HARVESTING AND HANDLING OF WOODY CUTTINGS

Special Topic

INTRODUCTION

Cuttings comprise the main live materials used in soil bioengineering construction. Live cut plant materials for soil bioengineering work can be gathered in the wild, i.e., harvested from existing native growing sites, or obtained from commercial nurseries that stock suitable cultivars. Attributes of cuttings from these two sources are summarized briefly below:

Native sources : Live cut plant material can be taken from existing, healthy, native growing sites. Such sites may be found within a few feet of the proposed treatment site, or could be located upwards of 80 km (50 miles) away in some cases. Longer hauling distances require more careful project coordination and impose greater constraints on handling and storage. A mixture of species should be harvested whenever possible.

Nursery sources : The USDA has released cultivars of Dogwood (*Cornus* spp*)* and Willow (*Salix* spp) species to commercial growers and nurseries that may be suitable for soil bioengineering stabilization work. These include "Streamco" purple osier willow (*Salix purpurea L.*), "Bankers" Dwarf Willow (*Salix X cottetii Kerner*), and "Ruby" Red Osier Dogwood (*Cornus stolonifera Michx*.). These cultivars were initially selected by the Natural Resources Conservation Service for outstanding performance as streambank stabilization plants. They are easy to clone and produce roots readily when cuttings are placed in moist soils.

PLANT SELECTION

Choose plant material adapted to the site conditions. When choosing live plant material for biotechnical erosion control applications, remember that young (less than 1 year old) wood or suckers will often sprout the easiest. However, older wood (2 to 5 years old) has greater vegetative (energy) reserves necessary to consistently sprout and older wood is much stronger. If possible, mix younger wood with older wood for the biotechnical erosion control application such that a majority of the material is 2 to 5 years old.

Hardwood cuttings are generally divided into three categories:

1. Stakes: 18-50 mm (¾-2 in) in diameter, with a minimum length of 400 mm (16 in).
2. Poles: 18-90 mm (¾-3.5 in) diameter and 2-3 m (6-9 ft) in length.
3. Branch cuttings: can have some smaller diameter branches (no smaller than 10 mm (3/8 in), combined with medium diameter branches, and are 1-3 m (3-9 ft) long depending on the application. Branch cuttings can be bundled for wattles, fascines or slope drains or used for brush layering techniques.

The following table presents a few of the common plant species used in bioengineering. Another excellent source of plant information can be found in Chapter 16, Appendix 16B of the *Engineering Field Handbook* (USDA, 1996).

TABLE 1: Soil Bioengineering Plant Species (excerpted from USDA, 1992)

Name	Location	Availability	Habitat value	Size/form	Root type	Rooting ability from cuttings
Acer negundo Boxelder	N, NE	Common	Excellent	Tree	Fibrous, mod.deep, spreading, suckering	Poor to fair
Alnus rubra Red Alder	NW	Very common	Excellent	Medium tree	Shallow, spreading, suckering	Poor to fair
Cornus amomum Silky Dogwood	N, SE	Very common	Very good	Small shrub	Shallow fibrous	Very good
Cornus racemosa Gray Dogwood	NE	Common	Very good	Med-small shrub	Shallow fibrous	Good
Populus angustifolia Narrowleaf Cottonwood	W	Common	Good	Tree	Shallow	Very good
Populus balsamifera ssp. trichocarpa fibrous Black Cottonwood	NW	Common	Good	Tree	Shallow	Very good
Salix amygdaloides Peachleaf Willow	N, S	Common	Good	Very large shrub	Shallow to deep	Very good
Salix bonplandiana Pussy Willow	W, MW	Very common	Good	Medium shrub	Fibrous	Very good
Salix purpurea Purpleosier Willow	N, S, E & W	Very common	Very good	Medium shrub	Shallow	Very good
Sambucus canadensis American Elderberry	NE, SE	Very common	Very good	Medium shrub	Fibrous	Good

TIMING

Timing is an important consideration in biotechnical work. This is particularly true in Mediterranean climates where there must be sufficient soil moisture present when cuttings are placed in the ground to insure satisfactory root formation and plant establishment. For example, woody cuttings installed in Northern California in the early winter will have sufficiently moist conditions to prevent desiccation while the cutting is developing roots. By early summer, there will be significant roots and shoots growing in response to the increased photosynthesis. By the time the typical autumn drought conditions occur, the plant will have had nine months to grow roots. By this time, these roots should be deep enough to tap into permanent water table, moist bedrock joints or into the capillary fringe. A similar woody cutting planted in the late spring of the year may not have had enough time to grow sufficient roots to allow the plant to survive its first dry season.

Cuttings can be collected any time during the dormant season, from leaf fall to just before the buds begin to break in the spring. Cuttings can also be collected during the growing season if most of the leaves are removed from the stem prior to planting, although establishment success will be lower (Hoag, 1993).

Spring plantings in non-riparian zones will have reduced success unless additional moisture (seeps, snow melt) is available. Occasionally, a wet year may extend the planting window. Summer plantings should be avoided because of hot temperatures and dry conditions (Allen & Leech, 1997).

HARVESTING CUTTINGS

A good source of willow is along highway or road right-of-ways. Another possible source is along drainage or irrigation canals. Maintenance supervisors are often happy to have the willows harvested. Regardless of whether the source plants are considered nuisance or a valuable resource, careful pruning will not permanently harm the shrub or tree. In fact, pruning often invigorates the plant and produces an abundant source of straight branches (whips) for harvest in a couple or years.

Choose live wood at least 2 years old. Avoid suckers of current year's growth as they lack sufficient stored energy reserves to sprout consistently.
The best wood is 2-5 years old with smooth bark that is not deeply furrowed. Select healthy wood that is reasonably straight. Try to remove cuttings from inside the crown of the existing plant and spread the harvesting activity throughout the stand to minimize visual impact. In general, one should avoid thinning more than 2/3 of the donor plant to avoid harming it.

Trim off all side branches from stakes and poles. Some side branches may be left on the branch cuttings intended for brush layering and fascines. Trim the terminal bud (the bud at the growing tip) so the plant energy will be rerouted to the lateral buds and adventitious tissue. There is some evidence that the terminal buds should not be removed on Cottonwoods. Schiechtl and Stern (1996) reports a high success (70-100% propagation take) using black poplar, which were end cuttings only (the terminal bud was left intact).

Cutting length is dependent on the application. Cutting should be long enough to extend 150-200 mm (6-8 in) into the permanent water table or capillary fringe for riparian plantings. At least 50-80% of the cutting should be below the ground surface to prevent desiccation. The cutting should extend above any competing herbaceous vegetation and should extend beneath the competing plant root mass.

SOAKING AND STORAGE

Research indicates that cuttings should be soaked for a minimum of 24 hours, whether they are stored, or harvested and immediately installed (Hoag et al., 1991). Some research recommends soaking the cuttings for as much as 10 to 14 days (Briggs & Munda, 1992; Fenchel et al., 1988).

Never let the cuttings dry out. Do not leave them exposed to direct sunlight. Cuttings may be stored in a cool, humid, dark place until ready to install. Platts et al. (1987) suggest a temperature of 24-32° F for cutting storage. Cuttings can be stored up to 6 months if the conditions are kept stable. Muhlberg & Moore (1998) recommend storage of refrigerated cuttings at 31-40° at 60 to 70 percent humidity. They also report success in Alaska with freezing the cuttings until installation. They recommend storing the cuttings with a small amount of ice to help reduce drying.


The left photo shows branch layers and pole plantings soaking in Branciforte Creek until installation with riprap (Santa Cruz County, CA). In the photo on the right, a triangular silt dike was used here to form a pond in a road ditch to soak live stakes (Sechelt, B.C.).

Prior to planting, soak the cuttings in water for 5 to 7 days (minimum 24 hours). Soaking will stimulate rooting and increase success. Remove them from water before the root tips emerge (this typically takes 7-9 days (Peterson & Phipps, 1976). When the cuttings are removed from the water, they should be immediately transported to the site and planted.

REQUIREMENTS FOR WOODY CUTTINGS

A large proportion of biotechnical erosion control and slope stabilization techniques involve the use of woody species which form adventitious roots. The woody shrubs and trees that are extensively used are Willow (*Salix* spp.), Cottonwood (*Populus* spp.), and sometimes Dogwood (*Cornus* spp.). Assuming that soil substrate exists, these plants have the following needs in order to be effective in biotechnical projects:

1. Sunlight and Exposure

Sunlight is necessary for plant growth. Willows and, to a lesser extent, Cottonwood are dependant of direct sunlight for proper growth. Given adequate moisture, Willow does well on a south or west-facing slope. Willow grown on a northern exposure or in a deeply shaded riparian may not persist. In such a situation, keep in mind that the willow material may still stabilize the slope or streambank and thus allow natural recruitment to occur.

2. Soil Moisture

As with any plants, woody cuttings require adequate soil moisture. A common misconception is that willows can only be used in riparian zones. Many grow at high elevations and in droughty areas. Additionally, upland willows grow well in California 's Mediterranean climate, characterized by cool, wet winters and hot, dry summers.

A woody cutting can dry out if it hasn't properly established roots before the dry season. With sufficient roots, the cutting has a good chance of utilizing the available soil moisture. If an upland willow, started from a cutting, survives the first couple of seasons it will probably persist, especially if it has tapped into seeps in fractured bedrock. Its roots will have established sufficiently to survive any seasonal fluctuations in soil moisture and the water table.

3. The Vadose Zone, Capillary Fringe, and the Water Table

Vadose Zone: The soil horizon located between the ground surface and the saturated soil zone. Given a specific site, the zone fluctuates with changing hydrologic conditions (precipitation, subsurface drainage, flooding, etc.). With regards to biotechnical planting, the vadose zone is the soil elevation region with a beneficial environment in which to install cuttings, live stakes, and poles that will encourage root growth, uptake of nutrients, and the exchange of gases.

Capillary Fringe: The distance water is wicked upwards above the water table by capillary action. Roots of woody cuttings should be able to reach this capillary fringe. Try to plant cuttings such that the branch, stake or pole extends 150-200 mm (6-8 in) into the capillary fringe.

Woody cuttings can also drown. Woody cuttings placed in the saturated soil zone, viz., below the ground water table, will suffocate. The plants require soil with sufficient aerated pore spaces to allow exchange of gases.

4. Inundation

Flooding will produce an anaerobic environment surrounding the root system. The duration and type of flooding has different impacts on woody plants. These impacts are varied depending on the plant's tolerance to flooding, which is in turn dictated by the growth of adventitious roots and new secondary roots under low oxygen conditions. Very tolerant species (*Willow, Cottonwood*) can maintain their "normal" roots (i.e., the root system that developed in an aerated medium) while producing new secondary and adventitious roots (Teskey & Hinkley, 1978). In fact, flood tolerant species generally have the ability to form adventitious roots in response to the anaerobic conditions. The new roots help the plant exchange oxygen for survival. Non-flood tolerant plants experience immediate die back.

5. Pre-Planting Soaking

In flood tolerant species like willow and cottonwood, the formation of adventitious roots is triggered by waterlogged conditions in the rhizosphere (that portion of the soil in the immediate vicinity of plant roots). Interestingly, there is much evidence linking adventitious root growth with the oxygen content of the floodwater for tree species (Teskey & Hinkley, 1978). Adventitious root development has been shown to be much greater under moving water than under stagnant water conditions and would appear attributable to the higher oxygen and lower CO_2 concentrations in moving water (Hook et al., 1970).

These studies and others done subsequently by USDA (Hoag, 1993) indicate that woody cuttings (willow, cottonwood) should be soaked in water for 5-7 days (minimum 24 hours) prior to planting. The aforementioned studies indicate that water high in oxygen, such as a running stream, may improve adventitious root formation. Bentrup and Hoag (1998) state that soaking swells the root primordia and may leach out natural anti-rooting hormones found in cuttings. Schaff, Pezeshki & Shields (2002) found that soaking Black Willow cuttings for 10 days improved growth, biomass production and survival, while those soaked for 3 days did not show a significant response. They also noted that studies of the response to a longer soaking period have not been done, and could reveal that the optimum soaking period is longer.

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