

**Seed Source Effects on Growth and Flowering of *Coreopsis lanceolata* and *Salvia lyrata*<sup>1</sup>**

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**Abstract**

*Coreopsis lanceolata* L. and *Salvia lyrata* L. from local (Monticello, FL) and nonlocal seed sources were transplanted into a field and maintained under low input, noncompetitive landscape conditions for 2 years. Plants of both species from local seed sources began flowering and were in full bloom earlier than plants from the nonlocal seed sources. Nonlocal *C. lanceolata* were larger throughout the study. Local *S. lyrata* were taller than nonlocal plants only when local plants were in flower and nonlocal plants were not. Survival percentage of *C. lanceolata* was equivalent from both seed sources, but higher for local *S. lyrata* compared to nonlocal, at the conclusion of the study.

**Index words:** lanceleaf coreopsis, lyreleaf sage, provenance, seed source, wildflowers.

**Species used in this study:** lanceleaf coreopsis, *Coreopsis lanceolata* L.; lyreleaf sage, *Salvia lyrata* L.

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## **Significance to Nursery Industry**

Growth and flowering of *Coreopsis lanceolata* (lanceleaf coreopsis) and *Salvia lyrata* (lyreleaf sage) were affected by seed source when transplants of these species were established and maintained under low input, noncompetitive landscape conditions. Plants originating from locally collected (north Florida) seed were usually smaller than plants from nonlocal seed but commenced flowering earlier (8 to 11 days for *C. lanceolata*; 12 to 18 days for *S. lyrata*) and attained peak flowering earlier (12 to 19 days for *C. lanceolata*; 10 to 12 days for *S. lyrata*). Moreover, local plants had higher or equivalent percentage survival compared to plants originating from nonlocal seed. These results may impact landscapers and growers when flowering date is an important consideration.

## **Introduction**

Planting native wildflowers in private and public venues has been practiced for years and with increasing frequency. Native wildflowers are commonly used in gardens (8), meadows (11), reclamation areas (10), parks and golf courses (18), and along roadsides (4, 7). To improve the success of wildflower plantings, utilization of local ecotypes of native wildflowers has been recommended (10, 12). Lickorish et al. (10) suggests a 'creative conservation' process that includes use of provenanced native seed appropriate for the site's soil type to provide elasticity for natural change.

The use of local native wildflower ecotypes is suggested because seed provenance can affect germination, survival, growth, and/or flowering of several native wildflower species. Meyer and Paulsen (15) clearly showed that germination of native *Eriogonum* Michx. (wild buckwheat) accessions were affected by elevation because of differences in climate. Habitat origin also affects germination characteristics of the *Penstemon eatonii* Gray (firecracker penstemon) (13) and *Linum perenne* L. (blue flax) (14). In a preliminary study conducted in

North Florida (16), seed source visibly affected growth, flowering, or survival of *S. lyrata*, *C. lanceolata*, *Gaillardia pulchella* Foug. (blanketflower), *Rudbeckia hirta* L. (black-eyed susan), and *Ipomopsis rubra* (L.) Wherry (standing cypress) when these species were direct seeded into the landscape. For example, *C. lanceolata* from local populations flowered profusely while the nonlocal plants (common garden variety commercially produced in Fresno County, CA) flowered sporadically. There was also a lower level of disease incidence on the local *C. lanceolata* and local *S. lyrata* compared to the nonlocal plants (nonlocal *S. lyrata* derived from seed commercially produced in Athens County, OH) of these species. In a subsequent study (17), *R. hirta* (established from transplants) from different seed sources (north Florida ecotype, central Florida selection, Texas selection) were evaluated at four low input landscape sites throughout Florida. The north Florida ecotype and central Florida selection survived substantially longer than the Texas selection, although the Texas selection was perceived as the showiest. In another study involving *R. hirta*, Beckwith (1) noted that a Texas ecotype had a weak facultative long day (LD) flowering response while a northern ecotype was an obligate LD plant. A difference in flowering among *R. hirta* ecotypes was also observed by Celik (2).

In the Norcini et al. study (16) mentioned above, evaluations were based on the populations of each species and seed source rather than on the qualities of individual plants within a population. Because of the inherent variation that can occur among seed propagated plants, seed source effects should also be determined by starting with relatively uniform plants transplanted to the landscape. Use of transplants is an alternative to direct seeding of native wildflowers when a more immediate impact is desired, or seed supply is limited as is frequently the case with seed of local native wildflower ecotypes. Hence, the objective of this study was to evaluate seed source effects on two growing seasons' growth, flowering, and survival of *C. lanceolata* and *S. lyrata* under low input, noncompetitive landscape conditions when established

using relatively uniform transplants.

## **Materials and Methods**

*Evaluation site.* Glyphosate (Roundup™; Monsanto) at 2.2 kg ai/ha (2 lb ai/A) was applied December 1, 1997 to four rows 3.5 m (10 ft) wide in a bahia/bermuda grass area at the North Florida Research Education Center (NFREC) - Monticello. The full sun site had a Dothan loamy fine sand, with a 2 to 5 percent slope. The soil nutrient levels (mg/kg) as of December 8, 1997 were as follows: Ca - 431 (.007 oz/lb), Mg - 52.2 (.0008 oz/lb), K - 45.1 (.0007 oz/lb), P - 9.9 (.0002 oz/lb), NH<sub>4</sub> - 0.39 (.000006 oz/lb), and NO<sub>3</sub> - 3.32 (.00005 oz/lb); pH was 5.2 (University of Florida/Institute of Food and Agricultural Sciences Soil Testing Lab). Nematode genera [nematodes/100 cm<sup>3</sup> (6.1 inches<sup>3</sup>)] present as of December 8, 1997, as determined by the University of Florida/Institute of Food and Agricultural Sciences Nematode Diagnostic Lab, were as follows: 38 spiral (*Helicotylenchus*), 19 stubby root (*Trichodorus*), 44 ring (*Criconemoides*, etc.), and 14 dagger (*Xiphinema*).

*Coreopsis lanceolata.* Local seeds were collected from a native population in Wakulla County, FL (USDA Hardiness Zone 8b; AHS Heat Zone 9) on July 12, 1996. Nonlocal seeds (1996 harvest) were a common garden variety that has been commercially produced in Fresno County, CA for several years (seed was purchased from Applewood Seed Co., Arvada, CO in the fall of 1996). On March 17, 1997, seeds from both sources were sown on Pro-Mix BX (Premier Brands Inc., Yonkers, NY) and lightly covered with medium. The plastic germination trays were 26 x 52 x 6 cm (10.2 x 20.5 x 2.4 in). On April 8, individual seedlings from both sources were transplanted to larger cups (32 cells/pack; each cell – 140 ml; 6 cm square top x 4.7 cm square bottom x 5.5 cm [2.4 x 1.9 x 2.2 in]) containing Pro-Mix BX. Plants were fertilized April 21 by bottom watering with a solution containing 95 mg/l (ppm) N (15N-12.9P-12.5K [15-30-15], Scotts-Sierra Horticultural Products Co., Marysville, OH) and 530 mg/l (ppm) soluble trace

elements (Dyna Green Soluble Trace Elements; A.H. Hummert Seed Co., St. Louis, MO); individual trace element levels (mg/l [ppm]) were: Fe - 44 ; Mn - 21; Zn - 28; Cu -19; B - 4; Mo - 0.4. On May 8, seedlings were treated with the fungicide metalaxyl (Subdue 2E; Ciba-Geigy) at 38 mg ai/l (ppm) by placing the cell packs in the fungicide solution until the medium was saturated. Germination and initial growth of the seedlings occurred in a greenhouse.

Seedlings were transplanted on May 21 into 2.5-liter (2.7-qt) black plastic containers filled with a substrate that consisted of 1.9 cm (0.75 in) diameter shaker screen pine bark (Georgia-Florida Bark and Mulch Co., Monticello, FL):Canadian sphagnum peat (Berger Peat Moss Inc., St. Modeste, Québec, Canada):rescreened 6B gravel (Martin Marietta Aggregates, Chattahoochee, FL) (3:1:1; by vol.) amended with 3.6 kg/m<sup>3</sup> (6.1 lb/cu yd) Osmocote 18N-2.6P-10K (18-6-12; 8-9 month formulation at 21C (70F); Scotts-Sierra Horticultural Products Co.) and 1.4 kg/m<sup>3</sup> (2.4 lb/yd<sup>3</sup>) Micromax 12S-0.1B-0.5Cu-12Fe-2.5Mn-0.05Mo-12Zn (Scotts-Sierra Horticultural Products Co.). Plants were grown outdoors on a black polyethylene bed cover under full sun and watered with overhead irrigation.

On December 3, uniform plants (within a seed source) were transplanted into an extended randomized complete block (row) design. There were three replications of each seed source per block, with a replication consisting of three plants. Plants were spaced on 0.6-m (2-ft) centers within a row. Plants received no supplemental irrigation (except at transplanting and during droughts) or fertilizer, nor were they treated with any insecticides or fungicides. Weeds were controlled with pine straw mulch, hand weeding, and an occasional application of glyphosate.

Vegetative plant height (measured from the soil surface to the top of the foliage) and two widths (width at widest point, and width perpendicular to widest point – foliage only) were recorded on December 5, 1997, and then monthly during March to November 1998 and February to November 1999. Total plant height (measured from the soil surface to the top of the

inflorescences) and two widths (width at widest point, and width perpendicular to widest point – including inflorescences) were also recorded. During 1998 and 1999, dates of first fully opened flower (after a hard freeze on February 15, 1999) and full bloom (visual estimate of when at least 75% of flowers were open) were recorded for each plant. Percent survival was recorded in November 1998 and 1999, and February 1999.

*Salvia lyrata*. Local seed was collected from a native population in an open field at the NFREC-Monticello (Jefferson County, FL; USDA Hardiness Zone 8b; AHS Heat Zone 9) in April 1997. Nonlocal seed (1996 harvest) was purchased in 1996 from Companion Plants (Athens, Ohio). While the original seed source is unknown, Companion Plants has been growing *S. lyrata* (seeds derived from the previous year's harvest used to plant subsequent year's crop) in Athens County, Ohio since 1985. On March 11 (nonlocal) and 12 (local) 1998, seed were sown on Metro Mix 220 (Scotts-Sierra Horticultural Products Co.) as described for *C. lanceolata*. Seedlings were transplanted on March 23 (local) or April 3 (nonlocal) into cell pack cups (see above) containing Metro Mix 220. Both local and nonlocal plants were transplanted to the field on April 29, 1998 in the same rows using an extended randomized complete block design as described for *C. lanceolata*. All cultural practices were the same as for *C. lanceolata*.

Vegetative and total plant growth were recorded (as described for *C. lanceolata*) from May to November 1998, February to November 1999, and February to May 2000. The first fully opened flower and full bloom dates (after hard freezes on February 15, 1999 and March 13, 2000) were recorded in 1999 and 2000.

Percent survival, which was recorded in November 1998 and 1999, February 1999, and May 2000, was based on mortality plus plant removal due to infection by cucumber mosaic virus (CMV). CMV was serologically suggested from samples submitted to the Florida Department of Agriculture and Consumer Services, Division of Plant Industries, Gainesville, FL. Plants with

leaf mottling typical of CMV were removed starting in June 1999.

*Data analysis.* Data were analyzed using SAS Version 6 and PROC GLM (19) with an appropriate model statement. Testing for differences between seed sources and estimating the standard errors of the mean used the estimate of error calculated from seed source replicates within blocks. Due to plant death, error degrees of freedom varied from its original value of 16 to 13 (*C. lanceolata*) or 12 (*S. lyrata*) by the end of the experiment. Percent survival by seed source was compared using the chi-square test for independence.

## **Results and Discussion**

*Coreopsis lanceolata.* Nonlocal plants (CL-NLOC) were taller and wider than local plants (CL-LOC) at all stages of growth (Table 1). In terms of flowering, CL-LOC began 11 and 8 days earlier than CL-NLOC in 1998 and 1999, respectively (Table 2). Date of peak flowering averaged 19 days earlier in 1998 and 12 days earlier in 1999 for CL-LOC compared to CL-NLOC. The earlier flowering of CL-LOC may have been related to its southern origin. Since there is evidence that *C. lanceolata* is a long day (LD) plant (3), CL-LOC may have had only a weak facultative LD response similar to what Beckwith (1) noted about a Texas ecotype of *R. hirta*, another Asteraceae species that is a LD plant (5). Given that *C. lanceolata* were 8-months-old and completely filled the 2.5-liter (2.7-qt) containers when transplanted to the field, both CL-LOC and CL-NLOC should have had enough leaves to respond to inductive photoperiods. Damann and Lyons (3) noted that *C. lanceolata* 'Early Sunrise' was most responsive to LD when it had 16 fully expanded leaves.

Long-term survival of both plants from both seed sources was poor (Table 2) although after 14 months all of the CL-LOC had survived while only 86% of CL-NLOC had survived. The poor long-term survival may have been related to nematodes. While *C. lanceolata* is resistant to root knot nematodes (6) (which were not present at the time of transplanting), and a

nematicidal thiophene has been isolated from its roots (9), this species may have been affected by the other nematode species that were present. However, landscapers may not be overly concerned about the potential of *C. lanceolata* to be short-lived because we have observed that CL-LOC easily reseeds and there is long-term sustainability of *C. lanceolata* plantings.

*Salvia lyrata*. Local plants (SL-LOC) were taller and/or wider than nonlocal plants (SL-NLOC) in May 1998 and April 1999 (Table 1). However, SL-NLOC plants were taller and/or wider commencing July 1998 and June 1999 (data not shown) and May 2000, with peak size occurring November 1998 and August 1999 (peak data not available for 2000) for both seed sources.

Onset and peak flowering were consistently earlier for SL-LOC than for SL-NLOC (Table 2). Moreover, the average onset and peak flowering dates probably would have been much earlier than reported in Table 2 because of freezes on February 15, 1999 and March 13, 2000 that killed the inflorescences. On these dates, 75% and 55% of SL-LOC, respectively, had open flowers. Of the SL-LOC that were blooming, the average onset of flowering before the freezes was February 12, 1999 and March 7, 2000. Only 6% and 11% (two plants each year) of SL-NLOC flowered prior to the freezes of 1999 and 2000, respectively. Because the freezes killed the inflorescences, all onset and peak flowering dates were based on dates subsequent to the freezes. Flowering of SL-LOC started 18 days (1999) and 12 days (2000) sooner than SL-NLOC, with peak flowering of SL-LOC 10 days (1999) and 12 days (2000) sooner than SL-NLOC.

While there were consistent differences in onset and peak flowering dates between SL-LOC and SL-NLOC, there is insufficient evidence to suggest that these differences were due to the manner in which SL-LOC and SL-NLOC responded to photoperiod. However, since flowering stems begin to elongate in mid-winter in north Florida, and flowering of *S. lyrata* is

probably related to day length (20), *S. lyrata* would seem to be a short day plant.

Eighty-nine percent of SL-LOC survived for over 2 years after transplanting but only 61% of SL-NLOC survived (Table 2). Differences in percent survival started becoming evident by February 1999 (10% level). Nonlocal and local plants from one replication were initially rogued because of CMV, with further removal for virus eradication limited to nonlocal plants. This suggests that the infection was from SL-NLOC and was spread to SL-LOC, perhaps by aphids, a CMV vector. Susceptibility of *S. lyrata* to nematodes has not been reported.

Grown under low input, noncompetitive landscape conditions, there were phenotypical and survival differences in *Coreopsis lanceolata* and *Salvia lyrata* derived from local and nonlocal seed sources. The earlier flowering of plants derived from local seed sources and higher survival rates, especially of *S. lyrata*, indicate some level of regional adaptation has occurred in these species. The earlier flowering of plants derived from seed of local plants also has implications for those using these species in residential, commercial, or roadside landscapes, as well as growers.

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Table 1. Growth of *Coreopsis lanceolata* L. and *Salvia lyrata* L. derived from local and nonlocal seed sources. Plants were transplanted to a low input, noncompetitive field site located at the NFREC, Monticello, FL on December 3, 1997 (*Coreopsis*) or April 29, 1998 (*Salvia*).<sup>z</sup>

Date	Veg. ht (cm)		Ave. veg. wd. (cm)		Total ht (cm)		Ave. total wd. (cm)	
	Local	Nonlocal	Local	Nonlocal	Local	Nonlocal	Local	Nonlocal
<i>Coreopsis lanceolata</i>								
Dec. 5, 1997	16.8	24.2*	28.3	43.9*	-	-	-	-
June 29, 1998	18.9	42.6*	36.9	67.9*	34.1	61.3*	55.4	94.7*
June 10, 1999	17.4	31.1*	44.0	63.2*	26.7	40.8*	50.5	73.2*
<i>Salvia lyrata</i>								
May 7, 1998	8.2*	4.3	11.7*	9.8	8.5*	4.3	11.7*	9.8
June 3, 1998	12.1 <sup>†</sup>	9.7	17.8	17.7	16.8*	10.9	18.0	17.5
Nov. 4, 1998	8.7	13.8*	21.0	21.0	29.6	45.7*	34.0	51.0*
Apr. 7, 1999	22.4	21.8	33.8*	30.4	54.9*	33.4	44.7*	31.2
Aug. 10, 1999	13.4	22.9*	31.3	35.9 <sup>†</sup>	56.8	67.2*	65.1	67.8
Mar. 13, 2000	10.5	9.0	30.0	27.1	20.8 <sup>†</sup>	11.7	30.0	27.1
May 24, 2000	17.8	26.8*	27.3	30.0	37.1	46.8*	39.7	34.8

<sup>z</sup>\*,<sup>†</sup> Differences between seed sources within date significant at  $P \leq 0.05$ , 0.10, respectively.

Table 2. Flowering and survival of *Coreopsis lanceolata* L. and *Salvia lyrata* L. grown from local and nonlocal seed sources after transplanting to a low input, noncompetitive field site located at the NFREC, Monticello, FL.<sup>z</sup>

	Date of first flower		Date of full bloom		% Survival		
	1998	1999	1998	1999	Nov. 1998	Feb. 1999	Nov. 1999
<i>C. lanceolata</i> /local	Apr. 9 <sup>*</sup>	Apr. 7 <sup>†</sup>	Apr. 16 <sup>*</sup>	Apr. 18 <sup>*</sup>	100	100 <sup>*</sup>	31
<i>C. lanceolata</i> /nonlocal	Apr. 20	Apr. 15	May 5	Apr. 30	97	86	25

  

	Date of first flower		Date of full bloom		% Survival			
	1999 <sup>y</sup>	2000 <sup>y</sup>	1999	2000	Nov. 1998	Feb. 1999	Nov. 1999	May 2000
<i>S. lyrata</i> /local	Mar. 25 <sup>*</sup>	Mar. 29 <sup>*</sup>	Apr. 7 <sup>*</sup>	Apr. 3 <sup>*</sup>	100	100 <sup>†</sup>	92 <sup>*</sup>	89 <sup>**</sup>
<i>S. lyrata</i> /nonlocal	Apr. 12	Apr. 10	Apr. 17	Apr. 15	94	92	72	61

<sup>z\*\*,\*</sup>, <sup>†</sup> Differences between seed sources within date significant at  $P \leq 0.01, 0.05, 0.10$ , respectively.

<sup>y</sup> Date of first fully opened flower following hard freezes on February 15, 1999 and March 13, 2000.