

# Nursery Production Techniques for Obligate Wetland Species

KIMBERLY K. MOORE, L. FISHER, AND D. L. SUTTON<sup>1</sup>

## ABSTRACT

Buttonbush (*Cephalanthus occidentalis* L.), water mint (*Mentha aquatica* L.), skyflower (*Hydrolea corymbosa* Macbr. ex Ell.), and lizard's tail (*Saururus cernuus* L.) plants were grown in 16 cm × 12.5 cm × 16.5 cm plastic containers filled with Metro Mix 500 (MM) or Pro-Mix BX (PM) growing substrates and fertilized with top dress applications of 35 g per pot of Osmocote Plus 15N-3.9P-10K (5.25 g of N) (8 to 9 month release), 10 g per pot pf Nutricote Total Type 70 18N-2.6P-6.7K (1.8 g of N), or 29.2 g per pot of Nutricote Total Type 70 18N-2.6P-6.7K (5.25 g of N). Sprinklers watered plants overhead for 15 minutes 3 times a day or 45 minutes once a day. For all four-plant species, there was no difference in growth between the two growing substrates. Better quality plants were grown with irrigation applied for 15 minutes 3 times a day compared to plants watered for 45 minutes once a day. For all plants watered once a day for 45 minutes, there was no difference in shoot dry weight among the fertilizer treatments. However, for plants watered for 15 minutes 3 times a day, greatest buttonbush shoot dry weight was produced using 35 g per pot of Osmocote Plus while greatest water mint, sky flower and lizard's tail shoot dry weight were produced using 29.2 g per pot of Nutricote Total. Substrates and fertilizer products used in this experiment appear to be feasible alternatives to using flooded sand to grow these plants classified as obligate wetland species.

**Key words:** Button bush, water mint, skyflower, lizard's tail, controlled-release fertilizer.

## INTRODUCTION

There are many showy and highly ornamental aquatic plants native to the US that until recently were not put into cultivation because they were considered "swamp weeds" (Speichert 2002). Production of both ornamental and native aquatic plants has increased in recent years because of interest in use of these plants in aquascaping, aquarium trade, restoration of wetlands and recognized importance for diversity of native plants in aquatic ecosystems (Sutton 1991).

In previous studies, maximum growth of plants classified as obligate wetland species like pickerelweed (*Pontederia cordata* var. *lanceifolia* (Muhl.) Torr.), water snowflake (*Nymphoides indica* (Thwaites) O. Kuntze), and arrowhead (*Sagittaria lati-*

*folia* Willd.) had been achieved in flooded sand with 20 to 35 g of Osmocote or Sierra fertilizer (17N-2.6P-8.3K plus minors) (3.4 to 5.95 g of N) (Sutton 1991, 1994, 1995). A recent study (Gettys and Sutton 2001) with pond apple (*Annona glabra* L.), another obligate wetland species, showed that seedling growth in a well-drained, non-flooded commercial nursery substrate was much greater than in flooded sand, but rate of growth varied widely depending on the type of fertilizer used.

The culture of obligate wetland species using terrestrial nursery production techniques could greatly enhance the ability of the aquatic plant industry to meet the demand for these plants. Sand substrates tend to have low water holding capacity, low cation exchange capacity (or nutrient holding capacity) and also tend to be heavy with a high bulk density which increases handling and transporting costs (Poole et al. 1981). However, peat based substrates commonly used in terrestrial nursery production have high water holding capacity, high cation exchange capacity and are lighter and easier to handle and transport (Poole et al. 1981). The objective of this experiment was to evaluate the feasibility of using two commercially available peat-based growing substrates, with two commercially available controlled-release fertilizer products, and two irrigation frequencies to grow buttonbush, water mint, skyflower, and lizard's tail.

## MATERIALS AND METHODS

In September 2003 and in May 2004, rooted cuttings of buttonbush, water mint, skyflower, and lizard's tail were transplanted into 16 cm by 12.5 cm by 16.5 cm plastic containers with drainage holes filled with Metro Mix 500 (MM) (The Scotts Company, Marysville, Ohio) or Pro-Mix BX (PM) (Premier Horticulture, Inc., Red Hill, Pa.)

At transplanting, fertilizer was top dressed as 35 g per pot of Osmocote Plus 15N-3.9P-10K (5.25 g of N) (8-9 month release at 70F) (The Scotts Company, Marysville, Ohio), 10 g per pot of Nutricote Total Type 70 18N-2.6P-6.7K (1.8 g of N), or 29.2 g per pot of Nutricote Total Type 70 18N-2.6P-6.7K (5.25 g of N) (80% of N released in 70 days) (Florikan, Inc., Sarasota, Fla.).

Five plants per treatment combination (substrate by fertilizer treatment [type and rate]) were placed into one of two irrigation frequencies. All plants received approximately 150 ml of water per day. Plants were either watered for 15 minutes 3 times a day (at 8 am, 12 pm, and 4 pm) or were watered for 45 minutes once a day (at 8 am). All plants were watered using overhead sprinklers (Roberts No. 435 sprinkler heads, Hummert International, Earth City Mo). The irrigation water used throughout the experiment had 0.36

<sup>1</sup>University of Florida, IFAS, Fort Lauderdale Research and Education Center, 3205 College Ave., Fort Lauderdale, FL 33314; e-mail: klock@ufl.edu.

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dS·m<sup>-1</sup> electrical conductivity, 94 mg·L<sup>-1</sup> CaCO<sub>3</sub> (calcium carbonate) total alkalinity, 0.6 mg·L<sup>-1</sup> NO<sub>3</sub>-N (nitrate nitrogen), 28 mg·L<sup>-1</sup> Ca (calcium), 6 mg·L<sup>-1</sup> Mg (magnesium), and 22 mg·L<sup>-1</sup> Na (sodium).

All plants were grown outside in full sun on black ground cloth, which covered an asphalt runway and were exposed to ambient growing conditions. The substrates never became saturated due to irrigation or rain events. Data on monthly average temperature, minimum temperature, maximum temperature, total rainfall, and solar radiation were recorded by the Florida Automated Weather Network (FAWN) (<http://fawn.ifas.ufl.edu>) for September to November 2003 and May to July 2004.

Initial substrate pH, electrical conductivity (EC) air-filled porosity (AFP), water-holding capacity (WHC) was determined. To determine pH and EC, substrates were extracted with distilled water using the saturated media extraction method (Warncke 1986). Initial pH and EC were determined on the extracted solution using a pH/conductivity meter (Acumet model 20, Fisher Scientific, Pittsburgh, Pa.). Percent air-filled porosity (AFP) and water-holding capacity (WHC) were determined in the 16 cm by 12.5 cm by 16.5 cm plastic containers by volume displacement methods (Niedziela and Nelson 1992).

Plants transplanted in September 2003 were harvested in November 2003 and plants transplanted in May 2004 were harvested in July 2004. At harvest, shoots were cut at the surface of the growing substrate to determine shoot dry weight. All data collected were analyzed using analysis of variance (SAS Systems, SAS Institute, Cary, N.C.).

## RESULTS AND DISCUSSION

For all plant species examined, there was no significant difference in shoot dry weight between the two growing substrates. Plants grown in MM were similar to plants grown in PM. Initial substrate pH, EC, MC, AFP, and WHC also were not different between MM and PM (Table 1). Because there was no difference in shoot dry weight between substrates, these data were combined.

Average shoot dry weight of plants grown in fall 2003 (September to November 2003) was less than shoot dry weight of plants grown in summer 2004 (May to July 2004) (Figures 1 and 2). The difference in plant growth due to growing season was more evident with sky flower plants than the other three species examined (Figure 2). Temperatures

TABLE 1. INITIAL SUBSTRATE pH, ELECTRICAL CONDUCTIVITY (EC), MOISTURE CONTENT (MC), AIR FILLED POROSITY (AFP), AND WATER-HOLDING CAPACITY (WHC) OF METRO MIX 500 (MM) AND PRO-MIX BX (PM).

Substrate	pH	EC (dS/m)	MC (%)	AFP (%)	WHC (%)
MM	5.7	0.70	57	19	47
PM	5.5	0.71	64	28	59
Significance	NS	NS	NS	NS	NS
Standard <sup>a</sup>	5.8-6.2	2.0-3.5	10-80	5-30	20-60

<sup>a</sup>Suggested standards based on recommendations from Warncke and Krauskopf (1983) and Fonteno (1996).

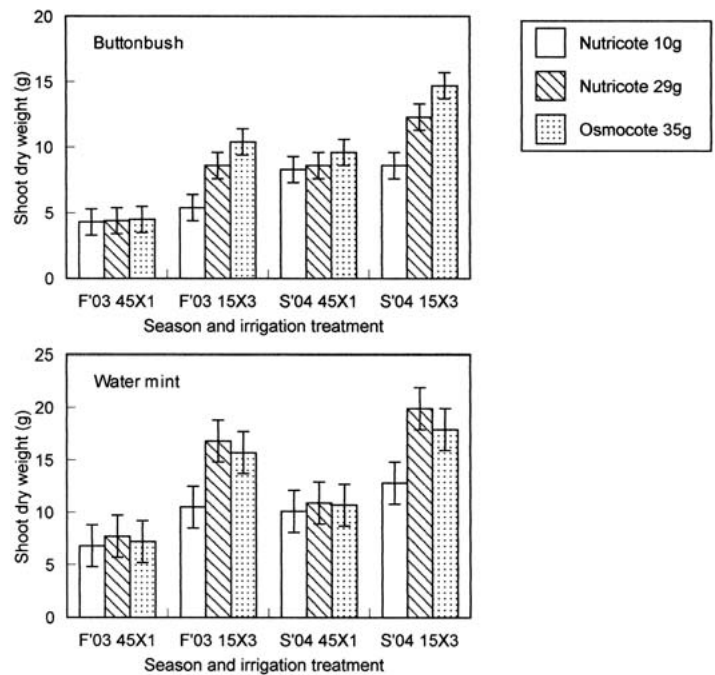


Figure 1. Shoot dry weight of buttonbush and water mint plants watered once a day for 45 minutes or 3 times a day for 15 minutes and fertilized with top dress applications of 35 g per pot of Osmocote Plus 15N-3.9P-10K (5.25 g of N) (8-9 month release at 70F), 10 g per pot of Nutricote Total Type 70 18N-2.6P-6.7K (1.8 g of N), or 29.2 g per pot of Nutricote Total Type 70 18N-2.6P-6.7K (5.25 g of N) (80% of N released in 70 days). Plants were grown in fall 2003 (F'03) and spring 2004 (S'04).

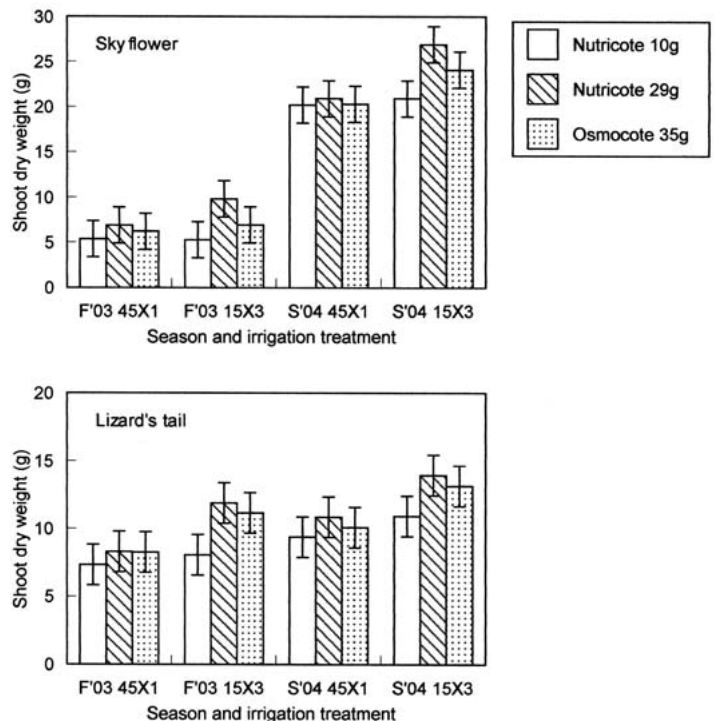


Figure 2. Shoot dry weight of sky flower, and lizard's tail plants watered once a day for 45 minutes or 3 times a day for 15 minutes and fertilized with top dress applications of 35 g per pot of Osmocote Plus 15N-3.9P-10K (5.25 g of N) (8-9 month release at 70F), 10 g per pot of Nutricote Total Type 70 18N-2.6P-6.7K (1.8 g of N), or 29.2 g per pot of Nutricote Total Type 70 18N-2.6P-6.7K (5.25 g of N) (80% of N released in 70 days). Plants were grown in fall 2003 (F'03) and spring 2004 (S'04).

TABLE 2. MONTHLY MEASUREMENTS OF AVERAGE TEMPERATURE, MINIMUM TEMPERATURE, MAXIMUM TEMPERATURE, TOTAL RAINFALL, AND SOLAR RADIATION COLLECTED SEPTEMBER TO NOVEMBER 2003 AND MAY TO JULY 2004 BY THE FLORIDA AUTOMATED WEATHER NETWORK (FAWN) ([HTTP://FAWN.IFAS.UFL.EDU](http://fawn.ifas.ufl.edu)).

Date	Temperature (°C)			Rainfall (cm)	Solar radiation (W·m <sup>2</sup> )
	Average	Minimum	Maximum		
Sep 2003	27.2	21.9	25.8	22.68	174
Oct 2003	25.9	17.9	34.4	6.02	183
Nov 2003	24.8	18.2	29.9	15.72	135
May 2004	25.7	16.6	35.6	3.33	264
Jun 2004	27.9	21.6	36.1	8.28	240
Jul 2004	25.3	22.5	36.2	19.66	234

were similar for both time periods but the 2003 experiment had approximately 1.4× more rain than the 2004 experiment (Table 2). However, average light levels in summer 2004 were 1.5× greater than in fall 2003. In preliminary studies (data not presented), we found that obligate wetland species growth was limited in a covered greenhouse compared to plants grown in full sun due to lower light levels.

Although we observed less plant growth in fall 2003 than in summer 2004, similar trends in plant response to irrigation and fertilizer treatment were observed in both seasons. Buttonbush, water mint, sky flower, and lizard's tail plants watered 3 times a day for 15 minutes had significantly greater shoot dry weight than plants watered once a day for 45 minutes (Figures 1 and 2). Because all plants received approximately 150 ml of water a day, it is possible that intermittent drying of the substrates watered once a day for 45 minutes resulted in reduced growth of these plants. All of these plants are classified as obligate wetland species and are commonly found in shallow water, swamps, marshes, ditches, and along lake and stream margins (Tobe et al. 1998, L.H. Bailey Hortorium 1976).

There was no significant difference in shoot dry weight among fertilizer treatments for all plants watered once a day for 45 minutes (Figures 1 and 2). Previous research has shown that release of nutrients from controlled-release fertilizer products incorporated into growing substrate were not significantly influenced by soil moisture levels between the permanent wilting percentage and field capacity (Maynard and Lorenz 1979, Lunt and Oertli 1962). However, when these products were top dressed, intermittent drying between irrigations reduced release rate of nutrients (Broschat 2005, Lunt and Oertli 1962). It is possible that the lack of response to different fertilizer types and fertilizer rates in plants watered once a day for 45 minutes was due to slower release of nutrients from Osmocote Plus and Nutricote Total Type 70.

For all plants watered 3 times a day, plant growth was greater for plants fertilized with 35 g of Osmocote Plus or 29.2 g of Nutricote Total Type 70 than for plants fertilized with 10 g of Nutricote Total Type 70 (Figures 1 and 2). This was expected considering 1.8 g of N was applied using 10 g of Nutricote as compared to 5.25 g of N applied using 35 g of Osmocote or 29.2 g of Nutricote. Greatest buttonbush shoot dry weight was observed for plants watered 3 times a day and fertilized with 35 g of Osmocote Plus while greatest water mint, sky flower, and lizard's tail shoot dry weight was achieved when plants were watered 3 times a day and fertilized with 29.2 g of Nutri-

cote Total Type 70 (Figures 1 and 2). Broschat (2005) reported that this Osmocote released nutrients faster than Nutricote under similar substrate environments and that after 7 months, approximately 90% of the total N had been released from Osmocote versus approximately 75% of the total N had been released from Nutricote. Gettys and Sutton (2001) observed greatest pond apple shoot dry weight in plants grown in Metro mix 500 under non-flooded conditions with 1.6 inches of water applied daily and Sierra 17N-2.6P-8.3K plus with minors fertilizer placed on the surface of the substrate at rates of 43.8 to 49.4 g per pot (7.5 to 8.4 g of N).

Obligate wetland species, like the ones described in this paper, have the potential to be grown using commercially available controlled-release fertilizer products and growing substrates combined with irrigation applied at least 3 times a day and the proper growing environment (light levels and temperature). Nevertheless, more work needs to be done with other obligate wetland species to develop improved production protocols.

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## LITERATURE CITED

- Broschat, T. K. 2005. Rates of ammonium-nitrogen, nitrate-nitrogen, phosphorus, and potassium from two controlled-release fertilizers under different substrate environments. *HortTechnology* 15(2):332-335.
- Fonteno, W. C. 1996. Growing media: Types and physical and chemical properties pp. 93-122. *In*: D. W. Reed (ed.). *A grower's guide to water, media, and nutrition of greenhouse crops*. Ball Publishing, Batavia, IL.
- Gettys, L. A. and D. L. Sutton. 2001. Effect of flooding and fertilizer on growth of seedlings of pond apple. *Proc. Fla. State Hort. Soc.* 114:205-209.
- L. H. Bailey Hortorium, Cornell University. 1976. *Hortus Third, A concise dictionary of plants cultivated in the United States and Canada*. Macmillan, New York, NY.
- Lunt O. R. and J. J. Oertli. 1962. Controlled release of fertilizer minerals by encapsulating membranes: II Efficiency of recovery, influence of soil moisture, mode of application and other considerations related to use. *Soil Sci. Soc. Amer. Proc.* 26:584-587.
- Maynard, D. N. and O. A. Lorenz. 1979. Controlled-release fertilizers for horticultural crops. *Hort. Rev.* 1:79-140.
- Niedziela, Jr., C. E. and P. V. Nelson. 1992. A rapid method for determining physical properties of undisturbed substrate. *HortScience* 27:1279-1280.
- Poole, R. T., C. A. Conover and J. N. Joiner. 1981. Soils and potting mixtures pp. 179-202. *In*: J. N. Joiner (ed.) *Foliage plant production*. Prentice-Hall, Inc. Englewood Cliffs, NJ.

- Speichert, G. 2002. New and native water plants. *Lawn and Garden Retailer* 1(5):36-39.
- Sutton, D. L. 1991. Culture and growth of pickerelweed from seedlings. *J. Aquat. Plant Manage.* 29:39-42.
- Sutton, D. L. 1994. Culture of water snowflake. *Proc. Fla. State Hort. Soc.* 107:409-413.
- Sutton, D. L. 1995. Culture of common arrowhead. *Proc. Fla. State Hort. Soc.* 108:414-418.
- Tobe, J. D., K. C. Burks, R. W. Cantrell, M. A. Garland, M. E. Sweeley, D. W. Hall, P. Wallace, G. Anglin, G. Nelson, J. R. Cooper, D. Bickner, K. Gilbert, N. Aymond, K. Greenwood and N. Raymond. 1998. Florida wetland plants: An identification manual. Fla. Dept. Environ. Protect., Tallahassee, FL.
- Warncke, D. D. and D. M. Krauskopf. 1983. Greenhouse growth media: Testing & nutrition guidelines. Mich. State. Univ. Agr. Facts Ext. Bul. E-1736.
- Warncke, D. D. 1986. Analyzing greenhouse growth media by saturated media extraction method. *HortScience* 21:223-225.