Research Reports

Seed Source Affects Flowering and Growth of Container-Grown Black-Eyed Susan (*Rudbeckia hirta* L.)[1]

Jeffrey G. Norcini and James H. Aldrich[2]
University of Florida, Institute of Food and Agricultural Sciences
North Florida Research and Education Center, 155 Research Road, Quincy, FL 32351

Abstract

Rudbeckia hirta, black-eyed susan, is a popular container-produced native wildflower. However, there is a growing demand for regionally adapted selections because of ecological and sustainability issues. In separate studies in 2001 and 2002, seed from three sources — north Florida (NFL), central Florida (CFL), and Texas (TEX) — were sown in the greenhouse in mid-January. Seedlings were transplanted to cell packs in early February. In early April, liners were potted in 2.5 liter (0.66 gal) containers and placed on an outdoor production bed under full sun. Full bloom occurred about 21.5 to 23 weeks after sowing. TEX achieved full bloom 10 days earlier than NFL or CFL. Except for CFL in 2001, most plants were of a commercially acceptable height. The most uniform growth or flowering trait based on coefficients of variation was date of full bloom, with date of first bloom just slightly more variable. Other growth and flowering traits were moderately to highly variable.

Index words: native wildflower, ecotype, gloriosa daisy.

Significance to the Nursery Industry

Black-eyed susan is a native wildflower that is widely grown in containers. Cultivars remain popular but demand for regionally adapted selections of native wildflowers has increased over the past 10–15 years. These types of plants have been requested because of their adaptability to the environmental conditions (climate, soils, insects, etc.) of a particular region as well as aesthetics. Regionally adapted plants are also more genetically diverse than cultivars, which facilitates long-term sustainability. This diversity, though, could affect crop uniformity. In this study, containerized black-eyed susan grown from seed derived from north Florida, central Florida, and Texas attained full bloom in mid to late June, about 21.5 to 23 weeks from the time of sowing seed. Most plants were of commercially acceptable height. While physical appearance of these regionally adapted, container-grown black-eyed susan was moderately to quite variable, blooming dates within a seed source were very uniform for a particular year when they were grown in a climate like that of their origin. Comparable results are possible in other regions of the United States when growing containerized black-eyed susan from seed sources adapted to those areas.

Introduction

Black-eyed susan (*Rudbeckia hirta*) is native throughout much of the United States (11), including Florida (17). Flow-

[1]Received for publication June 4, 2003; in revised form August 28, 2003. Florida Agricultural Expt. Station Journal Series No. R-09553. The authors are very appreciative of the technical assistance provided by John Zadakis and Melissa Thorpe.

[2]Associate Professor and Senior Biological Scientist, respectively.

The *Journal of Environmental Horticulture* (ISSN 0738-2898) is published quarterly in March, June, September, and December by the Horticultural Research Institute, 1000 Vermont Avenue, NW, Suite 300, Washington, DC 20005. Subscription rate is $65.00 per year for scientists, educators and ANLA members; $95.00 per year for libraries and all others; add $25.00 for international (including Canada and Mexico) orders. Periodical postage paid at Washington, DC, and at additional mailing offices. POSTMASTER: Send address changes to Journal of Environmental Horticulture, 1000 Vermont Avenue, NW, Suite 300, Washington, DC 20005.

ering is from late spring through fall, depending on the climate. Showy flowers, a long flowering season, and ease of cultivation make black-eyed susan a popular wildflower that is widely produced in containers. 'Indian Summer', 'Marmalade', and 'Goldilocks' are a few of the commonly grown cultivars (7). However, demand for regionally adapted selections of herbaceous native wildflowers like black-eyed susan is increasing as part of the escalating and widespread native plant movement. Local native plant enthusiasts as well as those involved in local restoration efforts are becoming more insistent on using regionally adapted plant material because of ecological and sustainability implications. For example, under low input conditions, a commercially produced Texas selection of black-eyed susan consistently senesced in late summer in northern Florida whereas black-eyed susan derived from native Florida populations survived and flowered through late fall (4, 8, 9). And in central Florida, a naturally occurring selection of black-eyed susan from central Florida outperformed 'Sonora' and 'Indian Summer' in a bedding plant trial (3).

Demand for containerized regionally adapted wildflowers like black-eyed susan is manifested by the number of nurseries specializing in production of native plants, many of which produce plants derived from local populations. One of the concerns that growers must deal with is crop uniformity. Regionally adapted black-eyed susan would be expected to be more phenotypically and genetically diverse than cultivars since they are derived from seed collected in the wild. Another issue is that information about producing these types of native wildflowers is very limited. The main sources of information are The Native Plants Network Protocol Database (6) and the U.S. Department of Agriculture Natural Resources Conservation Service (14); however, these web-based resources emphasize plug production for outplanting. Reference books about propagating and growing native wildflowers (2, 10) have excellent information that is useful to commercial producers but details about growing these plants beyond the liner or seedling stage is limited.

The objective of this study was to evaluate growth and flowering of container-grown black-eyed susan derived from three native seed sources — two from Florida and one from Texas.

Materials and Methods

Seed. Plants in this study were derived from a north Florida ecotype (NFL; seed originated from latitude 30.3–30.8 N), a lemon yellow flowered selection of a central Florida ecotype (CFL; seed originated from ~27.3 N), and a selection of a Texas ecotype (TEX; latitude data not available) that was produced by Wildseed Farms, Fredericksburg, TX. Norcini et al. (9) provided details about plant characteristics as well as additional information about seed origin.

Seeds of NFL were collected from containerized plants in November 2000 and August 2001 for the 2001 and 2002 studies, respectively. Seeds of CFL were collected from containerized plants from October to December 2000; these seeds were used for both the 2001 and 2002 studies. Seeds from Florida sources used in these studies were that which were retained by a #25 U.S.A. standard testing sieve (Fisher Scientific Company, Pittsburgh, PA) that had 0.71-mm openings (0.028 in). All seeds, including TEX, were stored at 7.2C (45F) until they were sown. Seeds of TEX were received in fall 2000 and January 2002 for the 2001 and 2002 studies, respectively.

2001 Study. Seeds were sown January 18, 2001, on the surface of MetroMix 200 (Scotts-Sierra Horticultural Products Co., Marysville, OH) that was contained in flats. Seeds were lightly covered with MetroMix 200 that had previously been screened through a #16 U.S.A. standard testing sieve opening 1.18 mm (0.047 in); flats were then placed in a greenhouse on a propagation mat (Pro-Grow Supply Corp., Brookfield, WI), which was set at 21C (70F). Seedlings were bottom fertilized with 50 mg/liter (ppm) N from Peters 15N–13.2P–12.4K (15–30–15; Scotts Co.) on February 1. Single seedlings were transplanted to cell packs [1204, Cassco, Montgomery, AL; vol. 75 ml (2.5 oz)] on February 6 or 7. Weekly bottom fertilization continued from February 19 until April 2. Ten plants of each seed source were potted into 2.5 liter (0.66 gal) containers on April 2. Mean seedling heights of these plants were as follows: TEX — 4.7 ± 0.7 cm (1.8 ± 0.3 in); NFL — 8.6 ± 1.0 cm (3.4 ± 0.4 in); CFL — 8.7 ± 1.4 cm (3.4 ± 0.6 in). The soilless medium was composed of 1.9 cm (0.75 in) shaker-screened pine bark:Canadian sphagnum peat (Berger Peat Moss Inc., St. Modeste, Quebec, Canada):rescreened 6B gravel (Martin Aggregates, Chattahoochee, FL) (3:1:1 by vol) that was amended with Osmocote 18N–2.6P–10K [18–6–12; 8–9 month formulation at 21C (70F); Scotts Co.] at 2.7 kg/m^3 (4.5 lb/yd^3) and Micromax 12S–0.1B–0.5Cu–12Fe–2.5Mn–0.05Mo–12Zn (Scotts Co.) at 1.1 kg/m^3 (1.9 lb/yd^3). The pots were arranged in a completely randomized design on black plastic in full sun. Overhead irrigation was 0.8 cm (0.3 in) per day until May 7, 0.8 cm two times per day until May 25, and 1.0 cm (0.4 in) two times per day for the remainder of the study. Rainfall and average minimum/maximum temperatures were as follows: April 3–30 — 4.4 cm (1.7 in), 12.9/27C (55.2/80.6F); May — 4.7 cm (1.8 in), 14.1/31.2C (57.4/88.2F); June — 35.7 cm (14 in), 19.3/31C (66.7/87.8F); July 1–13 — 7.4 cm (2.9 in), 22.4/33.4C (72.3/92.1F). Containers were manually weeded as necessary.

Commencing May 14, every Monday, Wednesday, and Friday, plants were evaluated for dates of first fully opened bloom (first bloom) and full bloom (subjective estimate of peak floral display). Parameters recorded at full bloom were height, average width [(widest width + width perpendicular to widest width) ÷ 2], number of main stems at substrate level, and number of flowers; growth index (GI) was calculated as (height + average width) ÷ 2.

2002 Study. Seed were sown on January 18, 2002, as previously described. Seedlings were bottom fertilized, as before, on February 1 and then weekly from February 14 to March 28. Seedlings were transplanted, as before, on February 5. Twenty plants of each seed source were potted on April 3 with the same soilless medium as in 2001 except the peat was from Acadian Peat Moss LTD (Lameque, New Brunswick, Canada). Mean seedling heights of these plants were as follows: TEX — 3.8 ± 1.2 cm (1.5 ± 0.5 in); NFL — 5.1 ± 1.8 cm (2.0 ± 1.7 in); CFL — 7.9 ± 3.0 cm (3.1 ± 1.2 in). The 2.5 liter (0.66 gal) pots were arranged in a completely randomized design on black plastic in full sun. Daily overhead irrigation was 0.9 cm (0.4 in) from April 3 to May 2 and 1.8 cm (0.7 in) from May 3 to July 8. Rainfall and average minimum/maximum temperatures were as follows: April 3–30 — 3.7 cm (1.5 in), 15.3/28.5C (59.5/83.3F); May — 6.9 cm (2.7 in), 16.8/30.7C (62.2/87.2F); June — 10.8 cm (4.3 in), 20.7/31.1C (69.3/89.8F); July 1–8 — 0.9 cm (0.4

Table 1. **Effects of seed source and year on growth and flowering of container-grown black-eyed susan.**

	At full bloom					
	Ave. width (cm)	Growth index[z]	No. of stems[y]	No. of flowers	Full bloom date[x]	First bloom to full bloom (days)
Seed source						
Texas	39.8b[w]	44.0b	7.5b	22.3b	June 17b	16c
North Florida	51.5a	51.7a	9.7a	28.4a	June 27a	23b
Central Florida	50.1a	49.2a	11.1a	32.2a	June 27a	36a
Significance[v]	0.0017	0.0006	0.0023	0.0002	< 0.0001	< 0.0001
Year						
2001	46.5	47.1	10.5a	27.9	June 29a	19.8b
2002	47.4	48.8	8.9b	27.5	June 21b	27.2a
Significance[v]	NS	NS	0.0400	NS	< 0.0001	0.0031

[z]Growth Index (GI) = [height + ((width at widest point + width perpendicular to widest point) ÷ 2)] ÷ 2.

[y]Number of main stems at substrate level.

[x]Analysis of variance was conducted using 'day of year' data; seed sown was sown on day 18 (January 18, 2001 and 2002).

[w]Means within seed source or year, followed by the same letter, are not significantly different, $P \leq 0.05$.

[v]Nonsignificant (NS) or *P* value.

in), 20.4/33.4C (68.8/92.1F). Containers were manually weeded as necessary.

The same parameters were recorded as in 2001. Recording of flowering data began May 1.

Data analysis. Data were subjected to analysis of variance using the General Linear Model (GLM) procedures of SAS. First and full bloom dates were analyzed using 'day of year' data; however, results are presented as calendar dates. Days of year were the same for 2001 and 2002 since 2002 was not a leap year. Main effects means were separated using Duncan's Multiple Range Test ($P \leq 0.05$). For significant year by seed source interactions, significant differences between the two years within a seed source were determined by single degree freedom contrasts. Crop uniformity was evaluated by calculating coefficients of variation (CV) for each growth and flowering parameter.

Results and Discussion

Depending on seed source, production of containerized black-eyed susan in full bloom under our conditions took about 21.5 to 23 weeks from the time of seeding in the greenhouse in mid-January, or about 10.5 to 12 weeks after liners were potted in 2.5 liter (0.66 gal) containers in early April (Table 1). Full bloom date of TEX (June 17) was earlier than NFL and CFL (June 27 for both). Plants from all three seed sources bloomed 8 days earlier in 2002 than in 2001. The earlier bloom dates in 2002 may have been related to the higher temperatures in 2002. Murneek (5) suggested that warmer temperatures favor flowering of *Rudbeckia bicolor* (which is now classified as *R. hirta*). Dates of full bloom were similar to those reported for TEX, NFL, and CFL grown under low input field conditions in Monticello, FL (9), which is 45 miles east of Quincy, FL, and has the same climate.

Date of first open bloom did not vary among seed sources in 2001 but in 2002 CFL began flowering 12 to 17 days earlier than either TEX or NFL, respectively (Table 2). Full bloom of TEX, however, occurred 10 days earlier than CFL or NFL regardless of year because full bloom date of TEX was only 16 days after first open bloom compared to 23 days for NFL and 36 days for CFL (Table 1). Number of days between first and full bloom was quite variable within a seed source (Table 3). In contrast, date of full bloom was the most uniform growth or flowering trait for black-eyed susan regardless of seed source or year of production, with CVs of only 2.4 to 4.3 (Table 3). Date to first open bloom was nearly as uniform as it only ranged from 3.2 to 4.6 for TEX and NFL, and 7.3 to 8.0 for CFL. The low CVs of these flowering traits relative to the other growth and flowering parameters have been reported for other native wildflower species derived from naturally occurring populations. Number of days to first flower for three phlox (*Phlox* L.) species had CVs that were very similar to ours not only in magnitude but also relative to other growth and flowering characteristics (13). Low CVs relative to plant height and/or number of open flowers have also been reported for several clarkia (*Clarkia* Pursh)

Table 2. **Significant seed source × year effects for growth and flowering of container-grown black-eyed susan.**

Seed origin	Height at full bloom (cm)	First open bloom date[z]
	2001	
Texas	48.5a[y]	June11a
North Florida	52.8a	June 10a
Central Florida	41.0b	June 9a
	2002	
Texas	48.0a	May 27b
North Florida	51.4a	June 1a
Central Florida	51.6a	May 15c
Significance[x]		
Seed source	0.0128	0.0001
Year	0.0910	<0.0001
SO × Year	0.0085	0.0043
Contrasts: 2001 vs. 2002		
Texas	NS	<0.0001
North Florida	NS	0.0035
Central Florida	0.0007	<0.0001

[z]Analysis of variance was conducted using 'day of year' data; seed sown was sown on day 18 (January 18, 2001 and 2002).

[y]Means within columns and years, followed by the same letter, are not significantly different, $P \leq 0.05$.

[x]Nonsignificant (NS) or *P* value.

Table 3. **Uniformity of growth and flowering characteristics of container-grown black-eyed susan from three seed sources in 2001 and 2002 as determined by coefficients of variation.**

Growth/flowering characteristic	Texas		North Florida		Central Florida	
	2001	2002	2001	2002	2001	2002
At full bloom						
Height	17.7[z]	16.6	12.9	11.8	14.5	13.3
Ave. width	21.2	21.1	14.1	24.9	17.8	25.5
Growth index	13.2	14.1	9.0	12.2	15.2	15.7
No. of stems	38.8	30.1	22.1	32.5	28.1	35.6
No. of flowers	36.5	30.7	25.1	28.1	36.5	34.4
Flowers per stem	48.2	37.0	20.8	26.6	27.8	26.5
Blooming dates						
First open bloom	3.5	3.2	4.6	4.1	8.0	7.3
Full bloom	4.3	3.1	2.9	2.5	2.6	2.4
First to full bloom	57.6	16.3	25.0	21.2	38.3	24.9

[z]Coefficient of variation = (standard deviation / mean) × 100.

species (15) as well as purple Chinese houses (*Collinsia heterophylla* Buist ex Graham) (16).

At full bloom, plants were at or near a commercially acceptable height. The local wholesale nursery industry prefers to ship containerized perennials that are 46 to 61 cm (18 to 24 inches) tall (Gale Allbritton, Green Industries Institute; personal communication). Although mean plant heights for TEX, NFL, and CFL (2002 only) were within this range (Table 2), individual plant heights for 20 to 30% of TEX, NFL or CFL (2002 only) were outside these limits (data not shown). For CFL in 2001, only 30% of plants at full bloom were 46 to 61 cm (18 to 24 in) tall (data not shown). In 2001, TEX and NFL were 18 to 29% taller than CFL; however, CFL and NFL had greater overall size (GI) and average width than TEX regardless of year (Table 1).

Both CFL and NFL had more stems and flowers than TEX (Table 1) but there were no differences in number of flowers per stem for seed source or year (overall mean = 3.1 ± 1.0). Although flower diameter was not measured, TEX appeared to have relatively large flowers and hence was deemed showier than CFL and NFL even though TEX had fewer stems and flowers. In a previous study, flower diameter of TEX was 37% greater than NFL and twice that of CFL (9).

In conclusion, the relatively uniform full and first bloom dates among all seed sources shows that the timing of flowering of CFL, NFL, and TEX seems to be well adapted to the conditions under which these plants were grown. However, there was comparatively greater variability for other growth and flowering traits (Table 3) even though these plants were grown in a climate like that of their origin. The relatively moderate to high CVs for these traits indicate that these traits were relatively plastic (12, 13), and that these traits of TEX, NFL, and CFL could vary depending on the environmental conditions under which they are grown (1). Results of our study suggest that analogous results might be obtained in other parts of the United States when growing containerized black-eyed susan from seed sources adapted to those regions.

Literature Cited

1. Abrahamson, W.G. 1979. Patterns of resource allocation in wildflower populations of fields and woods. Amer. J. Bot. 66:71–79.

2. Cullina, W. 2000. The New England Wild Flower Society Guide to Growing and Propagating Wildflowers of the United States and Canada. Houghton Mifflin Co., New York, NY.

3. Howe, T. 1998. Summary of flowering bedding plant trials spring 1998. Gulf Coast Research & Education Center-Bradenton Research Report BRA 1998-11. University of Florida, Institute of Food and Agric. Sci., Bradenton. pp 25.

4. Marois, J.M. and J. G. Norcini. 2003. Survival of black-eyed susan from different regional seed sources under low and high input systems. HortTechnology 13:161–165.

5. Murneek, A.E. 1940. Length of day and temperature effects in *Rudbeckia*. Bot. Gaz. 102:269–279.

6. Native Plants Network Protocol Database. 2002. http://nativeplants.for.uidaho.edu/network/search.asp. (accessed March 20, 2003).

7. Nau, J. 1996. Ball Perennial Manual: Propagation and Production. Ball Publ., Batavia, IL.

8. Norcini, J.G., J.H. Aldrich, L.A. Halsey, and J.G. Lilly. 1998. Seed source affects performance of six wildflower species. Proc. Florida State Hort. Soc. 111:4–9.

9. Norcini, J.G., M. Thetford, K.A. Klock-Moore, M.L. Bell, B.K. Harbaugh, and J.H. Aldrich. 2001. Growth, flowering, and survival of black-eyed susan from different regional seed sources. HortTechnology 11:26–30.

10. Phillips, H.R. 1985. Growing and Propagating Wildflowers. The University of North Carolina Press, Chapel Hill, NC.

11. Rickett, H.W. 1967. Wild Flowers of the United States, Vol. 2: The Southeastern States. McGraw-Hill, New York, NY.

12. Schlichting, C.D. 1986. The evolution of phenotypic plasticity in plants. Ann. Rev. Ecol. Syst. 17:667–693.

13. Schlichting, C.D. and D.A. Levin. 1984. Phenotypic plasticity of annual phlox: tests of some hypotheses. Amer. J. Bot. 71:252–260.

14. U.S. Dept. Agric., Nat. Res. Cons. Serv. 2002. Plant guides and fact sheets: a partnership between the National Plant Data Center and the Plant Materials Program. http://plants.usda.gov/cgi_bin/topics.cgi?earl=fact_sheet.cgi (accessed March 3, 2003).

15. Vasek, F.C. 1977. Phenotypic variation and adaptation in *Clarkia* section *Phaesostoma*. Sys. Bot. 2:251–279.

16. Weil, J. and R.W. Allard. 1964. The mating system and genetic variability in natural populations of *Collinsia heterophylla*. Evolution 18:515–525.

17. Wunderlin, R.P. 1998. Guide to the Vascular Plants of Florida. University Press of Florida, Gainesville, FL.