EFFECT OF CONTAINER SIZE AND FERTILIZATION ON FIELD ESTABLISHMENT OF SWEETGRASS PLANTS

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Abstract

Sweetgrass [*Muhlenbergia sericea* (Michx.) P.M Peterson] is a clump-forming grass native to the southern Atlantic and Gulf coasts. Its leaves are the main component of African-coiled basketry produced by the Gullah/Geechee community. The U.S. Army Corps of Engineers is including sweetgrass in their coastal restoration projects in South Carolina to reestablish populations depleted by development and damage from hurricanes. However, plant survival has been disappointing, possibly due to small size of commercial transplants. In 2010, the USDA, NRCS Brooksville PMC began a 6-mo greenhouse production study of the effect of container size (shallow cone tray – 5.6 x 6.0 (cm); deep cone tray – 4.7 x 11.4; and 11.0 x 8.3 round pot) and fertilization (complete slow release at 100 lb N per acre based on area vs. no fertilizer) on plant growth. After the greenhouse phase, the plants were planted on Daufuskie Island, SC, with and without hydrated polymer gel and/or slow release fertilizer (50 lb N per acre based on area). Plants from the round pots were larger at 6 months compared to the other containers, but root and shoot growth of all treatments declined at around 4 months in the greenhouse. Greenhouse fertilization increased plant weight, but reduced subsequent field survival and is not recommended. Larger size of the plants in the round pot treatment did result in improved field survival. Neither fertilization at transplanting nor polymer gel improved field survival. Using larger transplants or increasing the planting rate will be necessary to improve survival in coastal restoration plantings.

Introduction: Sweetgrass is found in coastal dune land and at the margins of the marsh and woods from North Carolina south to Florida and west to Texas. In dune areas, it generally occurs on back dune sites (Tackett and Craft, 2010). It is the main component used for African-coiled basketry produced by the Gullah/Geechee community around Mt. Pleasant and Charleston, SC (Grabowski, 2009).

Sweetgrass is being recommended by the U.S. Army Corps of Engineers (USACE), Charleston District for use in coastal restoration plantings in South Carolina to reduce erosion and to reestablish populations that have been depleted by development and damage from hurricanes and tropical storms in areas. Survival of sweetgrass plants in a 2009 USACE planned restoration planting was much lower than the 89% found in field plantings installed by Brooksville PMC staff in 2008 (Williams et al., 2009). One

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suspected cause of this poor survival may be smaller plant size of commercially produced transplants. The objective of this study was: 1) to determine the effect of pot size and fertilizer on the development of sweetgrass transplants and 2) to determine what effect the different greenhouse propagation methods combined with treatments applied in the field at transplanting have on the subsequent survival of sweetgrass plants.

Materials and Methods: *Greenhouse Study* – On 4 May 2010, pre-divided sweetgrass ramets (approx. 1.5 cm diameter) were planted into three container size treatments (Shallow – 5.6 x 6.0 (cm) , 38 per tray; Deep – 4.7 x 11.4, 50 per tray; and Round – 11.0 x 8.3 round pot, 15 pots per tray). Half of the trays of each container treatment were fertilized with slow release fertilizer (14-14-14, Osmocote® 3-4 mo, The Scott Company, LLC., Marysville, OH) at 100 lb N per acre based on surface area. Trays were arranged in the greenhouse at the USDA, NRCS Brooksville Plant Materials Center in a RCB design with six replicates.

One randomly selected ramet in each treatment/rep was harvested for destructive sampling beginning 4 wk after planting and every 4 wk afterward throughout the 6 mo greenhouse growing period. The ramets were washed to remove the growing medium and each ramet was laid on a ruled board to measure maximum root length and maximum leaf length. After measurement, the shoots and roots were severed at the crown, dried for 7 d and weighed. After the 5 mo evaluation was completed, the tops of all plants were trimmed to approx. 15 cm leaf length because of lodging.

Field Study - Treatments consisted of one plant from each of the six greenhouse propagation treatments planted with and without polymer gel (9 oz hydrated gel; Terra-Sorb® Medium, Plant Health Care, Inc., Pittsburg, PA) and/or fertilizer (Osmocote 14-14-14 slow release fertilizer, 3-4 mo, 50 lb N per acre) at three locations on Daufuskie Island, SC. In total, there were 24 establishment combinations (6 greenhouse treatments X 4 field planting treatments). For the two seaside planting sites, [Haig Point (HP) and Oak Ridge (OR)], each of the 24 treatments were planted parallel to the water line at three landscape positions relative to the water. At the interior planting site (INT), there was no landscape position variable. The sites were planted on 2 Nov. 2010. All treatments were replicated five times at all three locations.

Plant survival was rated quarterly (Feb, May, and August) in 2011 and plants were considered alive if any green leaves were present. Additionally, at the final rating date, plant height (cm, to the top of the tallest leaf or culm) and plant crown diameter (cm, average of two measurements taken at 90^{o} from each other) were determined. At the HP site, a large number of plants were pulled out of the ground, apparently by deer. Plants that were uprooted or could not be found were recorded as missing plots.

Greenhouse data were analyzed using Statistix, version 8.2 (Analytical Software, 2005) as a factorial experiment with time, pot size, and fertilizer as factors. The field data for the two coastal planting sites (HP and OR) were analyzed as a split plot with landscape position (Water, Middle, and Upper) as the main plot and the 24 treatments (greenhouse treatments X field planting treatments) as the subplot. The interior site (INT) was analyzed as a RCB.

Results and Discussion: *Greenhouse Study* – Maximum leaf length was significantly affected by both fertilizer application and pot size (Table 1). Fertilization increased leaf length throughout the greenhouse period until the tops in all treatments began to lodge and were trimmed at 5 mo. However, leaf growth appeared to plateau at 4 mo in the production cycle. Leaves of plants in the Deep treatment were significantly shorter than those from the Shallow or Round treatments. Increased shoot growth of the fertilized plants may negatively affect root production as indicated by the significantly lower root:shoot ratios in these treatments (Table 2). A criticism of traditional horticultural containers used to produce transplants for coastal restoration is that shallow profile containers produce plants with shallow root systems that limit access to water deeper in the soil profile (Thetford et al., 2005). However, in this study, unlike what Thetford et al. (2005) found for transplants of gulf bluestem [*Schizachyrium maritimum* (Chapm.) Nash], RSR did not increase with decreasing pot size, possibly due to higher growing densities in this study or overall slower growth of sweetgrass plants.

Initial transplant size has been shown to affect survival after outplanting (Davies et al., 2002; Leskovar and Vavrina, 1998). In general, larger sized transplants have at least better initial survival (Davies et al., 2002; Leskovar and Vavrina, 1998). But pot size also affects production costs, as smaller pot sizes mean more plants can be produced per unit of greenhouse space (Vavrina, 2011). Declines in growth parameters at 4 mo suggests that the production system used in this study was starting to interfere with plant growth. Perhaps changes to this system, such as the addition of supplemental lighting, would allow the use of longer production periods to maximize root growth.

Field Study - Plant survival declined over time at all planting locations and landscape positions (Table 3). Survival at the INT location was higher than the two coastal locations. The effect of landscape position on survival differed for the two coastal plantings, with survival generally better at the Upper landscape position at HP but not at OR. Salt deposition may account for the survival difference at these locations. The HP site is at the northeastern end of the island and protected from storm events by Hilton Head Island. However, plant height and average diameter were not affected by landscape position for the coastal plantings. The plants at the INT location were taller (53 cm) than at the coastal sites (39 cm HP; 44 cm OR), but they did not have a larger diameter (3.3 cm, 4.1 cm, and 3.7 cm for HP, OR, and INT, respectively). The greater height for the INT plants was probably due to a combination of shade and presence of flower culms on some of the INT site plants that were not observed on plants in the coastal plantings.

There was no consistent effect of greenhouse pot size on plant height within or across landscape position and/or locations (data not presented). Plant diameter was consistently larger for the Round treatment at the coastal sites (HP - 3.2, 3.2, and 3.7 cm for Shallow, Deep, and Round, respectively; OR – 3.2, 3.6, and 4.9 cm for Shallow, Deep, and Round, respectively), but not at the INT site (3.3, 4.2, and 4.4 cm for Shallow, Deep, and Round, respectively).

Until the plants were trimmed in the greenhouse, fertilized plants were larger than the non-fertilized plants regardless of pot size (Table 2). This larger size did not translate to better survival or growth in the field. Survival of plants produced with fertilizer applied in the greenhouse was similar to the non-fertilized plants for the INT planting, but 12 to 14% lower at more stressful coastal sites. In tomato transplants, Liptay and Nicholls (1993) found an inverse relationship between N fertilization during transplant production and field survival.

Sweetgrass survival and plant height was essentially the same regardless of site planting treatment and position and/or location combination (data not presented). Specific planting treatments, such as fertilizer and hydrophilic polymers (i.e., gel) are often used with coastal plantings. Little information exists on the benefit of using gel when planting coastal plants, but the practice is recommended (Williams, 2007). This is the first controlled study looking at the use of gel or gel+ fertilizer with coastal planting and neither proved beneficial in this case.

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Table 1. Effect of fertilization and pot size on mean maximum leaf length of sweetgrass plants during the greenhouse growing period at the USDA, NRCS Brooksville PMC.

Treatments	1 Mo	2 Mo	3 Mo	4 Mo	5 Mo*	6 Mo	Mean
	--cm--						
Non-fertilized	48	58	72	78	76	33	61a[1]
Fertilized	57	70	83	91	93	36	72b
Shallow	53	62	77	92	95	34	69a[1]
Deep	50	53	67	76	79	32	59b
Round	56	76	88	85	80	36	70a

*Tops trimmed to 15 cm after this evaluation date.

[1] Means with different letters are significantly different at P<0.05 according to Tukey's HSD.

Table 2. Effect of fertilization and pot size on mean root:shoot ratio of sweetgrass plants during the greenhouse growing period at the USDA, NRCS Brooksville PMC.

Treatments	1 Mo	2 Mo	3 Mo	4 Mo	5 Mo*	6 Mo	Mean
	---g/g---						
Non-fertilized	0.30	0.20	0.16	0.12	0.19	0.41	0.23a[1]
Fertilized	0.25	0.16	0.12	0.11	0.16	0.32	0.19b
Shallow	0.29	0.19	0.14	0.12	0.16	0.40	0.22
Deep	0.27	0.18	0.12	0.13	0.22	0.30	0.20
Round	0.27	0.17	0.16	0.10	0.14	0.40	0.21NS[2]

*Tops trimmed to 15 cm after this evaluation date.

[1] Means with different letters are significantly different at P<0.05 according to Tukey's HSD.

[2] NS indicates that means are not significantly different according to ANOVA at P<0.05.

Table 3. Mean plant survival at three planting sites and three landscape positions (coastal sites only) on Daufuskie Island, SC recorded at three post-planting evaluation dates.

	Haig Point			Oak Ridge			
No. Days	Water	Middle	Upper	Water	Middle	Upper	Interior
	-----------------%-----------------			-----------------%-----------------			----%----
89	70b[1]	71b	89a	89	81	83NS	96
190	70	52	71NS[2]	80	75	74NS	89
274	57ab	39b	73a	59	70	58NS	87

[1] Planting position means within planting site are different at P<0.05 for each evaluation date according to Tukey's HSD.

[2] NS indicates that planting position means are not significantly different within a planting site according to ANOVA at P<0.05 for each evaluation date.

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Survival of transplants planted on coastal restoration sites has been shown to be affected by greenhouse propagation factors, such as container volume and depth and fertilizer applications, as well as by the methods used to plant these transplants in the restoration sites. This study examined the effect of container size and fertilization during greenhouse propagation on growth of sweetgrass transplants, coupled with the effect of field planting treatments (hydrated polymer gel with or without slow-release fertilizers) on survival and growth of these transplants when planted in the field. Our data shows that although fertilizer increased growth of the sweetgrass plants in the greenhouse, it negatively affected survival of these transplants when planted on coastal sites. Transplants grown in larger diameter containers were larger; however, there was no consistent carryover response from this increased size that resulted in improved transplant success in the field planting. No beneficial effects were shown from any of the polymer gel or fertilizer field treatments on survival or growth of sweetgrass plants following transplanting.

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