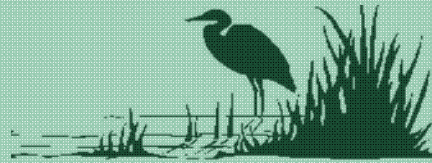


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Evaluation of fall versus spring planting of dormant hardwood willow cuttings with and without soaking treatment

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Introduction

The majority of riparian restoration and streambank bioengineering projects are installed in the spring as soon as weather permits. There are a number of reasons why spring plantings are more prevalent than fall plantings. There is the fear that fall collected cuttings may have been stressed due to hot summer temperatures, reduced water availability, insects and disease prior to cutting. Another reason is the idea that a cutting left on the tree over winter should be healthier than a cutting taken off the tree and left in the frozen ground for six months. Another one is that the cutting might rot during the wet dormant period. In some cases, most of the project planning usually takes place during the “down time” over the winter months, and restorationists are eager in the spring to get back outside as soon as possible.

Dormant fall planting of hardwood willow cuttings can be a very successful technique and preferable in many instances. For the highest survival, the bottom of a cutting must be planted into the lowest watertable which typically occurs in the fall. Fall planting may occur over a longer period of time and present a very long window of planting opportunity rather than the short planting window in the spring. Another reason to plant in the fall is that the cuttings are ready to start growing before the weeds get going in the spring. This is very important since in most springs, the ground is still too wet to plant the cuttings with equipment before the weeds start growing. In the past, we have recommended that the cuttings not be soaked in the fall, since they will be sitting in the ground all winter and should be able to absorb enough moisture to become fully hydrated by spring.

So which is better, fall planted cuttings or spring planted cuttings? Each season has its benefits and drawbacks. Fall planting often means that the cuttings are on the streambank much earlier than spring planted cuttings so some protection of the bank is possible when the spring runoff occurs. Furthermore, some root growth often will occur before runoff which helps with bank stability. To help increase fall planting establishment success, not only should the cuttings be harvested after leaf drop but new evidence indicates that soaking on an average of XX days helps to hydrate the cuttings before they are planted.

The benefits of pre-soaking willow and cottonwood cuttings prior to planting have been well documented (Edwards and Kissock 1975; Krinard and Randall 1979; Pezeshki et al 2005; Tilley

and Hoag 2007). Pre-soaking dormant hardwood cuttings has been shown to improve survival, increase vigor and cause greater production of roots and shoots. However, all studies have been conducted in the spring and have examined pre-soaking followed by immediate planting in laboratory or field conditions where plants can immediately begin growing after planting. A literature review yielded no reports of tests evaluating the efficacy of soaking, followed by a fall-dormant planting.

Figure 1. Dormant willow cuttings soaking (left) and stored without soaking (right) in walk-in cooler at 4°C prior to fall planting.



Methods

To determine whether fall pre-soaking would increase establishment success, we compared cuttings planted in the fall following a 14 day pre-soaking treatment, to fall planted with no pre-soaking, spring planted following 14 day pre-soak, and a non-soaked spring planted control. The cuttings were grown in Conetainers in the Plant Material Center (PMC) nursery.

Twenty-five dormant cuttings of peachleaf willow and coyote willow from the PMC willow cutting nursery were harvested on November 19, 2007. Peachleaf willow cuttings were 20 inches long with a basal diameter of about $\frac{3}{4}$ inches and the coyote willow cuttings were 20 inches long with a basal diameter of approximately $\frac{1}{2}$ inches. Although we normally recommend using cuttings $\frac{3}{4}$ inches or larger, the source location of the coyote willow did not have many cuttings larger than $\frac{1}{2}$ inch. The best, most vigorous stems were selected, and were smaller than expected. All side branches and terminal tips were removed at the time of harvest.

The cuttings were placed vertically in 5 gallon buckets filled 16 inches deep with water with 80% of the cutting submersed. The buckets were then placed in cold-dark storage at 4°C for 14

days prior to planting (November 26 to December 10). Plants not soaked were placed in cold-dark storage at 4°C until planting (fig 1).

We planted the soaked and non-soaked fall harvested cuttings on December 10, 2007 into 40 cubic inch Conetainers filled with a perlite/vermiculite mix and placed them outside (fig 2).

Figure 2. Cuttings planted into Conetainers in the fall and left outside over winter.



Cuttings for the spring treatments were harvested dormant on March 10, 2008 for peachleaf willow and March 21, 2008 for the coyote willow. Peachleaf willow cuttings were 20 inches long with a basal diameter of about $\frac{3}{4}$ inches and the coyote willow cuttings were 20 inches long with a basal diameter of approximately $\frac{1}{2}$ inches. On March 24, the spring harvested cuttings, which were the same size as the fall cuttings were placed in 5 gallon buckets to soak. Non-soaked spring-harvested cuttings remained in cold-dark storage. On April 7, 2008 we removed the cuttings being soaked and planted all of the spring collected cuttings (soaked and non-soaked) into 40 cubic inch Conetainers filled with the perlite/vermiculite mix.

After planting, all of the cuttings in Conetainers were partially submerged in an outdoor 4' X 8' X 1' tank, so they could be watered equally via sub-surface irrigation (fig 3). We initially filled the tank so that water rose 3 inches up the cones. Water levels were then manipulated to rise and fall ensuring that we provided adequate moisture for sprouting and growth.

Figure 3. Cuttings in 4'x 8'x1' metal tank for irrigation and establishment.



On May 19 (42 days after spring planting) we evaluated percent survival then carefully removed the peachleaf willow cuttings from their cones and washed the soil away from the roots. Roots and shoots were removed, separated, and air dried for four days and then weighed.

The coyote willow cuttings were grown longer than the peachleaf willow due to differences in growth rates. In order to have sufficient vegetation to accurately weigh, coyote willow cuttings were harvested on June 16 (70 days after spring planting). Roots and shoots were removed, separated, and air dried for eight days and then weighed on June 24.

Dates for peachleaf willow		Planted and moved		
	Collection	Soaked	outside	Biomass harvest
Fall non-soaked (F0)	11/19/07	NA	12/10/07	5/19/08
Fall 14 day soak (F14)	11/19/07	11/26/07-12/10/07	12/10/07	5/19/08
Spring non-soaked (S0)	3/10/08	NA	4/7/08	5/19/08
Spring 14 day soak (S14)	3/10/08	3/24/08-4/7/08	4/7/08	5/19/08

Dates for coyote willow				
	Collection	Soaked	Planted and moved outside	Biomass harvest
Fall non-soaked (F0)	11/19/07	NA	12/10/07	6/16/08
Fall 14 day soak (F14)	11/19/07	11/26/07-12/10/07	12/10/07	6/16/08
Spring non-soaked (S0)	3/21/08	NA	4/7/08	6/16/08
Spring 14 day soak (S14)	3/21/08	3/24/08-4/7/08	4/7/08	6/16/08

Results

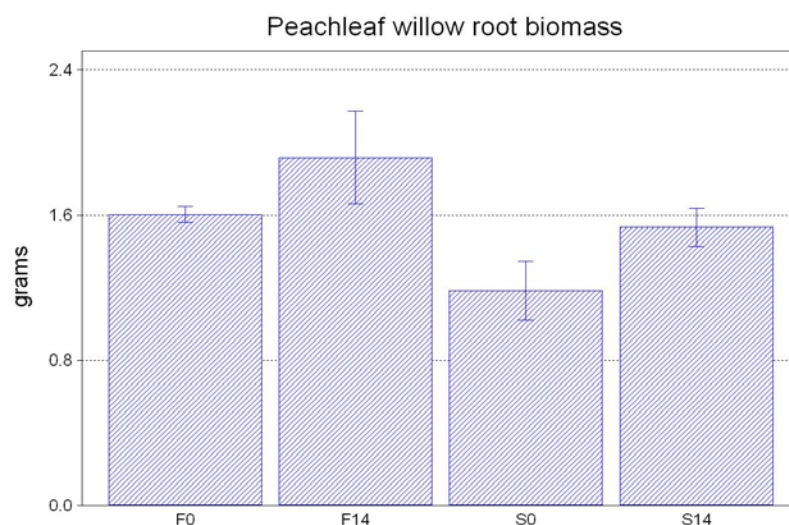
Peachleaf Willow

We had 100% survival from the peachleaf willow cuttings. Root and shoot production, however, did show differences between treatments (fig 4). In terms of roots and shoots, the *pre-soaked cuttings harvested and planted in the fall had better root and shoot production than all other treatments*. The poorest producer of roots and shoots was the spring harvested cuttings that did not receive a pre-soaking treatment. Unsoaked cuttings harvested and planted in the fall had root and shoot production similar to spring harvested and planted cuttings that had been soaked. Also, for fall and spring collected materials, soaked cuttings performed better than non-soaked cuttings harvested and planted within the same season (e.g., fall soaked cuttings out performed fall unsoaked cuttings, .spring soaked cuttings out performed spring unsoaked cuttings).

Coyote Willow

Two cuttings died in the fall soaked treatment of the coyote willow trial reducing survival to 92%. The reason for the cutting mortality isn't known. All other cuttings from the three remaining treatments survived. Despite the somewhat lower survival, fall harvested and pre-soaked cuttings had significantly greater root production than the other treatments (fig 5). Similar to the peachleaf willow trial, the pre-soaked cuttings had better root production than their non-soaked counterparts. Shoot production for coyote willow was essentially the same for all treatments.

Figure 4. Root and shoot biomass production of peachleaf willow: harvested and planted in the fall with no pre-soaking treatment (F0), 14 day pre soaking treatment (F14), harvested and planted in the spring with no pre-soaking treatment (S0) and a 14 day pre soaking treatment (S14). Error bars are +/- 1 standard error.



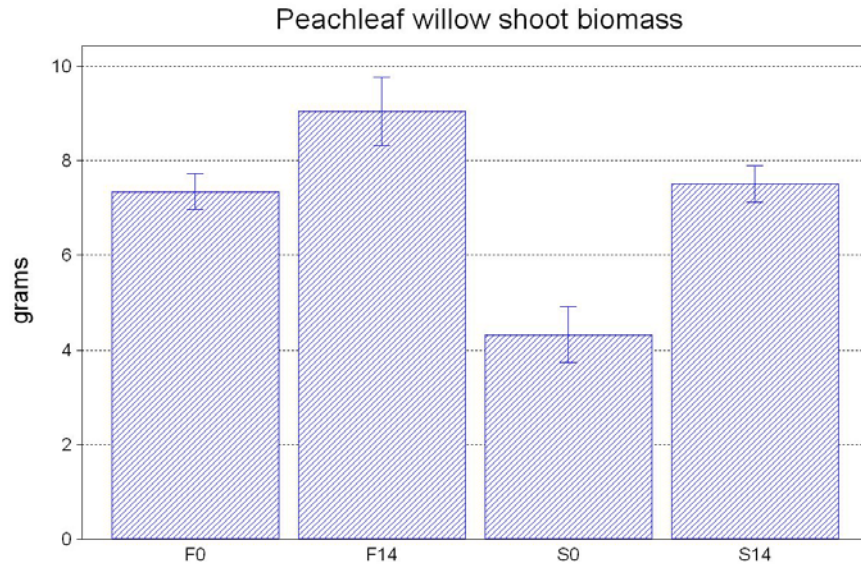
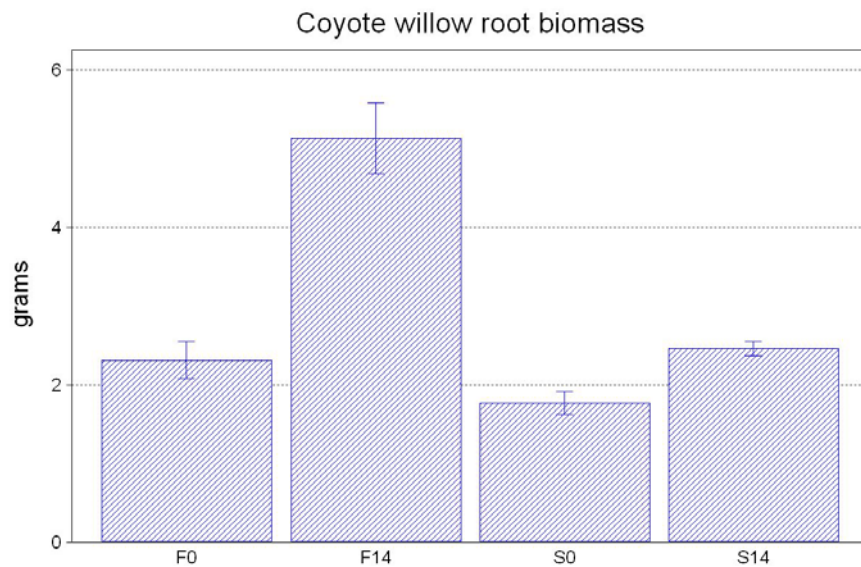
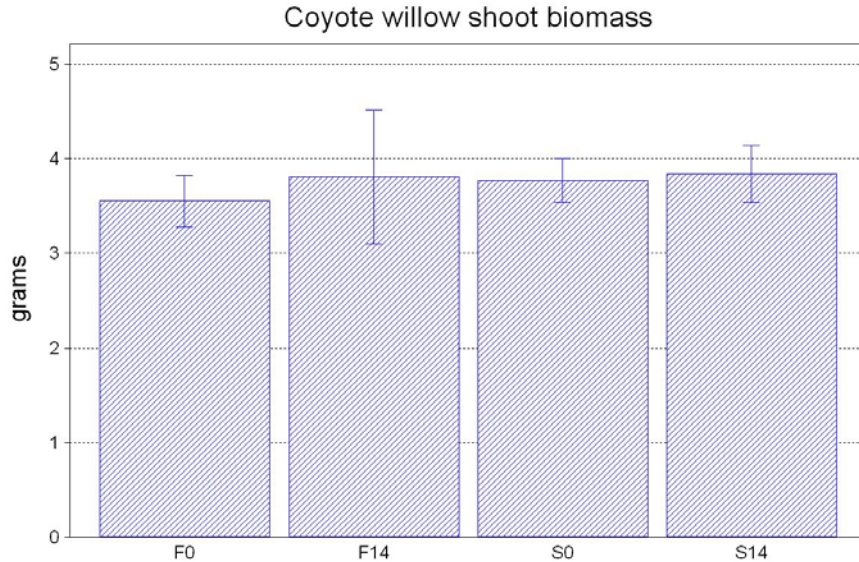


Figure 5. Root and shoot biomass production of coyote willow: harvested and planted in the fall with no pre-soaking treatment (F0), 14 day pre soaking treatment (F14), harvested and planted in the spring with no pre-soaking treatment (S0) and a 14 day pre soaking treatment (S14). Error bars are +/- 1 standard error.





Discussion

Woody plants (trees and shrubs) continue to lose moisture from their branches and needles over the course of the winter. Deciduous plants (plants dropping all of their leaves each fall), and evergreens, lose an appreciable amount of moisture through their branches, especially in windy environments. Furthermore when the ground temperatures are near freezing, plant water uptake and growth overall becomes very limited. To overcome cutting dehydration during the winter months supplemental water may be applied after woody plants become fully dormant, but before the ground is completely frozen (Scianna, 2008). However the results of the trials described in this paper suggest that a much easier way of assuring cutting hydration is presoaking and that a hydrated cutting is a better propagule regardless of the season.

Pre-soaking dormant willow cuttings in the fall before planting provides an added boost to help it maintain moisture levels through the winter and into the spring and get a jumpstart on root and shoot production when temperatures are warm enough to facilitate growth. In warm days of the later part of the dormant season, limited photosynthesis can occur through the stem and pre soaking induces the swelling of root primordia (Hoag and Tilley Citation?). As root primordia swells the roots are pushed out into the soil earlier than if the cutting had not been hydrated. Therefore presoaked cuttings planted in the fall are better adapted to site conditions at the onset of the growing season which translates into higher establishment success and more growth during the first growing season after planting.

These results suggest that presoaking and planting in the fall is likely more beneficial than presoaking and planting in the spring. Soaking cuttings after a spring harvest helps to hydrate the stem and swell the primordia, but perhaps not as much as soaking the cutting in the fall. Presoaking cuttings regardless of the collection and planting season is beneficial. The increase in survival and growth associated with fall harvested cuttings (soaked or unsoaked) coupled with a longer window of opportunity to collect material and plant in the fall makes a strong argument for planning and implementing cutting based revegetation projects in the fall.

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