Rooting Ability of Fifteen Native Shrubs Using Hardwood Cuttings in the Field and Greenhouse

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Abstract

There is a need for more information on how well native shrubs root from hardwood cuttings and how they can apply to soil bioengineering practices such as live stakes and fascines. The purpose of this work was to screen fifteen shrubs indigenous to the Pacific Northwest USA for their ability to root with and without a rooting compound in a greenhouse mist bench, well drained field, nursery bed, and saturated substrate (pond). Results indicate species with good potential are black twinberry (*Lonicera involucrata*), salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), and Pacific ninebark (*Physocarpus capitatus*). Indian plum (*Oemleria cerasiformis*), coyote brush (*Baccharis pilularis*), and red elderberry (*Sambucus racemosa*) have fair potential. Mock orange (*Philadelphus lewisii*) and flowering currant (*Ribies sanguineum*) may apply under limited circumstances.

Keywords

native shrub, hardwood cutting, live stake, fascine, root, plant growth regulator, soil bioengineering

Introduction

In the Pacific Northwest USA, landscape horticulturists utilize native shrubs more than ever (Hamilton et. al. 1998). Ecologists and erosion control specialists call on them almost exclusively over exotics for wetland restoration and streambank stabilization, including widely accepted soil bioengineering practices. To this end, propagation technology on regionally important species has increased substantially within the past decade. While methods for the more common and ornamental native shrubs are published (Kruckeberg 1996, Leigh 1997, Rose et. al. 1998), additional refinement is needed for many species.

Furthermore, the most frequently used woody plants for stream side soil bioengineering in western Oregon and Washington are native willows (*Salix* sp.), and to a lesser extent Douglas spirea (*Spiraea douglasii*), and western red-osier dogwood (*Cornus sericea* var. *occidentalis*). The applicability of other indigenous shrubs for practices such as unrooted live stakes, fascines (wattles), and brush mats is not widely known. For example, how well will other species root from older wood or grow when buried as a bundle or mat along a streambank? In addition, could plant growth regulators (PGRs) be used to treat dormant cuttings on-site and enhance establishment?

While some information exists on the relative ease of rooting hardwood cuttings (Leigh 1997, King Co. Dept. of Public Works 1993), rooting potential under various conditions, including the use of PGRs, merits further exploration. Therefore, the purpose of this work was to screen select indigenous shrubs for their ability to root with and without a rooting compound in a field, nursery bed, greenhouse and saturated soil.

Table 1. Shrub Names and Sources

Acc'n No.	Common Name	Scientific Name	Symbol	Source
171	snowberry	*Symphoricarpos albus*	SYALL	Skagit Co, WA
172	salmonberry	*Rubus spectabilis*	RUSP	Lane Co, OR
173	coyote brush	*Baccharis pilularis*	BAPIC2	Lane Co, OR
174	mock orange	*Philadelphus lewisii*	PHELG2	Lane Co, OR
175	Oregon viburnum	*Viburnum ellipticum*	VIEL	Linn Co, OR
176	red flwr currant	*Ribies sanguineum*	RISA	Lane Co, OR
177	Pacific ninebark	*Physocarpus capitatus*	PHCA11	Lane Co, OR
178	Indian plum	*Oemleria cerasiformis*	OECE	Lane Co, OR
179	blue elderberry	*Sambucus cerulea*	SACE	Asotin Co, WA
180	Pacific ninebark	*Physocarpus capitatus*	PHCA11	Whatcom Co, WA
181	red elderberry	*Sambucus racemosa*	SARAA	Skagit Co, WA
182	Indian plum	*Oemleria cerasiformis*	OECE	Skagit Co, WA
183	thimbleberry	*Rubus parviflorus*	RUPA	Lane Co, OR
184	Calif. hazelnut	*Corylus cornuta*	COCOC	Skagit Co, WA
185	cascara	*Rhamnus purshiana*	RHPU	Lane Co, OR
186	snowberry	*Symphoricarpos albus*	SYALL	Lane Co, OR
187	twinberry	*Lonicera involucrata*	LOIN5	Lane Co, OR
188	tall Oregon grape	*Mahonia aquifolium*	MAAQ2	Skagit Co, WA
189	blue elderberry	*Sambucus cerulea*	SACE	Lane Co, OR
190	red flwr currant	*Ribies sanguineum*	RISA	Benton Co, OR

Methods and Materials

Selection and Sources

Native shrub species were chosen on the basis of their relative ease of rooting, natural abundance or special features. Accession numbers, scientific names and sources for all material appear in Table 1. Branches were harvested in February 1998 and stored in a cooler (36 °F) until processed into cuttings. Healthy, vigorous plants were favored. The variety 'Plumas' sitka willow (*Salix sitchensis*) was used as a standard for comparison. The full array of species and sources was used in the greenhouse but only subsets were used at the other three study sites.

Study Locations

Four study sites were chosen for the experiments to represent a variety of growing conditions. They are an irrigated nursery bed (well drained sandy loam), a greenhouse mist bench, upland terrace (farm field, moderately well drained silt loam), and research pond (fill sand, saturated). The bed is located at the Lynn A. Brown (Bow) Plant Materials Center (elev. 200 ft.) operated by the Washington State Association of Conservation Districts and the last three sites are at the NRCS Plant Materials Center, Chorally, OR. (elev. 225 ft.).

Processing

Stems were cut into 8 in. and 12 in. segments for the greenhouse and outdoor studies respectively. Branches were fully dormant except for early bud swell in red elderberry, Indian plum, flowering currant and black twinberry. For consistency among species, apical buds were removed (except for a portion of species at Bow), previous year's growth was used unless second year wood was required for length or more material, side branches were removed (except for coyote brush), and stock quality was randomized among plots. However, for red and blue elderberry, standard lengths were occasionally exceeded in order to insure two nodes per cutting. Cuttings were left untreated or dipped for five seconds with Wood's rooting compound (WRC: Indole-3-butric acid 1.03%, 1 Napththalene acetic acid 0.51%, Ethanol SD 3A 78.46%, and Dimethyl formamide 20% by weight) diluted with water at a ratio of 5:1 and 10:1 (H_20:WRC). At Corvallis, the two broadleaf evergreens, Oregon grape and coyote brush, were further divided into treatments with and without foliage (leaves retained or clipped off).

Experimental Design and Planting

The experimental design is a randomized complete block with four replications and two, three or four treatments (control versus 1 or 2 treatments with WRC, and evergreens with and without foliage). For the greenhouse study, 8 in. cuttings were inserted to a depth of 5 in. in moist perlite. Spacing was 2 in. between and within rows. Each plot consisted of six cuttings. For the three outdoor studies, spacing was 6 in. within row and 24-30 in. between rows. Plots contained six cuttings at Corvallis and 15 at Bow. The 12 in. cuttings were inserted 8 in. into the substrate. All plantings were made in late February or early March.

Management

Greenhouse day length was 16 hours and minimum day and night temperatures were set at 65° F. Temperatures exceeded 90° on sunny days in May. Cuttings were misted 20 seconds/hr. during the day and once per night. No tent, fertilizer or bottom heat was used.

All outdoor plantings occurred in firm weed free soil. No fertilizer or overhead irrigation water was applied to the field or pond sites at Corvallis. However, All plots were hand weeded once. The rooting substrate in the pond was kept saturated or slightly flooded for the first eight weeks to simulate conditions in a shallow wetland or at the water line in a stream. At Bow, the nursery beds were irrigated five times from March through June, weeding was by hand and no herbicides were applied.

Data Collection and Analysis

Data collection included caliper of cutting, minimum caliper that rooted, length of longest shoot, number of live and dead shoots (not reported here), root length, root abundance (root counts or visual rating), location of root formation on the cutting, age of wood, and percent rooting success. Material that had at least one live root were counted as successful regardless of the condition or existence of a healthy shoot. Data were collected once at the end of each experiment (after approximately 14 weeks), except at Bow where data were collected after 10 and 14 weeks to gauge rate of development.

Each accession or species was treated as an individual experiment and analysis of variance conducted on factor A (root treatment). The F test was used to compare two means and Fisher's Protected Least Significant Difference (FPLSD) at the P=.05 level was used to separate three or more means. Species means (species as a treatment) were not statistically analyzed.

Results and Discussion

The results for the nursery bed experiment at Bow are shown in Table 2. and those for the greenhouse mist bench, field and pond studies at Corvallis are shown in Table 3. All data represents the mean of four replications. Means with different letters were significantly different at the P=0.5 level. Groups of means without letters are not significantly different or were not statistically separated because of missing values. Further definitions of codes and headings appear at the bottom of each table.

An overall rating (last column of Table 3) was assigned each species/treatment based on root abundance (first letter) and percent rooted (second letter). Performance in the pond (saturated sand) was not factored in because of the extreme conditions. In general, the following criteria was applied:

Letter	Root abundance	Percent Rooted
Poor(P)	8-10	0-30
Fair(F)	5-8	30-50
Good(G)	2-5	50-90
Excellent(E)	1-2	90-100

Across all experiments, any consistent

Table 2. Native Shrub Rooting trial: Nursery Bed (Bow PMC)

Accession/ Species	TMT	Caliper (mm)	Min. Caliper	Percent Rooted	Number of Roots 17-May	Number of Roots 11-Jun	Root Lgth. (cm) 17-May	Root Lgth. (cm) 11-Jun	Shoot Lgth.(cm) 11-Jun
184 COCOC	1	7.5	4	60	1	9.7	0.3	17.3	22.7
	2	6.3	4	60	2.5	6.5	1.3	14.5	17.1
	3	6.8	3	55	2.6	13.7	1.6	18.6	16.3
188 MAAQ2	1	7.7	6	40	0	1.9	0.0	2.3	0.0
	2	7	9	0	0	0	0.0	0.0	0.0
	3	6.2	5	20	0	1.5	0.0	2.5	5.0
182 OECE	1	6	4	95	4.2	14.3	1.9b	31.9	33.8
	2	6.2	5	80	4.7	11.9	1.7b	23.5	24.6
	3	6.8	4	95	4.6	12.9	2.4a	26.8	34.4
80 PHCA11	1	7.4	4	80	4.3	11.2	2.5	23.6	51.1a
	2	8.1	6	80	3.5	9.2	2.3	24.2	46.5ab
	3	7.4	4	75	4.5	12.1	2.0	18.4	30b
Plumas SASI	1	9.4	8	100	18.6	29.4	2.2	56.0	250.0
**	2	9.2	8	100	18.2	19.66	3.6	25.0	40.0
	3	9	8	80	28.6	30	4.4	35.0	147.5
179 SACE	1	9.2	5	60	2.8	9.9	2.7	25.4	29.2
	2	9.2	6	70	0	15.1	0.0	19.6	26.9
	3	8.6	8	60	3.3	10.4	2.0	21.7	28.6
181 SARAA	1	10.25	6	65a	4.8	15.2	3.1	24.4	33.6a
	2	8.7	5	60a	1.8	14.8	1.9	22.3	25ab
	3	9.9	8	35b	0	12.1	0.0	25.6	18.8b
171 SYALL	1	7	5	75	5	12.3	3.5	21.6b	49.7b
	2	7.3	4	65	4.3	13.7	2.7	27.4ab	60.8ab
	3	7.1	4	75	4	13.7	2.0	37.8a	76.4a

TMT = treatment. Treatment 1 = untreated. Treatment 2 = 5:1 dilution Wood's Rooting Compound (WRC). Treatment 3 = 10:1 dilution WRC. Means with different letters are significantly different at P = .05. Means without letters were not significantly different or were not analyzed because of missing data.
**SASI not replicated.

Table 3. Native Shrub Rooting Trial: Greenhouse, Field and Pond (Corvallis PMC)

Accession/ Species	TMT	Min. Caliper (mm)		Percent Rooted			Root Abundance			Root Lgth	Shoot Length (cm)			2 Yr	Root	Overall
		GH	FD	GH	FD	PD	GH	FD	PD	(cm)	GH	FD	PD	Wood	Loc.	Rating
171 SYALL	1	2.9	3.0	100	100	96	4.5	3.0	4.3	16.3	15.0	17.2	8.5	yes	Bnic	GE
	2	2.8	3.0	100	100	100	3.8	2.1	5.0	16.4	17.8	21.1	7.4	yes	Bnc	GE
172 RUSP	1	3.6	2.5	92	85	0	5.6	4.7	10.0	17.3a	7.1b	9.9	0.0	?	Bni	GG
	2	2.7	3.4	88	79	0	4.6	3.9	10.0	15b	10.3a	14.5	0.0	?	Ni	GG
173 BAPIC2	1	4.5	2.5	62	100a	<>	7.7ab	7.1	<>	13.5	5.6	5.1	<>	yes	Bi	FG
	2	3.1	2.9	71	79b	<>	6.5a	6.7	<>	12.6	6.3	5.0	<>	yes	Bni	FG
	4	2.4	2.0	42	88ab	<>	9.0b	7.7	<>	9.2	2.9	3.1	<>	?	Bi	PG
	5	2.2	2.0	54	96a	<>	7.6ab	7.7	<>	12.4	5.6	4.6	<>	yes	bNi	FG
174 PHLEG2	1	4.0	4.3	79	88	21	6.5	6.6	8.5	9.9	7.0	5.6	7.2b	yes	bnIc	FG
	2	3.5	3.5	79	92	13	5.8	6.8	9.3	10.9	8.2	5.5	6.3a	yes	bnIc	FG
	3	4.5	<>	83	<>	<>	5.1	<>	<>	9.9	11.1	<>	<>	yes	bIc	FG
175 VIEL	1	6.4	2.8	5	21	<>	9.9	9.7	<>	1.5b	2.6	2.2	<>	?	c	PP
	2	3.6	3.2	21	21	<>	9.6	9.8	<>	4a	1.5	2.7	<>	?	c	PP
176 RISA	1	3.2	4.3	46	42	0	8.9	9.4b	10.0	6.5	3.0	2.0	0.0	yes	bni	PF
	2	2.8	3.9	53	46	0	8.5	8.6a	10.0	6.2	2.3	4.8	0.0	yes	bni	PF
177 PHCA11	1	4.4	4.2	96	96	0	2.4	4.1	10.0	19.8	8.8	12.7	0.0	yes	BNI	GE
	2	3.2	2.9	96	100	8	3.6	3.8	9.0	17.2	11.2	12.6	8.5	yes	BNI	GE
	3	4.8	3.4	96	96	<>	3.1	4.2	<>	20.2	11.2	9.1	<>	yes	BNI	GE
178 OECE	1	4.0	6.1	21	17	0	9.5	9.3	10.0	9.2	2.7	11.4	0.0	yes	b	PP
	2	3.5	4.6	21	21	0	9.4	9.0	10.0	8.8	2.7	10.2	0.0	yes	bn	PP
179 SACE	1	5.1	7.0	23	4	0	9.7	9.9	10.0	3.3b	1.3b	1.0	0.0	?	nc	PP
	2	4.1	<>	23	0	0	9.4	10.0	10.0	18.8a	2.9ab	0.0	0.0	?	nc	PP
	3	6.2	<>	21	9	0	9.5	9.9	10.0	8.7b	4a	1.7	0.0	?	n	PP
180 PHCA11	1	2.3	3.4	71	87ab	0	5.3	5.2	10.0	22.2	13.2	9.4	0.0	yes	BNI	FG
	2	4.4	2.8	83	75b	0	4.4	5.0	10.0	18.7	11.8	10.5	0.0	yes	BNI	GG
	3	5.5	4.2	92	96a	<>	4.0	4.2	<>	16.8	12.1	11.0	<>	yes	BNI	GE
181 SARAA	1	4.5	6.6	71	63	4	6.3	6.8b	8.8	22.0	4.0	8.2	4.0	?	BNc	FG
	2	4.4	5.0	75	88	13	6.2	3.3a	9.3	17.1	4.9	8.8	4.3	?	BNi	FG
	3	3.3	<>	83	<>	<>	5.0	<>	<>	19.2	4.4	<>	<>	?	BNc	FG
182 OECE	1	2.5	2.9	71	79	0	7.8	6.4	10.0	7.9	1.8	9.4	0.0	yes	Bn	FG
	2	3.6	2.3	54	92	0	8.1	5.4	10.0	9.7	2.4	11.8	0.0	yes	BNc	FG
183 RUPA	1	5.3	6.5	4	38	0	9.9	9.5	10.0	9.0	2.1	4.0	0.0	?	c	PF
	2	4.8	4.6	9	29	0	9.9	9.2	10.0	2.0	2.7	4.2	0.0	?	bi	PP
	3	<>	3.4	<>	54	0	<>	9.0	10.0	<>	<>	3.8	0.0	<>	<>	PF

Table 3. Continued. Native Shrub Rooting Trial: Greenhouse, Field and Pond (Corvallis PMC)

Accession/ Species	TMT	Min. Caliper (mm)		Percent Rooted			Root Abundance			Root Lgth (cm)	Shoot Length (cm)			2 Yr Wood	Root Loc.	Overall Rating
		GH	FD	GH	FD	PD	GH	FD	PD		GH	FD	PD			
184 COCOC	1	4.0	8.2	17	4	0	9.8	9.9	10.0	3.8	2.6	1.1	1.8	?	c	PP
	2	4.6	3.5	38	13	0	9.4	9.9	10.0	4.6	2.0	1.5	0.0	yes	c	PP
185 RHPU	1	5.5	<>	22	<>	<>	9.7	<>	<>	9.0	1.7	<>	<>	?	b	PP
	2	<>	<>	0	<>	<>	10.0	<>	<>	0.0	0.0	<>	<>	<>	<>	PP
	3	3.0	<>	9	<>	<>	9.8	<>	<>	5.5	2.5	<>	<>	?	bni	PP
186 SYALL	1	2.3	<>	92	<>	<>	6.8b	<>	<>	11.3	9.5b	<>	<>	yes	Bni	FE
	2	1.9	<>	96	<>	<>	4.8a	<>	<>	18.6	12.5a	<>	<>	yes	Bnic	GE
187 LOIN5	1	1.8	2.8	88	100	50	4.0	3.1	7.7b	18.1	10.2	18.4	7.4b	yes	Bnic	GE
	2	2.5	2.9	92	100	54	4.0	3.4	5.3a	17.2	10.2	15.9	9.9a	yes	Bnic	GE
188 MAAQ2	1	5.7	4.3	10	21	<>	9.6	9.5	<>	4.6	2.5	2.0	<>	yes	bn	PP
	2	6.0	6.1	15	21	<>	9.9	9.5	<>	1.5	0.0	1.9	<>	yes	n	PP
4	3.5	7.8	6	6	<>	9.9	9.9	<>	1.0	0.0	1.3	<>	?	n	PP	
5	2.9	3.8	6	15	<>	9.9	9.8	<>	4.0	0.0	1.5	<>	?	n	PP	
189 SACE	1	<>	7.8	<>	17	<>	<>	9.8	<>	<>	<>	4.2	<>	<>	<>	PP
2	6.6	10.9	19	28	<>	9.8	9.3	<>	4.0	1.8	3.1	<>	?	n	PP	
190 RISA	1	2.6	<>	72	<>	<>	8.0	<>	<>	10.3	2.5	<>	<>	yes	bNi	PG
	2	2.8	<>	62	<>	<>	8.3	<>	<>	7.1	3.9	<>	<>	yes	bNI	PG
Plumas SASI	1	8.0	7.8	100a	96	100	1.2a	1.4	1.3	31.6a	39.1a	54.6	42.8	**	I	EE
	2	7.2	5.7	29b	100	100	7b	1.3	1.0	10.3b	26.6b	41.6	42.1	**	I	***

TMT = treatment: 1 = untreated. 2 = 5:1 dilution Wood's Rooting Compound (WRC). 3 = 10:1 dilution WRC. 4 = untreated w/ foliage intact. 5 = 5:1 dilution WRC w/ foliage intact. "GH = greenhouse. FD = field. PD = pond. Min. Caliper = minimum caliper which still rooted. Root Abundance based on scale of 1=best, 10=none. " 2 yr Wood refers to root formation on second year wood: Yes or ? (unknown). Means with different letters are significantly different at P = .05. Root Loc. refers to location of roots on the cutting: B(b) =basal. N(n) = nodal. I(i) = internodal. c = callus w/ roots. Upper case letters indicate predominant position of roots. Overall rating: 1st letter refers to root amount. 2nd letter refers to rooting success. P = poor. F = fair. G = good. E = excellent. <> = data not taken or available. "** SASI roots readily from 2nd year growth (not evaluated here).
*** SASI rooted readily in the FD and PD with WRC, but poorly in the GH due to toxcity."

improvement in cutting performance from the use of Wood's Rooting Compound is difficult to detect for most species. However, for both accessions of snowberry, treatment always decreased the minimum caliper of cutting that successfully rooted, and increased the number and abundance of roots, root length, and shoot length by the end of the experiments (excluding the pond data). When salmonberry was treated, root abundance and shoot length were greater in the greenhouse and field, but root length was less (greenhouse). Red elderberry (in the field), coyote brush and Indian plum (in the greenhouse) demonstrated increased nodal rooting when treated with WRC, but not necessarily more roots.

Any detrimental effect from using the rooting compound is not obvious from the data except for 'Plumas' sitka willow in the greenhouse. All roots completely died where the cuttings were dipped, causing high mortality. Yet, no negative reaction occurred in the field or pond.

Red elderberry demonstrated inconsistencies. Treatment with WRC significantly improved root abundance (and increased rooting percentage) in the field, but had no effect in the greenhouse and significantly reduced rooting percent at the 10:1 dilution level in the nursery bed.

The experiment using saturated (flooded) fill sand as a rooting substrate in a pond provides different results. Most species did poorly except for sitka willow, black twinberry and snowberry. This could suggest that these shrubs have greater tolerance to saturated conditions as cuttings. They may be more appropriate for use as live stakes along an immediate water line compared to other species, but further evaluation is needed.

Based on these studies, it appears that additional native shrubs (or at least certain clones) may have potential as live stakes and merit evaluation as live fascines and brushmattresses. Those with the highest potential include black twinberry, Pacific ninebark, salmonberry and snowberry. However the stem diameter of snowberry is generally to small for true live stakes. Species with intermediate potential appear to be red elderberry, coyote brush and Indian plum. The utility of species with variable results, like Indian plum, may improve significantly by maintaining vigorous cutting blocks or ecotype "selection" of fast rooting clones.

Other species might be considered under special circumstances. Despite fair survival, red flowering currant appears marginal at best because it was comparatively slow to root. However, given its ornamental and wildlife value, extra high density live staking could compensate for the problem and may be worth the effort and risk in benign environments. Mock orange remains a minor possibility for testing as live stakes or fascines because it rooted readily. Unfortunately, its fine roots did not penetrate a somewhat compacted silt loam soil in the field. Its use may be limited to moist, well drained coarse textured or unconsolidated soils.

Blue elderberry and thimbleberry rooted slowly and relatively poorly from hardwood cuttings (low root abundance, poor to fair rooting percentage), in contrast to some reports (Leigh 1997). However, this could easily be the result of differences in plant vigor, handling, genetics or growing conditions. As this work, literature, and personal communication with growers suggest, cascara, Oregon viburnum, California hazel, tall Oregon grape are probably best propagated by other methods, such as softwood cuttings, layering or seed, depending on the species.

Future work will include evaluating how well the more promising shrubs root from older wood (3-5 year old branches), respond to slow release fertilizer or other soil amendments, and establish horizontally as bundles (fascines) and mats. For most shrubs tested, the efficacy of treating material with plant growth regulators under difficult, on-site conditions, or even in a greenhouse mist bench, remains a question for these authors. Ultimately, the goals are to improve shrub rooting success for growers and increase the number of indigenous species applicable for soil bioengineering. This will provide further opportunity for revegetation and erosion control specialists to diversify plant communities and wildlife habitat along streams, shorelines and wetlands.

Acknowledgements

The authors wish to thank Jon Anderson, Sevenoaks Native Nursery, Albany, OR, and Ron Robinson, Balance Restoration Nursery, Lorane, OR, for their technical advice and plant materials.

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