among the top ten cut flowers. Many new cultivars have been released in the United States within the last 5 years, but comparative performance trials of these cultivars have been lacking. This trial evaluated 47 cultivars of *lisianthus* representing series (cultivar groups) that were marketed in the United States in 1998. Evaluations were made for rosetting, plug performance, cut-flower characteristics (vegetative and flowering attributes) as well as postharvest longevity of cut flowers. Significant differences among cultivars were found for all of the attributes evaluated. 'Malibu Purple', 'Catalina Blue Blush', and 'Alice Pink' were selected as the best performers in the seedling (plug) stage since they had less than 5% rosettes, large leaves and a vigorous root system. Cultivars were placed in classes based on flower color, flower size, and number of petals (single or double flowers). Cultivars were ranked for each of the

attributes and the total rank sum of all attributes (TRS) was used to select the best in class. Cultivars selected as best in class were 'Malibu Purple', 'Malibu Blue Blush', 'Alice Purple', 'Balboa Blue', 'Avila Blue Rim', 'Mellow Pink', 'Flamenco Wine Red', 'Flamenco Rose Rim', 'Alice Pink', 'Avila Rose' and 'Echo Pink', 'Alice White', and 'Mariachi White'.

**A**lthough *lisianthus* was listed in seed catalogues in the United States as early as 1886, it was virtually unknown as a cut flower in the United States until the early 1980s (Halevy and Kofranek, 1984; Roh and Lawson, 1984). *Lisianthus* is native to the plains states from Texas to Colorado, but its potential as a cut flower was not realized until significant improvements were made by Japanese seed companies. In Asia and Europe today, *lisianthus* is in the top ten cut flowers. In the United States, it is rapidly growing as an important cut flower helping to fill the void created when much of the traditional cut flower industry moved to Central and South America.

There has been an explosion of new cultivars released for the United States market in the last 5 years. In 1998, we identified more than 75 cultivars from 12 series listed in catalogues of companies marketing *lisianthus* in the United States. Cultivars marketed in the United States now primarily originated from breeding efforts of three seed companies in the United States and Japan. From communication with these companies, we anticipate that there will be over 200 cultivars marketed in the United States alone within the next few years and many more world wide.

To our knowledge, a replicated cut flower trial for *lisianthus* has not been conducted by the public sector in the United States since 1989 when 22 cultivars were evaluated (Roh et al., 1989). Unless these cultivars have been renamed, none of these cultivars are being marketed today. In Japan, 125 cultivars were evaluated in 1994 for their potential to rosette under high temperature, but other characteristics were not reported (Fukuda et al., 1994). Of the 125 cultivars evaluated, only five are sold in the United States today unless names have been changed for the United States market. This trial evaluated 47 cultivars of *lisianthus* with representative cultivars selected from series (culti-

var groups) marketed in the United States in 1998. Evaluations were made for rosetting, plug performance, cut flowering characteristics (vegetative and flowering characteristics) as well as post-harvest longevity of cut flowers.

## Materials and methods

**GERMINATION.** Seed of 47 cultivars of *lisianthus* were sown 12 Dec. 1998. Due to poor germination, six cultivars were resown 31 Dec. (Table 1). Germination was at 72 to 75 °F (22 to 24 °C) with a photosynthetic photon flux (PPF) of 30  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  for 12 h from cool-white fluorescent lamps.

Germination trays were moved to a glass greenhouse 2 weeks after sowing. Average night temperatures were about 65 °F (18.3 °C) with a minimum of 60 °F (15.5 °C), and average day temperatures were about 85 °F (29.4 °C) with maximums of 88 to 91 °F (31 to 33 °C). Seedlings were fertilized twice per week with a 16N-7P-14K water soluble fertilizer (15-16-17 Peat-Lite Special; Scotts Co., Marysville, Ohio) solution containing 250 ppm ( $\text{mg}\cdot\text{L}^{-1}$ ) N.

**SEEDLING EVALUATION.** Seedlings were transplanted 25 Jan. 1999 into 200-cell plug trays with 1-inch (2.5-cm) cells and grown in the same greenhouse with similar temperatures until 24 Feb. Seedlings were fertilized twice per week with a 15N-2P-12.4K water-soluble fertilizer (15-5-15 Ca-Mg Excel; Scotts Co., Marysville, Ohio) solution containing 500 ppm N.

The percentage of 100 seedlings of each cultivar that had not bolted by 11 Mar. (original sowing) or 18 Mar. (late sowing) were recorded as rosetted. Seedlings which had not rosetted had at least two elongated internodes on the bolted stem by 11 Mar.

Ten plants were randomly chosen out of one hundred seedlings at the time of transplanting to the field (24 Feb.) to evaluate seedling characteristics. Data recorded included seedling width (distance between two largest leaves at transplanting) and a subjective root development rating from 1 to 5, with 5 best; 1 = seedlings with a poor root system so that the root ball did not stay intact at transplanting and 5 = seedlings with a strong root system such that the root ball remained completely intact at transplanting. Means were presented with their standard deviation (Table 1) since the experimental design for seedling production did not allow mean separation procedures to be performed.

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EVALUATION OF VEGETATIVE AND FLOWERING CHARACTERISTICS. On 24 Feb., plugs were transplanted into ground beds within an opensided, fiberglass-covered, sawtooth greenhouse. Temperatures during the remainder of the test ranged from a low of 42 °F (5.6 °C) to a high of 98 °F (36.7 °C). Midday PPF ranged from 760 to 920  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ .

Ground beds were fumigated with a mixture of 67% methyl bromide and 33% chloropicrin at 350 lb/acre (392  $\text{kg}\cdot\text{ha}^{-1}$ ). Nutricote 10N-4.4P-14K (10-10-17 Plus, 180-d release; Agrivert Inc., Webster, Tex.) controlled release fertilizer was applied to the bed surface and raked into the top 1 inch (2.5 cm) of the bed at 400 lb of N per bed acre (448  $\text{kg}\cdot\text{ha}^{-1}$ ). In addition, plants were

fertilized on 5, 16, 23, and 30 Mar. with a 15N-2P-12.4K water soluble fertilizer (15-5-15 Ca-Mg Excel; Scotts Co., Marysville, Ohio) solution containing 500 ppm N because soil temperatures were below 80 °F (26.7 °C), the optimal temperature for release of nutrients from Nutricote. Plants were irrigated via two trickle tubes spaced 12 inches (30.5 cm) apart on the bed.

From 12 Mar. to 30 Apr., daylength was extended 4 h from twilight with a PPF of at least 2  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  at plant level provided by incandescent bulbs (photoperiodic lighting).

Ground beds were 3 ft wide (91 cm) and 6 inches high (15.2 cm). Two layers of 6 × 8-inch (15.2 × 20.3-cm) support wire were placed on the bed.

Two seedlings were planted per 6 × 8-inch rectangle resulting in 24 plants per plot arranged in a 4 × 6 pattern. Four of the center plants from each plot were harvested when two flowers per stem were open with reproductive parts visible. All harvested stems had a complete border of plants of the same cultivar. Stems were cut at the first internode above the soil. Data on harvested stems included the number of days from sowing to harvest, total height of the cut stem (from base of stem to uppermost flower or flower bud), weight of the cut stems trimmed to an 80-cm (31.5-inch) length (a length considered of the highest quality and that brings the greatest price), stem thickness measured at the first internode from the base, number of

**Table 1. Seedling characteristics, cut stem vegetative and flower attributes, and postharvest performance of 47 cultivars of cut lisianthus grown at Bradenton, Fla. Seeds were planted 15 Dec.<sup>2</sup> 1998, and plugs transplanted to ground beds 24 Feb. 1999.**

Cultivar	Seedling characteristics			Cut stem attributes							Postharvest		
	Rosette (%)	Seedling diam (cm ± SD)	Root <sup>1</sup> rating (value ± SD)	Days to flower (no.)	Plant ht (cm) <sup>2</sup>	Stem wt (g) <sup>3</sup>	Stem thickness (mm) <sup>4</sup>	Flowers/ stem (no.)	Flower diam (cm)	Petals/ flower (no.)	Vase life (days)	Bud <sup>5</sup> rating (5 = best)	Total <sup>6</sup> rank sum
Large, blue/purple, single flowers													
Bridal Marine	20	8.1 ± 0.7	3.6 ± 0.5	154	101	73	7.1	13	9.8	5	15	3.2	40.5
Bridal Ocean	18	4.6 ± 0.5	1.8 ± 0.4	162	129	49	6.7	10	9.0	5	21	4.0	28.0
Flamenco Blue	10	7.8 ± 0.7	3.6 ± 0.5	154	113	65	6.3	12	9.1	5	17	3.6	37.0
Malibu Deep Blue	23	7.3 ± 1.1	2.7 ± 0.5	148	109	58	6.7	12	11.1	5	18	3.6	39.0
Malibu Purple	4	9.3 ± 1.0	3.8 ± 0.8	145	101	68	6.7	11	11.8	5	21	3.6	47.0
Ventura Purple	13	7.2 ± 0.7	2.6 ± 0.5	143	94	63	6.5	12	9.6	5	22	4.0	37.5
Large, picotee/blush, single flowers													
Flamenco Blue Rim	28	6.8 ± 1.8	3.0 ± 0.7	150	116	51	6.2	9	10.9	5	16	2.8	28.0
Heidi Pastel Blue Imp.	17	5.9 ± 1.1	2.9 ± 0.7	153	94	74	7.6	13	9.5	5	18	4.8	41.5
Laguna Blue Blush	23	5.8 ± 1.1	2.5 ± 0.5	157	118	73	7.2	14	10.4	5	17	3.4	36.5
Malibu Blue Blush	11	7.3 ± 0.7	2.5 ± 0.7	147	103	59	6.7	13	9.8	5	18	4.2	42.0
Mellow Purple Picotee	7	8.5 ± 0.6	3.4 ± 0.5	156	119	53	6.6	11	9.0	5	18	3.6	41.5
Ventura Blue Blush	9	7.3 ± 0.8	2.0 ± 0.7	147	101	62	6.8	11	10.2	5	19	3.5	41.5
Small, blue/purple, single flowers													
Alice Purple	6	8.6 ± 1.0	3.7 ± 0.7	153	104	50	6.3	10	7.4	5	21	3.4	18.5
Tyrol Blue	17	7.4 ± 0.8	3.0 ± 0.5	153	102	66	6.0	12	8.4	5	17	3.8	14.5
Blue/purple, double flowers													
Avila Purple	0	7.5 ± 1.0	2.3 ± 0.6	152	112	61	6.3	10	10.0	20	13	3.3	24.0
Balboa Blue	19	7.1 ± 0.9	2.5 ± 0.5	156	116	85	7.6	18	9.5	13	16	2.2	24.5
Echo Blue	8	8.6 ± 0.6	4.4 ± 0.5	154	126	65	7.0	13	8.8	13	11	1.6	23.5
Picotee/blush, double flowers													
Avila Blue Rim	11	6.3 ± 0.5	2.7 ± 0.5	148	102	81	7.4	12	10.1	14	16	4.0	44.0
Balboa Blue Rim	22	5.0 ± 0.6	2.2 ± 0.4	155	114	70	7.2	13	8.6	13	20	3.7	28.5
Balboa Blue Blush	14	5.3 ± 0.7	1.8 ± 0.6	152	116	39	5.4	8	9.9	12	14	3.8	27.0
Catalina Blue Blush	5	9.2 ± 0.6	3.4 ± 0.7	155	114	80	7.0	13	9.7	9	15	4.0	38.0
Mariachi Misty Blue	32	5.9 ± 0.9	3.0 ± 0.5	153	113	87	7.3	15	9.1	24	16	4.2	42.5
Large, pink, single flowers													
Malibu Lilac	20	6.4 ± 0.9	2.6 ± 0.5	153	108	60	6.4	12	9.1	5	24	3.0	23.0
Royal Rose Lavender	20	6.4 ± 0.5	2.5 ± 0.5	148	104	77	7.8	15	10.5	5	21	3.4	36.5
Bridal Salmon Pink	25	7.0 ± 1.0	3.1 ± 0.9	158	104	65	7.3	13	9.9	5	20	4.0	29.5
Mellow Pink	8	7.4 ± 0.5	2.8 ± 0.4	151	103	72	7.6	14	9.4	5	23	4.2	39.5
Heidi Cherry Blossom	11	8.2 ± 0.6	4.7 ± 0.5	138	96	72	6.7	16	9.3	5	19	3.8	36.5
Large, red, single flowers													
Heidi Wine Red	35	4.2 ± 0.5	2.7 ± 0.5	161	96	55	5.8	9	8.8	5	22	2.0	12.0
Flamenco Wine Red	29	4.5 ± 0.3	2.2 ± 0.6	159	103	67	7.4	13	9.5	5	23	2.8	21.0

flowers and buds per stem, and flower diameter (flowers were pressed flat, upside down, and the diameter was recorded from petal tip to opposite petal tip).

The experimental design was a randomized complete block with three blocks, and four plants represented the experimental unit. Statistical analyses were performed on data using analysis of variance, and means separated where appropriate using Fisher's protected LSD<sub>0.05</sub> (PROC ANOVA, SAS Institute, Cary, N.C.).

**POSTHARVEST EVALUATION.** Five stems were selected at random for each cultivar, cut to 12 inches (30.5 cm), and placed in a processing solution (Chrysal Professional 2; Pokon & Chrysal USA, Miami, Fla.). Stems were selected which had one flower just beginning to open (visible reproductive parts) and at least

one unopened flower bud. The number of days until the open flower wilted was recorded. Unopened buds were given a subjective rating for overall appearance after they opened (1 to 5, with 5 best; 1 = flowers faded to 5 = similar flower color as the original flower).

A completely randomized design was used with five replications and each stem as the experimental unit. Statistical analyses were performed on data using analysis of variance, and means separated where appropriate using Fisher's protected LSD<sub>0.05</sub>.

**BEST IN CLASS.** Cultivars were placed in classes based on flower color, flower size, and number of petals (single or double flowers). Cultivars were ranked for each of the attributes. For two-way ties at a given rank, ranks n and n + 1 were replaced by rank n + 0.5, which was

assigned twice, and the next rank was n + 2. The total rank sum of all attributes (TRS) was used to select the best in class.

Results and discussion

**SEEDLING EVALUATION.** Though seedlings were grown from 29 Jan. through 24 Feb. in the greenhouse, high temperatures in combination with short days (Harbaugh, 1995; Harbaugh et al., 1992) apparently caused some rosetting in all but one of the cultivars ('Avila Purple'). 'Heidi Wine Red' had the highest percentage rosetted plants (35%) followed by 'Flamenco Wine Red' and 'Mariachi Pink' (29%) and 'Avila Purple' (0%), 'Alice Pink' (1%) and 'Avila Rose' (3%) the lowest.

Seedling width varied from 4.6 cm (1.81 inch) for 'Bridal Ocean' to 9.3 cm (0.76 inch) for 'Malibu Purple'. Root

**Table 1. (continued) Seedling characteristics, cut stem vegetative and flower attributes, and postharvest performance of 47 cultivars of cut lisianthus grown at Bradenton, Fla. Seeds were planted 15 Dec.<sup>2</sup> 1998, and plugs transplanted to ground beds 24 Feb. 1999.**

Cultivar	Seedling characteristics			Cut stem attributes							Postharvest		
	Rosette (%)	Seedling diam (cm ± SD)	Root <sup>3</sup> rating (value ± SD)	Days to flower (no.)	Plant ht (cm) <sup>4</sup>	Stem wt (g) <sup>5</sup>	Stem thickness (mm) <sup>1</sup>	Flowers/stem (no.)	Flower diam (cm)	Petals/flower (no.)	Vase life (days)	Bud <sup>6</sup> rating (5 = best)	Total <sup>7</sup> rank sum
Large, pink/picotée, single flowers													
Flamenco Rose Rim	24	5.8 ± 0.8	1.9 ± 0.7	153	98	70	6.6	12	10.3	5	18	4.0	15.5
Flamenco Pink Rim	27	6.4 ± 0.8	3.1 ± 0.3	143	114	62	6.8	11	10.5	5	18	3.6	17.5
Small, pink, single flowers													
Alice Pink	1	8.6 ± 0.8	3.7 ± 0.7	151	105	51	6.2	10	7.5	5	27	3.6	17.5
Tyrol Rose	24	6.4 ± 0.7	3.2 ± 0.4	157	113	65	6.8	11	9.0	5	16	3.6	15.5
Pink, double flowers													
Avila Rose	3	7.2 ± 0.7	3.1 ± 0.6	151	99	62	6.3	9	9.8	28	24	3.1	32.5
Echo Pink	18	6.3 ± 1.0	3.6 ± 0.7	155	109	69	6.5	12	8.9	11	18	3.2	32.5
Echo Lilac Rose	23	7.4 ± 0.8	3.9 ± 0.7	143	109	43	5.6	9	9.0	9	16	2.6	26.0
Mariachi Pink	29	5.6 ± 1.0	3.4 ± 0.7	153	115	60	6.4	10	9.6	25	15	3.4	29.0
Large, yellow/green/white, single flowers													
Mellow Yellow	24	5.9 ± 1.0	1.9 ± 0.6	155	119	64	6.8	13	10.3	5	18	3.8	---
Heidi Lime Green	21	6.3 ± 0.7	3.1 ± 0.6	155	111	56	5.5	14	9.3	5	14	4.4	---
Heidi White	27	6.3 ± 0.7	2.7 ± 0.5	150	99	73	7.3	13	10.3	5	16	5.0	---
Small, white, single flowers													
Alice White	8	8.8 ± 0.8	3.7 ± 0.7	151	102	54	6.2	11	8.0	5	31	3.4	20.0
Tyrol White	28	7.6 ± 0.8	3.0 ± 0.0	152	101	45	5.5	10	7.7	5	18	5.0	13.0
White, double flowers													
Echo Pure White	22	8.9 ± 0.9	3.8 ± 0.8	158	108	53	6.1	11	9.7	13	18	4.0	23.5
Mariachi White	11	6.9 ± 0.8	3.0 ± 0.7	162	110	78	6.5	14	9.0	20	16	4.0	24.0
Avila Ivory	7	8.9 ± 0.6	3.4 ± 0.7	153	98	74	7.4	13	9.1	11	16	3.8	21.5
Yellow/green, double flowers													
Catalina Yellow	18	7.8 ± 0.8	2.7 ± 0.5	156	111	84	7.1	15	9.6	11	10	5.0	---
Mariachi Lime Green	8	7.8 ± 0.6	3.9 ± 0.6	162	110	67	6.3	12	8.6	16	13	4.8	---
LSD <sub>0.05</sub>				3	9	15	0.8	3	0.7	1	5	1.1	

<sup>2</sup>Due to poor germination, 'Echo Lilac Rose', 'Flamenco Blue Rim', 'Flamenco Pink Rim', 'Heidi Cherry Blossom', 'Mariachi Pink', and 'Mariachi Misty Blue' were resown on 31 Dec.

<sup>3</sup>Root development rating from 1 to 5, with 5 best; 1 = seedlings with a poor root system such that the root ball did not stay intact at transplanting and 5 = seedlings with a strong root system such that the root ball remained completely intact at transplanting.

<sup>4</sup>Rating of bud that opened in the vase from 1 to 5, with 5 best; 1 = faded flower and 5 = flower color similar as primary flower.

<sup>7</sup>Total rank sum (TRS) calculated by adding the ranks of each attribute within a class.

<sup>2</sup>2.54 cm = 1.0 inch.

<sup>4</sup>454 g = 1.0 lb.

<sup>5</sup>25.4 mm = 1.0 inch.

vigor ratings ranged from 1.8 for 'Bridal Ocean' to 4.7 for 'Heidi Cherry Blossom'. Large leaves did not always match high root ratings. The most desirable plugs would be those with a low percentage of rosettes and easily pulled from the plug trays. Cultivars with a foliage width of  $\geq 7.0$  cm (2.76 inch) would be considered relatively large and easy to handle for transplanting. In addition, cultivars with large leaves fill the plug tray rapidly, an important characteristic for plug producers as well as for transplanting.

Plugs with an acceptable root system were those rated  $\geq 3$  where the root ball holds together during transplanting. Thus, 'Malibu Purple', 'Catalina Blue Blush', and 'Alice Pink' were selected as the best overall performers in the seedling (plug) stage since they had less than 5% rosettes, large leaves and a vigorous root system.

EVALUATION OF VEGETATIVE AND FLOWERING CHARACTERISTICS. The number of days from sowing to harvest varied by 19 d among cultivars. 'Heidi Cherry Blossom', 'Ventura Purple', 'Flamenco Pink Rim', and 'Echo Lilac Rose' had earliest harvest dates of 138 to 143 d from sowing while 'Bridal Ocean', 'Mariachi White', and 'Mariachi Lime Green' were the last cultivars to be harvested at 162 d from sowing.

Plant height ranged from 94 cm (37.0 inch) for 'Heidi Pastel Blue Imp.' and 'Ventura Purple' to 129 cm (50.8 inch) for 'Bridal Ocean'. Stem height is an important characteristic in the pricing of cut stems. In general, stems have to be  $\geq 80$  cm (31.5 inch) to bring the highest price. All cultivars that were evaluated exceeded this height.

We extended the day length for this test since this practice has been reported to increase stem length in lisianthus (Halevy and Kofranek, 1984). Our results indicated this practice may not be necessary and future trials could be conducted with out this high-cost production input.

Since flowers and flower buds were weighed as part of the cut stem weight, the cultivars with double flowers generally weighed more than those with single flowers. For double-flowering stems, 'Mariachi Misty Blue' had the greatest weight at 87 g (3.07 oz) and 'Echo Lilac Rose' the least at 43 g (1.52 oz). For single-flowering stems, 'Royal Rose Lavender' had the greatest weight at 77 g (2.72 oz) and 'Tyrol White' the least at 45 g (1.59 oz). 'Royal Rose Lavendar'

had the thickest stem [7.8 mm (0.31 inches)], while 'Balboa Blue Blush' had the thinnest [5.4 mm (0.21 inches)].

The number of flowers per stem and size of individual flowers differed significantly, both factors affecting perception of floriferousness and overall acceptance of harvested stems. Flower and bud number per stem ranged from 8 for 'Balboa Blue Blush' to 18 for 'Balboa Blue'. Flower diameter was smallest with 'Alice Purple' (7.4 cm, 2.91 inch) and largest for 'Malibu Purple' (11.8 cm, 4.65 inch). Breeders have introduced lisianthus with small flowers, such as 'Alice Purple', as a new category. For cultivars in this class of lisianthus (see Table 1), small flowers are desirable. For cultivars not in this class, larger is considered better for ranking purposes.

All single-flowered cultivars had five petals when the second flower to open was evaluated. The second flower was chosen because petal number and flower size often vary on the first flower to open (some have six petals), but petal number and flower size are generally consistent on all secondary flowers. For lisianthus with double flowers, petal number varied from 9 per flower for 'Catalina Blue Blush' and 'Echo Lilac Rose' to 28 for 'Avila Rose'.

Vase life was as short as 10 d for 'Catalina Yellow' and as long as 31 d for 'Alice White'. The longevity of open flowers is certainly an important factor for evaluation of postharvest performance. However, performance of buds that open while stems are in the vase also must be considered since they can cause a decrease in the aesthetic appeal of the arrangement before primary flowers have wilted. Buds that open under low interior light levels often have faded colors compared to those opened under greenhouse conditions (Marousky et al., 1985). Ratings  $< 3$  would indicate that flowers were faded and of poor quality. Ratings for secondary flowers opening in the vase ranged from 1.6 for 'Echo Blue' to 5.0 for 'Catalina Yellow', 'Tyrol White', and 'Heidi White'.

BEST IN CLASS. Best in class using the TRS (the sum of the rankings for all attributes within classes defined by flower size, color, and single or double flowers) were as follows: 'Malibu Purple' (large, blue/purple, single), 'Malibu Blue Blush' (large, picotee/blush, single), 'Alice Purple' (small, blue/purple, single), 'Balboa Blue' (blue/purple, double), 'Avila Blue Rim' (picotee/blush,

double), 'Mellow Pink' (large, pink, single), 'Flamenco Wine Red' (large, red, single), 'Flamenco Rose Rim' (large, pink-picotee, single), 'Alice Pink' (small, pink, single), 'Avila Rose' and 'Echo Pink' (pink, double), 'Alice White' (large, yellow/green/white, single), and 'Mariachi White' (white, double). There were several cultivars in single-entry classes and thus could not be challenged for best in class; TRS was not performed for these cultivars. Cultivars representing unchallenged best in class for large single yellow, green, or pure white flowers included: 'Mellow Yellow', 'Heidi Lime Green', and 'Heidi White'. Cultivars representing unchallenged best in class for double yellow or green flowers included 'Catalina Yellow' and 'Mariachi Lime Green'.

We recognize that growers may eliminate a cultivar based on a single negative attribute, or that growers might choose a cultivar because one attribute was more important for their marketing strategy regardless of the relative TRS within a class. However, the TRS method incorporates many factors that are often hidden or not considered by growers and we believe represents an optimum method for ranking overall performance.

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