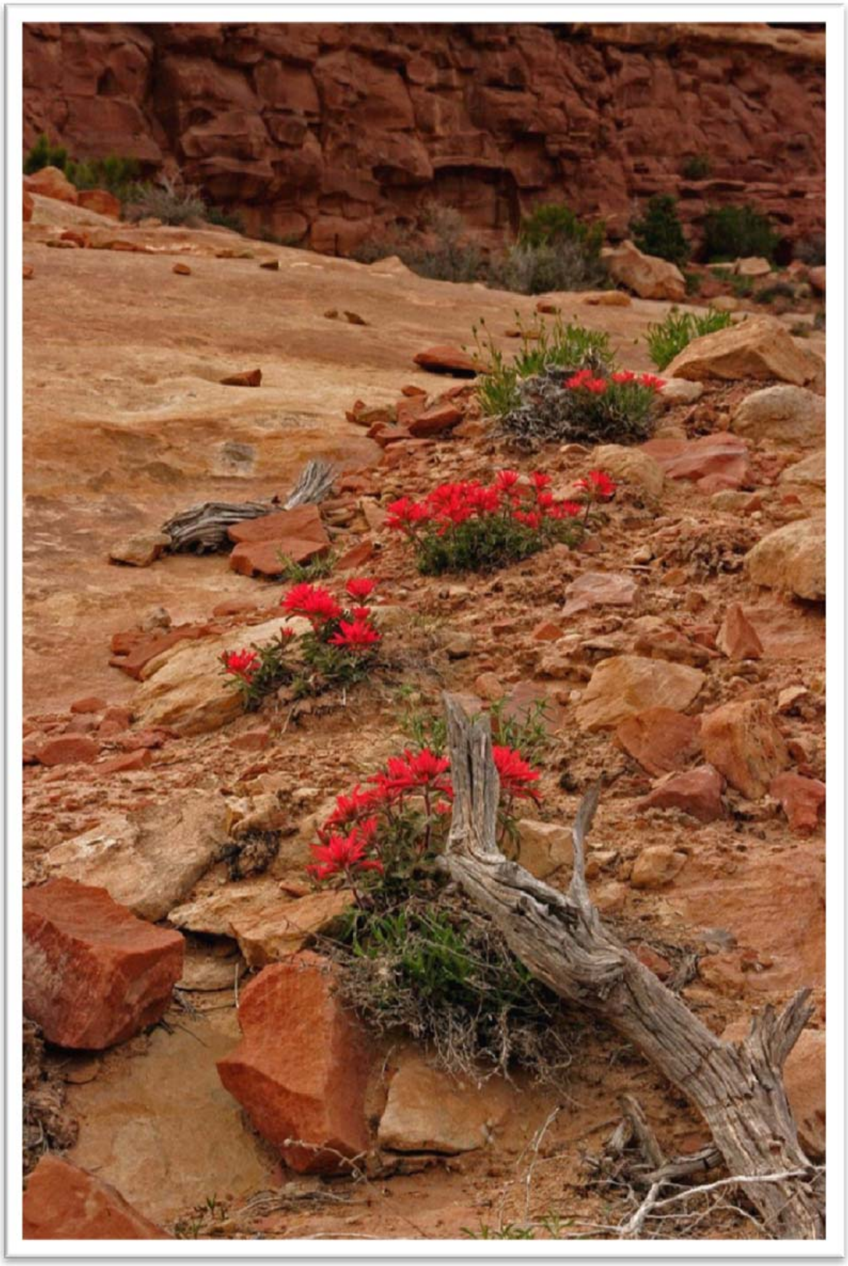
# Report of the Intermountain Native Plants Cooperative



*Volume 2* *December 2010*

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

# Report of the Intermountain Native Plants Cooperative

## Number 2 – December 2010

**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 Stephen L. Love and is of *Castilleja scabrida* on the Moki Dugway of San Juan Co. Utah.

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## Announcements

**2011 WERA** Meeting will be hosted, at yet to be determined date, by James E. Klett, Colorado State University, Fort Collins CO.

**Culture of native grasses and irrigation of native perennials**

Tracy Dougher

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**Goal 1. Continue to establish cultural requirements for native grasses in turfgrass applications.**

Experimentation is continuing on native fine fescue plots established to determine the effect of mowing height on quality, survivability, and longevity. Thirteen native fescue species and mixes were seeded in individual plots 90' x 5' in the fall and watered at 1" per week through the remaining fall period. The following spring, plots were watered evenly with 0.5 inches of water per week. Subplots (3.5' wide), perpendicularly intersecting the species plots, were left unmowed (nm) or mowed to a height of 0.5" (low), 1.5" (medium), or 3" (high) (see Fig. 1 and 2). In the first spring, weeds were controlled with a broadleaf herbicide. In subsequent seasons, weed emergence will be counted in the spring and controlled with a broadleaf herbicide once in the early spring, if necessary.

Fig. 1. Layout of the native and adapted fine fescue mowing height experiment. Two replicates are shown. The experiment includes 4 replicates of each mowing height.

| Species / Mowing Height | nm | med | low | high | low | med | high | nm |
|---|---|---|---|---|---|---|---|---|
| Festuca arizonica 'Redondo' | | | | | | | | |
| Festuca ovina glauca 'Blue Heron' | | | | | | | | |
| Festuca trachyphylla 'Berkshire' | | | | | | | | |
| Festuca trachyphylla 'Rescue 911' | | | | | | | | |
| Festuca trachyphylla 'Aurora Gold' | | | | | | | | |
| Festuca idahoensis 'Nezpurs' | | | | | | | | |
| Festuca ovina duriscola 'Durar' | | | | | | | | |
| Festuca rubra 'Florentine' | | | | | | | | |
| Festuca rubra commutata 'Tiffany' | | | | | | | | |
| Festuca ovina 'Covar' | | | | | | | | |
| Festuca rubra 'Molate' + Festuca ovina 'Covar' | | | | | | | | |
| Festuca rubra 'Molate' | | | | | | | | |
| Festuca ovina 'Black Sheep' + 'Covar' + Festuca ovina duriscola 'Big Horn' | | | | | | | | |

Experimental measurements on the plots include growth response as determined by height of regrowth prior to mowing, visual quality as determined by a rating scale of 1 (dormant) to 9 (highest quality) (Skogley and Sawyer, 1992), species survival, and species composition for mixes. In the second season after establishment, a survey of client preference was conducted with undergraduate students, master gardeners, and public tour groups. This survey addresses the preferences for the species and the mowing height of the fine fescues.

To date, establishment of these grass species and cultivars at a commercial site has been unsuccessful. Problems lie with initial establishment of a dense stand as well as drainage and weed problems at the grower's site.

Fig. 2. Picture of the established fine fescue plots mowed at various heights.

**Goal 2. Define the tolerances and limitations of native perennials in the built landscape.**

Twelve planting beds were constructed at the MSU Horticulture Farm. Three beds each will be drip irrigated at each of four levels (0, ¼, ½, and full supplementation). The experiment was set up in a randomized split-plot design with species randomized within each irrigation level (see Fig. 3). The beds are being planted with Montana native perennials, initially starting with 9-12 plant species for which greenhouse and propagation protocols have been established. Native plant nurseries in the state currently produce native species including *Achillea, Anemone, Campanula, Echinacea, Gaillardia, Geranium, Heterotheca, Iliamna, Monarda, Oenothera, Penstemon, and Ratibida*. The initial planting includes, but will not be limited to, several of these species. Priority for species in the planting beds will be for species that are not currently well-utilized in the landscape industry. The beds were designed large enough to allow addition of other species from Intermountain West research programs in future years. Plants will be observed and measured weekly throughout the summer for plant size and form, bloom number and size, and plant survival. In subsequent years, winter injury will be monitored. Plots will be hand-weeded. Evaluation and maintenance of plots will be in conjunction with MSU Master Gardener volunteers to provide an educational component to the project.

Fig. 3. Native perennials planting bed at the MSU Horticulture Farm. The planting beds can have varied levels of water.

**Literature Cited:**

Skogley, C.R. and C.D. Sawyer. 1992. Field research. p. 589-614. In D.V. Waddington, R.N. Carrow, and R.C. Shearman (eds.) Turfgrass. ASA, CSSA, SSSA, Madison, WI.

**Plants tested and marketed at Draggin' Wing Farm**

Diane Jones

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Draggin' Wing Farm in Boise has established an extensive demonstration garden in an effort to both test and showcase a variety of native and other xeric plants. In one section of the demonstration garden we are working on establishing a "Northern High Desert" landscape. The goal is to create a landscape style that is an aesthetically pleasing and immediately recognizable reflection of our high desert region. Foundation shrubs for this concept include sagebrush, rabbitbrush and bitterbrush. The initial planting was done in the fall of 2007. See photographs.

Draggin' Wing Farm demonstration garden in May, 2010

Sagebrush comes in several varieties that are useful in the xeric landscape. At lower, hotter elevations Basin Big Sagebrush (*Artemisia tridentata ssp. tridentata*) can make an interesting and attractive foundation plant, reaching 4 to 5 feet or more. Its commonly scraggly appearance can be modified by gentle pruning. Mountain Big Sagebrush (*Artemisia tridentata ssp. vaseyana*) is similar in appearance, but shorter and more compact, lending itself tighter spaces. In Western Idaho it grows naturally at elevationsof 4,000’ and above and may prove to be short-lived at lower elevations. Fringed Sagebrush (*Artemisia frigida*) is a very attractive low-growing plant with delicate, frilly leaves at ground level, topped by typical sagebrush flower stalks in mid-summer. In our trials, Fringed Sagebrush has proven to be carefree and undemanding—at home in both full sun and partial shade.

Gray Rabbitbrush (*Ericameria nauseosus*) is an unfailingly handsome foundation shrub with slim silver leaves and a generous yellow bloom in the fall. The trick to keeping rabbitbrush attractive in the landscape is heavy pruning in the spring. This encourages a flush of beautiful and vigorous new growth in late spring and summer while maintaining the plant in a nice, compact shape.

Bitterbrush (*Purshia tridentata*) is another excellent foundation shrub, with strong architectural qualities and a lovely burst of tiny yellow flowers in the spring. In a good year, the bitterbrush bloom is nothing short of spectacular, rivaling forsythia for trumpeting the welcome news of spring. Bitterbrush, like sagebrush, will adapt to gentle pruning.

All three of these shrubs, once established will survive very well without irrigation.

**Introduction of native and water-conserving species through the Plant Select® program**

James E. Klett

Colorado State University, Horticulture and Landscape Architecture


'Prairie Lode' sundrops (*Calylophus serrulatus*)

Due to the Plant Select® program, over 1.5 million plants, many of which are native plants, were reported sold in 2010 and helped citizens throughout the Great Plains and Intermountain areas become more successful in gardening. In 2010, seven plants from Plant Select® program were recommended for use for the Rocky Mountain and Plains States. Six were perennial and one was a woody plant. The plants included 'Prairie Lode' sundrops (*Calylophus serrulatus*), red feathers (*Echium amoenum*), Snow Mesa buckwheat (*Eriogonum wrightii var. wrightii*), red yucca (*Hesperaloe parviflora*), regal torchlily (*Kniphofia caulescens*), redleaf rose (*Rosa glauca* or *Rosa rubrifolia*), partridge feather (*tanacetum densum ssp. amani*).


Snow Mesa buckwheat (*Eriogonum wrightii var. wrightii*)

Numerous talks, tours etc. were given throughout 2010 about plant selection. A report on Plant Select® plants, many of which are natives, was given in February 2010 at the 2010 ProGreen Conference held in Denver, Colorado. This information as also been presented throughout 2010 to numerous other commodity groups in Colorado including Turf, Greenhouse, Garden Center and Nursery organizations. Also, a collaboration meeting was held with members of the

Colorado Green Industry in September 2010.

A demonstration garden meeting was held in June 2010 to provide information about Plant Select® plants. Plant Select® plants were distributed to various demonstration gardens throughout the region. Among the 70 Plant Select® demonstration gardens, more than 1 million visitors were reported.

Red feathers (*Echium amoenum*)

Plant Select® plants, which are either introductions (new to the market place) or recommendations (superior plants already produced in the nursery industry), sold throughout the state and region translates to marketing more profitable plants for growers and retailers throughout the region.

**Variation among common Utah globemallow species**

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Our group studies variation and diversity among intermountain western native plant species to 1) assure their stability and performance in home and commercial landscapes and 2) assess their useful range for growers to establish a market for their stock. *Sphaeralcea* (globemallow) species are a diverse group of forbs in the family Malvaceae. They are extremely drought-tolerant and readily cross-pollinate with one another. The fact that they readily hybridize makes field identification difficult and brings into question the identity of species distributed or sold for reclamation and home garden use. Four species are common to Utah: *S. coccinea*, *S. grossulariifolia*, *S. munroana* and *S. parvifolia*. Gooseberryleaf globemallow (*S. grossulariifolia*) is promoted as an attractive, drought-tolerant native species for northern intermountain western markets.

Our objective was to clarify taxonomic relationships among the four species by investigating morphological and genetic variation.

Taxonomy
The main taxonomic characters used to distinguish among *Sphaeralcea* species include leaf shape, pubescence and degree of dissection; flower arrangement on stems; and shape of the fruit (schizocarp). For practical field identification, leaf shape and degree of leaf dissection are the most commonly used characters (Fig. 1). However, our work has shown these characters to be quite variable within species and not reliable as the sole indentifying characters. We noticed that plants obtained from a variety of sources labeled as a single species were not consistent in their appearance. We also observed that plants grown from seed labeled as a single species and obtained from different sources produced plants with highly variable characters (Fig. 2). Further, we found that plants transplanted from the wild into a common garden responded to a common soil environment and irrigation regime by modifying their leaf size and degree of leaf dissection (Fig. 3).

Fig. 1. Leaf morphology of herbarium specimens of *S. coccinea*, *S. grossulariifolia*, *S. munroana*, *S. parvifolia* (left to right). Source: Intermountain Herbarium, Utah State University, Logan, UT

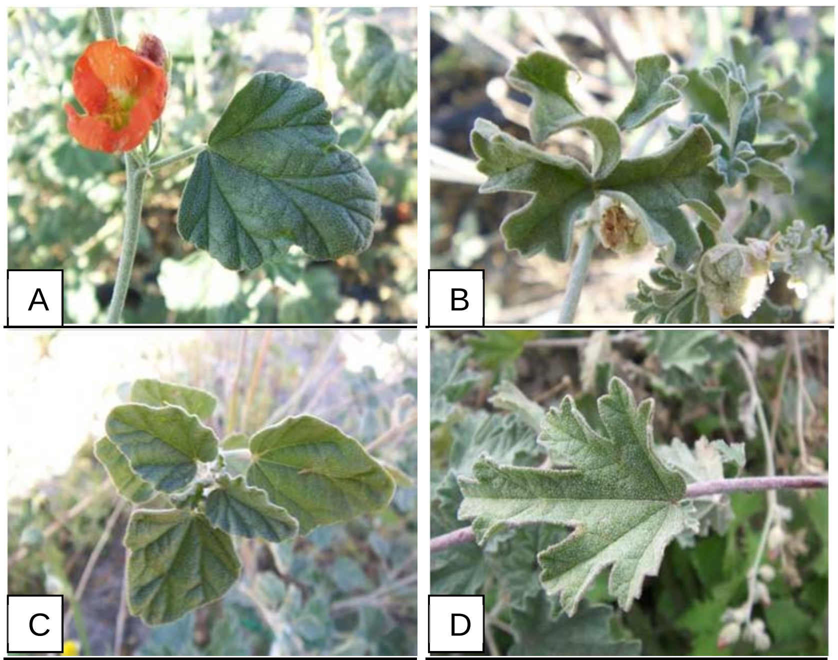


Fig. 2. Leaf morphology of *Sphaeralcea* grown from seed obtained from various sources. A and B were from seed labeled *S. grossulariifolia*; C and D were from seed labeled *S. munroana*.

Morphological Variation

We are studying morphological variation using two approaches: 1) common garden study and 2) comparison of herbarium- and field-collection specimens with type specimens.

*Common garden study*: Based on source locations of herbarium specimens, we collected at least five plants each of the four species from locations across Utah. According to these published locations in Utah, the ranges of *S. coccinea* and *S. grossulariifolia* overlap, and they are widely distributed across the state. In contrast, the ranges of *S. munroana* and *S. parvifolia* are distinct, and the species appear to be separated geographically by the Wasatch Mountain Range, *S. munroana* occurring northwest of the Wasatch Range, and *S. parvifolia* generally occurring southeast of the Range.

Plants were collected in early June and transplanted into a common garden at Greenville Research Farm in North Logan, UT. Once established, plants were cut back to within six inches of the crown and allowed to grow back through the summer. Measurements of leaf characters were made before cut-back and after re-growth.


Fig. 3. Leaf morphometric responses to common garden conditions. Leaves from plants prior to cut-back of stems (labeled “Old leaf”) are more deeply dissected than leaves from plants after re-growth (labeled “New leaf”). The leaves in each picture were removed from stems of the same plant.

*Comparison of herbarium- and field-collected specimens with type specimens*: A type specimen is the original plant specimen from which the description of a new species is made. We obtained type specimens for the four *Sphaeralcea* (three to 17 specimens for each species) from herbaria across the U.S. and Great Britain. We compared ten morphometric characters of our own field- and herbarium-collected specimens with those of the type specimens. Using a multivariate statistical analysis (Principal Components Analysis) to create a model of data from type specimens, we were able to verify the identity of local herbarium specimens, and to group field-collected specimens by their similarity to type specimens, based on the ten selected characters. Table 1 outlines the ten selected characters and their relationships across type specimens.

Based on our model, we found that while 94% and 100% of *S. coccinea* and *S. parvifolia* herbarium samples, respectively, identified with type specimens; only 12% of *S. grossulariifolia* samples identified with type specimens. None of the *S. munroana* herbarium samples were true to type; all *S. munroana* herbarium specimens clustered with *S. parvifolia* type specimens.

Genetic Variation

We used Amplified Fragment Length Polymorphism (AFLP) to resolve differences among the four species. Genomic DNA from leaf samples from 20 populations (10-12 plants per population) was extracted and subjected to the AFLP technique. The resulting amplified DNA fragments were separated on a gel matrix to compare the band patterns. These were scored, and the data were subjected to cluster analysis. The resulting groups were consistent with those resolved using morphometric characters.

Table 1. Statistical relationships among ten morphometric characters obtained from type specimens of the four *Sphaeralcea* species. No one character accounts for all differences among the species.

| **Character** | ***S. coccinea* (n = 8)** | ***S. grossulariifolia* (n = 5)** | ***S. munroana* (n = 3)** | ***S. parvifolia* (n = 17)** |
|---|---|---|---|---|
| Petiole length | - | - | - | - |
| Mid-lobe length | - | - | - | - |
| Mid-lobe width | - | - | - | † |
| Secondary lobe length | - | - | - | - |
| Secondary lobe width | - | - | - | † |
| Lobe depth | - | - | † | † |
| Pedicel length | - | - | - | - |
| Calyx length | - | - | - | - |
| Petal length | - | - | - | - |
| Flowers / node | † | - | - | - |

† indicates difference at $P < 0.05$.

Summary:
These data support the existence of two main groups rather than four within the *Sphaeralcea* species included in the study. In conclusion:

- *Sphaeralcea coccinea* is a distinct species. The presence of a single flower per node is characteristic.
- *Sphaeralcea munroana and S. parvifolia* may be ecotypes of a single species. They can be differentiated from *S. coccinea* by having an entire rather than a dissected leaf shape.
- *Sphaeralcea grossulariifolia* does not appear to be distinct, and may represent hybridization among the other species.

Publications:

Sriladda, C. and H. Kratsch. 2008. Adequacy of morphological traits in discrimination among four species in *Sphaeralcea* (Globemallow). Western Section of the American Society of Plant Biologists, Orem, Utah.

## Studies on Indian paintbrush establishment

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### Introduction

Indian paintbrush (*Castilleja*) species are notoriously difficult to transplant, establish, and maintain in a cultivated site. Reportedly, this is due in part, to their hemi-parasitic nature and dependence on a host plant. The limited, hair-like root system may add to their inability to extract adequate nutrients and water from soils typical to the intermountain west.

A few nurserymen have found methods to successfully raise and market *Castilleja* plants in limited quantities (Luna, 2005). This usually involves direct seeding into pots while simultaneously seeding an appropriate small-statured grass, such as blue grama. Although many attempts have been made to grow paintbrush, very little formal research has been conducted to evaluate critical factors for successfully transplanting and establishing *Castilleja* species into the garden. In the summer of 2010, a preliminary study was designed and initiated to study the impact of paintbrush species, host species, and supplemental water/nutrients on paintbrush transplant survival and establishment.

### Study Design

Seeds of three paintbrush species, *Castilleja integra, C. chromosa,* and *C. scabrida* were stratified at 4C for eight weeks beginning in February, 2010. After being allowed to germinate and emerge, seedlings with approximately five true leaves were transplanted into cone trays and allowed to grow until approximately two inches tall. During the last week of May, 2010 the seedlings were planted into a replicated field trial at the Aberdeen R & E Center (Declo silt loam, pH 8.4).

Treatments were designed to provide combinations of three *Castilleja* species, with or without one of three host plant species, and with or without supplemental water and nutrients. Limited numbers of seedlings, especially of *C. chromosa* and *C. scabrida*, did not allow use of a completely factorial design. The following eight treatments, replicated four times (RCBD), were utilized:

1. *C. integra* planted alone, no supplemental water/nutrients
2. *C. integra* planted with *Festuca idahoensis*, no supplemental water/nutrients
3. *C. integra* planted alone, weekly supplemental nutrients/water
4. *C. integra* planted with *Festuca idahoensis*, weekly supplemental nutrients/water
5. *C. chromosa* planted alone
6. *C. chromosa* planted with *Penstemon pinifolius*
7. *C. scabrida* planted alone
8. *C. scabrida* planted with *Eriogonum caespitosum*

Host species plants were paired with paintbrush seedlings at the time of field transplanting. Host plant seeds were stratified (except the Idaho fescue), transplanted into pots, and prepared for field transplanting on the same time schedule as the paintbrush seedlings. Pairing was accomplished by removing corresponding plants from pots, pressing the rootballs of paintbrush and host firmly together, placing them into a divot, and covering the adjoined rootballs with soil. Each plot consisted of a single paintbrush plant paired or non-paired with a single host plant. Plots were arranged in a grid with four feet between plots to insure root isolation.

After transplanting, plots were watered thoroughly. Additional water was added to aid establishment. Approximately 0.5 inches of water was added three times during the first week, twice the second week, and once the third week. After establishment, only three significant irrigation events occurred, with approximately 1.5 inches of water applied each time at approximately 5 week intervals.

Plots with supplemental water/nutrients were treated with 0.5 inches of a dilute solution of Miracle-Gro fertilizer. Supplements were added weekly beginning three weeks after planting and ending the last week of September.

Each week, paintbrush and host plants were rated for survival, vigor, symptoms of chlorosis, and presence of flowers. Ratings began one week after planting and continued until the last week of September when all paintbrush plants were either dead or mostly dormant.

**Results and Conclusions**

Establishment success in the trial was remarkably good. Most plants remained healthy in the first weeks following transplanting. Given the erratic historical results of transplanting paintbrush at Aberdeen, this was a favorable start to the study. Only four paintbrush plants suffered serious transplant shock, dying back to the soil surface, but all subsequently resprouted and initiated normal growth.

Analysis of the influence of paintbrush species was completed using only treatments without host plants and without supplemental water/nutrients. Among species, there was no significant difference in vigor rating at either 6 or 13 weeks after planting, although the vigor of *C. chromosa* trended markedly lower than that of the other species. Without a host, all of the *C. integra* plants survived the entire first season, while only 75% of the *C. scrabrida*, and none of the *C. chromosa* plants survived. Survival data was qualitative and not analyzed statistically (See table and pictures below).

| Species | Vigor 6 | Vigor 13 | %Survival |
|---|---|---|---|
| *C. integra* | 3.8 | 3.3 | 100 |
| *C. scabrida* | 3.5 | 2.3 | 75 |
| *C. chromosa* | 2.3 | 1.0 | 0 |
| LSD (.05) | ns | ns | |

C. integra

C. scabrida

C. chromosa

Analysis of host influence was completed without the treatments involving supplemental water/nutrients. The presence of a host plant provided a marked impact on paintbrush vigor, regardless of species (no interaction, therefore analyzed across species). Plants paired with hosts were significantly more vigorous by the end of six weeks and this difference became much larger by the end of the season. All plants paired with a host survived the first season of growth. Only 58% of the plants without paired hosts survived (see table and pictures below).

Visual observation led to another interesting discovery with respect to paired host plants. Paintbrush plants without hosts, regardless of species, all distinct symptoms of chorosis. Close inspection revealed symptoms typical of iron and/or zinc deficiency, with green leaf veins and yellow interveinal tissues. As a result of this observation, samples of paintbrush leaf tissue were collected from all plots and submitted for foliar nutrient analysis (not reported).

| Companion | Vigor 6 | Vigor 13 | %Survival |
|---|---|---|---|
| With | 5.3 | 7.4 | 100 |
| Without | 3.2 | 2.1 | 58 |
| LSD (.05) | 1.2 | 1.3 | |

Without host

With host

Impact analysis for supplemental water and nutrients was completed only on treatments that included *C. integra*. Vigor after six and 13 weeks was not significantly influenced by the addition of supplemental water and nutrients. However, there was a trend for greater vigor with supplements at three weeks, but none by the end of the season. The one observed factor that seemed to be influenced by the addition of supplements was the tendency for the plants to reach bloom stage (qualitative data, not analyzed statistically). Twice as many plants bloomed with supplements as compared to plants without (see table and pictures below).

| Supplements | Vigor 6 | Vigor 13 | %Bloom |
|---|---|---|---|
| Applied | 4.5 | 5.1 | 50 |
| Not applied | 3.9 | 4.9 | 25 |
| LSD (.05) | ns | ns | |

Without supplements

With supplements

In this preliminary study, a few additional unsubstantiated observations were made that may warrant followup. First, the two forb host species, pineleaf penstemon and mat buckwheat, appeared to be better hosts for paintbrush than Idaho fescue. This observation was confounded by the fact that paintbrush and host species were matched one-to-one. Consequently, this trend may be associated with differences in paintbrush species growth patterns. However, in historical observations made on these species when grown under equivalent conditions, vigor of *C. integra* has been the highest of the three species. When paired with Idaho fescue, this paintbrush species had the lowest vigor as compared to the other species which were paired with forb species. This may be related to a tendency for Idaho fescue to exhibit partial dormancy in late summer, making it a less efficient host, or may be due to any number of other unknown factors.

Although preliminary, this study does allow for some conclusions related to factors impacting paintbrush establishment. It appears that choice of *Castilleja* species has a marked impact on survival. This suggests that success may be had in evaluating a large number of species to identify those most likely to best withstand cultivation. Also, host plants have a marked influence on paintbrush vigor and survival. This result was expected and lends support to previous studies and assumptions. There appears to be much room for work to determine the best host species for paintbrush cultivation, match host and paintbrush species to optimize response, and to find host species that complement paintbrush with respect to plant size, bloom time, and flower color.

Lastly, it appears that providing supplemental water and nutrients has only marginal effects on transplanted paintbrush plants and does not take the place of a host relationship. This response may partially be an artifact of the high pH soils at the Aberdeen research site. Paintbrush grown in optimal soil conditions may show a different response.

This study was supported, in part, by a grant from the Idaho Nursery and Landscape Association.

Literature cited

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**Salt tolerance of selected native wildflower species**

Genhua Niu

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Native wildflowers are appropriate plants for water-conserving landscapes because they can reduce maintenance demands including limiting applications of fertilizers, pesticides and water. This study evaluated salt tolerance of five wildflowers, *Salvia farinacea* (mealy cup sage), *Berlandiera lyrata* (chocolate daisy), *Ratibida columnaris* (Mexican hat), *Oenothera elata* (evening primrose), and *Monarda citriodora* (lemon horsemint).

Seeds were germinated and seedlings were grown in a greenhouse before initiation of treatments. Plants were moved to a shade house with 25% light exclusion. After being acclimatized for two weeks, plants were treated with saline solutions at electrical conductivity (EC) of 0.8 (tap water, control), 2.8, 3.9, 5.5, and 7.3 $dS \cdot m^{-1}$ for 38 days.

Lemon horsemint was most sensitive to salinity stress and could not tolerate any elevated salinity in irrigation water. Chocolate daisy was moderately sensitive and may be irrigated with low salinity water, less than 3.9 $dS \cdot m^{-1}$. Based on the current study, the order of salt tolerance among the five species was Mexican hat > evening primrose and mealy cup sage > chocolate daisy > lemon horsemint. Mexican hat, evening primrose and mealy cup sage may be irrigated with recycled water at an EC less than 3.9 $dS \cdot m^{-1}$ without loss of aesthetic value.

**Salt tolerance of more bedding plants evaluated**

Bedding plants are extensively used in landscapes in the United States. As high quality water supplies become limiting in many parts of the world, the utilization of recycled water is being encouraged to irrigate landscapes. The relative salinity tolerance of eight bedding plant species, proved to be acceptable or excellent in semi-arid environment, was evaluated. Bedding species included in the study were, angelonia (*Angelonia angustifolia*), helenium (*Helenium anarum*), licorice plant (*Helichrysum petiolatum*), plumbago (*Plumbago auriculata*), vinca 'Rose" (*Catharanthus roseus*), and three cultivars of ornamental pepper 'Calico', 'Purple Flash', and 'Black Pearl' (*Capsicum annuum*).

Seedlings were irrigated with saline solutions at various salinity levels and salinity tolerance was determined according to their growth, visual quality, and physiological responses. Results indicated that all species were moderately salt tolerant and may be irrigated with alternative water sources with salinity up to 4.0 dS $m^{-1}$ without any salt damage and significant growth reduction. These bedding plants were evaluated twice for their salt tolerance, in an outdoor shade house and in the greenhouse. Therefore, it is safe to use reclaimed water to irrigate landscapes where these bedding plants are used. Assuming 50% of the landscapes in El Paso are irrigated with recycled water, the potential water saving may reach to 19,528 MG per year.

Publication list

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Niu, G., D.S. Rodriguez, and T. Starman. (2010). Response of bedding plants to saline water irrigation. *HortScience*, 45(4), 628-636.

Niu, G. and R.I. Cabrera. (2010). Growth and physiological responses of landscape plants to saline water irrigation – a review. *HortScience*, 45(11), 1605-1609.

Niu, G. and R. Cabrera. (2010). Irrigating ornamental horticultural plants with alternative water sources. In A.N. Sampson (ed.): *Horticulture in 21st Century* (pp. 143-160). Nova Science Publishers, New York.

Niu, G. and D.C. Rodriguez. (2010, January). Growth Response of Selected Bedding Plants to Three Irrigation Levels. Proceedings of Southern Nursery Association 55:195-199.

Niu, G., M. Gu, and D.C. Rodriguez. (2010, January). Nitrogen rate and form affected growth of Texas mountain laurel. Proceedings of Southern Nursery Association 55:349-353.

Wang, M., G. Niu, D.C. Rodriguez, and D. Zhang. (2010, January). Response of Zinnia Cultivars to Salinity. Proceedings of Southern Nursery Association 55:189-194.

## Selection and vegetative propagation of exceptional native woody plant clones

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**Abstract**
Existing populations of native woody plants includes individual plants with uniquely ornamental characteristics have may have potential for use in water-conserving landscaping. We utilized a variety of methods to identify accessions of *Acer grandidentatum* with exceptional fall color and other desirable characteristics. Identified trees were then evaluated, propagated by chip budding into a nursery environment, propagated from grafted stock by cuttings, and established in a mound layer bed as a potential means of inexpensive propagation by Utah growers. A key method of selecting accessions was through aerial photography coupled with GPS tracking, GeoSetter© software, and Google™ Earth as aids in locating plants on the ground. Initial propagation of wild maples was accomplished through chip budding, with the optimum time being mid-July to mid-August. Propagation by rooted cuttings was significantly enhanced by using etiolated shoots. Other native plants selected for propagation include *Paxistima myrsinites*, a hybrid of *Juniperus osteosperma*, *Cercocarpus intricatus*, an unidentified *Ericameria*, *Ceanothus martinii*, and a broom of *Cercocarpus ledifolius*. Cuttings from these selections were successfully rooted except for the juniper and the *C. ledifolius* broom.

**Introduction**
The increasing demand for woody landscape plants adapted to small, water conserving landscapes is creating a niche market for native plants with uniform, reproducible, aesthetically desirable characteristics such as brilliant fall color, dwarf form, or glossy leaves. Identifying, documenting, and asexually propagating such plants are the first steps in introducing them to the nursery and landscaping industries in Utah and the Intermountain West. This paper reviews our attempts to identify and propagate selected native plants for introduction into the landscape trade.

**Overall plant selection and propagation protocol**
Using bigtooth maple (*Acer grandidentatum*) as a model plant, we have developed a protocol for selecting and propagating plants for potential introduction into the landscape trade (Fig. 1). Initial accessions were chosen based on plant form and/or fall color and identified through word of mouth, chance observation, aerial photography with digital real-color images, or images from Google Earth™. Once selected, accessions were located on the ground and documented using GPS technology. Due to the difficulty in rooting cuttings, propagation was done by budding onto seedling rootstocks in a nursery environment (in this case a mound layer bed). Shoot cuttings of established scions were then used to propagate the accessions on their own roots before being planted in a stool bed to be used for further research on propagation by layering. Alternatively, budwood from established scions was sent to J. Frank Schmidt and Sons Nursery (Boring, Oregon) for evaluation in their nursery production system

and for rapid production of larger nursery stock for field evaluation. This protocol has three primary functions. First, to locate desirable accessions; second, to establish them in a nursery environment where cultural practices can be used to enhance propagation success; and third to enable further research on propagation and production with clonal stock of the accessions.

**Ground location of aerially photographed trees**

Aerial photography is an efficient way to screen many trees for highly visible characteristics such as fall color. But, it is difficult to locate trees on the ground by photograph alone in areas where there are no distinct landmarks. Photographed trees were located on the ground by tracking the path of the airplane during photography with a Garmin GPSMAP 60C or 60Csx and then using GeoSetter© software to link the time recorded on the image metadata with the location on the GPS track as determined by the corresponding track point time. GeoSetter© can then provide an image of the track and a marker where the camera was for each photograph (Fig. 2) on Google™ Earth. Selected photographs can then be compared with the corresponding Google™ Earth image as identified through GeoSetter© software. By matching features in the images, the tree in question can be identified (Fig. 3). Once the tree is identified, the latitude and longitude can be determined, entered into a GPS unit as a waypoint, and located on the ground (Fig. 4).

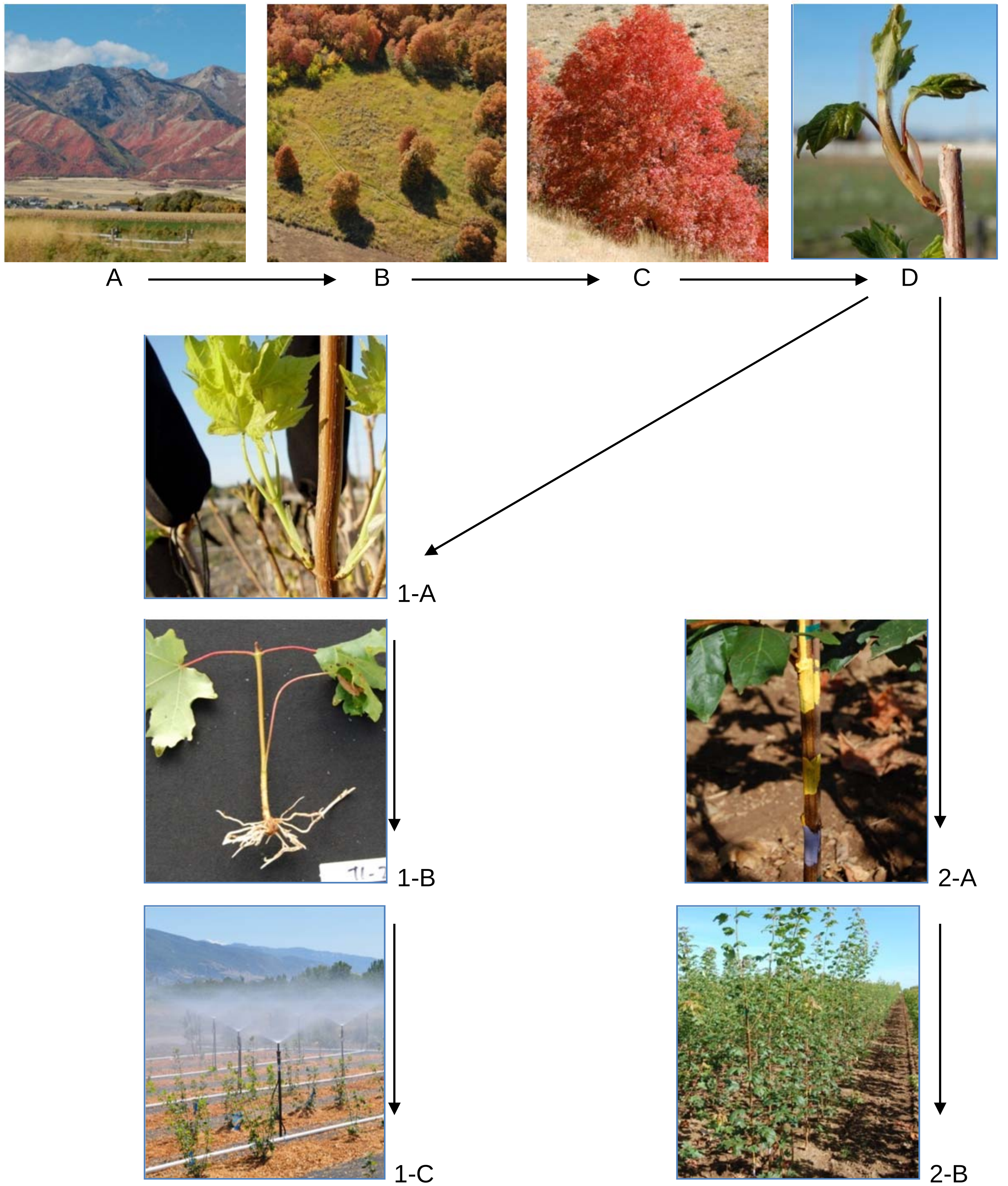


Fig. 1. The series of steps used in selection and propagation of bigtooth maple (*A. grandidentatum*). A. Native maple forests in Cache County, Utah; B. Aerial photograph of maple forest; C. Selected maple located on ground; D. Budded scion from maple accession on seedling rootstock; 1-A. Etiolated scion; 1-B. Rooted cutting from etiolated scion; 1-C. Own-rooted accession in mound layer nursery; 2-A. Alternate track of scion wood budded to rootstock in Oregon; 2-B. Grafted whips in preparation for field evaluation.

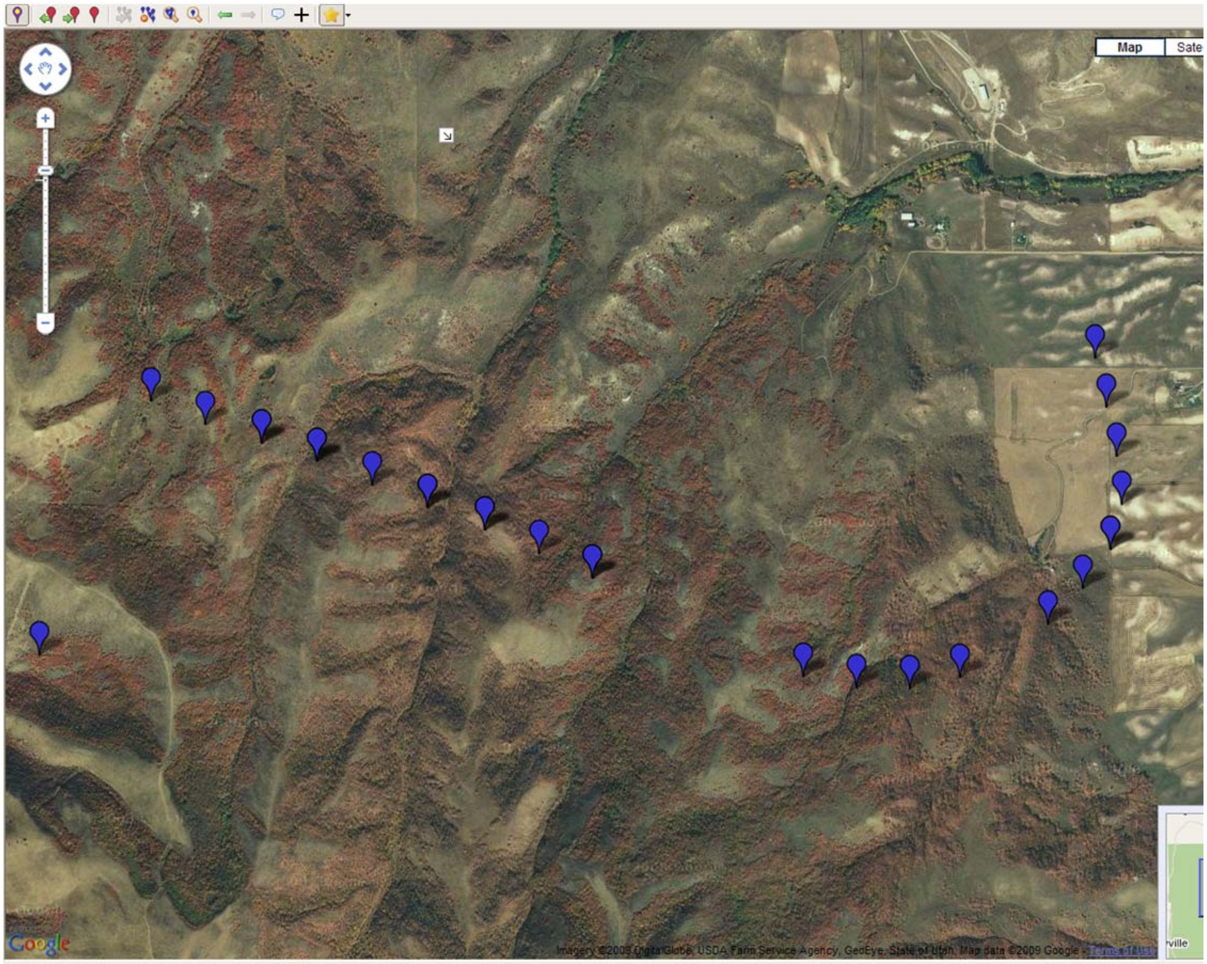


Fig. 2. GeoSetter© software generated track of photographs based on GPS track and digital image time data. Markers represent locations where photographs were taken.

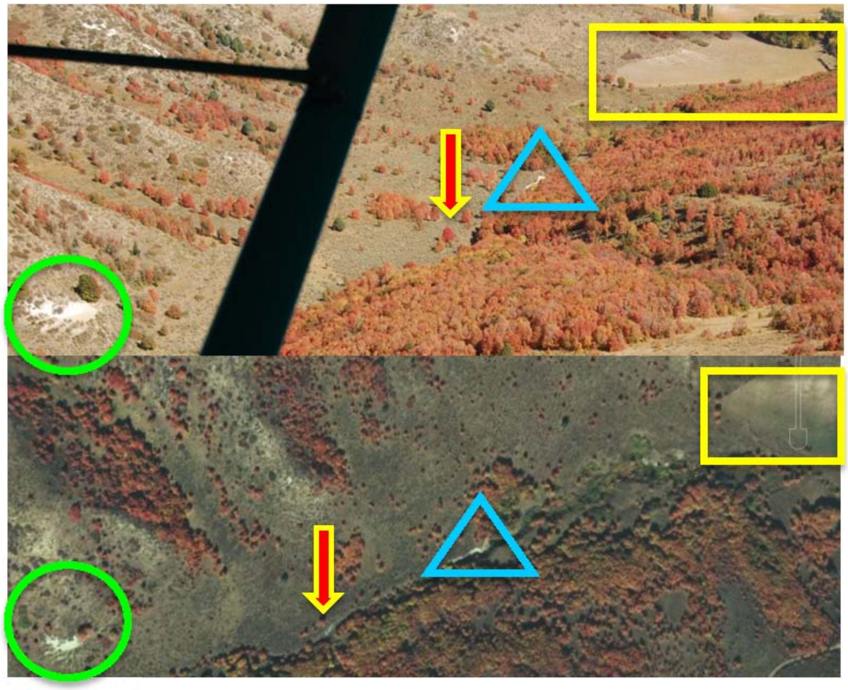

Fig. 3. Comparison of aerial digital image (upper) and corresponding Google™ Earth image (lower). Arrow indicates selected tree. Geometric figures mark corresponding geographic markers.

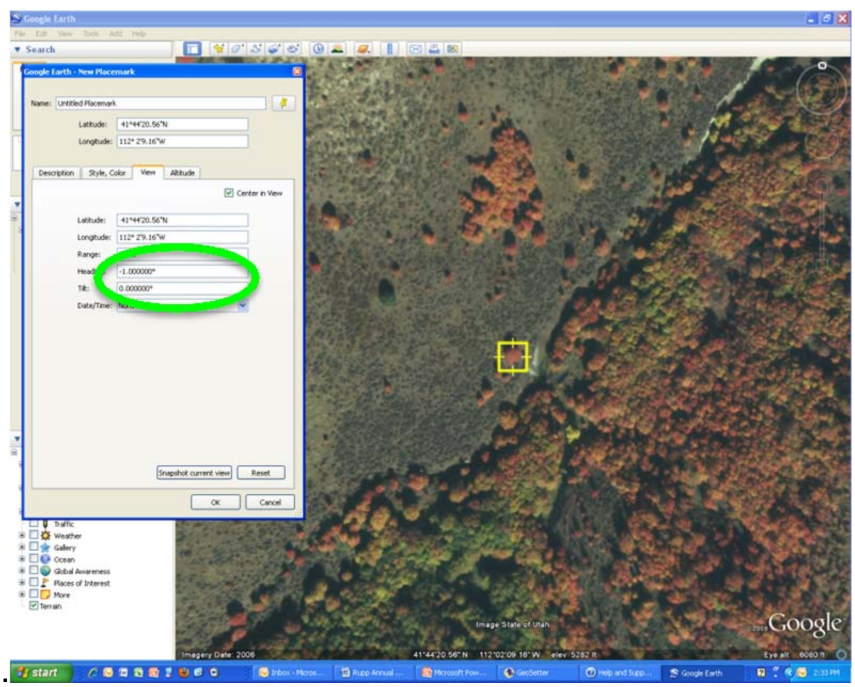


Fig. 4. Using Google™ Earth to determine the latitude and longitude of selected trees.

**Propagation of maple accessions by chip budding**
Bigtooth maple accessions were established in a nursery environment by collecting budwood of current season's growth and chip budding on to seedling rootstocks. Optimization of budding was determined with three experiments conducted in 2006, 2007, and 2009 with budding date as the variable. In 2006, a "return budding" experiment was conducted in which buds were removed from shoots of coppiced seedlings, and then chip budded back into the precise location from which they were removed to determine optimum budding time while decreasing the effects of budding technique. Fifteen coppiced plants were selected based on the presence of multiple shoots of moderately vigorous growth. The most ideal shoot was selected for budding on each specified budding date using dormant buds from the second node above the base. The subtending leaf was removed from the bud and Parafilm® Grafting Tape (12 mm x 102 mm) was used to fully cover all cut surfaces, but not the bud itself. Budding was performed weekly from 21 June to 6 Sept. 2006. In 2007, budwood was selected from a wild maple and budded as before on to 10 coppiced rootstocks biweekly from 15 June to 13 August, except the buds were entirely covered with grafting tape. The experiment was repeated in 2009 on a biweekly basis from June 22 to August 17, using coppiced rootstocks. The budwood was handled differently in that the base of the subtending petiole was retained to help protect the bud. Grafting tape was used to cover the entire bud and was cut after 3 weeks if it had not split on its own.

The results of these experiments as summarized in Fig. 5 show generally poorer success in June, especially with wild budwood. Budding was most successful in mid-July to early/mid August.

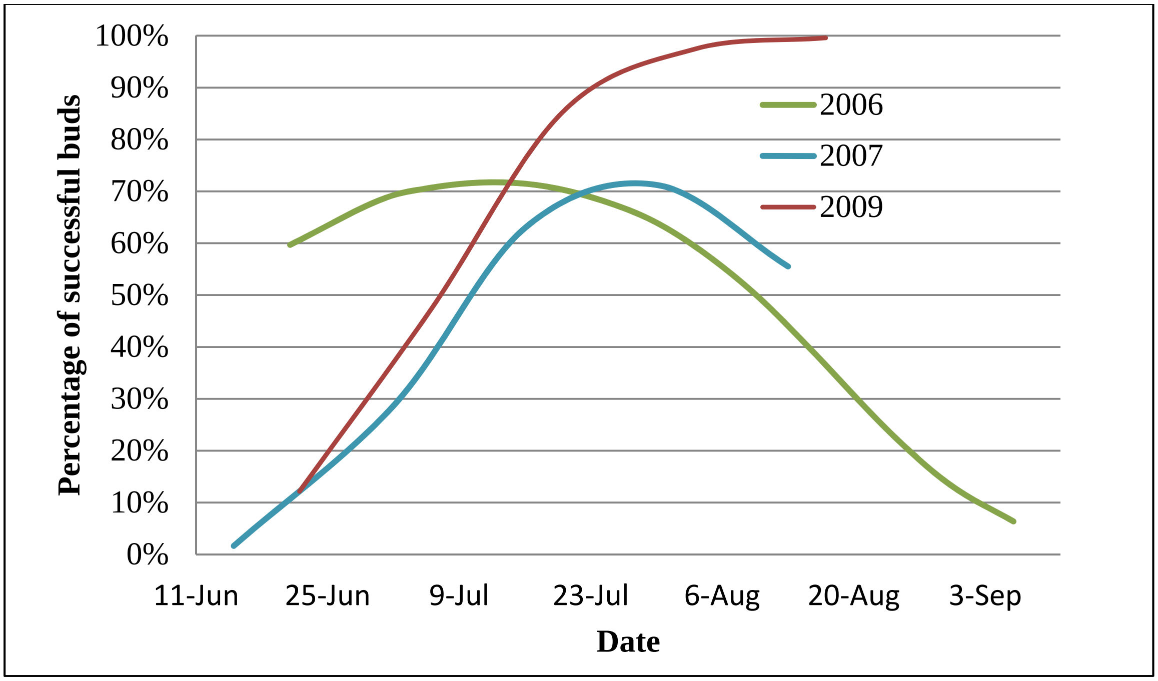


Fig. 5. Effect of 2006, 2007, and 2009 budding dates on successful budding for bigtooth maple using logistic regression statistical analyses.

**Propagation of maple accessions by shoot cuttings**

Established scions of five to six maple accessions were rooted in 2009 and 2010 using etiolation. Experiments were begun in the winter by making pruning cuts immediately below the third bud from the base of each shoot and leaving a stub above the most acropetal bud. Etiolation was accomplished by placing open-ended, black, velour, drawstring bags over the pruned, terminal shoots at bud swell with the drawstring tied just below the uppermost buds. Bud break occurred in the reduced light of the bag environment. The new shoots emerged from the bag, acclimating to full sun, while the etiolated base of the shoot remained covered by the bag. Softwood cuttings were taken when new shoots were 20-25 cm in length (May 24-June 2, 2010), trimmed to two sets of leaves, wounded, dipped in 4000 ppm IBA and 2000 ppm NAA as Dip ‘N Grow® (diluted with 50% ethyl alcohol) and stuck in a pre-moistened media (3:1 perlite:peat mixture). Cuttings were held in a shaded greenhouse under a reverse osmosis water intermittent mist (7 s every 12 min from 6:00 AM to 9:00 PM with bottom heat ranging from 20-30 C. Greenhouse temperatures ranged from 19-23 C. After four weeks, the rooting response was determined (Fig. 6 and 7). Etiolation significantly increased the percentage of rooted cuttings to greater than 90% with several accessions in 2010.

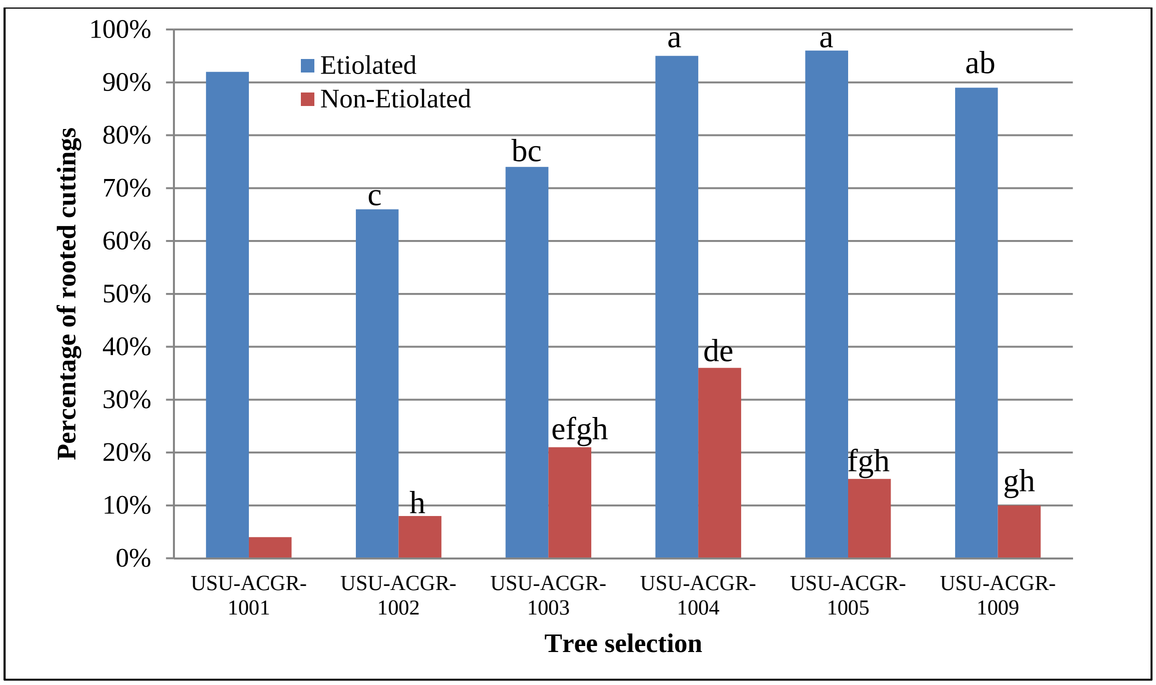


Fig. 6. The effect of etiolation in 2010 on the percentage of rooted cuttings of bigtooth maple. Etiolation significantly increased the percentage of rooted cuttings in all clones as shown by the two-sample t-test. Means with the same letter are not significantly different according to the SAS Mixed Procedure.

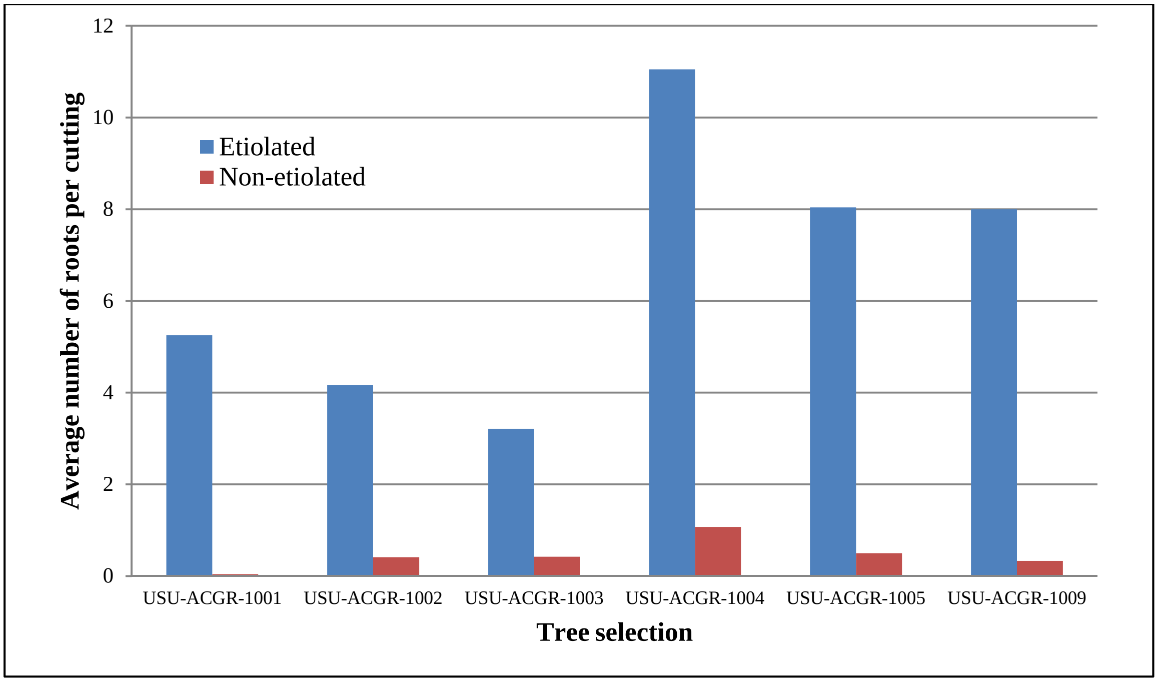


Fig. 7. Effect of etiolation in 2010 on average number of roots per cutting of bigtooth maple. The analyses showed that etiolated cuttings had a significantly greater number of roots per cutting than non-etiolated cuttings with a p-value<0.0000. Means with the same letter are not significantly different according to the SAS Mixed Procedure.

**Native plant selection and propagation**

In addition to bigtooth maple, we have selected and documented several native woody plants with potential for landscaping in northern Utah. In each case the ultimate goal is to evaluate the plants in a landscape setting and potentially encourage their use in production nurseries. A key step in meeting that goal is the asexual propagation of selected accessions. Asexual propagation of native plants has varying degrees of success between species, and when dealing with clonal selections, within species. Our preliminary attempts in each case are to use shoot cuttings as the means of propagation. Only if cuttings fail are more elaborate techniques employed. The following are examples of some of the selections we have made, as well as the variability present in propagation from cuttings.

***Paxistima myrsinites***

An accession of mountain lover (*Paxistima myrsinites*) was selected near Teton Pass, Wyoming in the summer of 2010. The plant was chosen for its relative tight, mounded form as well as its apparent hardiness as evidenced by growing on a south facing road cut at approximately 6800 feet elevation (Fig. 8).


Fig. 8. Accession of mountain lover (*Paxistima myrsinites*) from Teton Pass, Wyoming (left). Rooted terminal softwood cutting (right).

Terminal softwood cuttings were collected on 20 July and refrigerated until stuck on 22 July 2010. Cuttings were treated with 0, 2000, or 4000 ppm IBA as Dip 'N Grow® (diluted with 25% ethyl alcohol) and stuck in a pre-moistened media (4:1 perlite:peat v/v). Cuttings were held under intermittent mist (reverse osmosis water applied for 7 s/ 12 min) in a greenhouse with 60% shade and set at 65/60F DT/NT and with bottom heat at approximately 75F. After seven weeks, the percentage of rooted cuttings and number of roots per cutting was assessed. There were 22 cuttings per treatment. The cuttings rooted extremely well with 100% rooting in all treatments. While there was a trend toward increased numbers of roots per cutting with higher concentrations of rooting hormone, it was not statistically significant (Fig. 9).

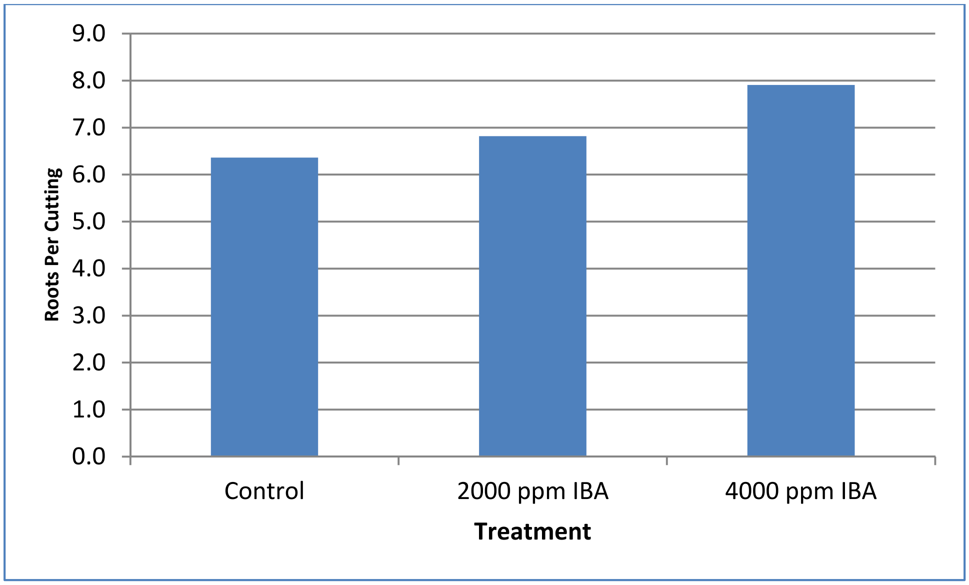


Fig. 9. Average number of roots per cutting of *Paxistima myrsinites* terminal cuttings. Analysis by Poisson regression indicates no significant difference in number of roots per cutting at $p<0.05$.

***Juniperus osteosperma***

A *Juniperus osteosperma* hybrid of unknown origin was selected from an old common garden at the Utah Department of Wildlife Resources Great Basin Experiment Station in Ephraim, Utah. The selection was based on unique form and resistance to deer browsing (Fig. 10).

Fig. 10. Photograph of *Juniperus osteosperma* hybrid illustrating lack of browsing (note intact foliage along entire length of tree) and unique form.

After a failed preliminary effort to root this plant, an experiment was designed to determine the effects of auxin concentration and mist versus white polyethylene tent for moisture control. Propagation was done by selecting terminal cuttings at breast height or lower on 21 Jan 2010. Cuttings were refrigerated until 23 Jan 2010 when trimmed to 12 cm in length and the bottom 2.5 cm stripped of leaves or shoots. Each cutting was wounded on one side by scraping with a knife blade perpendicular to the stem for about 5 mm. Cuttings were treated with 0, 2000, or 4000 ppm IBA as Dip 'N Grow® (diluted with 50% ethyl alcohol) and stuck in a pre-moistened media (4:1 perlite:peat v/v). Cuttings were held under intermittent mist (reverse osmosis water applied for 7 s/ 30 min until 24 May when changed to 7s / 12 min) or were placed in a closed, white plastic bag (Fig. 11), in a greenhouse set at 65/60F DT/NT and with bottom heat at approximately 75F. Shading was applied at 60% on about 24 May 2010. Cuttings were moved outdoors to the shaded north side of a building during early summer and evaluated on 17 August 2010 (29 weeks). While cuttings still appear quite healthy, there was only one rooted cuttings in the entire experiment. To date we are not able to propagate this plant at a commercially acceptable level.

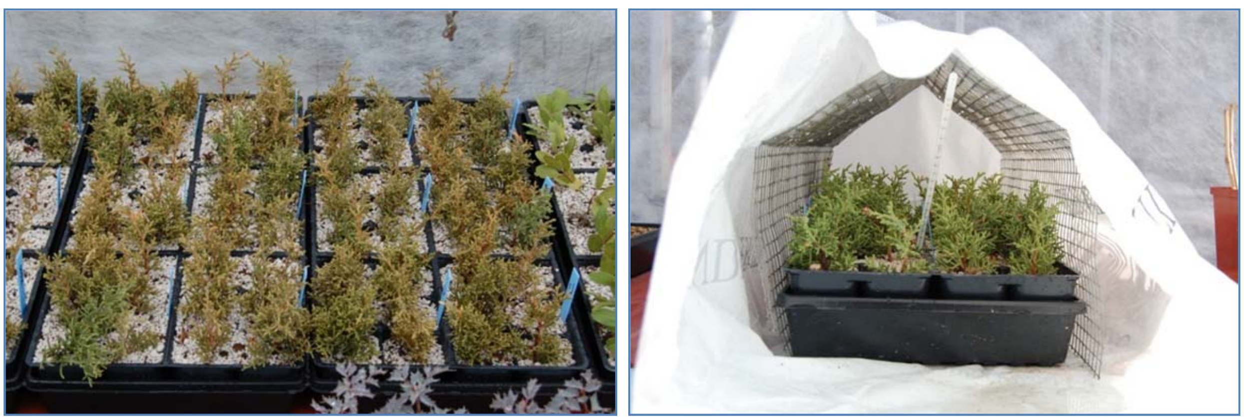

Fig. 11. Experimental design for rooting cuttings of the Juniperus osteosperma hybrid showing cuttings under intermittent mist (left) or in a white plastic tent (right) supported by ½-inch square hardware cloth.

***Cercocarpus intricatus***

We have selected a number of accessions of littleleaf mountain mahogany and in general have had good success in rooting cuttings. A seedling plant growing in a residential landscape in Logan, Utah (Fig. 12) was selected for its rounded form and as a test plant to evaluate cuttings from a plant grown under more optimal conditions than found in the wild. Terminal softwood cuttings were collected and stuck on 13 July 2010. Cuttings were treated with 0, 2000, or 4000 ppm IBA as Dip 'N Grow® (diluted with 25% ethyl alcohol) and stuck in a pre-moistened media (4:1 perlite:peat v/v). Cuttings were held under intermittent mist (reverse osmosis water applied for 7 s/ 12 min) in a greenhouse with 60% shade and set at 65/60F DT/NT and with bottom heat at approximately 75F. After eight weeks, the percentage of rooted cuttings and number of roots per cutting was assessed. There were 24 cuttings per treatment. This accession showed a very distinct benefit of supplemental auxins in enhancing the number of rooted cuttings as compared to an untreated control (Fig. 13).

Fig. 12. Photograph of *Cercocarpus intricatus* accession selected for rounded form and successful adaptation to growing in a residential landscape in Logan, Utah.

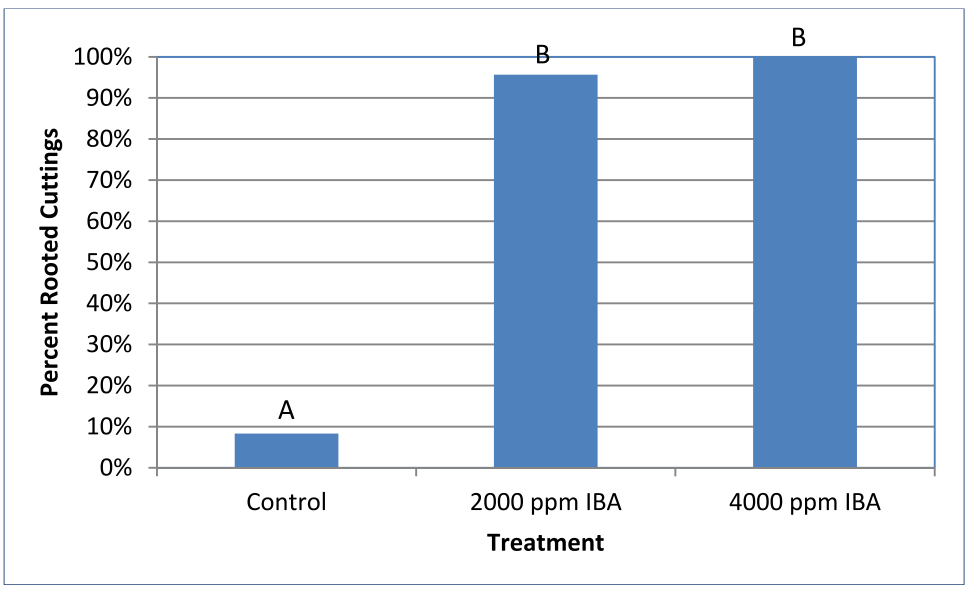


Fig. 13. The affect of rooting hormone treatments (2000 and 4000 ppm IBA as Dip ‘N Grow® (diluted with 25% ethyl alcohol) on percent root formation of Logan, Utah *Cercocarpus intricatus* accession. The same letters for each treatment denote nonsignificant comparisons at $P<0.05$ using Tukey’s HSD test (with 0 as 0.000001 and 1 as 0.999999).

Other selections of *C. intricatus* have been less successfully propagated. An accessession from Spring Mountain, Nevada (Fig. 14) chosen for its tight, globe-shaped form and hardiness (it was found on an open gravel ridge line at ca. 9200 feet elevation) was propagated as pre-softwood cuttings. Terminal cuttings of second-year wood were collected on 21 May 2010 and held on ice or at 4C until 24 May when stuck. Cuttings were treated with 0, 2000, or 4000 ppm IBA as Dip 'N Grow® (diluted with 50% ethyl alcohol) and stuck in a pre-moistened media (3:1 perlite:peat v/v). Cuttings were held under intermittent mist (reverse osmosis water applied for 7 s/ 12 min) in a greenhouse with 60% shade (beginning 25 May) and set at 65/60F DT/NT and with bottom heat at approximately 75F. After eight weeks, the percentage of rooted cuttings and number of roots per cutting was assessed. There were 26 cuttings per treatment. The effect of auxin concentrations of 0, 2000, and 4000 ppm on the cuttings was clearly evident with 15, 28, and 52% rooting respectively (Fig. 15). However, total rooting was only half that of the previously described selection. The difference in rooting could be due to many factors including storage time, season of harvest, tissue age, size of cuttings, and genetics. Another accession selected in the same location for its cascading/procumbent habit (Fig. 14-B) had no rooting under similar circumstances (data not shown).

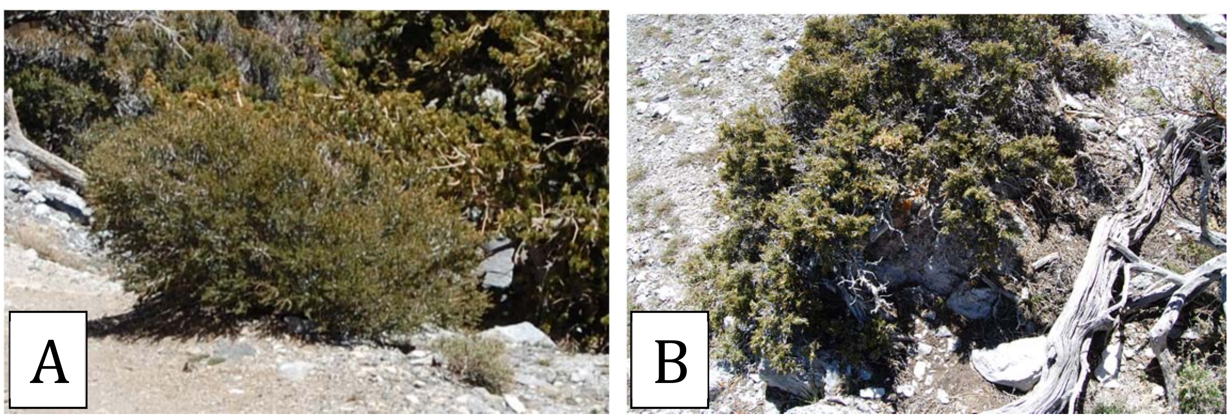


Fig. 14. Photographs of *Cercocarpus intricatus* accessions from Spring Mountain, Nevada selected for tight, global form (A) and cascading/procumbent form (B).

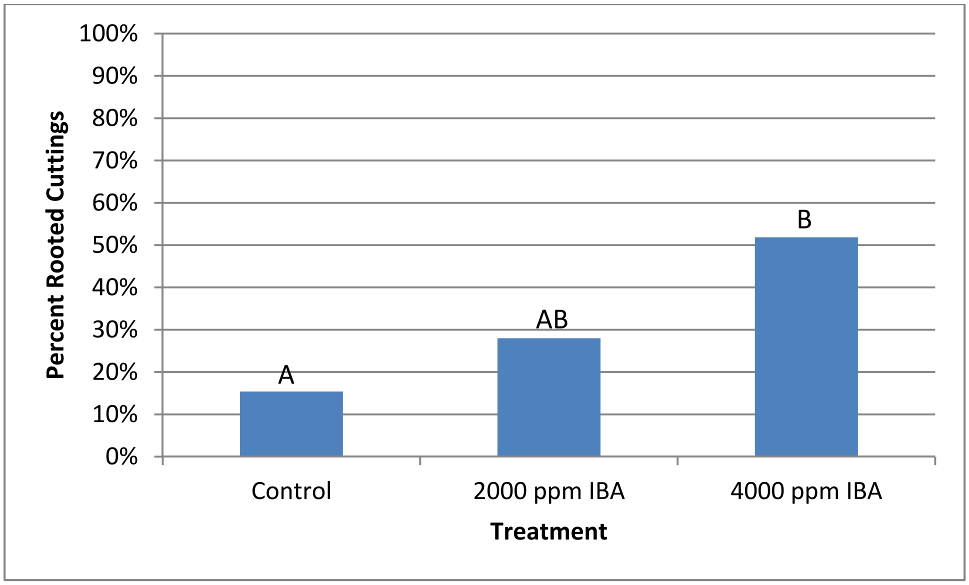


Fig. 15. The affect of rooting hormone treatments (2000 and 4000 ppm IBA as Dip 'N Grow® (diluted with 50% ethyl alcohol) on percent root formation of *Cercocarpus intricatus* (global form). The same letters for each treatment denote nonsignificant comparisons at P<0.05 using Tukey's HSD test.

***Cercocarpus ledifolius* (witch's broom)**
A witch's broom of *C. ledifolius* was selected from a plant near the summit of Logan Canyon, Utah. It is characterized by small leaves and shortened internodes (Fig. 16). Terminal softwood with 4-6 leaves cuttings were collected and stuck in Oasis® Root Cubes on 13 August 2010. Cuttings were treated with Hormodin 1, Hormodin 2, or untreated. Cuttings were held under intermittent mist (reverse osmosis water applied for 7 s/ 12 min) in a greenhouse with 60% shade and set at 65/60F DT/NT and with bottom heat at approximately 75F. After four weeks, cuttings had declined considerably and the great majority of leaves were dead. There were 40 cuttings per treatment. No cuttings rooted.

Fig. 16. Photographs of *Cercocarpus ledifolius* witch's broom located near the summit of Logan Canyon.

***Ericameria* spp.**
Rabbitbrush has a number of beneficial characteristics for use in water conserving landscapes, however, the plant is often prone to rank growth and excessive size. A selection of *Ericameria* (species unknown) growing at the Utah Botanical Center in Kaysville, Utah (grown from seed collected in the Raft River Mountains) was selected for propagation based on its small size (Fig. 17). Cuttings were collected on 1 June 2010 by placing in a sealed plastic bag with a moist paper towel and placed on ice until put in a 4C cooler later that same day. On 2 June 2010, 27 cuttings approximately 10 cm in length were rinsed, the lower 4 cm stripped of leaves, wounded by scraping the bark off one side for ca. 1 cm, and recut at the base. Cuttings were randomly assigned to treatments of Hormodin 1, Hormodin 2, or an untreated control and stuck in a 1:3 peat:perlite (v:v) rooting medium. Cuttings were held under intermittent mist (reverse osmosis water applied for 7 s/ 12 min) in a greenhouse with 60% shade and set at 65/60F DT/NT without bottom heat. The first roots appeared by 21 June. While auxin treatments appeared to enhance rooting (Fig. 18) there was not significant difference between treatments (possibly due to the limited sample size of 9 cuttings per treatment).

Fig. 17. Photograph of *Ericameria* spp selection located at the Utah Botanical Center in Kaysville, Utah. Knife is approximate 7 inches long.

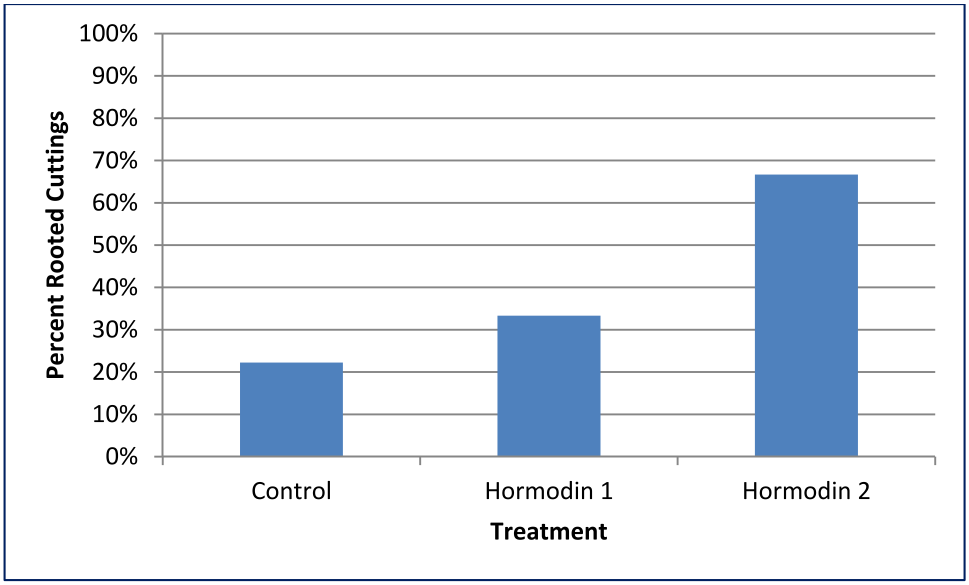


Fig. 18. The affect of rooting hormone treatments (untreated control, Hormodin 1, and Hormodin 2 on percentage of rooted cuttings of *Ericameria* spp. (Utah Botanical Center accession). ANOVA indicates that the results were not significantly different at $p<0.05$.

***Ceanothus martinii***

An accession of Martin's ceanothus (*Ceanothus martini*) was selected in Ephraim Canyon, Utah in the summer of 2010. The plant was chosen for its relatively tight, low-growing form. The parent plant was found on a northwest facing slope just above a road cut at about 7200 feet elevation (Fig. 19). Cuttings were collected on 18 July 2010 and held on ice or in a cooler until 19 July when stuck. Cuttings were randomly assigned to rooting hormone treatments of Hormodin 2, 2000 ppm IBA and 1000 ppm NAA as Dip 'N Grow® (diluted with 25% ethyl alcohol, dipped for 5 seconds at a 1 cm depth), and an untreated control. All cuttings (n=11) were placed in a 1:4 peat:perlite (v:v) rooting medium and held under intermittent mist (reverse osmosis water applied for 7 s/ 12 min) in a greenhouse with 60% shade and set at 65/60F DT/NT without bottom heat.

Fig. 19. Photograph of *Ceanothus martinii* in Ephraim Canyon, Utah.

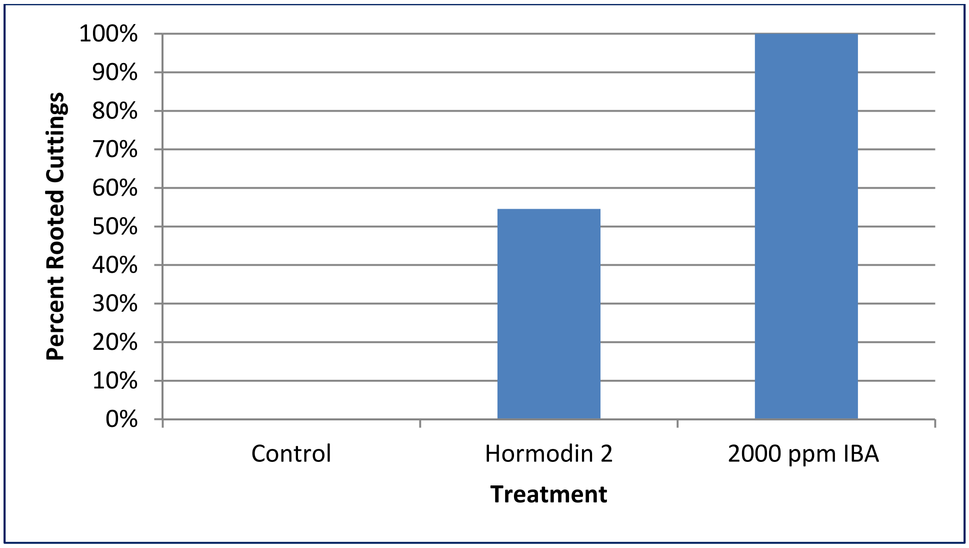


Fig. 20. The affect of rooting hormone treatments (untreated control, Hormodin 2, and 2000 ppm IBA as Dip 'N Grow) on percentage of rooted cuttings in *Ceanothus martinii*. Means of all treatments were significantly different at $p<0.05$ as determined by ANOVA (with 0 as 0.000001 and 1 as 0.999999) and Tukey's HSD.

Conclusions

We have been successful in identifying several plants with potential as water conserving landscape plants. As expected, the ease of propagating these plants varies greatly with the species and between selected accessions of the same species. We have been able to determine the best time for us to propagate bigtooth maple by budding, and have developed a means of successfully propagating bigtooth maple softwood cuttings through the use of etiolated shoots. We have also been successful in propagating accessions of *Cercocarpus intricatus*, *Paxistima myrsinites, Ericameria*, *and Ceanothus martinii* as softwood cuttings. In several instances we have been unsuccessful in vegetative propagation by cuttings. Those plants for which we have not been successful include *Juniperus osteosperma* and selected accessions of *Cercocarpus ledifolius*, *Cercocarpus intricatus*, *Ceanothus velutinus*, and *Amelanchier* spp. Continued work is being done to develop protocols for the vegetative propagation of these and other accessions of native plants.

## Selection and improvement of Idaho fescue (*Festuca idahoensis*) germplasm for turf applications

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University of Idaho; Aberdeen R & E Center, 1693 S 2700 W, Aberdeen, ID 83210

Objectives:

1. Evaluate the turf quality and performance of Idaho fescue (*Festuca idahoensis*) accessions collected from the Intermountain West.
2. Evaluate the seed production potential of Idaho fescue accessions to confirm reproductive potential from seed.
3. Select superior individual plants of Idaho fescue and establish them in seed productions blocks for use in development of improved synthetic cultivars with superior turfgrass quality.

The ultimate goal of this project is to produce new cultivars of Idaho fescue that have the potential to be utilized by the golf and home turf industry.

Introduction

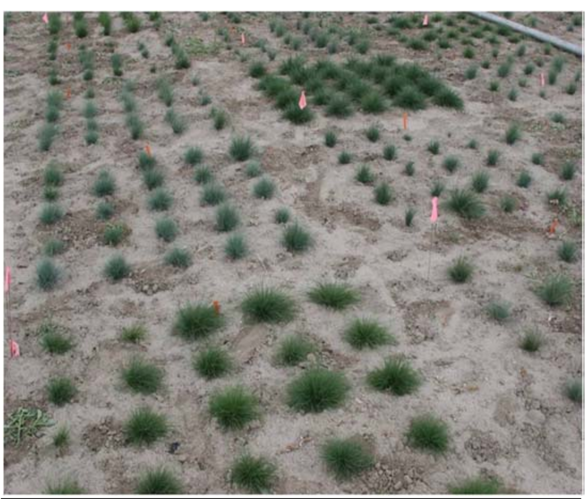
A native of the northern Great Plains and Intermountain West, Idaho fescue is a member of the *Festuca ovina* complex. Leaf color ranges from blue to dark green and both colors commonly co-exists within existing rangeland cultivar releases. Blue, glaucous leaf color has been associated with many plant species adapted to high irradiation environments characteristic of the high altitude regions of the intermountain west. Tendency for summer dormancy is another physiological characteristic key to Idaho fescue's survival in the low precipitation environments common in the intermountain west. Observed variations in these color and growth characteristics suggest considerable potential for Idaho fescue improvements.

Methods

In 2009, 42 accessions of Idaho fescue were acquired from industry and USDA seedbank sources. Twenty-six accessions were obtained from the USDA Plant Materials Center at Pullman, Washington. Ten accessions were obtained from Benson Farms, two from the NRCS Plant Materials Center at Aberdeen, ID, and one each from Thorn Creek Native Seed, Currans Family Farm, and Seeds Trust. A final accession was a collection made by project personnel in the Island Park region of Idaho. Accessions were chosen specifically to represent ecotypes from a variety of intermountain environments. Collection locales included sites in British Columbia and Alberta, Canada, Washington, Oregon, Idaho, Montana, and Wyoming. Such diverse environments increase the variability of the material, thereby increasing the opportunity for selecting superior turf types.

Idaho fescue accessions in plug trays prior to transplanting (left). Transplanting accessions in the field, May 17, 2010 (right)

In March 2010, seed of all 42 accessions were planted in plug trays in a greenhouse. After emergence, seedlings were thinned to a single plant per plug. Field planting occurred on May 17, 2010 when seedlings were approximately 3 inches tall. Of the initial 42 accessions, 36 were established in the field. Two accessions from the USDA seedbank were misidentified as to their species. Four additional accessions had poor seed emergence and did not produce enough plants for plot establishment. For the 36 remaining accessions, 100 plants were established in the field. Plants were arranged in a RCB with four replications of 25 plants each. Replicates were arranged as square blocks, 5 ft x 5 ft., with plants on 12 inch centers.



Variability among Idaho fescue

Prior to planting, the plot area was deep-tilled, packed and fertilized with urea at 1 lb N/1000 $ft^2$. Plugs were irrigated every other day until new growth was evident, and subsequently on demand to avoid drought symptoms. The soil is a loamy-sand (CEC 12.2) with a pH of 8.0. Plots were mowed at 2 ½ inches, irrigated to replace 75-80% of Kentucky bluegrass ET, and fertilized at 1lb N/1000 $ft^2$ in the fall.

Results and discussion

Accessions were evaluated on July 26 for growth and color variability, percentage of green (vs blue) individuals, growth habit (upright vs. decumbent), leaf texture, and degree of dormancy. Three accessions had 100% green plants, and another 6 accessions had greater than 50% green plants. Six accessions had zero green plants and another 12 had less than 10%. Most accessions have the characteristic fine leaves of the *F. ovina* complex, with only 1 expressing courser than normal texture. Five accessions showed a low level of summer dormancy with only a few plants showing partial dormancy, and another 17 accessions having plants expressing moderate levels of dormancy. This wide range of leaf color, leaf type, and growth habit provides good opportunity for selecting turf-type Idaho fescue cultivars.

In 2012, turf quality of entire plots and individual plants within plots will be evaluated. Turf characteristics for observation will include color, density, tillering, growth habit, lateral spread, mowing quality, avoidance of summer dormancy, and overall appearance. Plants showing superior performance will be used in the development of synthetic cultivars.

In 2013, plots and individual plants will be evaluated for seed productivity. Seed productivity data, along with turf quality measurements, will be used for final construction of parental genetic pools.

Summary Points

- 36 Idaho fescue accessions were established in the field.
- Accessions varied in number of green individuals, summer dormancy and growth habit.
- Accessions showed similar leaf texture characteristic of other fine fescues.
- Field observations suggest good opportunity for turf-type Idaho fescue development.

**Summary of native plant nursery operations - WERA-1013 Meeting – October, 2010**

Laura Smith and Robert Dunn

Westscape Wholesale NurseryWestscape , 423 N. Tracy, Bozeman, MT 59715

Background

Westscape Nursery is wholesale plant nursery operating in Belgrade, MT near Bozeman and is owned by Laura Smith and Robert Dunn. Westscape is a wholesale producer of containerized native grasses, perennials, shrubs, and some ornamental species for the commercial landscape trade and for reclamation projects of disturbed lands. Ongoing projects include production of native shrub species for the reclamation of the EPA Superfund sites at Butte, Anaconda, and the Upper Clark's Fork River, and a 4 year phytoremedial and reclamation demonstration project with the U.S. Fish and Wildlife Service at Hailstone National Wildlife Refuge near Rapelje, MT.

Westcape native plant greenhouse production

Westscape also has ongoing research projects using native halophyte species for reclamation of saline and selenium impacted lands resulting from coal bed methane exploration (and other natural causes) in eastern Montana and Wyoming. In 2010, Westscape was awarded a USDA-SBIR Phase II grant to further develop this work.

Climatic challenges

Within our principle service area (100 mile radius) we are faced with the challenge of growing for an extremely diverse set of climatic and geographic conditions. Our USDA Zone Map ranges from Zone 2 to Zone 5 +/-, with annual precipitation variation from 12 inches to more than 25 inches, and frost free days ranging from less than 60 to more than 125. From a nursery perspective, matching the right plants to their appropriate zones and micro-climates of the Northern Rockies region is an important consideration (or certainly should be). Customers and clients should also be aware and educated about selecting the right plants to match their specific conditions to insure long-term project success. In terms of native plants, we note that frequently our clients want and demand natives for their project although selected species may not persist at their site. There is a general public perception that if something is native to a region (e.g. Montana) then it's adapted ubiquitously to the entire state or region. We see this frequently, especially in the high end, high elevation ski areas where clients might insist on warm season, native prairie species for a site that may have 60 frost free days. The take home message being, know your zones and micro-climates.

Nurseries and the use of adapted material

Closely tied to the previous section on climatic challenges is the use of adapted plant material. As growers, we try adamantly to grow as much material as possible from known seed sources which match our zones and conditions for the obvious reason of overall better performance and long-term success. There is a great deal of plant material imported into our area from Washington, Oregon, Utah, and Idaho. We have observed (as well as others) that frequently this material does not do well in our climatic zones, especially over time in our conditions. It is not necessarily the winter temperatures as much as the fall and spring rapid fluctuations that are responsible for this response. Anecdotally, we are seeing an increase in these wide temperature swings in recent years. As an example, in October, 2009 we experienced an 80 degree temperature drop in a 24 period, going to 9 degrees (a record). Again in May, 2010, we recorded a record low of 15 degrees following temperatures in the 80's. These radical fall/spring shifts have been responsible for wide scale loses of unadapted material in our area, both in the nursery as well as the landscape setting. Many of us in the nursery business have taken note of these fluctuations and the deleterious effect on unadapted material.

Landscape project at Big Sky Resort, designed by Beth MacFawn and installed using Westscape Nursery plant material

Economic trends

As with much of the country, Montana has experienced a large drop-off in nursery sales during the recent recession. An informal poll of local nurseries in the Bozeman area indicates that sales are down 33% - 50%. Westscape has a well-established reclamation component with state and federal agencies which has helped to offset the effects of the economy on general nursery and landscaper-type sales.

Plant material wish list

- Ground covers
- Dry shade
- High altitude, short growing season

**Identifying germplasm for breeding native Intermountain drought tolerant flowers**

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Our research has focused on identifying and breeding intermountain native plants that can be used in arid urban landscapes. The breeding of these plants is directed at competing with traditional urban landscape flowering plants. Specifically these plants need to require less water and fertilizer than traditional commercialized bedding plants, not be “weedy,” and yet perform outstandingly in urban conditions. We have initiated work on these objectives using species from the genus *Penstemon*. Various reports state that there are approximately 270 species in the *Penstemon* genus all with centers of origin in North and Central America (Nold, 1999; Wolfe et al., 2006). There are 70 species reportedly native to Utah, more than any other state or similar region (Lindgren and Wilde, 2003; Nold, 1999). Many of the species have multiple varieties thus totaling 94 recorded *Penstemon* taxa in the state (Table 1). The 70 species represent five of the six subgenera into which this genus has been divided (Wolfe et al., 2006).

The first objective in any plant breeding project is to develop an understanding of available genetic diversity. To accomplish this step we have undertaken the collection of the 94 Utah *Penstemon* taxa. During the 2009 blooming season (May to October) we collected tissue samples and identified specific locations of 50 Utah taxa. During the 2010 season, we collected all but three of the remaining 44 (Table 1). Of the three remaining taxa we were unable to find two (*P. pseudospectabilis* var. *pseudospectabilis* and *P. deustus* var. *pedicellatus*) after expeditions into the rugged back-country where records indicate their presence in Utah. The third taxa (*P. cyananthus* var. *judyae*) is a botanical variety recognized by only a small number of taxonomists. We have yet to search for this taxa.

Besides gaining an understanding of the diversity of regional *Penstemon* we have also taken two additional steps to implement breeding *Penstemon*. First, we have collected seed from 66 Utah *Penstemon* taxa. Additionally we have procured more than 75 additional taxa via purchasing and trading seed. Second, we have initiated studies on understanding basic genetic structure of the *Penstemon* genus. Several authors have provided fundamental information on genetics of *Penstemon* (Gross and Rieseberg, 2005; Keck, 1945; Wolfe et al., 2002; Wolfe and Elisens, 1993; Wolfe and Elisens, 1994; Wolfe and Elisens, 1995; Wolfe et al., 2006; Wolfe et al., 1998). Furthermore, recent reports from our lab on the range of genome sizes of various taxa within *Penstemon* have allowed us to move our studies towards further understanding of the dynamics of the genus (Broderick, 2010; Broderick et al., 2010; Stevens et al., 2009).

Understanding *Penstemons’* genome size prepared us to do a small focused genomic 454 pyrosequencing study on four *Penstemon* species (*P. cyananthus*, *P. disectus*, *P.*

*davidsonii*, and *P. fruticosus*). These four species were selected because of what we understood about their genome size and what Wolfe et al. (2006) reported about the evolutionary relationships within the genus. This sequencing study produced 733,000 random *Penstemon* DNA fragments averaging 392 base pairs long. From that process we have developed 77 SSRs (simple sequence repeats) and begun evaluations as to their usefulness. Additionally, we are presently working on the bioinfomatics associated with the sequence and when complete will present a "snapshot" of the *Penstemon* genome.

The tools we have/are developing in combination with the knowledge derived from previous *Penstemon* breeding studies (Lindgren, 2000; Lindgren and Schaaf, 2007; Meyers, 1998; Viehmeyer, 1958) will allow us to set up very unique "wide crosses" (crosses between more distantly related *Penstemon* species). Viehmeyer (1958) hypothesized that wide crosses will "unlock" genetic possibilities yet to be seen in *Penstemon* breeding. By developing these new *Penstemon* lines we hope to work towards fulfilling a need in the nursery industry of an improved pallet of plant material that combine drought tolerance with reduced nutritional requirements.

Table 1. List of *Penstemon* species considered by the USDA Plant Database and recognized taxonomic botanists to have been reported indigenously in Utah. Specific *in situ* information and tissue samples listed in red were collected 2009, those in blue were collected in 2010, and those not yet collected in Utah are in black.

| Taxa # | Species and variety | Seed collected | Subspecies | Section | Subsection |
|---|---|---|---|---|---|
| 1 | *Penstemon abietinus* | Yes | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 2 | *Penstemon acaulis* | No | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 3 | *Penstemon ambiguus* var. *laevissimus* | No | *Penstemon* | *Ambigui* | |
| 4 | *Penstemon ammophilus* | No | *Habroanthus* | *Glabri* | |
| 5 | *Penstemon angustifolius* var. *venosus* | Yes | *Penstemon* | *Coerulei* | |
| 6 | *Penstemon angustifolius* var. *dulcis* | Yes | *Penstemon* | *Coerulei* | |
| 7 | *Penstemon angustifolius* var. *vernalensis* | Yes | *Penstemon* | *Coerulei* | |
| 8 | *Penstemon atwoodii* | Yes | *Penstemon* | *Coerulei* | |
| 9 | *Penstemon barbatus* var. *barbatus* | Yes | *Penstemon* | *Cristati* | |
| 10 | *Penstemon barbatus* var. *torreyi* | Yes | *Habroanthus* | *Elmigera* | |
| 11 | *Penstemon barbatus* var. *trichander* | Yes | *Habroanthus* | *Elmigera* | |
| 12 | *Penstemon bracteatus* | Yes | *Habroanthus* | *Elmigera* | |
| 13 | *Penstemon breviculus* | Yes | *Penstemon* | *Coerulei* | |
| 14 | *Penstemon caespitosus* var. *caespitosus* | No | *Penstemon* | *Cristati* | |
| 15 | *Penstemon caespitosus* var. *desertipicti* | Yes | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 16 | *Penstemon caespitosus* var. *perbrevis* | Yes | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 17 | *Penstemon carnosus* | Yes | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 18 | *Penstemon comarrhenus* | Yes | *Penstemon* | *Coerulei* | |
| 19 | *Penstemon compactus* | Yes | *Habroanthus* | *Glabri* | |
| 20 | *Penstemon concinnus* | No | *Habroanthus* | *Glabri* | |
| 21 | *Penstemon confuses* | Yes | *Penstemon* | *Cristati* | |
| 22 | *Penstemon crandallii* var. *atratus* | No | *Penstemon* | *Peltanthera* | *Centranthifolii* |
| 23 | *Penstemon crandallii* var. *crandallii* | No | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 24 | *Penstemon cyananthus* var. *cyananthus* | Yes | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 25 | *Penstemon cyananthus* var. *judyae* | No | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 26 | *Penstemon cyananthus* var. *subglaber* | No | *Habroanthus* | *Glabri* | |

| | | | | | |
|---|---|---|---|---|---|
| 27 | *Penstemon cyanocaulis* | Yes | *Habroanthus* | *Glabri* | |
| 28 | *Penstemon deustus* var. *pedicellatus* | No | *Penstemon* | *Penstemon* | *Deusti* |
| 29 | *Penstemon dolius* var. *dolius* | Yes | *Penstemon* | *Cristati* | |
| 30 | *Penstemon dolius* var. *duchesnensis* | Yes | *Penstemon* | *Cristati* | |
| 31 | *Penstemon eatonii* var. *eatonii* | Yes | *Habroanthus* | *Elmigera* | |
| 32 | *Penstemon eatonii* var. *undosus* | No | *Habroanthus* | *Elmigera* | |
| 33 | *Penstemon eriantherus* var. *cleburnei* | No | *Penstemon* | *Cristati* | |
| 34 | *Penstemon flowersii* | Yes | *Penstemon* | *Coerulei* | |
| 35 | *Penstemon franklinii* | Yes | *Penstemon* | *Cristati* | |
| 36 | *Penstemon fremontii* | Yes | *Habroanthus* | *Glabri* | |
| 37 | *Penstemon gibbensii* | Yes | *Habroanthus* | *Glabri* | |
| 38 | *Penstemon goodrichii* | Yes | *Penstemon* | *Cristati* | |
| 39 | *Penstemon grahamii* | Yes | *Penstemon* | *Cristati* | |
| 40 | *Penstemon humilis* var. *obtusifolius* | No | *Penstemon* | *Penstemon* | *Humiles* |
| 41 | *Penstemon humilis* var. *brevifolius* | Yes | *Penstemon* | *Penstemon* | *Humiles* |
| 42 | *Penstemon humilis* var. *humilis* | Yes | *Penstemon* | *Penstemon* | *Humiles* |
| 43 | *Penstemon idahoensis* | Yes | *Habroanthus* | *Glabri* | |
| 44 | *Penstemon immanifestus* | Yes | *Penstemon* | *Coerulei* | |
| 45 | *Penstemon laevis* | Yes | *Habroanthus* | *Glabri* | |
| 46 | *Penstemon leiophyllus* var. *leiophyllus* | Yes | *Habroanthus* | *Glabri* | |
| 47 | *Penstemon lentus* var. *albiflorus* | Yes | *Penstemon* | *Coerulei* | |
| 48 | *Penstemon lentus* var. *lentus* | Yes | *Penstemon* | *Coerulei* | |
| 49 | *Penstemon leonardii* var. *higginsii* | Yes | *Saccanthera* | *Saccanthera* | *Heterophylli* |
| 50 | *Penstemon leonardii* var. *leonardii* | No | *Saccanthera* | *Saccanthera* | *Heterophylli* |
| 51 | *Penstemon leonardii* var. *patricus* | Yes | *Saccanthera* | *Saccanthera* | *Heterophylli* |
| 52 | *Penstemon linarioides* var. *sileri* | Yes | *Penstemon* | *Ericopsis* | *Linaroides* |
| 53 | *Penstemon longiflorus* | No | *Habroanthus* | *Glabri* | |
| 54 | *Penstemon marcusii* | Yes | *Penstemon* | *Cristati* | |
| 55 | *Penstemon moffatii* | Yes | *Penstemon* | *Cristati* | |
| 56 | *Penstemon montanus* var. *montanus* | Yes | *Dasanthera* | | |
| 57 | *Penstemon nanus* | Yes | *Penstemon* | *Cristati* | |
| 58 | *Penstemon navajoa* | No | *Habroanthus* | *Glabri* | |
| 59 | *Penstemon ophianthus* | Yes | *Penstemon* | *Cristati* | |
| 60 | *Penstemon pachyphyllus* var. *mucronatus* | Yes | *Penstemon* | *Coerulei* | |
| 61 | *Penstemon pachyphyllus* var. *pachyphyllus* | Yes | *Penstemon* | *Coerulei* | |
| 62 | *Penstemon pachyphyllus* var. *congestus* | Yes | *Penstemon* | *Coerulei* | |
| 63 | *Penstemon palmeri* var. *eglandulosus* | No | *Penstemon* | *Peltanthera* | *Peltanthera* |
| 64 | *Penstemon palmeri* var. *palmeri* | Yes | *Penstemon* | *Peltanthera* | *Peltanthera* |
| 65 | *Penstemon parvus* | Yes | *Habroanthus* | *Glabri* | |
| 66 | *Penstemon petiolatus* | Yes | *Penstemon* | *Peltanthera* | *Petiolati* |
| 67 | *Penstemon pinorum* | Yes | *Penstemon* | *Cristati* | |
| 68 | *Penstemon platyphyllus* | Yes | *Saccanthera* | *Saccanthera* | *Heterophylli* |
| 69 | *Penstemon procerus* var. aberrans | No | *Penstemon* | *Penstemon* | *Proceri* |
| 70 | *Penstemon procerus* var. *procerus* | Yes | *Penstemon* | *Penstemon* | *Proceri* |
| 71 | *Penstemon pseudoputus* | Yes | *Habroanthus* | *Glabri* | |
| 72 | *Penstemon pseudospectabilis* var. *pseudospectabilis* | No | *Penstemon* | *Peltanthera* | *Peltanthera* |
| 73 | *Penstemon radicosus* | Yes | *Penstemon* | *Penstemon* | *Humiles* |
| 74 | *Penstemon rostriflorus* | Yes | *Saccanthera* | *Bridgesiani* | |
| 75 | *Penstemon rydbergii* var. *aggregatus* | No | *Penstemon* | *Penstemon* | *Proceri* |
| 76 | *Penstemon rydbergii* var. *rydbergii* | No | *Penstemon* | *Penstemon* | *Proceri* |
| 77 | *Penstemon scariosus* var. *albifluvis* | Yes | *Habroanthus* | *Glabri* | |
| 78 | *Penstemon scariosus* var. *cyanomontanus* | Yes | *Habroanthus* | *Glabri* | |
| 79 | *Penstemon scariosus* var. *garrettii* | Yes | *Habroanthus* | *Glabri* | |
| 80 | *Penstemon scariosus* var. *scariosus* | Yes | *Habroanthus* | *Glabri* | |

| | | | | | |
|---|---|---|---|---|---|
| 81 | *Penstemon sepalulus* | Yes | *Saccanthera* | *Saccanthera* | *Heterophylli* |
| 82 | *Penstemon speciosus* | Yes | *Habroanthus* | *Glabri* | |
| 83 | *Penstemon strictiformis* | Yes | *Habroanthus* | *Glabri* | |
| 84 | *Penstemon strictus* | Yes | *Habroanthus* | *Glabri* | |
| 85 | *Penstemon subglaber* | Yes | *Habroanthus* | *Glabri* | |
| 86 | *Penstemon thompsoniae* | No | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 87 | *Penstemon tidestromii* | No | *Habroanthus* | *Glabri* | |
| 88 | *Penstemon tusharensis* - AKA *P. caespitosus* var. *Suffruticosus* | No | *Penstemon* | *Ericopsis* | *Caespitosi* |
| 89 | *Penstemon uintahensis* | No | *Habroanthus* | *Glabri* | |
| 90 | *Penstemon utahensis* | No | *Penstemon* | *Peltanthera* | *Centranthifolii* |
| 91 | *Penstemon wardii* | Yes | *Habroanthus* | *Glabri* | |
| 92 | *Penstemon watsonii* | No | *Penstemon* | *Penstemon* | *Proceri* |
| 93 | *Penstemon whippleanus* | Yes | *Penstemon* | *Penstemon* | *Humiles* |
| 94 | *Penstemon yampaensis* | No | *Penstemon* | *Ericopsis* | *Caespitosi* |

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