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Screening of *Cercis* (Redbud) Taxa for Ability to Root From Cuttings[1]

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Abstract

The redbud (*Cercis* species) is a popular landscape small tree or shrub that is valued commercially for its early spring bloom and adaptability to a variety of environmental conditions. Despite its value to the nursery and landscape industries, large-scale production of redbud has been limited, due in part to the difficulty of propagating clonal (cultivar) material. We screened 11 *Cercis* taxa for the ability of stem cuttings to regenerate adventitious roots using four growth regulator treatments: Dyna-Gro K-L-N, Woods Rooting Compound, Hormo-Root 2, and KIBA. Overall, *C. chingii*, *C. glabra*, and *C. yunnanensis* had the highest percentage of cuttings that produced roots. The Hormo-Root 2 treatment resulted in the highest rooting percentage over all taxa combined. *C. chingii* produced the most roots, while *C. gigantea*, *C. siliquastrum*, and *C. yunnanensis* produced the longest roots. Selected clones from this study will be used in our established *Cercis* breeding program to broaden the genetic base of cultivated *Cercis* and to produce redbuds with superior ornamental and disease resistance traits that are easier to propagate.

Index words: *C. canadensis*, *C. canadensis* var. *texensis*, *C. chinensis*, *C. chingii*, *C. gigantea*, *C. glabra*, *C. griffithii*, *C. occidentalis*, *C. racemosa*, *C. siliquastrum*, *C. yunnanensis*, IBA, NAA, KIBA, propagation, cuttings.

Species used in this study: Eastern redbud (*C. canadensis* L.); Texas redbud (*C. canadensis* L. subsp. *texensis* (S. Watson) M. Hopkins); Chinese redbud (*C. chinensis* Bunge); Ching's redbud (*C. chingii* Chun); Giant redbud (*C. gigantea* Cheng.); *C. glabra* Pampanini; Afghanistan redbud (*C. griffithii* Boiss); Western redbud (*C. occidentalis* Torr.); Chain-flowered redbud (*C. racemosa* Oliver); Judas tree, lovetree (*C. siliquastrum* L.); Yunnan redbud (*C. yunnanensis* Hu et Cheng).

Growth regulators used in this study: Dyna-Gro K-L-N (IBA, NAA) indole-3-butyric acid, naphthalene acetic acid; Woods Rooting Compound (IBA, NAA); Hormo-Root 2 (IBA); KIBA, indole-3-butyric acid potassium salt.

Significance to the Nursery Industry

The redbud (*Cercis* species) is a popular landscape small tree or shrub that is grown for its early spring bloom and adaptability to a variety of environmental conditions. Despite its value to the nursery and landscape industries, large-scale production of redbud has been limited, due in part to the difficulty of propagating clonal (cultivar) material. We screened 11 *Cercis* taxa using four growth regulator treatments for the ability of stem cuttings to form adventitious roots. The clones that performed well will be used in our *Cercis* breeding program to develop superior redbud cultivars that propagate readily by stem cuttings, thus offering nursery growers a reliable alternative to seed-produced trees or difficult-to-propagate cultivars.

Introduction

The eastern redbud (*Cercis canadensis* L.) is a popular woody landscape plant native to eastern and central North America that is planted primarily for its showy early spring bloom. The genus *Cercis* (family Fabaceae) contains seven to 13 species or subspecies that occur in North America, Europe, and Asia (4, 6, 7). Mature plants range in size from small shrubs to trees, tolerate full sun to shade, and are hardy in USDA Zones 4–9. (6, 8). Despite the horticultural merit and wide adaptability of the genus, commercial propagation and interest in breeding *Cercis* has been limited due to the difficulty of propagating clonal material (2, 6). Identification of *Cercis* species, provenances, or individual plants that propagate readily by means of rooted cuttings is an important first step in breeding for this trait. Therefore, we conducted an evaluation of *Cercis* species to identify plants with superior ability to form adventitious roots from stem cuttings. It is hoped that these individual plants can then be used as parental material in our established *Cercis* breeding program to produce redbuds with superior ornamental and disease resistance traits that are easier to propagate.

Materials and Methods

Plant material. Seeds representing 47 seed lots from 11 *Cercis* taxa listed in Table 1 were purchased, collected at the U.S. National Arboretum in Washington, DC, obtained from Index Seminum or the Woody Landscape Plant Germplasm Repository in Glenn Dale, MD. In the fall of 1997, seeds were scarified by pouring boiling water over them and allowing them to soak for 24 hours. Scarified seeds were sown in a 2:1 (by vol) mixture of milled sphagnum and Q-ROK #4 (quartz sand, particle diameter 2 mm, Shurfire Distributors, Inc., Lanham, MD) in flats, and subjected to moist stratification for three months at 4C (39F) (11). Seed flats were then placed in a greenhouse with average temperature of 21C (70F) with supplemental halogen lighting, and seedlings were transplanted into individual bottomless quart bands in a Metro Mix®510:perlite (4:1 by vol) mixture amended with 1.5 lb/yd^3 MicroMax® micronutrients. In Spring 1999, plants were repotted to 1-gal containers, top dressed with 15 g Sierra 17–6–10, and grown in a polyhouse that was uncovered dur-

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Table 1. Number of seed lots and sources of seeds for each taxa tested.

Cercis Taxa	Number of seed lots tested	Sources of seeds[z]
C. canadensis L.	20	IL, MD, PA, DC, MA, NY
C. canadensis L. subsp. *texensis*	2	OK, IL
C. chinensis Bunge	3	CT, MA, France
C. chingii Chun	1	DC
C. gigantea Cheng.	2	China
C. glabra Pampanini	1	DC
C. griffithii Boiss	2	DC
C. occidentalis Torr.	4	MA, MT, OR
C. racemosa Oliver	2	DC
C. siliquastrum L.	9	Belgium, Czechoslovakia, France, Italy, Germany, Netherlands
C. yunnanensis Hu et Cheng	1	China

[z]The seed source indicates where seeds were purchased, collected, or obtained through Index Seminum, and not necessarily where the taxa originated. In all cases, the seed are open-pollinated.

ing the spring, summer, and fall, and covered and kept above freezing in the winter. Semi-hardwood cuttings for rooting experiments were taken in May 2000 from terminal branches of two-year-old plants approximately eight weeks after bud break. Each cutting contained five leaf nodes, including the terminal leaf. The bottom leaf was stripped off prior to treatment, and the basal 1 cm of each cutting was wounded on two sides by gentle scraping of the cortex to the cambium with a pruner blade or scalpel to aid in growth regulator uptake. Cuttings were treated with one of four growth regulator applications, and inserted in flats containing perlite:milled sphagnum (2:1 by vol). Flats were placed on 27C (80F) heated mats in a greenhouse with average air temperature of 24C (75F, range 20–32C). An automatic misting system provided a 6-second spray of mist every 10 minutes. Cuttings were evaluated after 8 weeks for number of roots and length of longest root. Cuttings with roots were transplanted to individual bottomless quart bands and were maintained in an uncovered polyhouse during summer and fall, allowed to go dormant, and overwintered in a covered polyhouse kept above freezing during the winter. In Spring 2001, cuttings were evaluated for overwinter survival.

Rooting treatments. Treatment 1: 5-minute soak in Dyna-Gro liquid K-L-N Rooting Concentrate (Dyna-Gro Nutrition Solutions, San Pablo, CA), containing 0.05% IBA and 0.10% NAA. Treatment 2: 5-second dip in Wood's Rooting Compound (Earth Science Products Corp., Wilsonville, OR), containing 1.03% IBA and 0.66% NAA, diluted 1:5 with water. Treatment 3: 1-second dip in Hormo-Root 2 (Rockland Chemical Co., Inc., West Caldwell, NJ), containing 2.0% IBA in talc. Treatment 4: 5-second dip in 20,000 ppm KIBA (Sigma Chemical Co, St. Louis, MO) dissolved in water.

Experimental design. The experiment was set up with three replications for each treatment. Each replication was placed on a separate heating mat, so that three heating mats contained four flats each, one for each of the four growth regulator treatments. Cuttings from the same stock plant were used for all four treatments within a replication in order to minimize the effect of parent plant on treatment effects. Each growth regulator treatment contained one cutting from each seed lot, so that a total of 564 cuttings were tested (47 seed lots × 3 blocks × 4 treatments). Data were analyzed using SAS Mixed Procedure (9).

Results and Discussion

As expected, there were differences among species in overall rooting percentage, ranging from 25% rooting in *C. racemosa* to 100% rooting in *C. chingii* and *C. glabra* (Table 2). The overall rooting percentages could not be statistically compared among species because several of the taxa had data from only one seed lot, which yields only one measurement for percent rooted. Analysis of the raw data for the number

Table 2. Overall performance of *Cercis* taxa for all treatments.

Cercis taxa	Rooting (%)	Over winter survival (%)	Average number of roots per cutting[z]	Average length of longest root (cm)[z]
C. canadensis	56	84	4.3e[y]	14.1c
C. can. subsp. *texensis*	63	100	5.7cde	13.9c
C. chinensis	74	93	11.5bc	15.8c
C. chingii	100	92	32.4a	16.3abc
C. gigantea	58	86	4.8de	21.2abc
C. glabra	100	100	10.2bc	15.8bc
C. griffithii	29	57	6.0cde	11.7c
C. occidentalis	58	86	7.8cd	14.0c
C. racemosa	25	50	8.5bcde	15.7abc
C. siliquastrum	69	99	11.4bc	24.7ab
C. yunnanensis	89	100	9.1bc	24.4ab

[z]Untransformed data are presented for clarity, although square-root transformed data were used for analyses. Data are from only those cuttings that produced roots.

[y]Mean separation within columns using LSD ($P = 0.05$).

Table 3. Percentage of cuttings that rooted (averaged over all taxa) using four growth regulator treatments.

Treatment	Active ingredient(s)	Carrier	Rooting (%)
1. Dyna-Gro liquid K-L-N	0.05% IBA, 0.10% NAA	water	63.8b[z]
2. Wood's Rooting Compound	1.03% IBA, 0.66% NAA	ethanol, dimethyl formamide	68.7ab
3. Hormo-Root 2	2.0% IBA	talc	76.0a
4. KIBA	20,000 ppm KIBA	water	47.4b

[z]Mean separation within columns by LSD ($P = 0.05$).

of roots and the longest root indicated the means and the standard errors were not independent. Therefore, the data were transformed by taking the square root of each measurement (number of roots, length of longest root). Analysis of the square-root transformed data indicated a strong effect of species for both number of roots and longest root (Table 2). For both measurements, there was no significant interaction between species and treatment. The variability in performance among individual cuttings was so large that there was no significant effect of mat (block) or parent plant.

Although our objective was to compare rooting success among various taxa, and not to compare various growth regulator treatments, it is possible to make limited statistical comparisons among the four growth regulator treatments (Table 3). The KIBA treatment resulted in 47% of cuttings rooting; Dyna-Gro resulted in 64% rooting; Woods resulted in 69% rooting; and Hormo-Root 2 resulted in 76% rooting. As stated above, our primary goal in this experiment was to identify *Cercis* species or clones with superior rooting ability, and not to compare various rooting treatments directly. We therefore used an assortment of active ingredients, concentrations, and carriers in order to ensure that our results were not compromised by an adverse effect of a single growth regulator or a significant treatment × taxa interaction. A nontreated control was unnecessary in this survey since levels of growth regulator concentration were not compared. Because we found no significant treatment × taxa interaction, future studies could focus on various levels of growth regulator(s) using a single carrier.

Reports on successful propagation of redbud by rooted cuttings are not common, and most studies focus specifically on propagation of *C. canadensis*. Tipton (10) successfully rooted *C. canadensis* var *mexicana* using KIBA on softwood cuttings taken soon after budbreak. Dillion and Klingaman (1) used IBA and NAA to root cuttings of a *C. canadensis* clone taken 3 weeks after budbreak. In both cases, taking the cuttings soon after budbreak appeared to be critical to rooting success. Micropropagation of *C. canadensis* has also been successful (3, 5, 12).

Using semi-hardwood cuttings from juvenile plants, we were able to root all the species we tested, including clones of *C. canadensis*. Although the limited number of seed lots tested for some taxa precludes statistical comparisons of rooting success among taxa, several taxa appeared to root well, including *C. chingii*, *C. glabra*, and *C. yunnanensis*. It is interesting to note that some authorities consider *C. glabra* and *C. yunnanensis* to be variants of *C. chinensis* (6), which also exhibited high rooting success in this survey. *C. chingii* also produced significantly more roots per cutting than any of the other taxa. Desirable ornamental characteristics in these taxa, including early flowering in *C. chingii* (6) and the upright shrubby habit, dense flower arrangement, and dark leaves of *C. glabra*, *C. yunnanensis*, and *C. chinensis* make these taxa especially valuable sources of germplasm for *Cercis* breeding.

We chose different growth regulator treatments based in part on the carrier (water, ethanol, or talc) and on the active ingredient(s) (IBA, KIBA, NAA), and were able to root plants of each taxon using each treatment. In general, the Hormo-Root 2 treatment was the most effective treatment among those we tested in rooting *Cercis* species.

The cuttings from this study were transplanted and overwintered, and will be selected for further testing after flowering to examine rooting ability from mature plants. We hope to use the variation in rooting ability, both among species and within *C. canadensis*, in a selective breeding program to broaden the genetic base of cultivated *Cercis* and to develop hybrid cultivars with superior ornamental attributes that propagate readily from cuttings.

Literature Cited

1. Dillion, D. and G. Klingaman. 1992. Hormone concentration and cutting maturity influences on rooting of redbud. HortScience 27:634 (Abstract).

2. Dirr, M.A., and C.W. Heuser, Jr. 1987. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Varsity Press, Inc., Athens, GA.

3. Geneve, R.L., S.T. Kester, and S. Yusnita. 1992. Micropropagation of eastern redbud (*Cercis canadensis* L.). Proc. Intl. Plant Prop. Soc. 42:417–420.

4. Krussmann, G. 1976. Manual of Cultivated Broad-leaved Trees and Shrubs. Volume I, A–D. Timber Press, Beaverton, OR.

5. Mackay, W.A., J.L. Tipton, and G.A. Thompson, 1995. Micropropagation of Mexican redbud, *Cercis canadensis* var. *mexicana*. Plant Cell, Tissue Organ Culture 43:295–299.

6. Raulston, J.C. 1990. Redbud. Amer. Nurseryman 171(5):39–51.

7. Rehder, A. 1990. Manual of Cultivated Trees and Shrubs. (2nd ed.). Dioscorides Press, Portland, OR.

8. Robertson, K.R. 1976. *Cercis*: The redbuds. Arnoldia 36:37–49.

9. SAS Institute. 1997. SAS/STAT Software: Changes and Enhancements Through Release 6.12. SAS Inst., Cary, NC.

10. Tipton, J.L. 1990. Vegetative propagation of Mexican redbud, larchleaf goldenweed, littleleaf ash, and evergreen sumac. HortScience 25:196–198.

11. Young, J.A. and C.G. Young. 1992. Seeds of Woody Plants in North America. Dioscorides Press, Portland, OR.

12. Yusnita, S., R.L. Geneve, and S.T. Kester. 1990. Micropropagation of white flowering eastern redbud (*Cercis canadensis* var. *alba* L.). J. Environ. Hort. 8:177–179.