NURSERY PRODUCTION OF WESTERN NATIVE PERENNIAL GRASSES

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Nursery Production of Western Native Perennial Grasses for Site Stabilization[1]

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Abstract

A variety of western native perennial grasses are being grown and tested in forestry liner containers at a land restoration nursery facility in Berkeley, California. The containers are 1 to 2 inches in diameter and 3 to 6 inches deep with a 2% taper. Soil volume varies from 4 to 9 cubic inches per liner and between 100 and 200 liners can be grown on 2 square feet of nursery space. A uniform soil mix of peat and vermiculite is used. The grasses responded well to liner production with insignificant seedling loss and plant die back. Plantable liners were produced within 12 weeks. Production costs are competitive with the lowest cost of liner-produced material.

Introduction

Native perennial grasses are useful for erosion control, long-term slope stabilization, dune restoration, mine spoils reclamation and habitat restoration (Bradshaw and Chadwick 1980, Rechenthin *et al*. 1965, Thornburg, 1982, McClaran and Bartolome 1981). Perennial grasses in the form of container-grown transplants have been used successfully in situations where broadcast seeding or seed drilling is not feasible (McClaran 1981). Transplants of the exotic rhizomatous dune grass, *Ammophila arenaria*, have been used effectively stabilizing coastal dunes on the west coast (Brown and Hafenrichter 1948). Transplants have been tested in the Sacramento River delta region on levee erosion control projects (bermudagrass, *Cynodon dactylon*, and native perennial ryegrass, *Elymus triticoides*) (Whitlow *et al.* 1979). In the Columbia River estuary transplants of tufted hairgrass, Deschampsia caespitosa, were used successfully in stabilizing dredge spoils (Mcvay *et al.* 1980). Recently mechanical planters have been developed to plant container grown material on highway rights-of-way (Gouveia 1981).

Containerized production of native perennial plants is a relatively new practice in erosion control and site stabilization (Landis and Simonich 1983). Many species of western native perennial grasses, both the rhizomatous and bunchgrass types, have never before been tested as container-grown stock. This study developed as a result of favorable responses of planted perennial grass liners at a California central coast landfill site. Native meadow barley (*Hordeum brachyantherum*), tufted hairgrass (*Deschampsia holciformis*), and purple stipa (*Stipa pulchra*) increased their cover through seedling establishment during two years after early fall and winter planting. Native perennial blue wildrye (*Elymus glaucus*) and red fescue (*Festuca rubra*) spread by rhizomes on the subsoil landfill.

The objective of this report is to evaluate the response of a variety of western native perennial grasses to liner or container production and to estimate the actual production costs. This is part of a larger study that seeks to develop low maintenance stabilized open-space capable of withstanding the disturbance associated with urban park use. This study was sponsored by Design Associates Working with Nature (DAWN), a non-profit corporation, in conjunction with the City of Berkeley and the California State Coastal Conservancy.

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Materials and Methods

This investigation was conducted at the Design Associates Working with Nature (DAWN) Living Laboratory at the Berkeley landfill site adjacent to the Berkeley marina. The climate of this site is characteristic of the bay margins of San Francisco Bay with mild temperatures, wet winters, and dry hot summers accompanied with morning and afternoon fog. Frost is recorded only two or three days a year in the winter months at this location.

Seed was collected by hand in the summer and early fall. Initial germination was begun in the month of February, however, germination was also begun in the spring months (April and May) and in late summer and fall (August through October).

The species tested the first winter and spring (1981) were California perennial grasses collected near the Bay Area. These species were *Bromus carinatus*, *Calamagrostis nutkaensis*, *Danthonia californica*, *Deschampsia caespitosa*, *E. glaucus*, *F. rubra*, *H. brachyantherum*, *Koeleria cristata*, *Melica californica*, and *S. pulchra*. The species tested the spring and fall of 1982 and 1983 were from California north coastal and inland locations. The species include *Bromus maritimus*, *D. californica*, *D. holciformus*, *Elymus triticoides*, *E. virescens*, *F. rubra*, F. *idahoensis*, and *H. californicum*. Species tested the winter and spring of 1984 were purchased or collected locally. They include *Agropyron spicatum*, *Bouteloua curtipendula*, *F. idahoensis*, *F. californica*, *Muhlenburgia rigens*, *Poa unilateralis*, and *S. lepida*.

Seedlings were germinated in square 3 inch-deep wooden nursery flats in an enclosed raised propagation bed with bottom heat. The bottom heat temperature was 70^o F. The air temperature during germination in the winter was within the 40^o-78^o F range, and 50^o-85^o F range in the spring (April-May) and late summer and fall months (August-October). Plants transplanted into containers were moved into a solar greenhouse for three to four weeks and then hardened off under 30% shade cloth. After eight weeks most to the liners were moved into the direct sun.

Plants grown into seedling containers are commonly referred to as liners. Three types of liners were tested: 2¼ x 2¼ x 3 inch tapered plastic "rose" pots which contain 9 cubic inches of soil space and two sized of sytroblocks. Styroblocks are solid styrofoam blocks with tapered cells or cavities. They and other similar containers systems are used by forest tree producers. As long as sand is not used in the soil mix, styroblocks can be reused for several years. The two types tested were the 1.5 x 6 inch 80 pack and the 1.1 x 5.25 inch 198 pack. The soil capacity of the 80 pack cells is 8 cubic inches per cell and the capacity of the 198 pack cells is 3.78 cubic inches per cell. The rose pots have 36 pots per square foot, the 80 pack has 41 cavities per square foot, and the 198 pack has 87 cavities per square foot.

The soil mix used is a peat and vermiculite combination with a pH range after wetting of 5.5-5.6. The soil mix is commercially produced and comes in 25-pound bags containing 4 cubic feet of mix. The soil has trace elements and starter nutrients. This mix was used for both the germination flats and the liner containers. During transplanting the soil mix needs to be packed firm into the pots or cells to prevent the plants from drying out. One bag of soil mix can pack 500 rose pots, seven 80 pack styroblocks, and six 198 pack styroblocks.

The grass seeds were lightly sprinkled on the flats filled with compressed soil mix. The seeds were covered with a thin layer of soil mix and watered daily. A flat lightly sprinkled with a half ounce of seed produced between one thousand and several thousand plants depending upon the seed size and viability.

After transplanting the grasses were fertilized with a light application of 10-10-5 KPK fertilizer (1:200 or 1 tablespoon concentrate per gallon of water) every six weeks. Fertilization was stopped for two months in the summer for plants begun in the winter and spring (February-

May). Plants begun in the late summer or early fall (August-October) were not fertilized after November. Fertilization application resumed in April the following spring for these plants.

Results

The germination of the grasses was uniform with shoots emerging in five to seven days for all the species tested except for native oatgrass, *Danthonia californica*. *Danthonia* germination began 10 days after planting and was sparse. While the other species showed no delayed germination, i.e. all the germinable seed sprouted at the same time, *Danthonia* seed continued to germinate for many months.

All the grass seedlings were ready to transplant within 16 days after the planting date and were transplanted into containers during the third week. At this time the seedlings averaged 2 or 3 inches in height. *Danthonia*, *Deschampsia*, *Calamagrostis*, and *Koeleria* averaged only an inch in height, however, their root systems were as extensive as the larger seedlings. These species were the first to develop the second basal buds.

The germination times and growth characteristics of the grasses were similar for the grasses sown in the spring and in the fall. Danthonia continued its long germination pattern. Plants could be found germinating in piles of the previous year's discarded germination mix.

The roots of the perennial grasses were well established in their containers after ten days. Six weeks after the planting date the seedlings could be pulled carefully from their containers without falling apart. *B. carinatus*, *B. maritimus*, *E. glaucus*, *H. brachyantherum* and *M. californica* were fully rooted in their containers in eight weeks. They averaged 4 to 5 inches in height and had 3 to 5 tillers in the 80 packs and the rose pots. The other species tested filled their containers in 10 to 12 weeks. The top growth of *Calamagrostis*, *Danthonia*, *Deschampsia*, *Koeleria*, *F. rubra* and *F. idahoensis* averaged 2 to 3 inches in the 80 packs and rose pots when fully rooted. All the grasses in the 198 pack (3.78 cubic inches soil volume) were smaller at all stages of development than those in the larger volume containers (See Figure 1).

Plants that were germinated in the fall and over-wintered in their containers ceased their top growth and became dormant until April when they resumed growth and flowered in their containers. Plants that were germinated in the winter and spring continued to grow with flower culms emerging by the fourteenth week for all species except *Calamagrostis*, *Deschampsia* and *Koeleria*. These species did not flower in their containers until the following year (spring and summer).

Regardless of when the plants were germinated, either during the winter or the spring, by fall they showed the same amount of top and root development. Seedlings of *Danthonia* that were potted into liners throughout the winter, spring and early summer were all of equal size in the fall, however, the late spring and early summer plants had few or no flowering culms.

Different types and amounts of fertilizer were applied the first year. Heavily fertilized grasses had to be watered more often and occasionally dried out completely in their containers. It is thought that this was due to the inability of their root systems in the small containers to provide adequate moisture. For this reason the fertilization rates were kept low so that the plants would have a balanced root to shoot ration. Cutting the plants back (once or twice a year) prevented drying out and encouraged new culms to develop. Clipping studies are now being conducted. It has been found that most of the grasses respond well to late summer and fall clippings and to clipping immediately before planting.

Figure 1. Mature and establishing native grasses in the 89-pack and 198-pack styroblocks.

Some species did not live as long as others in containers. After one year *B. carinatus*, *B. maritimus*, *E. glaucus*, *H. brachyantherum*, *H. californicum*, *M. californica* and *P. unilateralis* were not growing vigorously. With one clipping *Agropyron spicatum*, *B. curtipendula*, *C. nutkaensis*, *D. californica*, *K. cristata*, *M. rigens*, *S. pulchra*, and *S. lepida* maintained vigor through the second year.

The perennial grasses tested were remarkably resistant to disease and dieback during germination, transplanting and growth in the liners. No loss was attributed to damping-off even though other herbaceous and woody perennials were affected in adjacent flats and liners. During the investigation the mortality rate was about 0.3 percent (three plants in a thousand).

Table 1 outlines the cost of producing a perennial grass liner for the three types of containers. The cost of the containers was extended for five years with a 20% rate of container loss. This assumes that the containers will be returned after planting. The space estimate is based upon semi-improved land in industrial zones of the Bay Area ($0.15 per square foot per month). Space and utility costs in agricultural areas and in areas where wholesale nurseries operate are substantially lower. The space occupied by liner stock would ideally be occupied for four to six months, however, these space estimates are for the entire year ($1.80 per square foot). Labor costs for germination and repotting works out to be about $0.125 per plant no matter which size container the plants are potted into. This is a generous estimate based upon 40,000 plants being produced and 600 plants potted up per person per 6-hour day at $12.50 per hour gross wage. The maintenance estimate includes watering and weeding of the containers for a full year instead of the ideal four to six months. This maintenance estimate is based upon the care of 1000 square feet of growing space that can be thought of as a small part of a larger diverse nursery business. A thousand square feet of growing space is needed to produce 40,000 rose pots or 80 pack liners and 87,000 198 pack liners.

Table 1.—Cost estimates (per plant) for producing liner stock of native perennial grasses.

	Rose pots (9 cu. in.)	80 pack (8 cu. in.)	198 pack (3.8 cu. in.)
Soil	$0.027	$0.02	$0.01
Containers	0.01	0.018	0.077
Space	0.05	0.044	0.022
Fertilizer & Utilities	0.0035	0.0035	0.0035
Repotting	0.125	0.125	0.125
Maintenance	0.03	0.03	0.03
Total	$0.25	$0.24	$0.20

Discussion

Liner production has to be coordinated with planting times. The timing and technique of planting liner stock of perennial grasses is as critical as it is for most woody and herbaceous perennials. If there is to be no irrigation the planting window narrows. In California this window occurs during the fall and winter with the onset of the rainy season and soil moisture recharge. Elsewhere in the west early spring plantings are possible when temperatures and moisture permit. The most important factor in liner establishment is moist subsoil. In this regard the grass roots require good contact with the soil to prevent the plant from drying out. Clipping is helpful because it reduces the foliage surface area and stimulates new root and bud development.

Because of the quick production time of perennial grasses in liner containers, plants germinated after collection in the Bay Area (August-October) can be ready for planting in warmer areas of central and coastal California by December. In cooler high elevation areas where temperature permits and moisture is still adequate for establishment, grasses can be planted by April. If these early first planting windows are missed, plants can be held in healthy condition until the following planting season.

Utilizing the same materials as used in this investigation, forestry nurseries produce tree liners in the cost range of $0.12 to $0.17 each. These nurseries reduce their per liner costs by producing large volumes of liners (500,000 to 1,000,000), mixing their own soil mix, paying lower nursery space costs, and reducing labor costs. A growing demand for native perennial grass liner stock will further reduce the cost estimates in Table 1. Similarly, the per-liner costs in Table 1 reflect the cost of smaller volumes (40,000 to 80,000) and special orders.

Conclusion

1. The western native perennial grasses tested in this investigation responded well to liner production.
2. Except for the varieties of *D. californica* tested, all the grasses germinated easily.
3. During the investigation seedling and plant dieback and loss was virtually absent.
4. The average amount of time it takes to produce a plantable liner varied between eight and twelve weeks.
5. Depending upon the species and volume needed, native perennial grasses can be produced in the cost range of $0.12 to $0.25 each.

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