Report of the Intermountain Native Plants Cooperative

Volume 5 *December 2013*

An annual report of research and extension activities for members of WERA-1013, Intermountain Regional Evaluation and Introduction of Native Plants

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Forward

The Intermountain Native Plants Cooperative, initiated in 2007, is a group of researchers who share an interest in utilizing native plants in arid urban landscapes, sharing research-based information, and exchanging superior germplasm. All are members of WERA-1013, Intermountain Regional Evaluation and Introduction of Native Plants, an officially recognized Western Education/Extension and Research Activity. The Report of the Intermountain Native Plants Cooperative is published annually and contains announcements of studies in progress by members and updates of germplasm evaluations. Some of the various research reports include work on such diverse topics as the selection criteria of native plants for urban landscapes, sexual and asexual propagation techniques of unique plants, native plant breeding techniques, native plant genetic diversity studies, evaluations on weediness of native plants in the urban landscapes and many other native plant related studies.

Cover: The photo on the cover was taken by Mikel R. Stevens and is of “Sweet penstemon” (*Penstemon angustifolius* var. *dulcis*), a native only to the sand dunes near Delta, Utah.

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Announcements

2014 American Penstemon Society Annual Meeting will meet at the Springdale, Utah, Community Center each evening May16 and 17th. There will be tours in the region to see *Penstemon* and other native plants May 16-18, 2014. For more details visit http://apsdev.org/aps/meetings.html

2014 WERA Meeting will be hosted by Larry Rupp and Mikel Stevens in USU Botanical Center, 920 S. 50 W., Kaysville, UT, October 10-11, 2014.

2014 The Eriogonum Society Annual Meeting will be out of Twin Falls, Idaho, during the 3rd week of June, 2014 (final dates still to be determined). For details visit http://www.eriogonum.org/

Flower evaluation and the Plant Select® Program in Colorado

James E. Klett
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1. Annual and Perennial Flower Evaluation Research

In 2013, approximately 1050 different varieties of annuals were grown in our research/display garden. Weather at our site during 2013 included cooler temperatures in June followed by good moisture in early July, then very warm temperatures in August and early September. On July 29, 2013 the annuals were judged by approximately one hundred industry personnel and advanced Master Gardeners to determine 'Best Of's in many different categories. Lantana 'Lucky Sunrise Rose' was chosen as our Best of Show and Petunia 'Cascadias Indian Summer' was chosen as Best New Variety. Twenty three other varieties were chosen to be 'Best Of' in each of the separate genera.

Approximately seventy new perennial taxa were added in 2013 to our two winter-three growing season perennial trials. Ten taxa were identified as 'Top Performers' including: **'**
Anemone hupehensis 'Pretty Lady Diana' PP 22,332, *Anemone hupehensis* 'Pretty Lady Emily' PP# 22,303, *Baptisia* Decadence Lemon Meringue PPAF, *Geranium* 'Eureka Blue' PP 21,984, *Hibiscus* Summerific® Cranberry Crush PP 21,984 , *Penstemon* Schmidel 'Blue Riding Hood' PP 23,066, *Nepeta* 'Novanepjun' PP 22,919 and *Agastache* 'Blue Boa' PPAF.

2. Plant Select®

In 2013 five plants were either introduced or recommended to industry and gardening public. Also Plant Select® introduced the Petite Program to the public in 2013. The four recommended plants included: *Echinacea tennesseensis* (Tenessee Purple Coneflower), *Cramba maritima* (Curly Leaf Sea Kale), *Linum narbonense* (Narbonne Blue Flax) and *Arctostaphylos x coloradensis* 'Chieftan'. The one new introduction for 2013 is *Sedum sediforme* (Turquoise Tails Blue Sedum). The three Plant Select® Petites for the initial year include: *Primula elatior* (Oxslip Primrose), *Heuchera pulchella* (Sandia Coralbells) and *Clemalis scottii* (Scott's Clematis).

Evaluation Trials for future Plant Select® introductions and recommendations are still being conducted at Colorado State University in Fort Collins and Denver Botanic Garden at Chatfield in the Denver Metro Area. In 2013 we added twelve different taxa which are being evaluated under two irrigation treatments. Data is recorded every two weeks concerning flowering, overall plant appearance and

potential for self-seeding. Industry personnel also view trials yearly at both sites and evaluate.

In 2013, a poster paper was presented at National American Society for Horticultural Science annual meeting on eight plants that were not selected for introduction or recommendation into the Plant Select® program. These plants included*: Albium altaicum, Centaurea bella, Globularia punctata, Penstemon fruticosus, Penstemon wilcoxii, Salvia multicaulis, Sanguisorba tenufolia* and *Tetraneuris scaposa*. All of these taxa exhibited remarkable ability to not only survive but to thrive when receiving less than 45cm of precipitation annually and only periodic irrigation during the growing season.

References:

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Nevada Cooperative Extension to focus on increasing local retail sales of native plants

Heidi Kratsch
University of Nevada Cooperative Extension, Reno, NV

Introduction

Penstemon garden on the grounds of the UNCE office in Reno Nevada

The greatest challenge to increasing use of native plants in northwestern Nevada urban landscapes is lack of local availability and prevailing myths about native plant characteristics. The objective of the Nevada Native Plant Extension project is to encourage greater adoption of native plants by the local retail nursery industry and the general public in the urban areas of northwestern Nevada. We are using a variety of strategies to achieve this goal. In 2012, we established a University of Nevada Cooperative Extension (UNCE) Master Gardener Native Plants club that helped to establish several native plant demonstration gardens in the region, and assists with propagation research on a variety of species unknown to local retailers. In 2013, we received funding from the American Penstemon Society to plant a Penstemon Demonstration Garden on the grounds of the Washoe County Extension building. We also received funding from the USDA Forest Service to develop a native plant online education module and accompanying fact sheets for Extension Master Gardener training. The training module and accompanying educational publications describe appropriate native plant species for the region, and highlight their use in promoting landscape water conservation, pollinator preservation and wildland-urban interface fire hazard reduction.

Methods

<u>Washoe County Cooperative Extension Penstemon Demonstration Garden</u>

UNCE Master Gardeners installing the Penstemon garden

In May 2013, UNCE Master Gardeners planned and installed a Penstemon demonstration garden on the grounds of the Washoe County Extension building. Ninety plants, representing nine regionally appropriate Penstemon species were planted on the west side of the building. The species planted were *Penstemon palmeri*, *P. pseudospectabilis*, *P. x mexicali* 'Red Rocks', *P. eatonii*, *P. strictus*, *P. clutei*, *P. virens*, *P. barbatus* 'Elfin Pink' and *P. pinifolius* 'Tall Orange Mix'. The soil was

prepared by ripping to eliminate roots of the Rose of Sharon shrubs that previously occupied the space. The site was amended with high quality aged compost. A temporary drip system was installed for first-year root establishment, and set to irrigate three times per week for 30 minutes the first month, and tapered to once per week thereafter. A public survey was developed to gather marketing information about public perception, plant preferences and plant purchasing habits related to Penstemons and other flowering perennials. The survey period was from June 2013 through June 2014. Information gathered will be disseminated to nursery owners, landscapers and the public by way of a planned Native Plant Summit to be held in June 2014. A UNCE fact sheet was developed titled "Penstemons are for Great Basin Gardens" for distribution at educational events.

UNCE Master Gardener Online Training Module on Native Plants

Funding was received from the USDA Forest Service to develop an online training module to educate UNCE Master Gardeners about regionally appropriate native plants for urban garden use. An accompanying UNCE Special Publication was developed, "Flowers at the Border: Plant native flowers around your yard to attract native pollinators and other beneficial insects." This publication will be used to support the information provided in the Master Gardener training and for use in another UNCE program, Grow Your Own, which trains the general public on growing edible and ornamental plants in northern Nevada. This publication is an extensive list of herbaceous annual and perennial plants native to northern Nevada or similar climates in surrounding states. It highlights plant characteristics, cultural requirements and their demonstrated capacity to attract and support pollinators and other beneficial insects.

Penstemon Characteristics and Observations

The following is a description of the Penstemon species used in the garden, along with our initial observations.

Penstemon palmeri

Palmer's Penstemon
Height: 2 to 5 feet
Bloom: May through August; pink, sometimes with deep pink guidelines; yellow-bearded staminode
Light: Full sun
Soil: Sandy or gravelly, well-drained
Natural habitat: Native over much of the western U.S. in blackbrush, sagebrush, Joshua tree, pinyon-juniper and ponderosa pine communities.
Landscape use: Flowers have a sweet fragrance; could be used as a north- or east-facing backdrop to smaller statured Penstemons or other sun-loving perennials to avoid shading them.
Observations: Very sensitive to over-watering; it is reported that *Fusarium* wilt is a problem under irrigated conditions. Six of our ten plants have already succumbed to disease.

Photo credit: John P. Weiser

Penstemon pseudospectabilis
Desert Penstemon
Height: 2 to 4 feet
Spacing: 2 feet
Bloom: April through June; brilliant magenta; blooms over a long period
Light: Full sun
Soil: Dry, well-drained
Natural habitat: Desert areas in California, Utah, Arizona and New Mexico
Landscape use: Use as a specimen plant in a perennial garden; evergreen foliage; bright flowers attract hummingbirds.
Our observations: Quick to establish; tolerates irrigation better than *P. palmeri*.

Photo credit: John P. Weiser

***Penstemon x mexicali* 'Red Rocks'**
Red Rocks Penstemon
Height: 1 to 1-1/2 feet
Spacing: 1-1/2 feet
Bloom: May to first frost; deep rose-pink
Light: Full sun to part shade
Soil: Moderately fertile, well-drained;
Natural habitat: Hybrid; does not occur naturally
Landscape use: Use in areas that get regular irrigation or precipitation through the summer; will self sow.
Our observations: Will bloom all the way to first frost with regular irrigation.

Photo credit: UNCE

Penstemon eatonii
Firecracker Penstemon
Height: 1 to 2 feet
Spacing: 1-1/2 feet
Bloom: May through July; rich red
Light: Full sun
Soil: Sandy, rocky, well-drained
Natural habitat: Wide distribution from desert up to subalpine across the Intermountain West and into Arizona and New Mexico
Landscape use: Use in masses in a pollinator garden; attracts hummingbirds
Our observations: Must have excellent drainage.

Photo credit: John P. Weiser

Photo credit: John P. Weiser

Penstemon strictus
Rocky Mountain Penstemon
Height: 1 to 2 feet
Spacing: 2 feet
Bloom: June through August; deep purple to electric blue
Light: Full sun or part shade
Soil: Moderate fertility; well-drained
Natural habitat: Native to the southern Rocky Mountains; Colorado, Wyoming, Utah, New Mexico, Arizona
Landscape use: Use in perennial beds where the blue color provides the illusion of depth.
Our observations: More tolerant of fertile, irrigated soils than other Penstemon species.

Photo credit: John P. Weiser

Penstemon clutei
Sunset Crater Penstemon
Height: Up to 3 feet
Spacing: 2 feet
Bloom: May to June; bright pink
Light: Full sun
Soil: Low fertility, well-drained
Natural habitat: Native to a limited area near Flagstaff, Arizona in volcanic soils around Sunset Crater.
Landscape use: Use in masses where they can self-sow and spread.
Our observations: We have experienced low survival in compost-amended soil.

Photo credit: Gary A. Monroe @ USDA-NRCS PLANTS Database

Penstemon virens
Blue Mist Penstemon
Height: 1 foot
Spacing: 1 foot
Bloom: May to July; small, cornflower blue
Light: Full sun; afternoon shade preferred
Soil: Sandy, well-drained
Natural habitat: Native to the eastern Front Range in Wyoming and Colorado.
Landscape use: Use as a low border in an area that gets lots of morning sun.
Observations: We have observed burning of foliage with a western exposure.

***Penstemon barbatus* 'Elfin Pink'**

Photo credit: John P. Weiser

Elfin Pink Penstemon
Height: 2 feet
Spacing: 1-1/2 feet
Bloom: June to August; true pink
Light: Full sun
Soil: Well-drained, compost-enriched
Natural habitat: southern Colorado south to northern Mexico
Landscape use: Use in masses for a dramatic effect.
Observations: This cultivar has thrived with weekly irrigation in compost-amended soil.

***Penstemon pinifolius* 'Tall Orange Mix'**

Photo credit: John P. Weiser

Pineleaf Penstemon
Height: 1-1/2 feet
Spacing: 2 feet
Bloom: May to August; bright orange-red
Light: Full sun
Soil: Well-drained
Natural habitat: Native to New Mexico and Arizona in gravelly or sandy soils and on rocky slopes up to 8500 feet.
Landscape use: Shrubby, fine-texture foliage; give lots of space in a perennial garden or in front of a shrubby backdrop; attracts hummingbirds.
Observations: Slow to establish, but we have experienced good survival of new transplants.

Conclusions

We have installed nine species of Penstemon in a common garden under similar conditions of soil fertility and irrigation. This has allowed us to compare their performance in a typical garden situation in western Nevada. Although it is still early to judge, we believe that introducing the easiest and most fool-proof species to our retail nurseries, which are largely unfamiliar with native plant species, will be most successful. *Penstemon pseudospectabilis*, *P. x mexicali* 'Red Rocks', *P. strictus* and *P. barbatus* 'Elfin Pink' have performed well under our conditions of regular irrigation and compost-amended soil. *Penstemon palmeri* and *P. clutei*, though spectacular under the right conditions, may prove frustrating to all but seasoned native plant gardeners in our area. *Penstemon virens* could do well, but under more limited cultural conditions. We suspect *P. pinifolius* will perform well in the long term but are withholding judgment until their second growing season due to slow establishment.

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The Genus *Penstemon*: Taxonomy as related to performance in landscape applications

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Introduction

Penstemons are among the most attractive of Intermountain West wildflowers. The genus consists of 279 species, native almost entirely to North America (one species in Guatemala), and primarily to the Rocky Mountains and coastal ranges of the United States and Canada. Taxonomists theorize that this is a young genus, rapidly evolving, with extremes of variation for virtually every measureable characteristic. This variation provides exceptional opportunities for finding and selecting plants with superior garden performance and adaptation.

Penstemon davidsonii on a cliff overlooking Crater Lake in Oregon.

Taxonomy

The common morphological characteristic of all penstemons is the presence of four fertile stamens plus a fifth sterile stamen called a staminode. This latter structure contains no anther sacs. The staminode is thicker than a typical anther filament and is often flattened and/or has a beard of dense hairs on the tip. This fifth stamen is thought to be the source of genus name – pent (fifth) stemon (stamen).

Presence of four fertile anthers (above) and a staminode (below) of *Penstemon glaber*, the definitive morphological characteristic of the genus.

The genus *Penstemon* belongs within the family Plantaginaceae (previously included in Scrophulariaceae). The genus is subdivided at several levels, the result of a need to bring order to a very complex group of species. Categorical divisions are as follows:

- Subgenus – the genus *Penstemon* is divided into 6 subgenera
- Section – 3 of the 6 subgenera are further divided into 12 sections
- Subsection – 5 of the 12 sections are further divided into 23 subsections
- Species – total species 279

Assignment of *Penstemon* species at the subgenus level is based primarily on anther morphology, although staminode and corolla morphology are utilized, as well. Anthers of *Penstemon* species vary for presence or absence of hairs, shape of the anther sacs, position of sac pairs relative to one another, and location and structure of the valves (defines the line of dehiscence). General descriptions of anther and flower morphology for the six sub-genera are as follows (Photographs courtesy of Mikel Stevens, BYU):

Subgenus	**Morphological Characteristics**
Dasanthera	Anthers are covered with dense, tangled white hairs (look like cotton balls). The corollas are long, lavender to pink, and 2-keeled.

Saccanthera — The anther sacs remain parallel (horseshoe-shaped) before and after dehiscence (pollen release). The line of dehiscence (opening for pollen release) is limited to the top of the sacs across and next to the connective (point of filament attachment).

Habroanthus — The anther sacs are often parallel prior to dehiscence. They become divergent (acutely angled) at dehiscence. The line of dehiscence is only at the distal ends (away from the filament attachment point) of each individual sac.

Penstemon — At the time of dehiscence, the two anther sacs tend to extend in opposite directions, at a 90 degree angle to the filament. The line of dehiscence runs full length of the sacs and across the connective. For many species, upon dehiscence, each anther will open completely up creating a flat surface made up of the two valves (a characteristic known as explanate).

Dissecti — Anther sacs are broad and pouch-like. The line of dehiscence is limited to the area of the connective, similar to Saccanthera species. The corollas are pale lavender and fuzzy. Leaves of plants in the Dissecti subgenus are uniquely dissected and fern-like. The one member of this sub-genus, *Penstemon dissectus*, is a species of the Appalachian Mountains in the eastern United States.

Cryptostemon — The line of dehiscence for the anther sacs runs full length, including across the connective, somewhat like members of the subgenus Penstemon but the valves just barely open. A coiled staminode is the most unique morphological feature of the flowers from this sub-genus. Subgenus Cryptostemon includes a single species, *Penstemon personatus*, which occurs only in north-central California.

Although classification of species assigned to individual subgenera is based on anther, staminode, and flower morphology, species within subgenera tend to share many characteristics important to the gardener. In this monograph, subgenera divisions will be used to help organize penstemon species into a logical presentation of their horticultural qualities. Detail will be provided for only 4 of the 6 subgenera. The two subgenera Dissecti and Cryptostemon will not be discussed as each contain a single species, neither of which are important contributors to western landscapes.

Subgenera Characteristics and Species Notes

Over 150 species of penstemon have been evaluated for garden performance at the University of Idaho's Aberdeen R & E Center. The information gathered makes possible generalized statements of subgenera horticultural characteristics and detailed species descriptions relative to horticultural performance. This information can be used to select penstemons for landscape applications. It is important to realize that performance assessments are biased by soil and climate conditions in Aberdeen, Idaho. Winter conditions at this location are equivalent to USDA Hardiness Zone 4; limited winter snow cover results in minimal protection from cold, dry winds; summer months are hot, lack precipitation, and are typified by extremely low humidity; and soils are moderately heavy and alkaline (pH 8.2 to 8.5).

Subgenera summaries and detailed descriptions for horticulturally valuable species within those subgenera are provided for Dasanthera, Saccanthera, Habroanthus, and Penstemon.

Subgenus Dasanthera:

Name Derivation: dasy=hairy, anthera=anther

Inclusive species: 9

General characteristics: Subgenus Dasanthera consists primarily of very long-lived, woody, evergreen shrublets. Two species, *Penstemon montanus* and *Penstemon lyallii* are exceptions, being herbaceous in nature but still long-lived. Flowers are pink to purple and have a recognizable shape, being large, long, and keeled (ridged on top and bottom).

Potential Horticultural Weaknesses: Winter hardiness in cold, dry climates characterized by limited snow cover is the most significant issue for species in this subgenus. Even moderate winter injury may limit bloom potential for woody species that set flower buds in the fall. Other issues include a short bloom period (usually about 3 weeks in spring) and some tendency for leaf chlorosis when grown on high pH soils.

***Potential Horticultural Strengths*:** Most species in this subgenus are sufficiently long-lived to serve as permanent features in the landscape. All have very attractive foliage that provides post-bloom aesthetic value.

Dasanthera Species with Poor or Marginal Performance in Aberdeen, Idaho:

- ✓ *Penstemon barrettiae* – winter injury, lack of tolerance to high pH soils.
- ✓ *Penstemon davidsonii* – winter injury, lack of tolerance to high pH soils.
- ✓ *Penstemon rupicola* – winter injury, lack of tolerance to high pH soils.

Dasanthera Species Showing Superior Horticultural Potential in Aberdeen, Idaho:

Penstemon montanus (Central Idaho Penstemon, Cordroot Penstemon): One of the herbaceous Dasanthera species, this plant produces flowers on new growth and is never bothered by harsh winter conditions. It is native to high elevation locations in Idaho, Montana, Wyoming, and Utah. Mature height is about 10 inches. The leaves are somewhat triangular, pointed, and enhanced by a glistening surface and attractive color patterns. The flowers are large, pink to purple, and held just above the foliage. Bloom period for this species is exceptionally long for the subgenus, sometimes as much as 8 to 9 weeks. This is an excellent plant for a rock garden or placement among short-statured plants in mixed bed or border.

Penstemon lyallii (Lyall's Penstemon, Lyall's Beardtongue): Another herbaceous representative of Dasanthera, this species has a tall, bushy habit. It is native to the mountain ranges along the Idaho-Montana border. Mature plants grow to heights approaching 3 feet under good growing conditions. The plants are heavily branched and produce masses of lavender flowers in late spring and early summer. Bloom period is longer than typical for the subgenus, extending 4 to 5 weeks. The flowers are large, flattened, and have a closed mouth, an unusual characteristic among penstemons. The size and dominant appearance of *Penstemon lyallii* make it a good subject for a tall mixed bed or border.

Penstemon fruticosus (Shrubby Penstemon, Bush Penstemon): This is a widespread woody shrublet of the three Northwest States, Montana, and Wyoming. Success with this species in a harsh climate such as Aberdeen has been dependent on selection of a hardy form. The accessions we have tested vary widely for expression of winter injury, but some have adequate hardiness to be of horticultural value. The plants are woody, evergreen, and grow to a height of 18 inches. The leaves are dark green, sometimes toothed, long-lasting, and very attractive. The flowers are light purple, very large, keeled, and attractive. Bloom period extends for about three weeks, late May into June. This species can be used in many situations in the landscape, but may be at its best planted with trees and shrubs that provide some afternoon shade.

Other Potentially Useful Dasanthera Species:

- ✓ *Penstemon ellipticus* – similar in many ways to *Penstemon fruticosus*.

Subgenus Saccanthera:

Name Derivation: sacc=sac-like, anthera=anther

Inclusive species: 29

General characteristics: The subgenus Saccanthera is somewhat variable with respect to horticultural characteristics, making universal descriptive statements somewhat problematic. Plants of species in this subgenus are usually robust, showy, and relatively long-lived. Many are semi-evergreen in warm climates but most tend to be herbaceous where winters are cold. Flower characteristics are variable with color ranging from blue, to purple, to pink, to red. Flower size ranges from medium-small to large, with most species having relatively large flowers. Many species in this group have later and longer bloom periods than their counterparts in other subgenera. With some exceptions, species within this subgenus make very good garden plants.

Potential Horticultural Weaknesses: A few of the species in this subgenus lack hardiness where winters are harsh. Some species, especially those from the coastal mountain ranges of Oregon and California, are not adapted to soils with high pH. Otherwise, species in this subgenus have few shortcomings. A few species in Saccanthera are difficult to propagate from seed due to a tendency for poor germination.

***Potential Horticultural Strengths*:** Many species in this subgenus are relatively long-lived. Most are floriferous and have long bloom periods. Many Saccanthera species bloom from late summer into fall, making them very useful for complementing spring blooming perennials.

Saccanthera Species with Poor or Marginal Performance in Aberdeen, Idaho:

- ✓ *Penstemon azureus* – not fully winter hardy, iron chlorosis in high pH soils.
- ✓ *Penstemon cusickii* – relatively short-lived.
- ✓ *Penstemon leonardii* – poor seed germination, difficult to propagate.
- ✓ *Penstemon parvulus* - not fully winter hardy, iron chlorosis in high pH soils.
- ✓ *Penstemon purpusii* - not fully winter hardy, iron chlorosis in high pH soils.
- ✓ *Penstemon serrulatus* – iron chlorosis in high pH soils.

Saccanthera Species with Superior Horticultural Potential in Aberdeen, Idaho:

Penstemon platyphyllus (Broadleaf Beardtongue): A narrow endemic that is found only in Utah's Wasatch Mountains. Plants are herbaceous with numerous stems and a lax, shrubby form. Mature plants are about 20 inches tall. The dark smooth, dark green leaves are located on the lower half of the flowering stems. Bloom period is long, usually starting in late June and lasting 7 to 10 weeks. Flowers are medium violet, fairly large, and produced in abundance. *Penstemon platyphyllus* is effectively used in mixed beds or borders.

Penstemon richardsonii (Richardson's Penstemon, Cutleaf Beardtongue): Native to the dry, eastern slopes of the Cascade Range of Oregon and Washington. This is an herbaceous species with stiff, almost woody stems, and an open, somewhat haphazard growth habit. Mature plants are about 20" tall. The dark green, lobed or toothed leaves grow along the flowering stems. The flowers range in color from lavender to bright candy pink. The corollas are open-faced and bulbous. Bloom period is very long, starting in July and often lasting until frost. This is a remarkably beautiful plant that can be used in the landscape anywhere a moderate sized perennial is needed. (Photo complements of Rugged Country Plants).

Penstemon rostriflorus (Bridge's Penstemon): Attractive to both people and hummingbirds, this species is one of the best garden plants in the genus. It is native to the mountain of six southwestern states. The plants are upright to gracefully spreading with a height range of 12 to 30 inches. The small, inconspicuous, narrow, medium green leaves are borne on the flowering stems. The dark red flowers are abundant and the bloom period is from late June until frost. The corollas are narrow with protruding upper petals and lower petals that curve downward. . *Penstemon rostriflorus* is excellent for a xeric, sunny, mixed perennial bed or border.

Penstemon sepalulus (Littlecup Beardtongue): This narrowly endemic species is found primarily in the southern end of Utah County, Utah. In the garden, the herbaceous plants produce a prodigious number of slender, lax, graceful, 24 inch tall flower stems. The narrow, bluish-green leaves are located full length of the flowering stems and are an attractive element of the plant. The flowers are dark lavender and fairly large. The extended bloom period is 8 to 12 weeks from mid-June into September. *Penstemon sepalulus* makes a great addition to a mixed border or bed. (Photo complements of Mikel Steven, BYU)

Penstemon triphyllus (Riggin's Penstemon): Native to the canyons of the lower Snake and Salmon Rivers in Idaho, Oregon, and Washington. The herbaceous plants have a dense, bushy form and grow to a height of about 15 inches. The pointed, lobed, dark green leaves grow on the flowering stems. The light lavender flowers, small for the subgenus, are produced in large numbers. Bloom period is relatively long, 5 to 7 weeks in July and August. *Penstemon triphyllus* makes a great addition to a rock garden, mixed bed, or low border.

Penstemon venustus (Venus Penstemon, Blue Mountain Penstemon, Lovely Penstemon): Few plants can match this herbaceous species for sheer mass of flowers. The large, robust plants produce numerous, tall (up to 3 feet), stiff, flowering stems that put on an amazing show during June and July. The leaves are large, dark green, toothed, and occupy almost the entire length of the flowering stems. The plants remain healthy and attractive long after bloom ceases. The bloom period runs for 6 weeks from June into July. The large flowers can range in color from blue to purple, with varying expression of color intensity. *Penstemon venustus* can be used as a wildflower element in a naturalized meadow, mass planted for dramatic effect, or used singly as a specimen plant is a mixed bed or border.

Other Potentially Useful Species in the Saccanthera Subgenus:

- ✓ *Penstemon glandulosus* – somewhat difficult to establish but has beautiful flowers and tolerates some shade.
- ✓ *Penstemon heterophyllus* – more compact than most species in the subgenus, very floriferous.

Subgenus Habroanthus:

Name Derivation: habro=beautiful, anthera=flower

Inclusive species: 51

General characteristics: The subgenus Habroanthus is divided into two very distinct botanical sections. The Glabri section is made up primarily of species with tall, stiffly upright spikes, although a few species express a compact habit. With few exceptions, Glabri species produce beautiful blue to purple flowers. Most species in this section share another common trait, short life span. Most species in the Glabri section are herbaceous, moderately tall, and bloom in the spring. The section Elmigera is composed entirely of tall plants with tubular red flowers. Plants in this section tend to be longer lived than those in Glabri, express semi-evergreen tendencies in warm climates, and are exceptionally attractive to hummingbirds. Although superior garden plants can be found in both sections, the greatest horticultural value is found in the section Elmigera.

Potential Horticultural Weaknesses: The single characteristic that keeps most Habroanthus species out of the garden is short life span. Many species will live 2 to 4 years and be attractive for only 1 or 2 of those years. A few of the species, especially those of Mexican origin, are also not hardy in Zone 4 Aberdeen. Many species in this subgenus also have fairly short bloom periods and are not especially attractive after flowering ceases.

***Potential Horticultural Strengths*:** Remarkably beautiful flower color is the strength of the Habroanthus subgenus. The Glabri section produces flowers with some of the purest and most intense blue colors in nature. Species in the Elmigera section produce flowers in striking red to red-orange hues. Many species in this last section produce plants of significantly large stature to be used to fill large spaces in the landscape.

Habroanthus Species with Poor or Marginal Performance in Aberdeen, Idaho:

- ✓ *Penstemon comarrhenus* – tall stems often break off in the wind (some gardeners like this species anyway).
- ✓ *Penstemon cyananthus* – short-lived.
- ✓ *Penstemon cyaneus* – short-lived.
- ✓ *Penstemon glaber* – short-lived.
- ✓ *Penstemon lemhiensis* – short-lived.
- ✓ *Penstemon payettensis* – short-lived.
- ✓ *Penstemon speciosus* – short-lived.

Habroanthus Species with Superior Horticultural Potential in Aberdeen, Idaho:

Penstemon barbatus (Beardlip Penstemon, Golden-beard Penstemon, Scarlet Bugler): A long-lived member of the section Elmigera native to Utah, Colorado, Arizona, New Mexico, Texas, into Mexico. Plants of this species develop a semi-evergreen clump of leaves in late summer and fall. The next spring, these leaves give rise to several stiffly upright 2 to 6 foot mostly leafless flowering stems. The loosely arranged flowers are tubular, bright red, (occasionally pink, lavender, or orange) with bottom petal lobes that point backward and hug the corolla. Bloom period is long, late June into September. *Penstemon barbatus* is a great specimen plant and can complement many taller shrubs or perennials in mixed beds or borders. This is an easy plant to cultivate.

Penstemon cardinalis (Cardinal Penstemon): Although not as long-lived as some other garden-worthy species in this sub-genus, the blood-red flowers of this plant create an amazing summer show. Somewhat rare in nature, the species is native to locations in New Mexico and Texas. The herbaceous plants grow to a height of 3 feet and are clothed with large, bright green leaves, adding to their beauty. Flowers are narrowly tubular with very small petal lobes and are very attractive to hummingbirds. Bloom period is up to 9 weeks in late June into August. *Penstemon cardinalis* is excellent for complementing a variety of other plants in mixed beds and borders.

Penstemon hallii (Hall's Beardtongue): This species is one of the smaller members of the subgenus, 8 to 10 inches tall when mature. It is native to high elevations along the Front Range of Colorado. The leaves are mostly basal and after a few years grow into mats up to 2 feet across. The leaves remain attractive all summer. The chubby, open-mouthed blue flowers grow on short, stout, upright stalks. Bloom period is 4 to 5 weeks in June and early July. *Penstemon hallii* can be effectively used in rock gardens and in front of taller plants in beds and borders.

Penstemon labrosus (Scarlet Beardtongue, San Gabriel Beardtongue, Rabbit Ears): The appeal of this plant is the unusual color and shape of the flowers. The corolla is bright red-orange to salmon-red. The upper lobes project upward like rabbit ears while the unusually long lower lobes dangle downward. The flowers last for about 11 weeks, July into September. In spite of being native the coastal in interior mountains of Southern California, this species is very hardy in Zone 4 climates. Plants are mildly rhizomatous and slowly grow in diameter over time. Leaves are somewhat narrow, light green, rather sparse, and mostly basal. Flower stalks are rather few in number, stiffly upright, and about 3 feet tall. *Penstemon labrosus* should be place in the landscape in a specimen role where the unusual flowers can easily be seen and enjoyed.

Penstemon strictus (Rocky Mountain Penstemon, Porch Penstemon, Strict Beardtongue): One of the few spiked, blue- to purple-flowered species that thrives long enough to be a good garden plant. The species is native over a broad range of the Rocky Mountains from Wyoming southward. Plants produce a dense, dark green, semi-evergreen mat of basal leaves, from with 20 to 30 inch vertical spikes appear. The flowers are dark blue to bluish-purple. Bloom period is 4 to 6 weeks in June and July. This plant does well under common, irrigated garden conditions and makes a great accent plant for mixed beds and borders.

Penstemon subglaber (Smooth Penstemon): Although not overly long-lived, this is another of the large-flowered, blue penstemons that is sufficient protracted to be useful in the garden. It is native to Idaho, Utah, Wyoming, and California. Mature plants can be as much as 3 feet tall. Basal semi-evergreen leaves are glossy and dark green. Large, intensely dark blue flowers (sometimes grade into violet and lavender) develop on upright, wand-like spikes. Bloom period is longer than for *P. strictus*, usually about 6 weeks. *Penstemon subglaber* is an effective element of a naturalized wildflower planting or a mix bed or border.

Other Potentially Useful Species in the Habroanthus Subgenus:

- ✓ *Penstemon caryi* – a moderately compact species with sky blue flowers.
- ✓ *Penstemon gibbensii* – graceful plants with blue flowers and a long bloom period.
- ✓ *Penstemon idahoensis* – a long-lived floriferous plant with small blue flowers.
- ✓ *Penstemon mensarum* – moderately long-lived; striking dark blue flowers.
- ✓ *Penstemon perpulcher* – upright plants, often tall, dark blue flowers.

Subgenus Penstemon:

Name Derivation: pent=fifth, stemon=stamen

Inclusive species: 188

General characteristics: The subgenus Penstemon includes a very large number of extremely diverse species. This subgenus is further divided into 9 sections and 19 subsections. Consequently, any statement of species characteristics will be rife with exceptions. This subgenus includes both the smallest and largest members of the genus. Amongst the members of this subgenus are species with the smallest flowers (most inclusive species exhibit relatively small flowers); but exceptions like *Penstemon grandiflorus* and *Penstemon palmeri* have very large flowers. A fair percentage of species are foliaceous with leaflets growing into the inflorescence on the flowering stalks. For species with small flowers, this reduces overall visual impact of the plants. Exceptions have openly visible and colorful flowers. Flower color in the subgenus Penstemon is as variable as the other characteristics, with blue the most common, but red, pink, violet, lavender, purple, yellow, and white are all common.

Potential Horticultural Weaknesses: Any description of horticultural weakness will have exceptions in this variable subgenus. Occasional species within the group are weedy from seed, making them difficult to handle in landscapes. Others have the opposite problem, difficult to propagate from seed. Like the species classified in Habroanthus, many members of this subgenus are short-lived. Some species in the Penstemon subgenus are not hardy in a Zone 4 climate. A small proportion of inclusive species lack adaptation to alkaline soils. Mixed in with the weak members of the subgenus are those adapted to the climate and soils of southeastern Idaho and are well-behaved in pots and in the garden.

***Potential Horticultural Strengths*:** Again, variability makes comprehensive statements of horticultural strengths difficult. But among the numerous species in the subgenus Penstemon are those that combine longevity, beauty, hardiness, and ease of propagation. Most of the penstemon species best suited to rock gardens, partly a result of diminutive size, come from the subgenus Penstemon. Also, there are a number of species that are adapted to shade and moist conditions, valuable traits in many landscapes.

Penstemon Species with Poor or Marginal Performance in Aberdeen, Idaho:

Many of the 188 species in the subgenus Penstemon have not been evaluated in plots at Aberdeen, Idaho. As more evaluations are completed, lists of species exhibiting inferior or superior landscape characteristics will expand. Species identified to date that exhibit unacceptable or marginal performance include:

- ✓ *Penstemon acuminatus* – short-lived.
- ✓ *Penstemon aubietinus* – limited bloom period, lacks showiness.
- ✓ *Penstemon auriberbis* – short-lived, lacks showiness.

- ✓ *Penstemon californicus* – not winter hardy.
- ✓ *Penstemon carnosus* – short-lived.
- ✓ *Penstemon clutei* – short-lived.
- ✓ *Penstemon deustus* – difficult to propagate from seed.
- ✓ *Penstemon franklinii* – short-lived.
- ✓ *Penstemon floridus* – short-lived, weedy from seed.
- ✓ *Penstemon grandiflorus* – short-lived.
- ✓ *Penstemon harbouri* – limited bloom period, unattractive in summer heat.
- ✓ *Penstemon janishiae* – short-lived.
- ✓ *Penstemon laricifolius* – short-lived.
- ✓ *Penstemon lentus* – short-lived.
- ✓ *Penstemon nitidus* – short-lived.
- ✓ *Penstemon pachyphyllus* – short-lived.
- ✓ *Penstemon palmeri* – short-lived, weedy from seed (many people love this plant).
- ✓ *Penstemon smallii* – not winter hardy, not adapted to alkaline soils.
- ✓ *Penstemon superbus* – not fully winter hardy.
- ✓ *Penstemon triflorus* – not winter hardy.
- ✓ *Penstemon virens* – diminutive and lacks showiness.

Penstemon Species with Superior Horticultural Potential in Aberdeen, Idaho:

Penstemon confertus (Yellow Penstemon): One of the rare penstemon species adapted to seasonally moist conditions, it is native to the coniferous forests of Idaho, Montana, Oregon, and Washington. The plants form dense mounds of semi-evergreen leaves. From these mounds emerge 15”, vertical spikes topped by numerous small, light yellow flowers. The small size of the flowers is compensated by the sheer number of blooms. The bloom period is moderately long, 4 to 6 weeks in late May to early July. The neutral color of *Penstemon confertus* makes it easy to match with other plants in rock gardens, beds, and borders, including moderately moist sites in partial shade.

Penstemon eriantherus (Fuzzy-tongue Penstemon): A diminutive plant with intriguing flowers that have fat, fuzzy faces. A widespread species of shallow soils in the Northwest, middle Rocky Mountain States, and westernmost of the Northern Plains States. The plants grow only 5 to 8 inches tall. In late May and early June, for about three weeks, the chubby, violet flowers seem to engulf the plant. The leaves are fuzzy, pointed, and light green. *Penstemon eriantherus* is an excellent subject for a xeric rock garden.

Penstemon glabrescens (Crandall's Beardtongue): A mound-forming species with fir-like leaves and flowers that are embedded in the foliage. Sometimes classified as a subspecies of *P. crandallii*, it is native to southern Colorado and northern New Mexico. The light blue flowers are partially embedded or held just above the finely textured foliage. At maturity, the plants are usually less than 8 inches tall. Multiple cycles of bloom occur, the most prolific for about 6 weeks in early summer, then off and on for the rest of the summer. *Penstemon glabrescens* makes a nice addition to a rock garden or the front of a low bed or border.

Penstemon humilis (Lowly Penstemon, Low Beardtongue): One of the first penstemons to bloom in the spring, this is a widespread species of the western states. Depending on provenance, it comes in a variety of forms, most less than a foot tall. The flowers of this species are small and the bloom period only about 4 weeks long, but hundreds of bright blue flowers herald the arrival of a new season. The foliage is dark green and dies back to the ground in late summer. *Penstemon humilis* is a good plant for a moderately dry rock garden, but will also provide accent in a low bed or border with other plants that provide color later in the season.

Penstemon ovatus (Eggleaf Beardtongue): This species is native to the moderately moist crown of the Washington and Oregon Cascade Mountains. Consequently, it is adapted to partial shade and moist, irrigated conditions. Plants are leafy throughout and appear green and healthy all summer. In June and July, 20 inch panicles of medium to dark blue flowers set off the dark green leaves. Bloom period is moderately long, 7 to 9 weeks, June into early August. *Penstemon ovatus* is a great addition to shrub and tree beds where there is moderate level of moisture and partial shade.

Penstemon pinifolius (Pineleaf Penstemon, Pineneedle Beardtongue): Named for the appearance of the foliage, branches of this species look like pine boughs. The species is native to the mountains of southeastern Arizona and southwestern New Mexico. This is an outstanding small-statured landscape plant. In bloom, the plants are about 12 inches tall. The foliage is dense, evergreen in warmer climates, and attractive throughout the year. The flowers are red, tubular, and numerous. Bloom persists for almost three months during summer. *Penstemon pinifolius* is a great specimen plant for a xeric rock garden, but also works to complement other plants in the front of beds and borders.

Penstemon secundiflorus (Sidebells Penstemon): A long-lived exception among a taxonomic section of short-lived species. Commonly found in dry, rocky places in the Rocky Mountains of Wyoming, Colorado, and New Mexico. The tough, long-lasting foliage is a pleasant bluish-green color. Flowers grow along one side of the upright, somewhat crooked, 18 inch spikes. Flower color ranges from pink to violet. Blooms persist for 3 to 4 weeks in June and July and sometimes secondary flushes of bloom occur later in the summer. *Penstemon secundiflorus* works well as an accent plant in a variety of xeric beds and borders.

Penstemon teucrioides (Teucrium-leaved Beardtongue, Germander Beardtongue): Included by some botanist in the *Penstemon caespitosus* species complex, this is a typical representative of the unusual and beautiful mat-forming plants in the Caespitosi subsection. It is native to western Colorado and northwestern New Mexico. The plants form dense mats a few inches tall but up to 3 feet across. Leaves are narrow and needle-like. The sky blue flowers sit on top of the foliage. Bloom begins in mid-June and lasts up to 5 weeks, sometimes followed by sparse secondary bloom in mid-summer. The flowers around the edges of the mat bloom first and eventually spread to cover the entire plant. When in bloom, *Penstemon teucrioides* is a striking plant and makes a great addition to a dry rock garden.

Penstemon whippleanus (Whipple's Penstemon): Native to high-elevation woodlands throughout the Rocky Mountain States. This species is adapted to seasonally moist, partially shaded conditions; a valuable addition to a traditional landscape. Plants will show drought stress symptoms under extreme xeric conditions. The plants are leafy throughout and create a verdant effect in the garden. Flower color ranges from white, through grayish-blue, to dark purple. The best forms have dark purple or wine-colored flowers. The bloom period is moderately long, 4 to 6 weeks in June and early July. *Penstemon whippleanus* can be used to complement shrubs and trees in a partially shaded bed, but is also used effectively in full sun.

Other Potentially Useful Species in the Penstemon Subgenus:

- ✓ *Penstemon alamosensis* – tall with loose spikes of dark pink flowers.
- ✓ *Penstemon ambiguus* – bushy with light pink, phlox-like flowers; adapted to heat.
- ✓ *Penstemon attenuatus* – long-lived, spring blooming with blue or yellow flowers.
- ✓ *Penstemon griffinii* – slender, graceful plants with light blue June to July flowers.
- ✓ *Penstemon havardii* – tall, with attractive reddish leaves and fuchsia flowers.
- ✓ *Penstemon idahoensis* – mounding, floriferous plants with bluish-violet flowers.
- ✓ *Penstemon linarioides* – small plant with fir-like leaves and sky blue flowers.
- ✓ *Penstemon kunthii* – hardiest of Mexican species with dark red flowers.
- ✓ *Penstemon peckii* – short, upright plants with tiny pink or blue flowers.
- ✓ *Penstemon pumilus* – diminutive spring blooming plants with dark blue flowers.
- ✓ *Penstemon ramosus* – medium-tall openly-branched plants with dark red flowers.
- ✓ *Penstemon ramaleyi* – finely texture mounding plant with enduring blue flowers.
- ✓ *Penstemon utahensis* – upright spikes of bright pink flowers, short-lived.
- ✓ *Penstemon wilcoxii* – loose panicles of dark blue flowers, adapted to shade.

Conclusions

The genus penstemon is a rich source of plant materials for creating and enhancing water-conserving landscapes in the northern Intermountain West. Many of the 279 species in the genus have garden-worthy traits that include ease of propagation, longevity, hardiness, adaptation to alkaline soils, attractive foliage, beautiful flowers, long bloom periods, and lack of pest issues. Horticulturally superior species exhibit a range of colors, textures, forms, plant dimensions, and other characteristics that make them useful in a variety of design situations.

Four of the 6 subgenera of the genus *Penstemon* contain horticulturally superior species. Understanding subgenera characteristics helps in identifying specific species for specific landscape applications. The subgenus Dasanthera is made up largely of long-lived, evergreen shrublets. The subgenus Saccanthera includes primarily species that are herbaceous, tall, bushy, floriferous, and late blooming. Habroanthus includes the large-flowered, spike-forming, dark blue species that are usually short-lived, but also include a number of long-lived, tall, red-flowered species. The fourth subgenus, Penstemon, is a complex and variable group of species that includes numerous beautiful plants useful in designing rock garden.

Domestication and breeding efforts are making penstemons more accessible in the nursery trade. Combined with an increasing need for water-conserving landscape designs, enhanced availability points to a bright future for penstemons in the garden.

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Evaluation of native plants for use in California landscapes and water mitigation sites and propagation of *Romneya coulteri*

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Objectives:

There were three objectives of our research activities during the past year: 1) using native plants in vegetated filter strips and determining their ability mitigate nutrients from entering watersheds, 2) developing alternative methods of propagating *Romneya* coulteri (Matilija Poppy or California Tree Poppy), and 3) evaluating ornamental native groundcovers for their performance in drought induced landscapes.

Accomplishments:

Filter-strip water mitigation: The use of native plants to mitigate nutrients and pesticides from entering watersheds has become an important Best Management Practice (BMP) for nurseries, orchards, row crops, and other agricultural commodities. By using native, rather than non-native plants on water runoff areas, there is no chance of non-native plant species invading California wildlands. In addition, mitigation of impaired waters from entering watersheds is provided with these native filter strips.

Vegetated native plant filter strip at Tree of Life Nursery, San Juan Capistrano, California.

During the past several years, the University of California has been working with area Farm Advisors and other scientists to develop vegetated filter strips that can be used in agriculture to mitigate pollutants from entering watersheds. During this time, we evaluated several native plants, either colonized or not-colonized with mycorrhizae, to determine their nitrate and phosphate uptake efficiency. The information gained from the evaluation of native plants in vegetated filter strips has been incorporated into our extension programs associated with BMPs in agriculture. Several farmers have utilized native-plant filter strips over the past several years, some of which have been demonstrated in outreach programs.

Micropropagation of Romneya coulteri: *Romneya coulteri* is a plant native to California coastal sage scrub and chaparral communities and spreads by rhizomes. However, this plant is difficult to propagate from seeds and vegetative cuttings; therefore, alternative methods of plant propagation are needed to ensure that this plant is readily available to the landscape industry.

For propagation of *Romneya coultei*, we have developed a successful micropropagation method so that this plant can be propagated via tissue culture. Since this propagation method has been recently developed,, we have not been able to get this information out in publications or extension programs.

Evaluation of native plants in water-conserving landscapes: Many California native plants are drought tolerant. However, very little information is available regarding the degree of drought tolerance and how aesthetically acceptable these plants are in a given drought condition. In our field trials we are evaluating two California native plant species, *Salvia* 'Gracias' and *Coreathrogyne filaginifolia*. After three years, we have gradually reduced watering to 40% of ETo.

Field day showing the native plant evaluation plots at the Riverside Agricultural Experiment Station.

The evaluation of *Salvia* 'Gracias' and *Coreathrogyne filaginifolia* has been done for the past three years. Likewise, the performance of native plants in the groundcover studies has been part of a 'Turf and Landscape Field Day' at our Agricultural Experiment Station in Riverside, CA.

Outputs:

The major output of our program has been to show people how to use native plants in landscapes and also how to use native plant filter strips as BMPs to mitigate pollutants from entering our watersheds. Hands-on demonstrations and field days have been an important and essential part of both of these extension programs.

Activities:

Our research activities involve determining which native plants are more active at mitigating pollutant runoff in vegetated filter strips. In landscapes, our research aims are to determine the degree of drought exposure of native plants that is aesthetically acceptable to the public. The extension activities associated with these programs are conducting hands-on displays and field demonstrations for the public and agricultural sectors.

Impact Statements:

We have two long-term impacts. The most notable, is the use of native plants to mitigate nutrient runoff before it enters watersheds. The development of this as a BMP is being used in agriculture, as well as urban landscapes. In addition, we have introduced the use of native plants to the landscape industry so that they have an understanding of the performance expectations and management of native plants in landscapes.

Publication:

Corkidi, L., D.J.Merhaut, E.B. Allen, J. Downer, J. Bohn and M. Evans. 2011. Effects of mycorrhizal colonization on nitrogen and phosphorus leaching from nursery containers. HorScience 46(11):1472-1479.

Plans for a Rocky Mountain display garden at the University of Wyoming

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At the time of our 2013 meeting, the beginnings of a botanic/display garden on the University of Wyoming camps were taking shape. The new UW president, Dr. Robert Sternberg, convened a committee, of which I am a member, to put together a plan for such a garden. (November 25, 2013 update: the potential garden is now in limbo as Dr. Sternberg has already resigned as UW president.)

The location is the southwest corner of campus and is about 2.3 acres in size (Fig. 1).

Fig. 1. Location of possible future University of Wyoming botanic/display gardens in Laramie, Wyoming. Photo from Google Earth, October 7, 2013. Blue arrow indicates All-America Selections Display Garden.

The garden will most likely be comprised of a series of “rooms” or areas with emphases on certain types of plants. One of these rooms will undoubtedly focus on plants native to the Rocky Mountains in general and Wyoming in particular. The area to be used is adjacent to the current location of the All-America Selections Display Garden, which is just to the right of circle at the top in Fig. 1 (blue arrow) and is in its entirety in Fig. 2.

Fig. 2. University of Wyoming All-America Selections Display Garden, Laramie, Wyoming. Photo September 12, 2013, Karen Panter.

The All-America Selections Display Garden at UW is home to several named varieties of native plants:

Echinacea purpurea 'Cheyenne Spirit' – This was the first year in our gardens for this cultivar and had not yet bloomed at the end of the growing season (Fig. 3). The photo of the flowers (Fig. 4) is courtesy All-America Selections.

Fig. 3. *Echinacea purpurea* 'Cheyenne Spirit'. Photo August 7, 2013, Karen Panter.

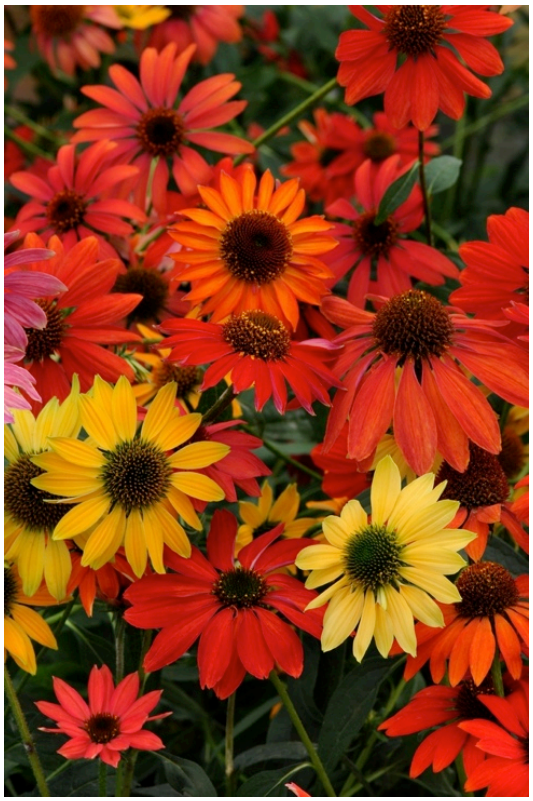

Fig. 4. *Echinacea purpurea* 'Cheyenne Spirit' in bloom. Photo courtesy All-America Selections (www.all-americaselections.org).

Echinacea purpurea 'Powwow Wild Berry' – These bloomed in the first year of planting at UW (2012) (Fig. 5).

Fig. 5. *Echinacea purpurea* 'Powwow WildBerry'. Photo July 30, 2013, Karen Panter.

Gaillardia aristata ‘Arizona Apricot’ – Beautiful blanket flower that also bloomed the first of planting (2012) (Fig. 6).

Fig. 6. *Gaillardia aristata* ‘Arizona Apricot’. Photo July 30, 2013, Karen Panter.

Gaillardia ‘Mesa Yellow’ – bloomed in 2012 as well; its first year in the ground (Fig. 7).

Fig. 7. Gaillardia ‘Mesa Yellow’. Photo July 30, 2013, Karen Panter.

Last but not least, my involvement in the University of Wyoming's Berry Biodiversity Conservation Center green roof is drawing to a close (Fig. 8). I contributed to the roof by growing 26 species of Wyoming native plants from seeds in spring 2011. Seedlings were subsequently planted on the roof in June 2011.

The green roof waterproof membranes were compromised in summer 2012, resulting in leaks to the room beneath it. Consequently all plants on the roof were dug up, planted in #1 containers, and taken to the local golf course where they were housed temporarily. The roof had to be completely removed and replaced; plants were re-installed in September 2012. Survival of the plants is being monitored.

Fig. 8. Berry Biodiversity Conservation Center green roof in the center with the path curving through it. Photo from Google Earth, October 7, 2013.

Vegetative propagation of little-leaf mountain mahogany

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Abstract

Maximizing the utility of littleleaf mountain mahogany (*Cercocarpus ledifolius* var. *intricatus*) (CLI) for use in water conserving landscapes requires that it be vegetatively propagated to preserve clonal characteristics of superior plants. Specimens of CLI were selected over a three year period from wild and domestic sources in Utah and Nevada, and a series of experiments conducted to determine propagation requirements. We found that some selections and conditions resulted in greater than 90% rooting, while others had less than 10% rooting. While source and growing conditions of parent plants confound a direct conclusion, it appears that there is genetic variation in rooting potential among CLI selections. For those selections that did root, supplemental auxin increased the percentage of rooted cuttings from 0-15% for untreated controls to 42-100% for those that were treated. We further found that summer propagation of cuttings in a Nearing frame was not as effective as propagation in a greenhouse, though this conclusion requires further study because of the presence of *Fusarium* infection in the Nearing frame plants. Lastly, we found that CLI can be rooted via mound layering, but in the subsequent year under our conditions it did not generate enough new basal shoots for this to be an effective means of propagation.

Introduction

Littleleaf mountain mahogany (*Cercocarpus ledifolius* var. *intricatus* (CLI)) is a small, densely branched shrub rarely more than eight feet tall. The leaves are small and almost needle-like in appearance due to their revolute margins (curled inward on the underside) (Van Buren, et al., 2011). It is commonly found in harsh, dry, rocky sites at a variety of elevations throughout the Intermountain area and has potential for use in water conserving landscapes because of its tolerance to extremes in temperature and precipitation. It is uniformly actinorhizal, evergreen, and capable of natural hybridization with other *Cercocarpus*. Its appearance and growth habits are variable with high potential for selection of superior forms for managed landscapes (Rupp, 2012).

Effective vegetative propagation of native plants can be approached by several methods including cuttings and layering (Hawver and Bassuk, 2000). This report summarizes propagation results with accessions collected from multiple plants, locations, and times.

Materials and Methods

Wild and landscape-grown accessions of CLI were selected over a three year period from sources in Utah and Nevada (Fig. 1, Rupp, et al., 2011). Unless otherwise stated, propagation conditions were as follows: Cuttings were collected as shoot tips and held on ice or in a 4°C cooler for 0-3 days until stuck. Prior to sticking, lower leaves were removed, and the stem base wounded and dipped in various concentrations of indole butyric acid (IBA) and naphthalene acetic acid (NAA) as Dip 'N Grow® in 25% ethanol for 5 seconds. Cuttings were stuck in a 4 : 1 perlite : peat rooting substrate on bottom heat (21-28°C) under intermittent mist with deionized water and in a glass greenhouse at 18/16°C D/N setpoint temperatures. During the summer the greenhouse had 60% shade supplemented with Reemay row cover material used as a canopy surrounding the mist bench to reduce air movement across cuttings. In the winter high pressure sodium lamps were used to provide 18 hour days. Cuttings were evaluated for rooting approximately eight weeks after sticking. In those cases where percent rooting was statistically

analyzed a generalized linear mixed model of logistic regression was used to predict the effects of variables using the PROC GLIMMIX package in SAS 9.3 (2011, SAS Institute, NC).

Experiment 1.

Cuttings of previous season's growth of a columnar form (CLI-1) were collected on 21 Jan. 2010 at Ephraim Canyon, UT at an elevation of approximately 6500 feet. On 22 Jan. 2010, the cuttings were treated with a 5 s quick dip of either 0/0, 2000/1000, or 4000/2000 ppm IBA/NAA in 50% ethanol (n=12). Intermittent mist was applied for 7 s every 30 m during lighted periods. Cuttings were evaluated on 18 March 2010 after 8 weeks.

Experiment 2.

A prostrate (CLI-2) and an upright, rounded (CLI-3) form of CLI were selected at Spring Mountain, NV at 9300 feet elevation. Cuttings of previous season's growth were taken on 21 May 2010 and stuck on 24 May after being treated with a 0/0, 2000/1000, or 4000/2000 ppm IBA/NAA in 50% ethanol quick dip for 3 seconds (n=26). Cuttings were stuck in 3 : 1 (v/v) perlite : peat. Cuttings were placed in a greenhouse under standard conditions. Intermittent mist was applied for 7 s every 12 m. Cuttings were evaluated on 22 July 2010 after 8 weeks.

Experiment 3.

Cuttings of a rounded form (CLI-4) were collected on 13 July 2010 from a landscape in Logan, UT. Cuttings were stuck that same day after being wounded and then treated with a quick dip of 0/0, 2000/1000, or 4000/2000 ppm IBA/NAA in 25% ethanol (n=24). Cuttings were held in a greenhouse under standard conditions. Intermittent mist was applied for 7 s every 12 m. Cuttings were evaluated on 10 Sept 2010 after 8 weeks.

Experiment 4.

Cuttings of CLI-3 (from greenhouse-grown containerized stock plants) and two landscape plants (CLI-5 & 6) were collected on 2 July 2012 at Logan, UT (n=48). On 3 July 2012 cuttings were trimmed to 9.5-13.5 cm depending on source, wounded, dipped for 5 seconds in 2000/1000 ppm IBA/NAA in 25% ethanol, and stuck in a 4 : 1 perlite : peat rooting substrate. Cuttings were randomly assigned (n = 48) to a standard greenhouse environment or a Nearing frame and drenched with 2.5 g/L Alliette fungicide. The greenhouse plants were misted as required, but at approximately 10 seconds every 15 minutes during daylight hours. The Nearing frame environment was full shade with a northern exposure, a transparent plastic sash covering the plants, and misted as required, but approximately 7 seconds every 60 minutes. Light levels in the greenhouse averaged 192 µmol/m^2/s and in the Nearing frame 46 µmol/m^2/s. Cuttings were evaluated on 14 Aug 2012 after 6 weeks when cutting health and rooting were evaluated.

Experiment 5.

Four mother plants of CLI-1 previously established in a mound layer bed at Kaysville, Utah were prepared for layering by shearing while dormant. On 11 July 2013, 16 shoots from each plant were selected and randomly assigned treatments of either a girdle at the stem base, treatment with 4000/2000 ppm IBA/NAA in 25% ethanol, a combination of the girdle and auxin treatments, or an untreated control. Following treatment, conifer wood shavings were mounded around the plants to a depth insuring the bases were covered by at least 5 cm of shavings. Sprinkler irrigation was applied to keep the wood shavings moist as needed with a maximum of twice daily (11:00 AM and 4:00 PM) for 5 minutes. Layered shoots were harvested on 2 Nov. 2012 and evaluated for rooting.

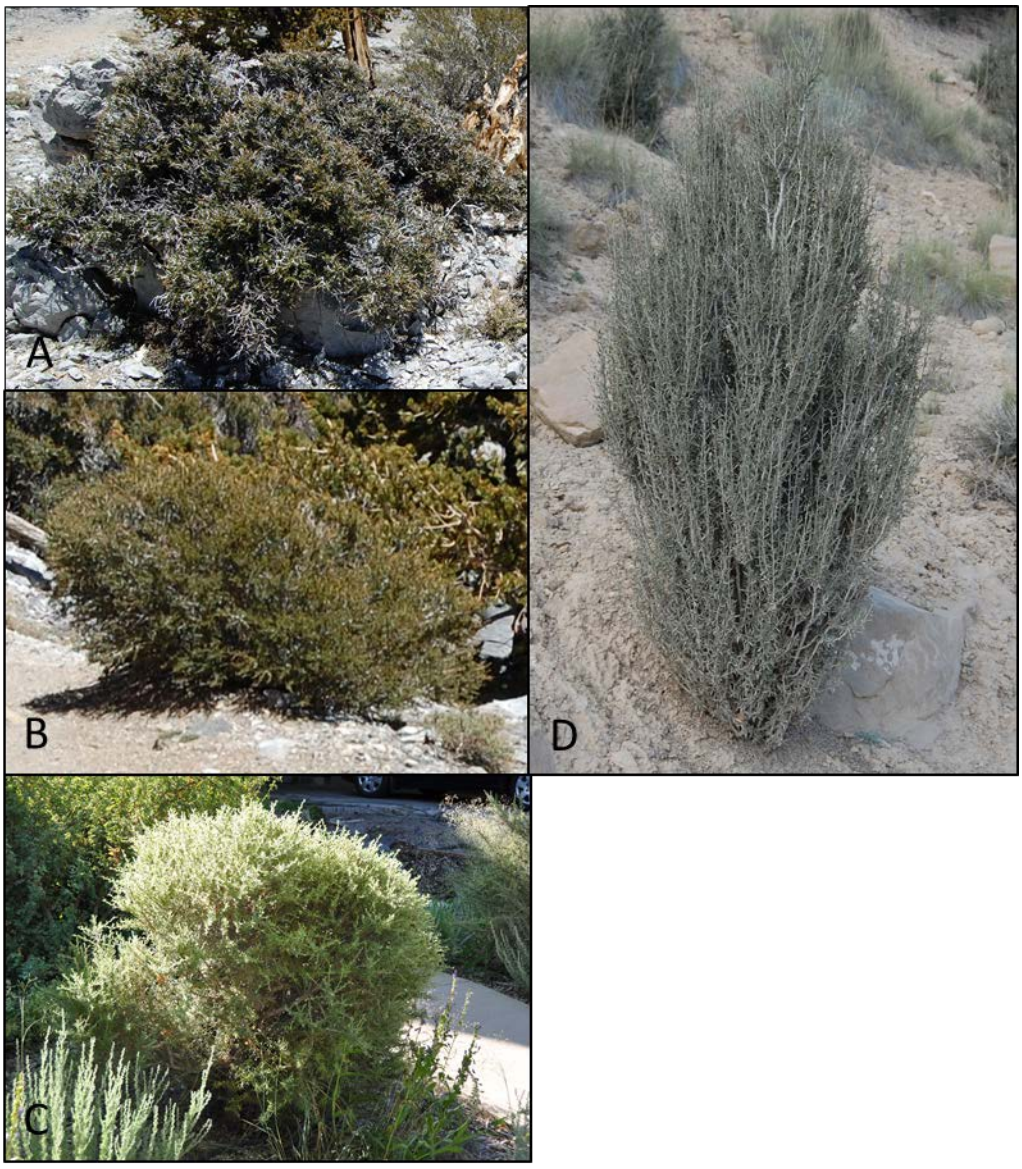

Fig. 1. Examples of *Cercocarpus ledifolius* var. *intricatus* collected and tested for vegetative propagation (A = CLI-2, B = CLI-3, C = CLI-4, D = CLI-1).

Results

Experiment 1

The results of experiment one indicated that accession CLI-1 could be rooted, but at a relatively low rate of success (42% maximum). Supplemental auxin treatments significantly increased the percentage of cuttings forming roots from 0% to 33% for the low auxin rate and 42% for the higher rate. The number of roots per cutting was also increased as a result of auxin treatments. (Fig. 2).

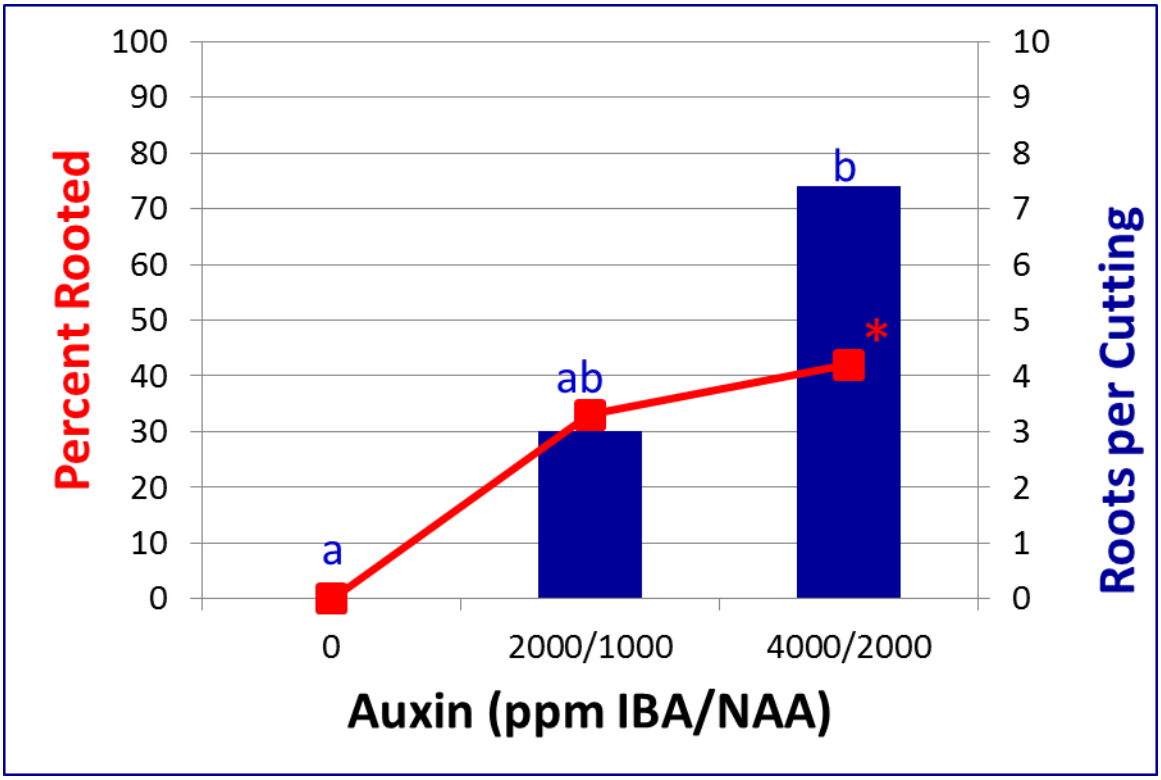

Fig. 2. The effect of auxin concentration on rooting of cuttings from accession CLI-1. Data points with different letters are significantly different. Asterisks indicate an overall significant effect of auxin treatment on percent rooting.

Experiment 2

In experiment two we found that accession CLI-2 was very difficult to root and had a maximum of 8% rooting. The cuttings from this selection were very small (of necessity due to limited annual growth) and slow growing and had a mortality rate of 36% for controls, 48% for 2000/1000 ppm IBA/NAA treatments, and 81% for 4000/1000 ppm IBA/NAA treatments. The accession CLI-3 rooted more readily with a maximum of 52% of the cuttings forming roots. There was a significant affect of auxin treatments on increased rooting percentage, but no significant difference in the number of roots per cutting for CLI-3 (Fig. 3).

Experiment 3

The results of experiment 3 indicate much higher rooting than the other experiments with both auxin treatments resulting in over 90% success and even the control rooting at 8% (Fig. 4). Roots per cutting were similar between the low and high rates of auxin at 6.4 and 5.5 respectively. The rooted control cuttings averaged only 1.5 roots per rooted cutting.

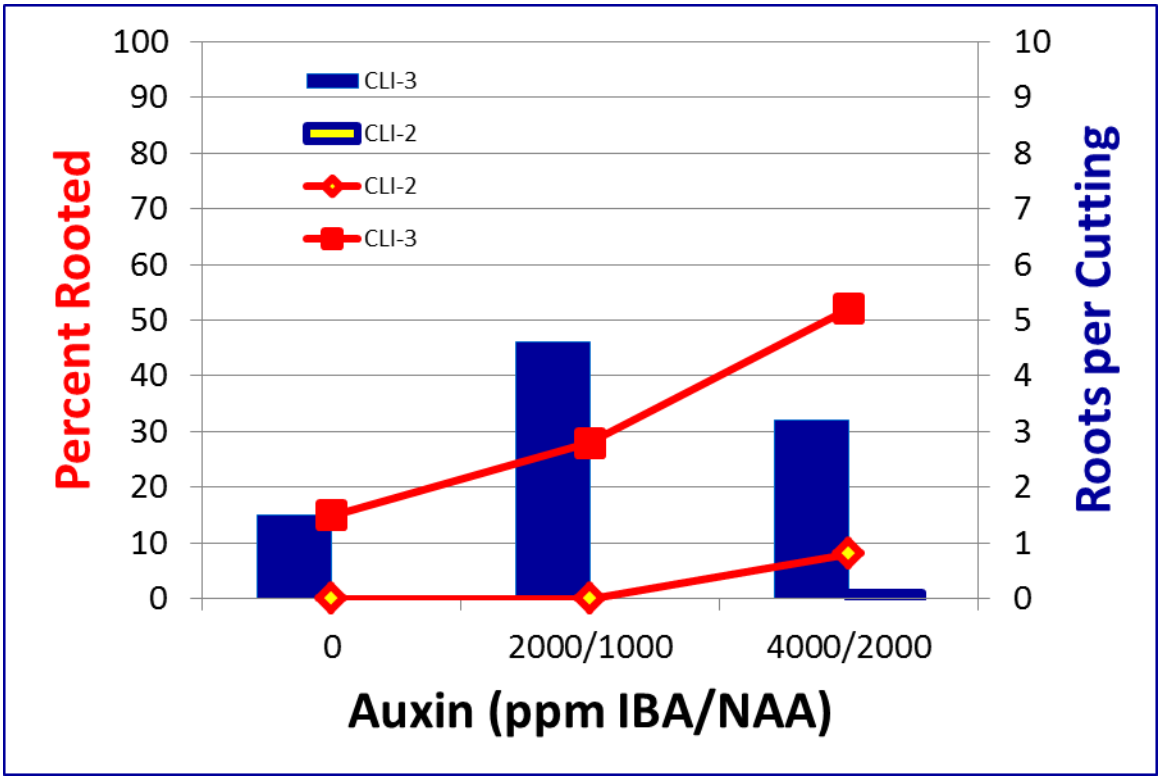

Fig. 3. The effect of auxin concentration on rooting of cuttings from accessions CLI-2 and CLI-3. Asterisks indicate an overall significant effect of auxin treatment on percent rooting.

Experiment 4

Results of this experiment indicated that 85% of the CLI-3 cuttings in the greenhouse rooted (Fig. 5), while only 2% rooted in the Nearing frame (data not shown). Cuttings of CLI-5 and CLI-6 averaged 6 and 2% rooting in the greenhouse, respectively. Neither CLI-5 nor CLI-6 rooted in the Nearing frame. Early on in the experiment it was apparent that cuttings in the Nearing frame were declining. The leaves were rated on a scale of 1-5 (1 being dead and 5 being healthy) and greenhouse cuttings scored 4.3 while Nearing frame cuttings scored 3.4. After 6 weeks all cuttings of CLI 5 & 6 were dead in both environments, while 85% of the CLI-3 cuttings were dead in the Nearing frame and none were in the greenhouse (data not shown). The dead cuttings in the Nearing frame were found to be infected with *Fusarium*.

Experiment 5

Results of this experiment indicated rooting success of 0, 0, 0, and 44 percent for control, auxin, girdle, and girdle/auxin treatments respectively (Fig. 6). When attempts were made to repeat the experiment in 2013 it was apparent that there was not enough regrowth of new shoots to repeat the layering process. The morphology of this plant and its lack of regrowth from the base would indicate that it is a poor selection for propagation by layering.

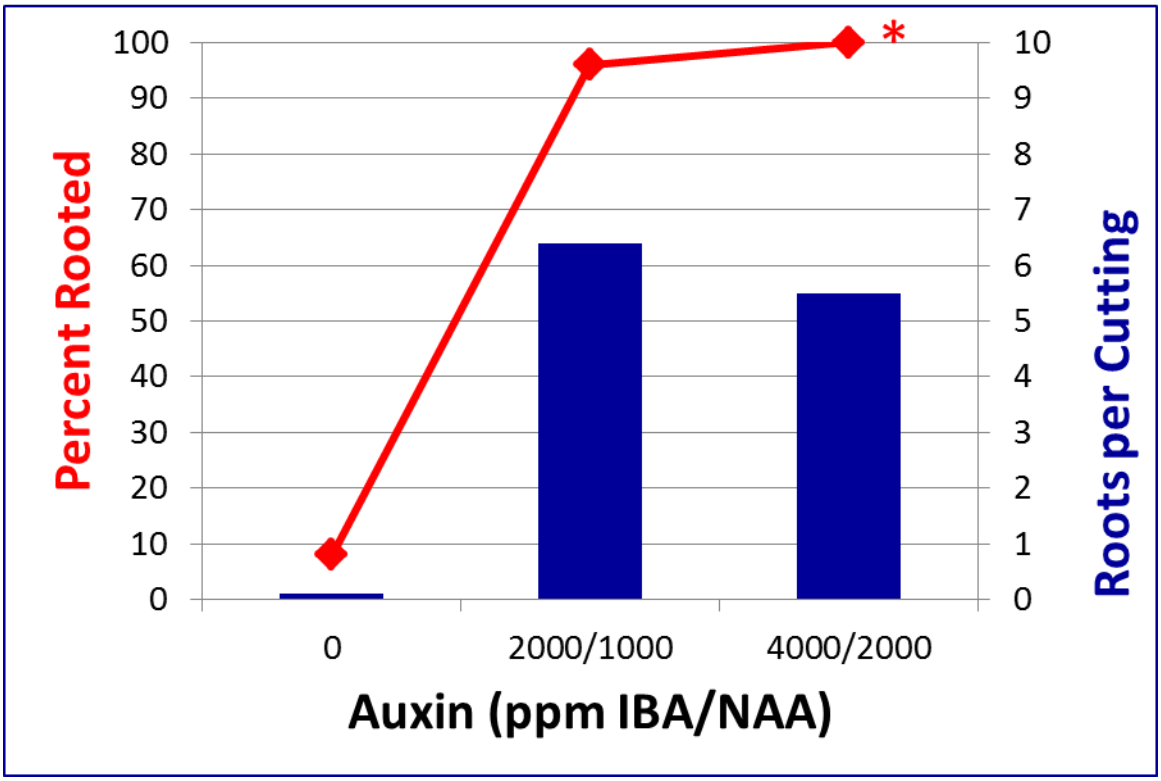

Fig. 4. The effect of auxin concentration on rooting of cuttings from accession CLI-4. Asterisks indicate an overall significant effect of auxin treatment on percent rooting.

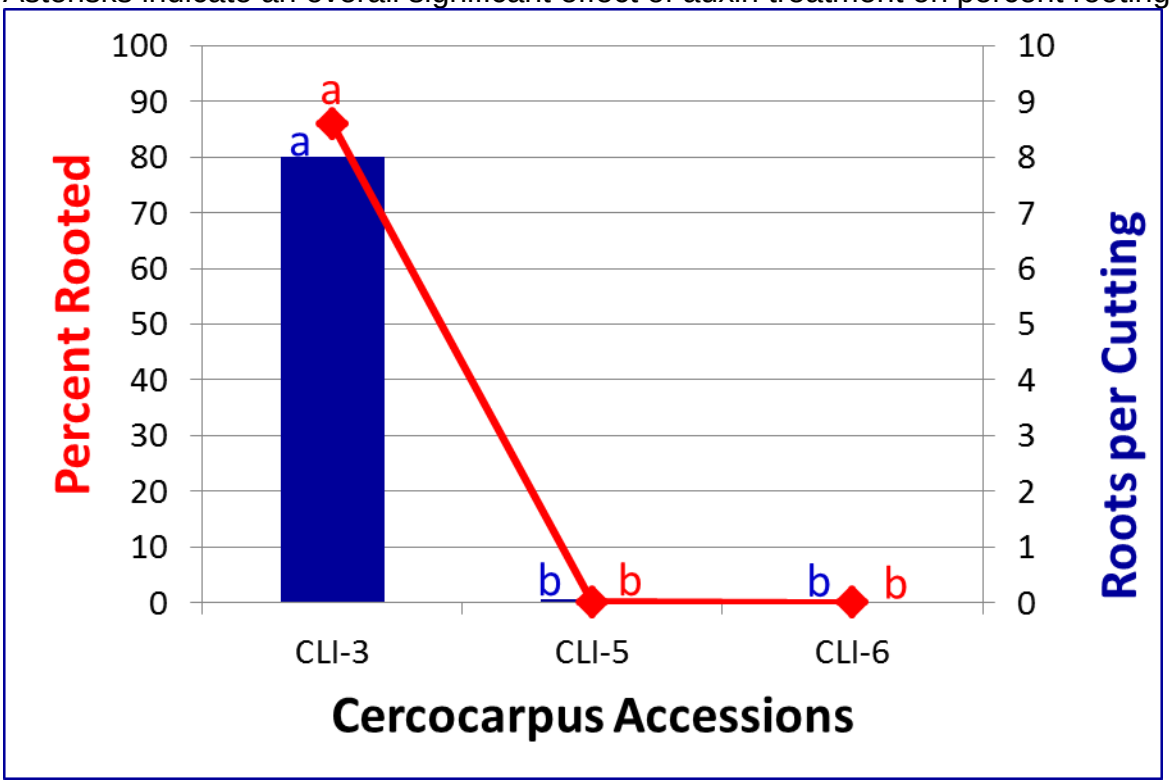

Fig. 5. Response of three accessions (CLI-3, 5, and 6) to rooting conditions. Data points with different letters are significantly different.

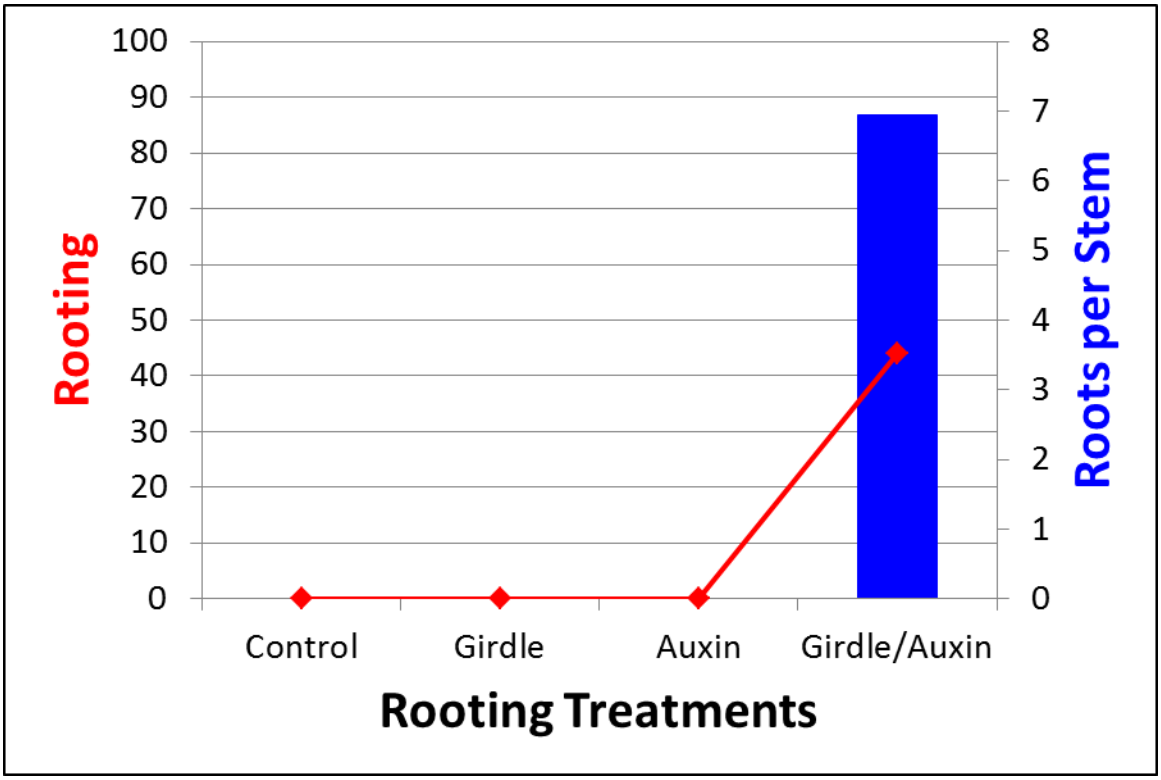

Fig. 6. The effect of girdling and hormone treatments on rooting of layers of CLI-1.

Conclusions

The overall conclusion of this work is that CLI can be rooted as a cutting or as a layer. Further, it is clearly shown that supplemental auxin enhances both the percentage rooting and the number of roots per cutting within those accessions that rooted. There are also differences in rooting among different accessions with CLI-3 and 4 rooting most easily, CLI-1 being moderate, and CLI-2, 5, and 6 being most difficult. When drawing this conclusion it should be kept in mind that there was no single experiment directly comparing accessions with uniform stock plant growing conditions. In one case (CLI-3), cuttings collected from the wild plant in May rooted at 28% with 2000 ppm IBA, while cuttings of the same accession taken from container grown stock plants and rooted in July resulted in 85% rooting success. Other impacts are less clear with almost 100% of the landscape-grown CLI-4 rooting and none of the landscape-grown CLI-5 and 6 rooting. Further, CLI-1 rooted at 42% as cuttings from wild plants and a very similar 44% as layers treated with both hormone and girdling.

In general, there appears to be little direct effect of season on rooting of cuttings as cuttings stuck in January, May, and July were all successfully rooted.

The experiment evaluating Nearing frames as a less expensive alternative to greenhouses for cutting propagation clearly showed less rooting success in the Nearing frame. However, the presence of *Fusarium* in dead cuttings, and subsequent research in progress showing greater rooting success would suggest that additional research is needed to see if increased sanitation and improved environmental control might not improve cutting propagation success.

Lastly, the experiment with layering was disappointing in the overall success rate, and more specifically, its lack of potential for yearly production over an extended period. Given the extra space and labor involved in layering, and the poor regeneration of CLI-1 after being layered, it would appear that propagation by cuttings is the preferable method.

Further research with *Cercocarpus ledifolius* var. *intricatus* is warranted to determine if differences in rooting success may be indicated by factors such as plant size, vigor, or leaf-to-stem ratios. Additional work is also needed to determine if recalcitrant accessions can be induced to root by treatments other than those tested.

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Progress report on the "breeding native flowers for drought tolerant urban landscapes" project

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As June of 2013, we located, sampled tissue, collected herbarium specimens, and photographed, *in situ*, native wild populations of all 69 *Penstemon* species reported to be within the borders of Utah (validated using the USDA Plant Database, 2013). Two additional species (*P. pseudospectabilis* and *P. venustus*) have been found in non-cultivated conditions in Utah, although, neither is considered to be native to Utah. *Penstemon venustus* is a probable introduction by man; however, *P. pseudospectabilis* has been found in at least one location that is not likely to have been introduced via human activity. The *P. pseudospectabilis* herbarium sample was collected in 1991 by Kenneth D. Heil in a very remote area near "Mikes Mesa" in San Juan Co. Utah (S29 NE1/4, T40S, R13E). The sample (017150) is presently housed at the herbarium of San Juan College, Farmington, New Mexico. Locating *in situ* populations of all reported species within Utah paves the way for publication of a book entitled "*Penstemon* of Utah", with an intended audience of both professionals and laymen.

In August, 2013, our article "*Developing molecular tools and insights into the Penstemon genome using genomic reduction and next-generation sequencing*" was accepted for publication in BMC Genetics (Dockter et al., 2013). In that paper we reported the following:

> "**Background:** *Penstemon's* unique phenotypic diversity, hardiness, and drought-tolerance give it great potential for the xeric landscaping industry. Molecular markers will accelerate the breeding and domestication of drought tolerant *Penstemon* cultivars by, creating genetic maps, and clarifying of phylogenetic relationships. Our objectives were to identify and validate interspecific molecular markers from four diverse *Penstemon* species in order to gain specific insights into the *Penstemon* genome.
> **Results:** We used a 454 pyrosequencing and GR-RSC (genome reduction using restriction site conservation) to identify homologous loci across four *Penstemon* species (*P. cyananthus*, *P. davidsonii*, *P. dissectus*, and *P. fruticosus*) representing three diverse subgenera with considerable genome size variation. From these genomic data, we identified 133 unique interspecific markers containing SSRs and INDELs of which 51 produced viable PCR-based markers. These markers produced simple banding patterns in 90% of the species × marker interactions (~84% were polymorphic). Twelve of the markers were tested across 93, mostly xeric, *Penstemon* taxa (72 species), of which ~98% produced reproducible marker data. Additionally, we identified an average of one SNP per 2,890 bp per species and one per 97 bp between any two apparent homologous sequences from the four source species. We selected 192 homologous sequences, meeting stringent parameters, to create SNP markers. Of these, 75 demonstrated repeatable polymorphic marker functionality across the four sequence source species. Finally, sequence analysis

indicated that repetitive elements were approximately 70% more prevalent in the *P. cyananthus* genome, the largest genome in the study, than in the smallest genome surveyed (*P. dissectus*).
Conclusions: We demonstrated the utility of GR-RSC to identify homologous loci across related *Penstemon* taxa. Though PCR primer regions were conserved across a broadly sampled survey of *Penstemon* species (93 taxa), DNA sequence within these amplicons (12 SSR/INDEL markers) was highly diverse. With the continued decline in next-generation sequencing costs, it will soon be feasible to use genomic reduction techniques to simultaneously sequence thousands of homologous loci across dozens of *Penstemon* species. Such efforts will greatly facilitate our understanding of the phylogenetic structure within this important drought tolerant genus. In the interim, this study identified thousands of SNPs and over 50 SSRs/INDELs which should provide a foundation for future *Penstemon* phylogenetic studies and breeding efforts."

As we launch our breeding program, we are very interested in three characteristics, pleasant smell, large bloom size, and drought tolerance. A review of old American Penstemon Society bulletins along with our molecular and field studies lead us to conclude that we should begin our interspecific breeding work using 12 *Penstemon* species and their botanical varieties: *P. barbatus*, *P. eatonii*, *P. carnosus*, *P. compactus*, *P. gibbensii*, *P. navajoa*, *P. pachyphyllus*, *P. palmeri*, *P. petiolatus*, *P. scariosus, P. pseudospectabilis*, and *P. strictus*. Photographs of most of these species can be viewed in Fig. 1. Each of these species is noted for characteristics that would make them valuable in an urban landscape. For instance, the varieties of *P. scariosus* have dark blue flowers - a color less commonly available in the landscape industry. Furthermore, this species has large flowers. Also, bloom persists well into July (bloom starts in late May) under very hot, dry conditions.

Penstemon barbatus and *P. eatonii* are often attributed with the ability to more easily hybridize with other species in nature. *Penstemon barbatus* is also noted for having a longer life span in cultivation and is already in the garden trade (Viehmeyer, 1954). Furthermore, both of these species have flowers in tones of red, which is a popular color in the urban landscape.

As a last specific example, *P. palmeri* is one of only two species within this genus that is known to have a very pleasant fragrance when in bloom. It has been used to create a number of interspecific hybrids as early as 1957 and was used as parental stock for many years (Viehmeyer, 1957; Viehmeyer, 1959a; Viehmeyer, 1959b; Viehmeyer, 1960; Viehmeyer, 1961; Viehmeyer, 1962; Viehmeyer, 1965; Viehmeyer, 1966a; Viehmeyer, 1966b; Viehmeyer, 1973). Moreover, *P. palmeri* has very large flowers and is well adapted to the very hot, dry conditions of southwestern US deserts.

The other members of our 12-species parental pool are very closely related to the ones mentioned and share many of their landscape-friendly traits. They all exhibit drought tolerance along with other species specific characteristic of interest, such as attractive leaf color and/or morphology, appealing flower color and size, prominent plant size, and so-on.

Fig. 1. *In situ* photographs of 11 of the 12 species we have identified as valuable parental material with which to initiate our drought tolerant *Penstemon* interspecific hybrid breeding program.

P. barbatus

P. eatonii

P. carnosus

P. compactus

P. gibbensii

P. navajoa

P. pachyphyllus

P. palmeri

P. scariosus

P. petiolatus

P. strictus

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