Using Water Reservoir Containers to Produce Plants for Wetlands Sites©

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Deschampsia cespitosa **'Northern Lights,'** ***Lobelia*** **'Queen Victoria,'** ***Pennisetum alopecuroides*** **'Little Bunny,' and** ***Symphoricarpos albus*** **were potted into 1-gal (2.7 liter) nursery containers filled with unamended Douglas-fir bark. For each taxa, half the plants were potted into containers with traditional drain holes and the other half were potted into containers with drain holes located 2-inches (5 cm) above the base of the pot. For all species studied, the largest plants were grown in water-reservoir pots under 18 min of irrigation when provided 18 g of fertilizer. Use of water-reservoir containers induced the development of aerenchyma tissue in roots of all plants except** ***Pennisetum*****. Production in water-reservoir containers improved survival of** ***Symphoricarpos*** **after planting into water-saturated soils.**

INTRODUCTION

With increasing emphasis on clean waterways for a healthier environment, there is an increasing demand for plants to be used along the shoreline of streams, lakes, ponds, and constructed or natural wetlands. When installed along a shoreline, the rootball of some plants may be inserted into water-saturated soils while others may be inserted into very dry soils. Using a single container production system to grow plants that are "prepared" for planting in both saturated and dry soils is problematic.

Plants that are adapted or acclimated to water-saturated soils often develop adventitious roots at the soil surface to take advantage of the oxygen in the upper soil levels or develop extensive aerenchyma tissue (air-filled pore spaces) in the roots (Justin and Armstrong, 1987; Visser et al., 1996). Movement of oxygen from aerenchyma tissue in roots into the water-saturated soil helps protect the plant from potentially toxic components that develop in anoxic conditions (sulfides) and provides oxygen to beneficial microorganisms surrounding the root system. Aerenchyma also provides a pathway for venting potentially harmful plant- or soil-produced gases such as ethylene or methane (Blom and Voesenek, 1996). To survive planting in water-saturated soils, plants must already have the correct anatomical and morphological structures or they must grow them rapidly.

When grown in water-reservoir containers, some plants produce two types of roots. Roots growing above the water-saturated zone are acclimatized to well-drained conditions while roots growing in the water reservoir of the container contain aerenchyma tissue and are acclimated to water-saturated soils. Hypothetically, plants produced using water-reservoir containers can be planted into water-saturated or dry shoreline soils with equal chance of successful establishment. Increasing the production of plants needed for shoreline and wetlands sites might be possible using a combination of typical nursery production facilities and water-reservoir containers.

Previous studies have demonstrated successful production of various species using water-reservoir pots, growing the same size or larger plants in the same time using less water (Eakes et al., 1999; Ranney et al., 1995; Tilt et al., 1994). However, these studies did not report on the establishment of the plants in water-saturated soils after the production cycle.

Our objectives were: (1) to identify plants that will produce aerenchyma tissue in roots growing in the water-saturated zone of water-reservoir containers; (2) to determine if production using water-reservoir pots can be adapted to typical nursery production facilities; and (3) to determine how plants grown using water-reservoir pots perform after planting along shorelines in soggy and dry soils.

MATERIALS AND METHODS

In June 2000, 2¼-inch (5 cm) potted liners of *Deschampsia cespitosa* 'Northern Lights,' *Lobelia* 'Queen Victoria,' *Pennisetum alopecuroides* 'Little Bunny,' and *Symphoricarpos albus* were potted into traditional 1-gal (2.7 liter) containers or into 1-gal containers with water reservoirs. Water-reservoir pots had drain holes located on the side walls 2 in. (~5 cm) above the base of the container to provide 40% additional water storage compared typical containers with drain holes located at the base of the side wall. Containers were filled with unamended Douglas fir bark and top-dressed with either 9 or 18 g of Osmocote 18N-2.6P-10K per pot. Plants were placed on gravel beds under three overhead irrigation regimes (run times of 12, 18, or 50 min daily) in a retractable roof facility (50% shade from white poly film when the shade is extended over the crop). The experiment was a 2 × 2 treatment arrangement with 9 randomized blocks split within three irrigation durations (n=27). Shoot size was recorded in Nov. 2000. All plants remained in the retractable roof structure during winter. The number of plants surviving after winter storage was recorded on 1 May 2001.

On 11 May 2001, *Deschampsia*, *Lobelia*, and *Symphoricarpos* grown with or without water-reservoir containers were planted along a soil moisture gradient at Pacifica near Williams, Oregon. Edaphic conditions were characterized by water-saturated, moist, or dry soils based on proximity to shoreline of a pond below an earthen dam. A similar planting was established on 1 June near a pond at the Oregon Garden near Silverton, Oregon. Survival was evaluated on 15 August 2001.

RESULTS

Five months after potting, the largest plants for all species studied were grown in water-reservoir containers using 18 min of irrigation application and 18 g of fertilizer (Table 1). Compared to plants grown using typical 1-gal containers and 50 min of irrigation, plants grown using 18 min of irrigation in water-reservoir pots had larger shoots while using about 63% less water.

Root growth in the water-saturation zone of the rootball in the water-reservoir containers was similar among all species except for *Lobelia* and *Symphoricarpos*. Both *Lobelia* and *Symphoricarpos* had less root growth in the water-saturated area of the substrate in water-reservoir pots. For all plants except *Pennisetum*, roots growing in the water-saturated zone were typically thicker compared to roots growing above the water-saturated zone. Anatomical analysis of roots growing in the water-saturated zone showed aerenchyma tissue in all species studied except *Pennisetum*.

Table 1. Influence of irrigation duration, fertilization rate, and container type on shoot size of *Deschampsia cespitosa* 'Northern Lights,' *Lobelia* 'Queen Victoria,' *Pennisetum alopecuroides* 'Little Bunny,' and *Symphoricarpos album* 150 days after potting. Values are means"standard errors.

Irrigation duration[1]	Fertilizer rate[2] (g)	Container type[3]	Shoot size[4]			
			Deschampsia	*Lobelia*	*Pennisetum*	*Symphoricarpos*
12 min	9	base	26.1±0.6	40.7±1.4	17.8±0.9	14.5±0.5
		reservoir	28.1±0.8	40.2±1.4	19.3±0.9	19.2±0.9
	18	base	25.3±0.7	44.2±0.9	19.5±1.1	17.4±1.1
		reservoir	30.0±0.7	43.2±1.6	21.7±0.5	20.9±0.7
18 min	9	base	27.9±0.7	41.9±1.3	16.2±0.8	17.8±0.8
		reservoir	28.0±0.5	41.1±1.2	20.3±0.9	24.6±0.7
	18	base	27.9±0.7	42.8±1.3	20.5±1.1	19.9±0.8
		reservoir	30.1±0.5	47.1±0.9	22.8±0.8	26.1±0.6
50 min	9	base	27.0±0.9	36.5±3.5	18.6±1.2	19.1±0.9
		reservoir	28.0±0.5	40.9±2.1	19.8±1.1	24.4±0.8
	18	base	27.6±0.9	42.9±1.8	19.9±0.9	21.0±0.6
		reservoir	28.8±0.7	45.5±1.1	21.5±0.7	24.2±0.7
Significance (PR>F)[5]						
Irrigation duration (I)			0.177	0.287	0.816	0.001
Fertilization rate (F)			0.024	0.001	0.016	0.007
Container type (C)			0.001	0.239	0.001	0.001
I × C			0.032	0.192	0.194	0.060
F × C			0.088	0.672	0.794	0.028

[1] Overhead irrigation applied for 12, 18, or 50 min daily.
[2] Controlled-release fertilizer (Osmocote 18-6-12) applied as a top-dress application.
[3] Four drain holes at the base of the container side walls, or located 5 cm above the base (reservoir).
[4] Shoot size (cm) as (average shoot width + height)/2.
[5] ANOVA F-test. There were no three-way (IHFHC) interactions among irrigation duration, fertilization rate and container type, nor two-way (I H F) interactions between irrigation duration and fertilization rate.

In Spring 2001, there were no losses following winter storage, except for *P. alopecuroides* 'Little Bunny,' which had more that 50% death in all treatments. Root rot pathogens were not present in soil samples from the containers of *Pennisetum*. Results may differ for nurseries using recycled irrigation water that may contain higher levels of disease inoculum.

At the Pacifica site, no clear differences have been observed between the *Deschampsia* or *Lobelia* grown in traditional containers compared to plants grown in water-reservoir pots. All *Deschampsia* and *Lobelia* installed in the driest soil died, while all planted in the water-saturated soil survived. In contrast, 75% of *Symphoricarpos* produced in traditional containers and planted into water-saturated soil died, while all *Symphoricarpos* produced in water-reservoir containers and planted into water-saturated soils survived. Similar responses were recorded at the Oregon Garden site.

DISCUSSION

Results of this study showed that *Deschampsia, Pennisetum,* and *Symphoricarpos* had larger shoots when grown using water-reservoir containers under typical nursery production conditions. Oddly, *Lobelia,* a species that tolerates submergence of its roots, did not consistently grow larger in water-reservoir pots. The production of aerenchyma tissue in roots was induced by using water-reservoir containers in all species studied except *Pennisetum*.

The hypothesis that plants grown in traditional containers would be less acclimated to installation in water-saturated soils compared to plants grown in water-reservoir pots was demonstrated only for *Symphoricarpos. Deschampsia,* and *Lobelia* may readily acclimate to water-saturated soils following traditional container nursery production.

Using water reservoir containers may help reduce water use and irrigation runoff in some situations. Many species will grow aerenchymous roots in the water-saturated zone of the substrate in water-reservoir containers, which may improve transplant performance after installation in water-saturated soils.

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INTRODUCTION

The Landscape Plant Development Center is a relatively young organization. It was established in 1990 with a mission of developing superior landscape plants with emphasis on plants that are more tolerant of biological and environmental stresses. The Center was started because there is a need for greater diversity of landscape plants that are tolerant of environmental and biological stresses. Unfortunately, many landscape plants presently available are not well adapted to withstand the harsh conditions of the man-modified environments found on many landscape sites. I have seen figures and surveys indicating that the life span of the average tree planted in city conditions may only be 7 to 10 years.

The Center is a nonprofit corporation with a Board of Directors from all over the United States. The Center relies completely on grants and donations for the support of its research efforts. It operates as a cooperative effort of researchers located at many different institutions across North America, Europe and Asia. Headquarters for the Center is at the Minnesota Landscape Arboretum.

We utilize the following general approach for our breeding projects. The cooperative nature of the Center, allows us to use the plant collections of participating institutions to do hybridization. This gives us access to a very broad range of genetic diversity. First generation hybrids (F1s) are grown at a location with a very favorable climate. When a plant with good tolerance to a given environmental stress is crossed to another plant that may not be very tolerant but that possesses other desirable qualities, the first generation hybrids are intermediate in tolerance to the stress between that of the two parents. Thus, if these hybrids were grown in a severe climate the F1 population may not survive. However when the next generation of plants is produced by intercrossing the F1 siblings, some of the progeny will be as stress tolerant as the most tolerant of the original parents and a few plants may even have greater tolerance than the tolerant original parent. We can therefore select those individuals that combine the desired qualities from the less-tolerant parent with the tolerance of the more hardy parent. Second generation hybrids are planted in many different geographic regions by our cooperators. Superior plants will be selected from these populations that are well adapted to the climatic conditions of the region in which they are selected. Thanks to a generous donation of land by the J. Frank Schmidt Family Charitable Trust, we now have a research station in Oregon to grow our first generation hybrid populations and produce the second