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Selection and Vegetative Propagation of Native Woody Plants for Water-Wise Landscaping

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ABSTRACT

Native woody plants with ornamental characteristics such as brilliant fall color, dwarf form, or glossy leaves have potential for use in water conserving urban landscapes. Individual accessions with one or more of these unique characteristics were identified based on the recommendations of a wide range of plant enthusiasts (both professional and amateur). Documentation of these accessions has been done through locating plants on-site where possible and then developing a record based on digital photography, GPS determined latitude and longitude, and place marking of Google Earth© images. Since desirable characteristics are often unique to a single plant, utilization of these plants by the landscape industry requires that they be clonally propagated. Methods of asexual propagation including grafting, budding, layering and cuttings may be successful with native plants, but are species and even accession specific. We report on the successful cutting propagation of Arctostaphylos patula*,* A. pungens*, and* Cercocarpus intricatus*, and lack of success with* Juniperus osteosperma*, and* Mahonia fremontii*.*

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INTRODUCTION

There is a market for trees and shrubs native to the Intermountain west for use in low-water landscaping that conserves water without impacting landscape quality or function. Based on horticultural precedent, there is an even greater market value for exceptional clones of these native plants that not only conserve water, but bring aesthetic and functional value to the landscape. In order to take advantage of this market, it is important that highly ornamental accessions of native woody plants be identified and methods for their successful propagation and production be developed. Currently, improved selections of many of the native plants indigenous to the Intermountain area are not available in the nursery trade, and are therefore unavailable for water conserving landscapes.

We have documented over 32 species of native plants with one or more exceptional clones, and are currently investigating another 17. While clones of some, such as mountain lover (*Paxistima myrsinites*), can be easily propagated vegetatively, others have either never been tried or have shown only limited success. The purpose of our research is to select exceptional clones, determine optimum propagation methods, and make both the materials and the methods available to the industry and the consuming public.

MATERIALS AND METHODS

Locating and Selecting Plants

The success of this project is a result of individuals willing to share their knowledge of unique specimens of native woody plants in Utah and adjacent states. We have polled botanists, natural resource managers, native plant enthusiasts and others regarding such plants, and are in the process of documenting suggested plants (tables 1 and 2). Some individual plants have been shown directly to us, while other suggestions have been referrals to general populations. In both cases we have found that in the process of documenting selected plants we have found additional plants with as good or even greater potential. Utilization of these plants in the landscape industry is dependent on their ease of propagation and production, and their performance in the landscape over an extended period of time. In reality, most of the plants listed will probably not be adopted for commercial production. But, some have great potential to enhance local landscaping and aid in water conservation.

Table 1. Native woody plants suggested for use in low-water landscaping, including the source of recommendation and the general location.

No.	*Genus*	*Species*	Source	Utah Counties or State
1	*Acer*	*glabrum*	Hale	Nevada
2	*Acer*	*glabrum*	Rupp	Sanpete
3	*Acer*	*glabrum*	Rupp	Sanpete
4	*Acer*	*glabrum*	Warner	Sevier
5	*Acer*	*grandidentatum*	Barker	Carbon
6	*Acer*	*grandidentatum*	Laub	Box Elder
7	*Acer*	*grandidentatum*	Morris	Cache
8	*Acer*	*grandidentatum*	Morris	Cache
9	*Acer*	*grandidentatum*	Morris	Cache
10	*Acer*	*grandidentatum*	Morris	Cache
11	*Acer*	*grandidentatum*	Morris	Cache
12	*Acer*	*grandidentatum*	Richards	Cache
13	*Acer*	*grandidentatum*	Richards	Cache
14	*Acer*	*grandidentatum*	Richards	Cache
15	*Acer*	*grandidentatum*	Richards	Cache
16	*Acer*	*grandidentatum*	Richards	Cache
17	*Acer*	*grandidentatum*	Richards	Cache
18	*Acer*	*grandidentatum*	Richards	Cache
19	*Acer*	*grandidentatum*	Richards	Cache
20	*Acer*	*grandidentatum*	Reid	Iron
21	*Acer*	*grandidentatum*	Reid	Iron
22	*Acer*	*grandidentatum*	Rupp	Cache
23	*Acer*	*grandidentatum*	Rupp	Cache
24	*Acer*	*grandidentatum*	Rupp	Cache
25	*Acer*	*grandidentatum*	Rupp	Cache
26	*Amelanchier*	spp.	Love	Bingham Co., ID
27	*Amelanchier*	spp.	Rupp	Rich
28	*Amelanchier*	*utahensis*	Bowns	Iron
29	*Amelanchier*	*utahensis*	Bowns	Iron
30	*Arctostaphylos*	*patula*	Rupp	Kane
31	*Arctostaphylos*	*patula*	Rupp	Garfield
32	*Arctostaphylos*	*patula*	Stevens	Sanpete
33	*Arctostaphylos*	*pungens*	Bowns	Washington
34	*Arctostaphylos*	*pungens*	Bowns	Washington
35	*Betula*	*occidentalis*	Rupp	Sevier
36	*Ceanothus*	*greggii*	Bowns	Washington
37	*Ceanothus*	*martinii*	Monsen	Sanpete
38	*Ceanothus*	*velutinus*	Rupp	Cache
39	*Ceanothus*	*velutinus*	Rupp	Rich
40	*Cercocarpus*	*intricatus*	Kjelgren	Cache
41	*Cercocarpus*	*intricatus*	Monsen	Beaver
42	*Cercocarpus*	*intricatus*	Rupp	Clark County, NV
43	*Cercocarpus*	*intricatus*	Rupp	Clark County, NV
44	*Cercocarpus*	*intricatus*	Stevens	Sanpete
45	*Cercocarpus*	*ledifolius (broom)*	Wildrick	Rich
46	*Cornus*	*sericea*	Rupp	Cache
47	*Ericameria*	*nauseosa ssp. nauseosa var. speciosa*	Stevens	Juab
48	*Ericameria*	spp.	Anderson	Box Elder

Table 1 (cont.). Native woody plants suggested for use in low-water landscaping, including the source of recommendation and the general location.

No.	*Genus*	*Species*	Source	Utah Counties or State
49	*Fraxinus*	*anomala*	Rupp	Emery
50	*Juniperus*	*osteosperma*	Rupp	Kane
51	*Juniperus*	*osteosperma*	Stevens	Sanpete
52	*Juniperus*	*scopulorum*	Rupp	Emery
53	*Juniperus*	*scopulorum*	Rupp	Emery
54	*Juniperus*	*scopulorum*	Stevens	Sanpete
55	*Juniperus*	*scopulorum*	Stevens	Sanpete
56	*Juniperus*	x *osteosperma*	Stevens	Sanpete
57	*Mahonia*	*fremontii*	Rupp	Cache
58	*Mahonia*	*fremontii*	Warner	Sevier
59	*Mahonia*	*repens*	Cope	Cache
60	*Mahonia*	*repens*	Cope	Cache
61	*Mahonia*	*repens*	Cope	Cache
62	*Mahonia*	*repens*	Rupp	Sanpete
63	*Paxistima*	*myrsinites*	Rupp	Teton County, WY
64	*Philadelphus*	*microphyllus*	Rupp	Emery
65	*Pinus*	*edulis*	Stevens	Sanpete
66	*Pinus*	*edulis*	Stevens	Sanpete
67	*Purshia*	*tridentata*	Rupp	Millard
68	*Quercus*	*gambelii*	Rupp	Millard
69	*Quercus*	*gambelii*	Rupp	Beaver
70	*Quercus*	*gambelii*	Stevens	Sanpete
71	*Quercus*	*pauciloba*	Bowns	Iron
72	*Rhus*	*aromatica simplicifolia*	Bowns	Washington
73	*Rhus*	*glabra cismontana*	Stevens	Juab
74	*Salvia*	*dorii 'Clokeyi'*	Anderson	Clark County, NV
75	*Shepherdia*	*rotundifolia*	Rupp	Washington

Full names of sources include: Richard Anderson, Philip Barker, James Bowns, Kevin Cope, Eric Hale, Roger Kjelgren, Thomas Laub, Steven Love, Stephn Monsen, Jerry Morris, Chad Reid, Melody Richards, Larry Rupp, Richard Stevens, Janett Warner, and Carl Wildrick.

Documenting Plants and Locations

Current technology has made the documentation of individual plants a simple process. Identified accessions are documented with digital photography and the latitude and longitude determined by GPS (Garmin GPSMAP® 60CS or 60CSx). We have also found it helpful to place-mark the accession on a Google Earth© image to facilitate finding it (figure 1).

Vegetative Propagation

In horticultural production systems, asexual propagation of clonal material is used to establish the large numbers of uniform plants demanded by the industry and the consuming public. The characteristic of genetic diversity within a selected population of plants so desirable in reclamation is not a priority, since the high value of horticultural crops allows economic management of the problems that occur with clonal populations. Our goal with vegetative propagation has two parts. First, we are interested in asexual propagation as a means of initially establishing clones of wild plant materials in a nursery environment (figures 2 and 3). Once established, we are then focusing on how to economically propagate large numbers of the selected clone in a nursery setting. Given that rooting of cuttings is a genetic trait, determining the best method of propagation is not trivial. Response to cuttings or other propagation methods can vary significantly between clones. Research done with nursery-grown stock plants is also much more applicable to commercial production nurseries and will help us in our goal of assisting nurserymen of the interior western states to produce these plants.

Table 2. Native woody plants suggested for use in low-water landscaping, but not yet fully documented, including the source of recommendation and the documented location.

No.	*Genus*	*Species*	Source	Utah Counties or State
1	*Amelanchier*	*alnifolia*	Monsen	Iron
2	*Amelanchier*	*utahensis*	Monsen	Washington
3	*Arctostaphylos*	*patula*	Monsen	Wayne
4	*Artemisia*	*cana*	Monsen	Bighorn County, .MT
5	*Artemisia*	*cana*	Schulz	Eastern Wyoming
6	*Artemisia*	*filifolia*	Bowns	Washington
7	*Artemisia*	*nova*	Monsen	Juab
8	*Artemisia*	*pedatifida*	Schulz	Eastern Wyoming
9	*Artemisia*	*rigida*	Monsen	Ada County, ID
10	*Artemisia*	*rigida*	Schulz	Washington State
11	*Artemisia*	*rothrockii*	Monsen	Sanpete
12	*Atriplex*	*hymenelytra*	Stevens	Washington
13	*Ceanothus*	*prostratus*	Hanson	Adams County, ID
14	*Ceanothus*	*prostratus*	Monsen	McCall County, ID
15	*Ceanothus*	*prostratus*	Monsen	Sanpete
16	*Ceanothus*	*prostratus*	Monsen	Ada County, ID
17	*Ceanothus*	*velutinus*	Monsen	Ada County, ID
18	*Cercocarpus*	hybrid	Monsen	Sheridan County, WY
19	*Cercocarpus*	*intricatus*	Monsen	Millard
20	*Cercocarpus*	*intricatus*	Monsen	White Pine County, NV
21	*Cercocarpus*	*intricatus*	Monsen	Rio Blanco County, CO
22	*Cercocarpus*	*ledifolius*	Schulz	Juab
23	*Cercocarpus*	*ledifolius* x *montanus*	Monsen	Sheridan County, WY
24	*Cupressus*	*arizonica*	Monsen	Sanpete
25	*Ericameria*	*nauseosus salicifolia*	McArthur	Sanpete
26	*Fallugia*	*paradoxa*	Monsen	Sevier
27	*Juniperus*	*scopulorum*	Monsen	Bighorn County, .MT
28	*Juniperus*	*scopulorum*	Monsen	Caribou County, ID
29	*Juniperus*	*scopulorum*	Stevens	Sanpete
30	*Peraphyllum*	*ramosissimum*	Hanson	Washington County, ID
31	*Physocarpus*	*alternans*	Kitchen	Millard
32	*Pinus*	*edulis*	Stevens	Millard
33	*Populus*	*tremuloides*	Stevens	Sanpete
34	*Populus*	*Tremuloides*	Reid	Iron
35	*Prunus*	*virginiana*	Welsh	Utah
36	*Purshia*	*tridentata*	Monsen	Sanpete
37	*Quercus*	*gambelii*	Stevens	Sanpete
38	*Quercus*	*turbinella*	McArthur	Salt Lake
39	*Salvia*	*argentea*	Schulz	Eastern Wyoming
40	*Symphoricarpos*	*Longiflorus*	Kitchen	Millard

Full names of sources include: James Bowns, Alma Hanson, Stanley Kitchen, Durant McArthur, Stephen Monsen, Leila Shultz, Richard Stevens, Janett Warner, and Stanley Welsh.

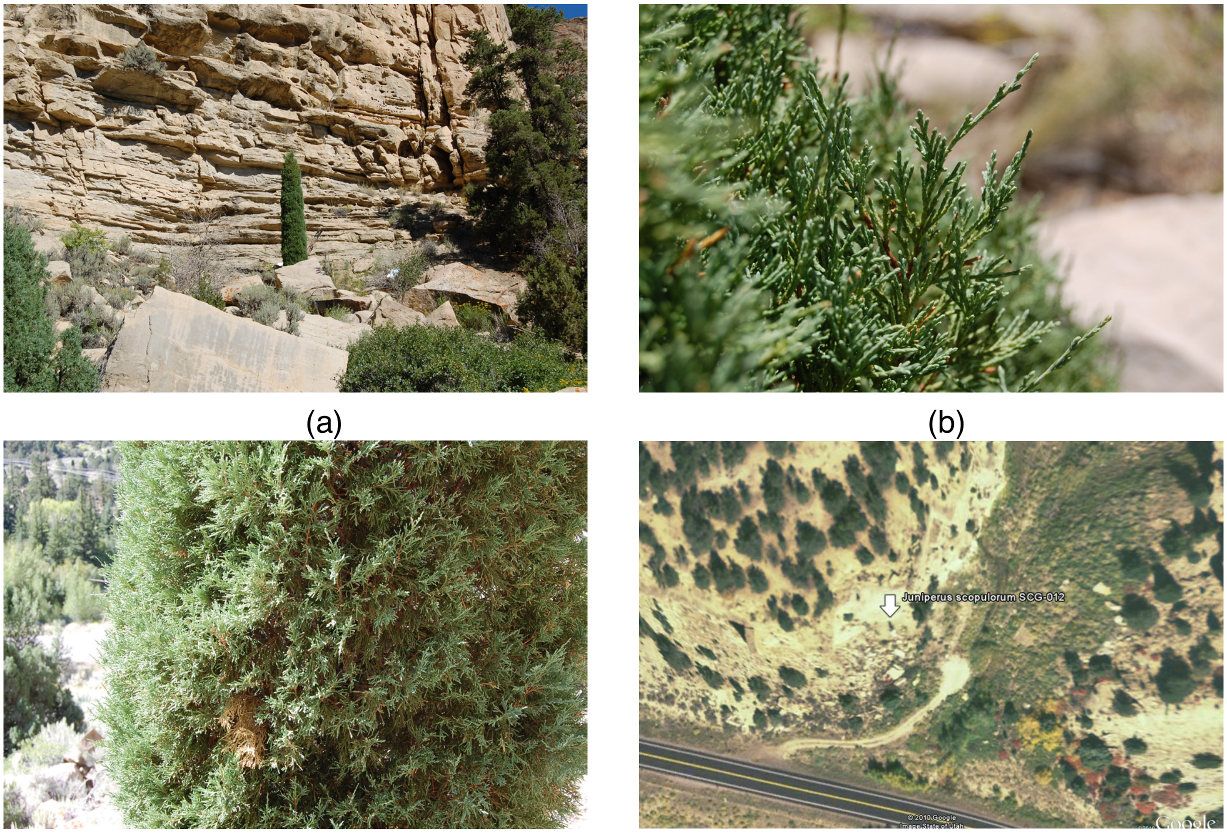


Figure 1. Documentation of an exceptionally columnar form of *Juniperus scopulorum;* site view with plant (A), close up of foliage (B), mid-view of foliage (C), and location on Google Earth© image (D).

Propagation of Evergreen Shrubs by Hardwood Cuttings

In an effort to further define vegetative propagation requirements of native shrubs, cuttings of previous season's growth were collected on Jan. 19-21, 2010 from a number of native shrubs (table 3) and propagated in a glass greenhouse in Logan, Utah. Cuttings were initially held on ice in a portable cooler until placed in a refrigerated storage at 4° C until Jan. 22-23 when stuck in a 4 perlite : 1 sphagnum peat (by volume) rooting substrate, with a reverse osmosis water mist (7 s/30 min during light period) and approximately 22-28° C bottom heat in a 18/16° C day/night greenhouse and 18 hour day length (using high pressure sodium lamps). The effect of auxin on rooting was examined by treatments of 0/0, 2000/1000, and 4000/2000 ppm indolebutryic acid (IBA)/naphthaleneacetic acid (NAA) as Dip 'N Grow® (Clackamas, Oregon) diluted in a 50 percent ethanol solution applied as a 5 s quick dip (n=12). Cutting positions were periodically randomized on the mist bench. Rooting was evaluated after 7 weeks for all plants except juniper which was evaluated after 15 weeks. Evaluations consisted of determining the percentage of rooted cuttings and the number of roots per rooted cutting (root primordia were classified as roots if their length exceeded their width).

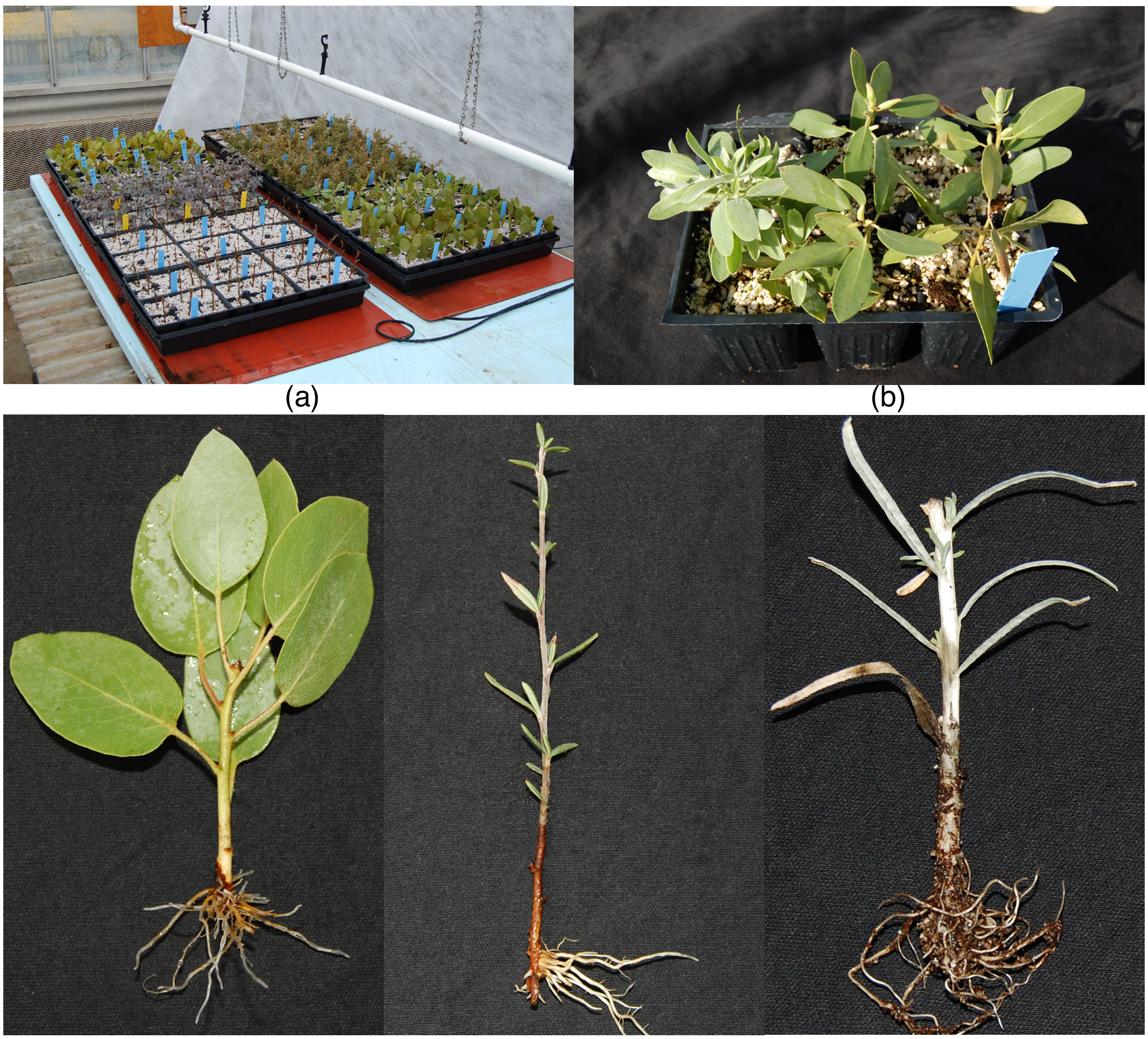
Statistical analysis of the percentage of rooted cuttings was done with logistic regression since the data have a binomial distribution and the method calculates a standard error value independent of cutting performance. Because the number of roots per cutting is considered count data, that analysis was done by ANOVA using square-root transformed data (Compton 2008).

RESULTS AND DISCUSSION

The effect of auxins on rooting as determined by percentage of rooted cuttings and number of roots per cutting showed a great deal of intra- and inter-specific variability (tables 4 and 5).

(a) (b) (c)

Figure 2. Side-veneer grafts (A & B) and chip budding (C) of *Acer grandidentatum* scions on seedling rootstocks as a means of clonal propagation and of establishing wild plant material in a controlled nursery environment.



(c) (d) (e)

Figure 3. Asexual propagation of cuttings using intermittent mist with bottom heat (A) and container packs (6 cm L x 5.5 cm W x 7 cm H) with 4:1 perlite:peat rooting medium (B). Successful propagation of hardwood (dormant) cuttings of *Arctostaphylos patula* (C) and *Cercocarpus intricatus* (D), and of semi-hardwood cuttings of *Ericameria nauseosa* ssp. *nauseosa* var. *speciosa* (E).

Table 3. Shrub sources for hardwood cuttings used in propagation trials.

Accession	Source	Notes
Arctostaphylos patula (002)	Sanpete County, Utah	High elevation
Arctostaphylos patula (014)	Kane County, Utah	Easily rooted
Arctostaphylos pungens (020)	Washington County, Utah	Large, multiple stems
Arctostaphylos pungens (021)	Washington County, Utah	Single stem form
Cercocarpus intricatus (003)	Sanpete County, Utah	Columnar form
Juniperus osteosperma (005)	Sanpete County, Utah	Purported hybrid, deer resistant
Mahonia fremontii (016)	Sevier County, Utah	Wildland Nursery stock block

Table 4. The effect of 0/0, 2000/1000, and 4000/2000 ppm indolebutryic acid (IBA)/naphthaleneacetic acid (NAA) as Dip 'N Grow® on percentage of rooted cuttings of selected specimens of native shrubs (n=12). Plant abbreviations are: *Arctostaphylos patula* (002) [ArcPat 002], *A. patula* (014) [ArcPat 014], *A. pungens* (020). [ArcPun 020], *A. pungens* (021) [ArcPun 021], *Cercocarpus intricatus* (003) [CerInt 003], *Juniperus osteosperma* (005) [JunOst 005], and *Mahonia fremontii* (016) [MahFre 016].

	ArcPat 002	ArcPat 014	ArcPun 020	ArcPun 021	CerInt 003	JunOst 005	MahFre 016
Rooting Hormone	**Percentage of Rooted Cuttings**						
0 ppm IBA/NAA	67	0	17*	67	0*	0	0
2000/1000 ppm IBA/NAA	92	0	83*	42	33*	0	0
4000/2000 ppm IBA/NAA	92	0	83*	58	42*	0	0

*Columns with asterisked data indicate a significant effect of rooting hormone on the percentage of rooted cuttings as shown by logistic regression at P=0.05 as calculated with Statistix 9 (Analytical Software 2008). Values of 0 were analyzed as 0.000001 for CerInt 003.

Table 5. The effect of 0/0, 2000/1000, and 4000/2000 ppm indolebutryic acid (IBA)/naphthaleneacetic acid (NAA) as Dip 'N Grow® on roots per rooted cutting of selected specimens of native shrubs (n=12). Plant abbreviations are: *Arctostaphylos patula* (002) [ArcPat 002], *A. patula* (014) [ArcPat 014], *A. pungens* (020) [ArcPun 020], *A. pungens* (021) [ArcPun 021], *Cercocarpus intricatus* (003) [CerInt 003], *Juniperus osteosperma* (005) [JunOst 005], and *Mahonia fremontii* (016) [MahFre 016].

	ArcPat 002	ArcPat 014	ArcPun 020	ArcPun 021	CerInt 003	JunOst 005	MahFre 016
Rooting Hormone	**Average Number of Roots per Rooted Cutting**						
0 ppm IBA/NAA	4.8 a[1]	0	4.0 a	6.6 a	0 a	0	0
2000/1000 ppm IBA/NAA	11.8 b	0	10.3 a	16.8 b	3.0 b	0	0
4000/2000 ppm IBA/NAA	8.3 ab	0	17.9 b	6.0 a	7.4 b	0	0

[1]Means followed by different letters within columns are significantly different based on Analysis of Variance of square-root transformed data at P=0.05 and pairwise comparisons using Least Significant Differences completed with Statistix 9 (Analytical Software 2008). Values of 0 were analyzed as 0.000001 for CerInt 003.

Arctostaphylos
Cuttings of wild manzanita (*Arctostaphylos*) generally root better when taken as terminal cuttings during the winter, though cultivated plants can be more readily rooted year round (Borland and Bone 2007; Trindle and Flessner 2002). Our results were similar with good numbers of roots and rooting percentages of up to 92 percent of selection *A. patula* (002) (greenleaf manzanita) when treated with supplemental auxins. While it failed in this experiment, we have successfully rooted *A. patula* (014) previously (Rupp 2009, unpublished data) and it was noted that this group of cuttings had symptoms indicative of stem rot. Borland and Bone comment on the prevalence of *Phytophthora* (root rot) as a significant and generally fatal disease of *Arctostaphylos* cuttings, suggesting that greater attention to sanitation and the use of fungicides may be of benefit.

Cercocarpus intricatus
A review of the literature has shown no record of propagation for littleleaf mountain-mahogany (*C. intricatus*) by cuttings. Our research allows this method to be successful and that there is a significant effect of auxin treatments on both the percentage of rooted cuttings and the number of roots per cutting. While we were only able to root 42 percent of the cuttings taken, the number is high enough to suggest that fine-tuning the propagation process should increase rooting to a commercially acceptable level.

Juniperus osteosperma
Junipers are a very commonly used plant in the landscape horticulture industry with multiple references regarding their propagation (Dirr and Heuser 2006; Hartmann and others 2011). In general upright selections of the genus *Juniperus* are considered difficult to propagate by cuttings (Connor 1985). Vegetative propagation of Utah juniper (*J. osteosperma*) has been studied very little, with only one citation of success in the literature (Reinsvold 1986). In this study we attempted to propagate a purported hybrid of Utah juniper found in Sanpete County, Utah. While the mother plant has desirable characteristics in both form and deer resistance, we were unable to induce any root formation, even when extending the rooting time to 15 weeks. Successful propagation of this accession may require the use of grafting to establish it in a nursery environment followed by empirical applications of treatments such as length of propagation time, wounding, rooting hormone formulations, rejuvenation, and others.

Mahonia fremontii
Similarly to junipers, there are a number of species within *Mahonia* that are used in the landscape industry – including the native Frémont's mahonia (*M. repens*). Cuttings of these plants can be successfully rooted, though the ease of rooting varies with the species and cultivar. Propagation of *M. fremontii* by vegetative means has not been recorded in the literature. A preliminary study of rooting cuttings of *M. fremontii* showed successful rooting (Rupp 2010, unpublished data). However, in this experiment there was no rooting, but rather a blackening of the cutting stem bases. Based on research with other *Mahonia* species, the blackening and lack of rooting could be due to the time of year the cuttings were taken (Dirr and Heuser 2006). It is also interesting to note that all methods of *Mahonia* propagation reviewed in Dirr and Heuser used talc as the rooting hormone carrier, and our preliminary experiment also successfully used a talc carrier, which raises a question as to the suitability of the alcohol-based quick dip used in this experiment.

CONCLUSIONS

The potential for selecting exceptional specimens of native woody plants for use in water-conserving landscapes is very good and we have successfully identified a number of plants with potential for use in the industry. Asexual propagation to preserve genotypes is also successful in many cases. In those cases where clones from genera known to form adventitious roots (in other words *Juniperus* and *Mahonia*) did not root, further research is required to determine if these selections are genetically recalcitrant or if factors such as disease, timing, conditions when collecting, and/or storage practices are inhibiting rooting. Both improved propagation techniques and observation of selections over several years in a landscaped environment are required before these plants can be promoted for use in the industry. We continue to search for plants with the drought, cold, and soil hardiness needed for the intermountain area and the aesthetic attributes that would contribute to residential landscapes.

ACKNOWLEDGMENTS

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