TECHNICAL NOTE

USDA - Natural Resources Conservation Service
Boise, Idaho

TN Plant Materials NO. 57 October 2012

EFFECTS OF LONG-TERM REFRIGERATED STORAGE ON HARDWOOD WILLOW CUTTINGS

Derek Tilley, Agronomist, NRCS, Aberdeen, Idaho
Loren St. John, PMC Team Leader, NRCS, Aberdeen, Idaho

This technical note describes dormant hardwood cutting survival of three native willow species under varying lengths of storage in dark refrigerated conditions.

Introduction

Planting healthy, vigorous cuttings is essential to successful establishment of riparian willow plantings for streambank erosion control practices. The vigor of the cutting during the initial planting phase is critical to establishment and long-term survival. Cuttings are often harvested dormant in late winter prior to the scheduled planting, but schedules frequently become preempted by unforeseen circumstances. Installation is then forced to wait until the completion of groundwork, construction, or until conditions become favorable, or when money for the planting is approved. Willow cuttings are commonly kept in long-term storage for weeks to months after their scheduled installation date, which raises the question, “how long can cuttings be kept in storage and still retain enough vigor to be used in riparian restoration projects?”

Cutting survival under storage conditions is dependent on water loss and the prevention of infection (Behrens, 1988). Unfavorable conditions can kill cuttings or reduce rooting potential (Behrens, 1988). Best storage conditions for dormant cuttings are those that cause no water stress and prevent the spread of fungal pathogens. The best means to achieve this is to lower the temperature and increase humidity (Behrens, 1988; Davis and Potter, 1985). Relative humidity should be kept near 100% (Behrens, 1988; Scianna et al., 2005), while an optimum temperature for cutting storage is approximately 24° F (Behrens, 1988; Cram and Lindquist, 1982). However meeting these parameters is more feasible with small nursery cuttings than for larger cuttings intended for riparian bioengineering projects, as many riparian restoration projects are limited in resources. Cutting storage locations may include basements, root cellars, snow drifts, walk-in refrigerators or in plastic bags outside during winter months.

Winter storage of completely dormant, leafless, cuttings is a well established practice without any major problems (Behrens, 1988); however difficulties arise when storage becomes prolonged. Cuttings should maintain vigor in freezing conditions outside fairly well if protected from disease, wind, or insects. Heeling-in cuttings as well as fall dormant planting have also proven successful as means of storage and establishment (Cram and Lindquist, 1982; Tilley and Hoag, 2009).

Long term storage effects on hardwood cuttings for restoration are less understood. The majority of cutting storage research involves small diameter cuttings used for nursery stock production. For example, Cram and Lindquist (1982) obtained best survival of 8 inch nursery willow cuttings after 6 months when stored at 24° F. They also saw higher survival rates of cuttings stored in polyethylene compared to non-wrapped cuttings. This study conducted by the Aberdeen Plant Materials Center (PMC) addresses long term storage on larger diameter cuttings of three willow species commonly used for riparian restoration projects in the Great Basin Region.

Materials and Methods

Three native willow species representing clonal, small tree and large tree types were harvested on November 29 and 30, 2011. Peachleaf willow (*Salix amygdaloides*) [SAAM] was harvested from the PMC cutting nursery. Yellow willow (*S. lutea*) [SALU] was collected from a native stand at Quaking Aspen Spring south of Rockland, Idaho. Coyote willow (*S. exigua*) [SAEX] was collected from a native stand on the Curlew National Grassland north of Holbrook, Idaho. All cuttings were trimmed to a length of 24 inches with a basal diameter of 3/4 to 1 inch. The cuttings were stored exposed (not wrapped in polyethylene) in a dark walk-in cooler with temperatures ranging from 34 to 36° F and 82% relative humidity for 0, 60, 120, 180 and 240 days.

After removal from storage, the cuttings were allowed to grow for 32 days in a growth chamber and were then evaluated for 1) percent survival (visible active growth, root initials, or healthy green stem tissues), 2) percentage of cuttings with root initials (ruptured bark exposing inner white tissues), 3) average number of shoots and roots per cutting, 4) average shoot and root mass, and 5) percent bud break (new buds visible on stem). Shoot and root mass was measured after air drying for 14 days at 72° F.

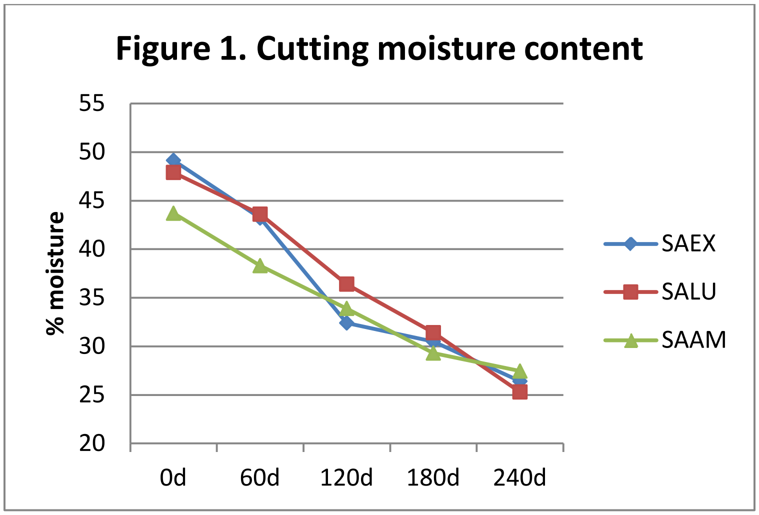
A second set of cuttings was used to measure cutting moisture content. Fresh weights were measured after storage treatment conclusion, and dry weights were recorded after oven drying at 140 °F for 10 days.

For a detailed description of the materials and methods of this trial, contact the PMC.

Results

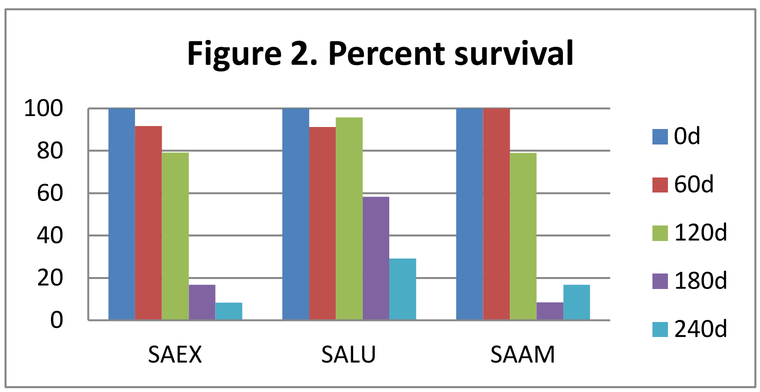
Cutting moisture content

The three willow species began the storage treatment with between 40 and 50% moisture content. Cutting moisture decreased steadily for all three species at a rate of approximately 0.1% per day. After 240 days water content ranged from 25 to 30% (figure 1).



Cutting survival

Cutting survival decreased significantly among peachleaf and coyote willow between 60 and 120 days of storage (figure 2). Between 60 and 120 days of storage, peachleaf willow cutting survival dropped from 100% to 79%, while coyote willow dropped from 92% to 79% survival. Survival of yellow willow did not decrease significantly until between 120 and 180 days of storage. Cutting survival for all three species continued to decline with increasing lengths of storage. Survival of peachleaf and coyote willow at 180 days was 9 and 17% respectively. Very few cuttings of any species were recorded as living at the 240 day evaluation.



Root development

Root initial development was significantly higher after 0 and 60 days of storage compared to longer storage lengths (figure 3). Between 60 and 120 days of storage the percentage of cuttings bearing root initials decreased from 88 to 42% for coyote willow, 79 to 50% for yellow willow, and 96 to 58% for peachleaf willow. After 120 days of storage coyote and peachleaf willow had essentially zero root initial development. Yellow willow root initial development dropped significantly between 180 and 240 days of storage with no initials forming from the 240 day treatment.

The number of roots per cutting did not differ significantly with storage treatment for coyote willow; however significant differences in roots per cutting were detected after 120 and 180 days for peachleaf and yellow willow respectively (figure 4). With 240 days of storage no root production was recorded for any species. Root biomass differed significantly between 60 and 120 days of storage in peachleaf willow and after 180 days of storage in coyote willow (figure 5). No differences were detected in root biomass among the treatments with yellow willow.

Figure 3. Percentage of cuttings with root initials

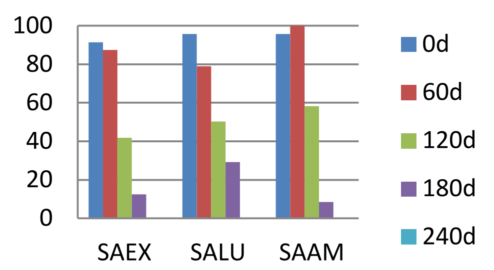


Figure 4. Average number of roots per cutting

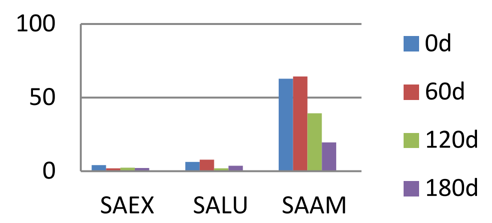
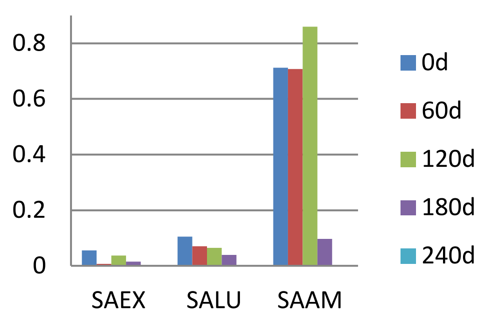
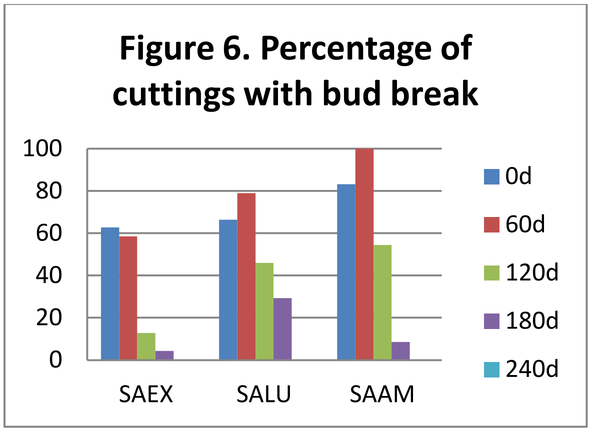


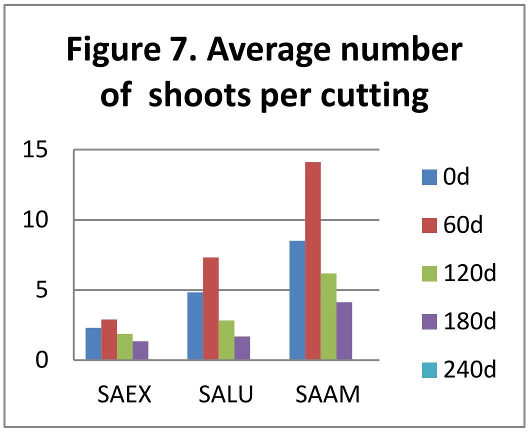
Figure 5. Root mass (g)

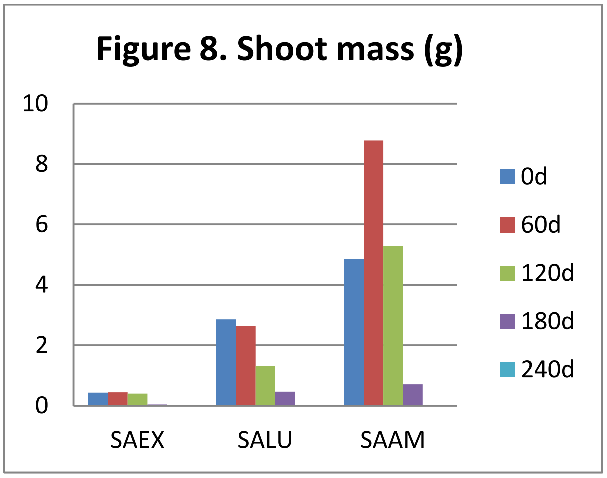


Shoot development

Bud development was significantly lower in coyote willow and peachleaf willow after 60 days of storage (figure 6). Significant differences in bud development were detected in yellow willow after 120 days of storage. At 180 days of storage, coyote and peachleaf willow showed 4 and 9% bud development respectively, while yellow willow had 29% of cuttings with bud break. No significant differences were seen in number of shoots per cutting for coyote willow (figure 7). Reductions in number of shoots were observed however after 120 days of storage for yellow and peachleaf willow. No significant differences were detected for shoot biomass for coyote or yellow willow (figure 8). Shoot biomass was significantly lower in peachleaf willow after 180 days of storage.







Discussion

This study shows that restoration sized dormant willow cuttings can be stored in refrigerated conditions for at least 2 months before risking significant decreases in vigor and survival. After 60 to 120 days of storage, survival and growth responses declined steadily, increasing the likelihood of establishment failure in field conditions. Cutting vigor can be sustained for longer periods with colder temperatures (Behrens, 1988) and better moisture retention (Scianna et al., 2005), but if these conditions are unobtainable it is recommended to plant cuttings within 2 to 3 months after harvest.

Root and shoot biomass would have been easier to separate means with a longer period of growth before evaluation. The miniscule weights obtained from dry root and shoot production for coyote and yellow willow were difficult for the scales used to measure. However the trends in general showed decreasing root and shoot biomass correlating to increasing storage lengths and decreasing survival rates as expected. Peachleaf willow did show anomalously high growth after 60 days of storage, but that did not differ significantly from the 0 day treatment.

Some differences in growth response could be observed between species; however species data were not compared against each other statistically. Yellow willow had fair survival after 180 days, while the other species dropped significantly in survival after 120 days. Peachleaf willow was very productive in shoot and root biomass compared to the other two species.

Survival, the most important measurement, decreased significantly after 60 days for coyote and peachleaf willow and after 120 days for yellow willow. Survival was less than 60% for all species after 120 days.

References

Behrens. V. 1988. Storage of unrooted cuttings. In: Davis, T.D., Haissig, B.E., and N. Sankhla (eds). Adventitious Root Formations in Cuttings. Dioscorides Press, Portland, OR. Pp. 235-247.

Cram, W.H. and C.H. Lindquist. 1982. Refrigerated storage for hardwood cuttings of willow and poplar. Tree Planters' Notes. 33 (4). 3p.

Davis, T.D. and J.R. Potter. 1985. Carbohydrates, water potential, and subsequent rooting of stored *Rhododendron* cuttings. HortScience 20:292-293.

Scianna, J.D., Logan, R., and D. Ogle. 2005. Temporary storage and handling of container, bareroot and cutting stock. USDA-NRCS Plant Materials Technical Note No. 45. Boise, Idaho. 6p.

Tilley, D.J. and J.C. Hoag. 2009. Evaluation of fall versus spring dormant planting of hardwood willow cuttings with and without soaking treatment. Native Plants Journal. 10(3): 288-294.

Volk and others, 2004. Effect of cutting storage conditions during planting operations on the survival and biomass production of four willow (Salix L.) clones. New Forests. 28: 63-78.