

## Breeding *Penstemon* and *Clematis*®

Dale T. Lindgren

University of Nebraska–Lincoln, West Central Research and Extension Center,  
North Platte, Nebraska

Email: dlindgre@unlnotes.unl.edu

**The University of Nebraska–Lincoln West Central Research and Extension Center (UNL-WCREC) has a history of breeding and selecting *Penstemon* since the 1950s. Other genera of plants, including *Clematis*, have received attention as well. In the last few years, the ornamental selection program at the UNL-WCREC has used three general methods of plant development: (1) selection from native populations, (2) bulk population, and (3) controlled crosses. It is critical, as well, that new selections are easy to propagate using economical and reliable methods.**

### PENSTEMON

Several ornamental *Penstemon* selections have been made directly from native populations at the UNL-WCREC. One example is *Penstemon* 'Prairie Snow,' which is a white-flowered form of *P. grandiflorus*. In order for this white-flowered selection to breed true, it needs to be isolated from *P. grandiflorus* plants with other colored flowers (Lindgren and Schaaf, 1990). An example of a *Penstemon* using the bulk population selection method is 'Prairie Palette'. Flower colors in 'Prairie Palette' vary from white to purple to red (Lindgren and Schaaf, 1999). The third method of plant development is using controlled crosses (Lindgren and Schaaf, 2007). Many crosses have been made in the genus *Penstemon*. In reality, relatively few interspecific crosses have led to successful cultivars.

**Crossing Techniques for *Penstemon*.** A detailed description of techniques in crossing *Penstemon* has been described in several references (Lindgren, 2000; Lindgren and Wilde, 2003). The first step is to collect pollen from species or hybrids that will be used as the male parent. Pollen may be used immediately or be preserved (by refrigeration or freezing) for later use. The flowers to receive pollen are prepared by removing the anthers, staminode, and petals, which is usually done just before the flower opens. The flowers to be pollinated have their petals and anthers removed by grasping the sepals with the fingers of one hand and clasping the lower side of the outer end of the bud and pulling it forward with the other hand. What remains is the ovary and the style with the stigma, all enclosed in the sepals. The style will usually bend downward and form a tiny sticky knob (stigma) when it is receptive. The pollen, from a plant to use as the male parent, is applied generously on the receptive stigma of the female parent. The pollinated pistil should be labeled with a small jeweler's tag, giving the name of the female parent, the male or pollen donor parent and the date of the cross. With successful pollination, the style withers and the ovary begin to swell. It will take approximately 6 weeks, depending on species and weather conditions, for the seeds to ripen. The seeds should be collected after the capsule has turned brown, but before the capsule splits. Once the seeds are dried and harvested, the information on the tag can be transferred to the seed envelope. Successful, as well as unsuccessful, pollinations should also be part of the records you keep (Lindgren and Wilde, 2003).

From experience with *Penstemon* pollinations at the UNL-WCREC, the following general comments on *Penstemon* crosses have been formulated:

- Crosses between *Penstemon* species in the same subsection are relatively successful. However, there is relatively little variability in the progeny.
- Crosses between *Penstemon* species in different subsections provide some of the most interesting progeny.
- Natural selection has been very effective in developing species adapted to their particular environment.
- There are opportunities for breeding projects in the genus *Penstemon* with emphasis on flowering traits, foliage traits, adaptation, and disease reaction.

**Penstemon Propagation.** *Penstemon* can be propagated by a number of different methods. Many *Penstemon* can be propagated by cuttings, some can be easily divided, and some have been shown they can be propagated in tissue culture (Lindgren and Wilde, 2003; Lindgren and McGown, 1992). *Penstemon* taxa are commonly propagated from seed. Seed pre-germination treatments include cold stratification, scarification, and light (Meyer et al., 1995; Lindgren, 2000). However, some species/cultivars germinate readily with no seed pre-germination treatment. An example of a seed germination study can be found in Table 1 (Lindgren and Schaaf, 2004). As the information in Table 1 suggests, stratification time, seed age, and species all influenced seed germination.

**Table 1.** Percent germination of *Penstemon* seed.

Age (years)	<i>P. grandiflorus</i>		<i>P. strictus</i>	
	Stratification (weeks)			
	0	8	0	8
	(%)	(%)	(%)	(%)
1	5.5	25.0	3.5	27.5
2	13.5	29.0	23.5	47.5
3	11.5	24.5	42.5	30.0
4	20.5	29.0	43.5	51.0
5	7.5	0.5	44.0	29.5
6	5.0	0.0	28.5	21.5
7	0.5	2.0	14.0	10.0
8	1.5	1.0	8.0	4.5
9	0.0	0.0	1.5	0.0
10	1.0	0.0	0.0	0.0

There can be significant variation in progeny in populations from seed. For example, seedlings from open-pollinated seed of *Penstemon digitalis* 'Husker Red' can vary significantly in foliage and flower color.

## CLEMATIS

There are many traits that can be targeted for improvement in breeding *Clematis*. These include: (1) architectural forms and growth habits, (2) flowering traits, (3) seed heads, (4) foliage characteristics, and (5) adaptive traits (cold hardiness, drought tolerance, disease resistance) (Lindgren, 2006).

**Crossing Techniques for *Clematis*.** Crossing techniques have been discussed in detail for *Clematis* in the book edited by Neil Anderson (Lindgren, 2006). Pollen can be collected by rubbing a small camel-hair brush or a pipe cleaner on the anthers to collect the pollen. The fertile stamens on a *Clematis* flower generally begin releasing the pollen from the outside group of stamens and ripen inward. The stigmas (tip of the pistil, female part of the flower) at this time, or several days later, become receptive for the pollen. Stigmas usually start to curve downward and become sticky as they become receptive to accept pollen. The pollen can be transferred to the stigma using pipe cleaners or a camel-hair brush. Once the pollination is completed, the pollinated flower should be covered or protected for several weeks to prevent pollination contamination from outside sources. This pollination procedure can be repeated on the same flower in a few days to increase the chance of successful pollination.

Seeds should be dry when collected or should be allowed to gradually dry before storage and stored in a cool, dry location. Seed from each *Clematis* cross should be placed in a labeled envelope for storage.

**Propagation of *Clematis*.** Cuttings, in general, are the best and most commonly used method of propagating *Clematis*. Division of plants can be used to propagate *Clematis* species/selections, such as *C. recta*, *C. heracleifolia*, and *C. integrifolia*, the clump-forming species. Most of the vining forms of *Clematis* can also be propagated by layering (Lindgren, 2006). Seed germination requirements of *Clematis* vary greatly from species to species. Seed germination may occur in as short a time as 2 weeks and as long as 36 months (Fair and Fair, 1997). Reports on germinating *Clematis* seed would suggest that seed should be planted immediately after harvest or within a few weeks to a few months after harvest (Toomey and Leeds, 2001). However, for some species, seed can be stored up to 2 years with no refrigeration and still maintain viability (Rudolph, 1974).

There are many opportunities for breeding *Penstemon* and *Clematis*. New selections of both genera can be made. Finding new selections adapted to wide geographic locations and using reliable methods to propagate them will insure the success of new plant material.

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