Buddleja and *Cercis* Breeding at North Carolina State University©

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INTRODUCTION

Breeding efforts in butterfly bush (*Buddleja* spp.) and redbud (*Cercis canadensis*) have been ongoing at NCSU since 1998. The goals of this program are to develop improved ornamental forms of these two popular landscape plants, and to contribute to the knowledge of the genetics of important traits found in these taxa. Considerable progress has been made in these objectives, which is summarized below.

BUDDLEJA BREEDING

Efforts in *Buddleja* breeding have focused on the development of cultivars demonstrating compact growth habit, improved flower color, and reduced seed set. To date, 'Blue Chip' and 'Miss Ruby' have been released from the program.

'Blue Chip' resulted from open pollination of NC2003-7. NC2003-7 was derived from open pollination of a family obtained from the controlled hybridization of 'Honeycomb' x NC2000-1. 'Honeycomb' is a yellow-flowered cultivar of *Buddleja* ×*weyeriana* Weyer. NC2000-1 is an interspecific hybrid derived from a controlled cross of *B. davidii* var. *nanhoensis* (Chitt.) Rehd. 'Nanho Purple' and *B. lindleyana* Fort. ex Lindl. 'Blue Chip' has a symmetrical, compact, spreading habit. In replicated trials of 10 plants, unpruned 'Blue Chip' averaged 79.8 cm height and 123.6 cm width (height/width ratio = 0.65) after two growing seasons. Plants are very dense, a consequence of abundant lateral branching. Inflorescences average 8 cm in length, and produce

up to 200 flowers. Color of open flower petals is violet-blue (RHS 90C). Flowers are fragrant. Anthers are malformed or lacking and produce little to no viable pollen. In a field setting surrounded by numerous fertile cultivars, 'Blue Chip' produced few fruit, and seed set was extremely low, although minimal numbers of seedlings were produced.

'Miss Ruby' resulted from controlled hybridization of 'White Ball' x 'Attraction' made in 2002. 'Miss Ruby' has an upright, globose habit. In replicated trials of 10 plants, unpruned 'Miss Ruby' averaged 106.3 cm height and 117.4 cm width (height/width ratio = 0.91) after two growing seasons. Plants are very dense, with abundant lateral branching. Inflorescences average 10.6 cm in length, and produce up to 160 flowers per inflorescence. Unopened flower buds are red-purple (RHS 71A), and open to red-purple (RHS 71B to 71C). Flowers are fragrant. In a field setting surrounded by fertile cultivars, 'Miss Ruby' produced moderate amounts of seed, but less than most commercial cultivars of *Buddleja*.

'Miss Ruby' and 'Blue Chip' were entries in the 2008 Royal Horticultural Society *Buddleja* Euro-trial at RHS Garden Wisely, England. Of 97 cultivars included in the trial, 'Miss Ruby' and 'Blue Chip' ranked first and second, respectively, in the public popularity poll.

Currently we are in the final stages of evaluation of numerous advanced selections that demonstrate unique flower color, compact habit, and varying degrees of sterility. Performance and characteristics of these selections will be discussed.

CERCIS **BREEDING**

Efforts in *Cercis* breeding have focused on developing improved and novel ornamental forms, taking advantage of the remarkable genetic diversity in *Cercis canadensis* and *Cercis canadensis* var. *texensis* (Texas redbud). In 2009, the cultivars 'Ruby Falls' and 'Merlot' were released from the program.

'Ruby Falls' is a distinct purple-leaf cultivar of weeping redbud (*C. canadensis*) being released as an alternative to 'Covey' (Lavender Twist ™). 'Ruby Falls' originated as a second generation descendant from the controlled hybridization of 'Covey' x 'Forest Pansy' (both *C. canadensis*). 'Ruby Falls' was selected for its attractive purple leaf color and weeping growth habit. Retention of purple color in leaves during the growing season is similar to that of 'Forest Pansy'. 'Ruby Falls' demonstrates excellent branching. Flowering is prolific, and flower color is an attractive reddish-purple. 'Ruby Falls' has been trialed for four years in Jackson Springs, North Carolina (USDA hardiness zone 7b), and has proven fully cold hardy in this location. Long-term trials have not been conducted in other regions, but it is anticipated that 'Ruby Falls' will be well adapted to USDA hardiness zone 6 and higher. United States Plant Patent Applied For (PPAF).

'Merlot' is a distinct cultivar of redbud being released as an alternative to 'Forest Pansy'. 'Merlot' originated as a second generation descendant from the hybridization of 'Texas White' (*C. canadensis* var. *texensis*) x 'Forest Pansy' (*C. canadensis*). 'Merlot' was selected for its attractive purple leaf color and semi-upright growth habit, in contrast to the open, spreading habit of 'Forest Pansy'. Leaves of 'Merlot' are smaller, thicker, and glossier than those of 'Forest Pansy', and maintain their attractive appearance well into the latter part of the growing season, unlike those of 'Forest Pansy' which often become unattractive and necrotic in late summer. Retention of purple color in leaves is similar to but slightly inferior to 'Forest Pansy'. 'Merlot' demonstrates excellent branching and dense growth, and is shorter in stature than 'Forest Pansy'. Flowering is prolific, and flower color is an attractive reddish-purple. Fertility of 'Merlot' is reduced as compared to most redbuds. Pods develop after flowering, but typically abort in early summer. Trials of 'Merlot' and 'Forest Pansy' in various testing locations have shown superior heat tolerance of 'Merlot' as compared to 'Forest Pansy', typical of its "texensis" parent. 'Merlot' has

been trialed for six years in Jackson Springs, North Carolina (USDA hardiness zone 7b), and has proven fully cold hardy in this location. Long-term trials have not been conducted in other regions, but it is anticipated that 'Merlot' will be well adapted to USDA hardiness zone 6 and higher. A United States Plant Patent has been applied For (PPAF).

Currently, numerous advanced selections and newly created hybrid combinations are under evaluation and further development. The performance and landscape potential of these selections will be discussed.

GENERAL COMMENTS ON *CERCIS* BREEDING PROTOCOLS

Hybridization of redbud presents challenges. Fruit set on an individual redbud tree or cultivar growing in the same location varies significantly from year to year. This often may be a function of cold temperature exposure during bloom or post-pollination, but often low fruit set is observed in years that are judged ideal for potential fruit set. This unpredictable fruit setting ability often limits hybridization success. We have resorted to various options for hybridization over the years. Although no formal documentation exists in the literature, our work, and the work of other breeders, clearly suggests that eastern redbud (and the "texensis" form of eastern redbud) is self-incompatible. This means that any tree is incapable of producing seed from a self-pollination event; outcrossing to a different cultivar or genetically different tree is required to obtain seed. This is a distinct advantage in a hybridization program, as one can accomplish genetic crosses using any number of strategies without the need for emasculation (male flower part removal) of the female parent. We have created hybrids using the following protocols.

Hand pollination in a field setting. This process entails identifying the appropriate female tree, and collecting freshly opened flowers off of the chosen male parent. Alternatively, one could use pollen collected days or weeks earlier, and stored in a freezer in tightly sealed vial until use. A

small branch on the female parent is wrapped in netting or fine mesh screening material a few days prior to the date of hybridization to exclude pollinating insects. At the time of hybridization, the netting is temporarily removed, and the open flowers from the male parent are brushed against the stigmatic surface of the female flowers. Emasculation of the female parent is not necessary. Alternatively, one can collect pollen from the flowers of the male parent on the tip of a camel's hair brush, and use the brush for pollen transfer. The netting is replaced after all flowers at the proper developmental stage have been pollinated. The branch can be repollinated repeatably over a period of time to pollinate flowers that were previously too immature to pollinate earlier.

Hand pollination in a greenhouse setting. This procedure is basically the same as the field pollination protocol, except we use as female parents potted plants containing flower buds in 15 gallon or larger pots. Potted female parent plants are over wintered outside under natural conditions, and brought into the greenhouse as flower buds just begin to open. Pollen from the male parents also can be collected from trees managed similarly. Alternatively, if pollination is timed correctly, pollen can be obtained by cutting shoots off of field grown trees and forcing shoots in water in the greenhouse to promote flower development. This hybridization technique has worked well for us, as it eliminates the risk of frost/freeze injury to flowers and developing fruit which we so often experience in a field setting. One critical factor we have identified to enhance fruit set in the greenhouse is to provide an appropriate diurnal temperature fluctuation to simulate natural conditions. Typically, we attempt to maintain a day: night temperature regime of 24:13 °C (75:55 °F).

Field isolation blocks. Taking advantage of the existence of self incompatibility in redbud, one can accomplish hybridization by planting the two chosen parents together in an planting block

isolated as far as possible from other redbud trees. When possible, we typically try to maintain at least 183 m (200 yd) between blocks at our research facility. Natural pollinators will transfer pollen between trees, and because of self-incompatibility, any seed obtained should represent hybrid seed. This technique has worked very well to date. We also use this strategy to isolate F_1 (first generation progeny) plants for production of genetically pure F_2 seed from a particular cross.

Cages and bumblebee hybridization. This procedure was used to accomplish the hybridization that ultimately gave rise to 'Ruby Falls'. For this procedure, we enclose potted trees, or closely planted field trees, in a six-foot-cube screen cage supported by 2 cm (0.75 in.) PVC pipe. A small "research" hive of bumblebees (Koppert Biological Supply, Inc.., Romulus, MI) is placed in the cage at the time of flowering to accomplish pollination. Our success with this technique has been variable. In some cases, we have obtained acceptable fruit set, but in other instances, no fruit set was obtained on trees containing thousands of flowers. Perhaps the number of bumblebees is too high for the number of flowers available for them to work. Under such a scenario, we observe that the bees become agitated and begin to physically damage the flower parts. It may be desirable to remove the beehive a few days after placement in the cage. We plan to use this technique less and resort to the alternatives discussed above for future hybridizations.