Landscape

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Section Editor

Louisiana Super Plants – A Review of the Program and the Plants (2010 – 2014)

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Significance to Industry: The survey indicated that not only did the program increase sales of Louisiana Super Plants, but overall sales at a business also increased. More than 60 percent said the Super Plants program increased traffic flow or interest in their business. All the respondents indicated that the program increased overall sales in their business from 10 percent to 60 percent. Eighty-five percent of the respondents said the Louisiana Super Plants program had been beneficial to the nursery and landscape industry. When asked to name the Super Plant that had the greatest impact on sales, one respondent wrote "no one plant, but an increase in general plant knowledge and interest." The Louisiana Super Plants program is proving to be a marketing plan that works.

Nature of Work: The Louisiana Super Plants program was started in 2009, with first plants being named in the fall of 2010, to identify and promote exceptional plants that perform well in Louisiana. Louisiana's summer heat and humidity are tough on plants, and most plants recommended for other parts of the United States will not always perform well here.

The LSU AgCenter and Louisiana's nursery and landscape industry, through the Louisiana Nursery and Landscape Association, identified the need for a state-based program that uses university research to identify and promote exceptional plants for Louisiana landscapes. Funding for this project was provided through the Louisiana Department of Agriculture and Forestry with U.S. Department of Agriculture Specialty Crop Block Grant Program funds.

The Louisiana Super Plants program has three parts. The first identifies outstanding plants. The second makes sure the plants are available at retail nurseries and garden centers. The third promotes the plants to Louisiana gardeners.

Each Super Plant must have at least two years of rigorous evaluations and have a proven track record under north and south Louisiana growing conditions. Louisiana Super Plants must prove hardy across the state. Louisiana Super Plants must be easily produced and available for all nursery and landscape industry wholesalers and retailers to market and sell.

Louisiana Super Plants are selected two years in advance of release. The Louisiana Super Plants selection committee composed of LSU AgCenter personnel selects plants based upon observations made in replicated plots and demonstration trials across the state.

The Louisiana Super Plants advisory committee, which is composed of nursery and landscape industry personnel from across the state, meets with the plant selection committee for further scrutiny of the plant's landscape ability and marketability. This selection process gives each Super Plant the combined rating of university-tested and industry-approved.

To ensure that Louisiana Super Plant selections are available at retail nurseries and garden centers, the Louisiana Super Plants selection committee works closely with Louisiana wholesale growers so they produce plenty of the selected plants. At the same time, retail sellers are kept informed of the selections and are encouraged to carry them in their garden centers and nurseries. In addition, display signs containing plant photos and growing information are provided to nurseries and garden centers to help customers find and choose Louisiana Super Plants.

Results and Discussion: The first Louisiana Super Plants were promoted in the fall of 2010. To date, 28 plants have been identified as Louisiana Super Plants, and more than 200 retail and grower operations have signed up to participate in the program. Surveys of participants were conducted to determine the impact the Louisiana Super Plants program had on sales. In the first season (fall 2010) of Louisiana Super Plants, one wholesale grower reported a 145 percent increase in sales of Amazon dianthus over the previous year. A retail garden center had a 1,920 percent increase in Camelot foxglove sales. Sales of the woody ornamental Shishi Gashira camellia were up by 45 percent at one wholesale grower.

A larger survey was conducted during the summer of 2012 after four marketing seasons. Retail and wholesale businesses participating in the Louisiana Super Plants program were contacted by email, and 15 percent responded. Of the participants who responded, 40 percent described their business as retail, 40 percent as wholesale, none as landscape design, and 20 percent as landscape installation and maintenance. Eighty percent of the respondents said the program had a positive effect on their business. Fifty percent of the respondents said sales or use of Super Plants in their business increased from 21 percent to 40 percent after the promotion began; the other 50 percent indicated increased sales of 20 percent or less.

Table 1. Listing of Louisiana Super Plants by Season (Fall 2010 – Fall 2014)

Year	Spring	Fall
2010	--------	Amazon Dianthus
	--------	Camelot Foxglove
	--------	Shishi Gashira Camellia
2011	Serena Angelonia	Swan Columbine
	Butterfly Pentas	Redbor Kale
	Frostproof Gardenia	Belinda's Dream Rose
	Shoal Creek Vitex	Southern Sugar Maple
2012	Senorita Rosalita Cleome	Sorbet Viola
	BabyWing Begonia	Conversation Piece Azalea
	Penny Mac Hydrangea	Evergreen Sweetbay Magnolia
2013	Little Ruby Alternanthera	Diamonds Blue Delphinium
	Bandana Lantana	Drift Roses
	Aphoridite Althea	Willow Oak
2014	Luna Hibiscus	Mesa Bicolor Gaillardia
	Kauai Torenia	Rabbiteye Blueberry
	Flutterby Tutti Fruitti Buddleia	

Preliminary Discoveries of Varied Rain Garden Substrate Compositions

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Index words: Stormwater runoff, bioretention cells, nitrogen and phosphorus remediation

Significance to the Industry: The filter bed substrate and plants in rain gardens remediate polluted stormwater runoff. Growth of two rain garden species, *Panicum virgatum* L. 'Shenandoah' and *Monarda fistulosa* L. were affected by rain garden filter bed substrate composition. *M. fistulosa* and *P. virgatum* 'Shenandoah' grown in composted yard waste (CYW) produced significantly larger shoot dry weights than pine bark (PB) for both, sand and slate filter bed substrates. Overall, substrate composition did not have an effect on pH or volume of effluent. However, the amount of organic matter did impact pH and EC for slate which had a quadratic trend for pH and a linear trend for EC with increasing organic amendment amounts during the first half of the season.

Nature of Work: Rain gardens are non-irrigated, planted landscape features (also referred to as bioretention cells) and are popular stormwater control measures (SCMs) that are designed to capture polluted stormwater runoff from impervious surfaces. They are built by excavating and creating depression areas within the landscape so that the stormwater can be captured and allowed to infiltrate (1). After excavation they are refilled with a filter bed substrate and planted. An environment is created within the rain garden where adsorption, filtration, sedimentation, volatilization, ion exchange, plant uptake and biological decomposition occur (5).

The first rain garden was built in Prince George's County, Maryland in the mid 1990's. Since then, limited research has considered the importance of plants and filter bed substrate composition for rain gardens. Sand based filter bed substrates are recommended due to their suitable hydraulic conductivity and permeability (2). In North Carolina, these sand filter bed substrates are required to be 85-88% by volume sand, 8-12% fines (silt and clay), and 3-5% organic matter (5). Pine bark (PB) is often used as the organic matter source in filter bed substrates. Even less research has examined different sources of and methods of adding organic matter to rain garden substrates. Hsieh et al., (4) found that having a permeable sand layer over a less permeable soil layer increased stormwater retention within the filter bed substrate and allowed nitrification in the well aerated portion of the substrate and denitrification in the saturated, low permeable layer. The less permeable bottom soil layer also allowed increased contact time between dissolved phosphorus and the media and was found to be more effective in total phosphorus removal (3). However, evaluating an organic matter source such as PB or composted yard waste (CYW) has not been considered as an option for creating a low permeability layer that allows denitrification to occur within the rain garden substrate.

Sand filter bed substrates are heavy, expensive to ship, non-renewable, and may not be the best choice for supporting plant growth and stormwater remediation in rain gardens. There are potential alternative filter bed substrates, organic matter sources and methods of adding organic matter that can support plant growth and remediate polluted stormwater runoff similar to or better than the recommended sand filter bed substrates. The main objectives of this research were to: 1) Determine the roll of different sources of organic matter amendments in rain garden filter bed substrates and 2) Analyze different combination methods and amounts of organic matter additions to filter bed substrates for their ability to adsorb/retain nutrients while still supporting plant nutrient uptake and growth.

The experimental design was a randomized complete block design in a factorial treatment arrangement with four replications, two species (*Panicum virgatum* L. 'Shenandoah' and *Monarda fistulosa* L.), and two harvest dates (November 6, 2012 and May 7, 2013). Thirty-two substrates resulted from combinations of two filter bed substrates, two organic matter amendments, two combination methods, and eight different combination amounts. The two filter bed substrates used were sand (80% washed sand, 15% clay and silt fines and 5% pine bark v/v/v) (Wade Moore Equipment Company, Louisburg, NC) and slate (Permatill, Carolina Stalite Company, Salisbury, NC). Both, sand and slate were amended with two different organic matter amendments, pine bark (PB) and composted yard waste (CYW) (City of Raleigh Yard Waste Recycling Center, Raleigh, NC). PB and CYW were added as either a band in the depths of 1, 2, 3, or 4 inches or by incorporation using approximately the same amounts of organic matter in the amounts of 5, 10, 15, and 20% (v/v) (Figure 1). For the banded treatments, four inches of either sand or slate were added to the bottom of the container. Then the 1, 2, 3, or 4 inch band of CYW or PB was added and then the container was topped off with either sand or slate to within one inch from the top to allow for irrigation ponding. Black Pecan King 1020 containers (6.06 gallons) (Haviland Plastic Products, Haviland, OH) were filled with the thirty-two filter bed substrate compositions and planted on June 1, 2012. The plants were watered without fertilizer for the first two weeks daily to allow establishment. Thereafter, plants were fertigated with 0.2 mg/L of P (supplied by diammonium phosphate, 18-46-0) and 1.66 mg/L of N (supplied by ammonium sulfate 21-0-0-24) to simulate average polluted stormwater runoff (6). One inch of fertigated water was applied once a week (June, 2012-October, 2012), once a month (November, 2012-March, 2013), and every two weeks (April, 2013-May, 2013) using a low-volume spray stake (PC Spray Stake, Netafim, Ltd., Tel Aviv, Israel) to mimic rainfall patterns for Raleigh, NC. Pots were placed into five gallon buckets with a hole drilled into the bottom sitting on bricks to allow for the collection of effluent from fertigation applications. For each fertigation application, volume of effluent, electrical conductivity (EC) and pH were measured using a Hanna pH/EC meter (HI 8424, Hannah Instruments, Ann Arbor, MI). This study was conducted at North Carolina State University's Horticultural Field Laboratories, Raleigh, NC (longitude: 35°47'29.57"N; latitude: 78°41'56.71"W; elevation 136 m). All variables were tested for differences using regression, analysis of variance procedures, and lsd means separation procedures ($p > 0.05$) where appropriate (5).

Results and Discussion: The three-way and two-way interactions for volume of effluent by sample date were generally non-significant. Additionally, regression analyses for the effect of the amount of organic amendment were neither linear nor quadratic (data not shown).

The three-way and two-way interactions for pH and EC analyzed by sample date were generally non-significant. When pH and EC were analyzed using regression for the effect of amount of organic matter amendment by sample date and base, sand tended to be neither linear nor quadratic [(pH: 6/15/12=6.6, 5/2/13=6.2) (EC: 6/15/12=0.40 mS, 5/2/13=0.17 mS)]. With slate, there was a quadratic trend for pH and a linear trend for EC during the first half of the season [pH: 6/15/12=7.2, 5/2/13=6.5) (EC: 6/15/12=0.66 mS, 5/2/13=0.39 mS)].

For shoot dry weights the species x filter bed substrate composition interaction was significant ($p<0.0001$). When analyzed by species the three-way interaction, base x amendment x method, and the two-way interaction, base x method, were non-significant for both, *P. virgatum* 'Shenandoah' and *M. fistulosa*. However, the two-way interactions, base x amendment, and amendment x method were significant for both species. When analyzed by species and base *M. fistulosa* had a significant amendment x method interaction when grown in sand but not when grown in slate. *P. virgatum* 'Shenandoah' had the opposite response with a significant amendment x method interaction when grown in slate but not when grown in sand. LSD means separation procedures were used for the main effects of combination method and organic matter amendment (Figure 2 & 3). When using banding as the combination method with sand, *M. fistulosa* shoot dry weight was significantly higher than with the combination method of incorporation, while the opposite was true for slate (Fig. 2). For *P. virgatum 'S*henandoah' there were no significant differences between shoot dry weights for banding or incorporation with sand, but with slate, banding produced significantly larger shoot dry weights than incorporated (Fig. 2). The organic matter amendment of composted yard waste (CYW) produced greater shoot growth than pine bark (PB) for both *M. fistulosa* and *P. virgatum* 'Shenandoah' in both sand and slate (Fig. 3).

In conclusion, rain gardens are one of the more utilized SCMs because they are able to fit into many different types of spaces (small or large) unlike other SCM options. They also provide numerous ecological benefits and if planted appropriately can be aesthetically pleasing. For this study, both sand and slate filter bed substrates created a suitable environment for plant growth. With the addition of CYW, there were larger shoot dry weights than PB when added to the sand and slate filter bed substrates. The methods of banding or incorporating had varied effects on plant dry weights depending on the combination with the filter bed substrates.

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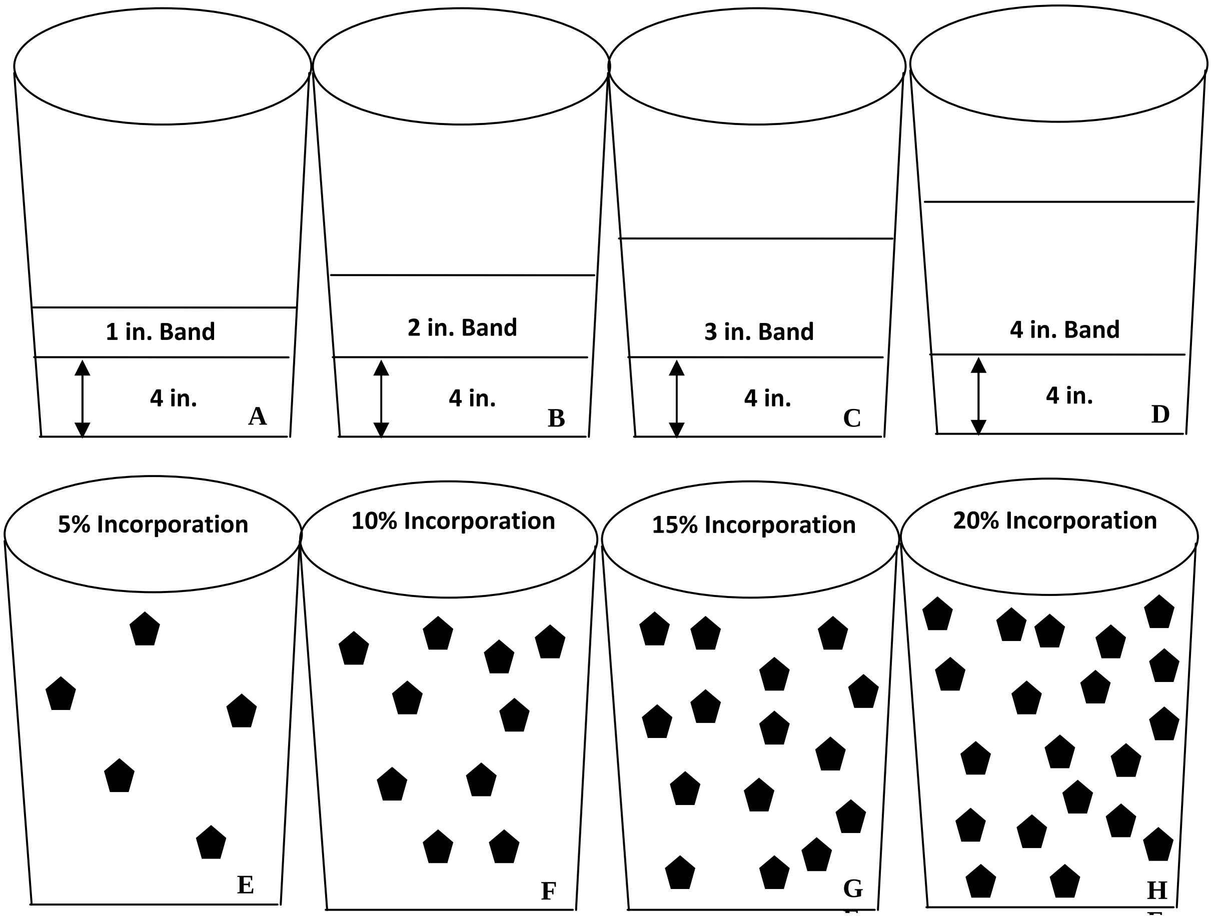

Figure 1. Schematic of different filter bed substrate combination methods and combination amounts. The two organic matter amendments were added as either a band in the depths of 1, 2, 3, or 4 inches or by incorporation using approximately the same amounts of organic matter in the amounts of 5, 10, 15, and 20% (v/v). A: Combination method of banding with combination amount of 1 inch, B: Combination method of banding with combination amount of 2 inches, C: Combination method of banding with combination amount of 3 inches, D: Combination method of banding with combination amount of 4 inches, E: Combination method of incorporation with combination amount of 5%, F: Combination method of incorporation with combination amount of 10%, G: Combination method of incorporation with combination amount of 15%, and E: Combination method of incorporation with combination amount of 20%.

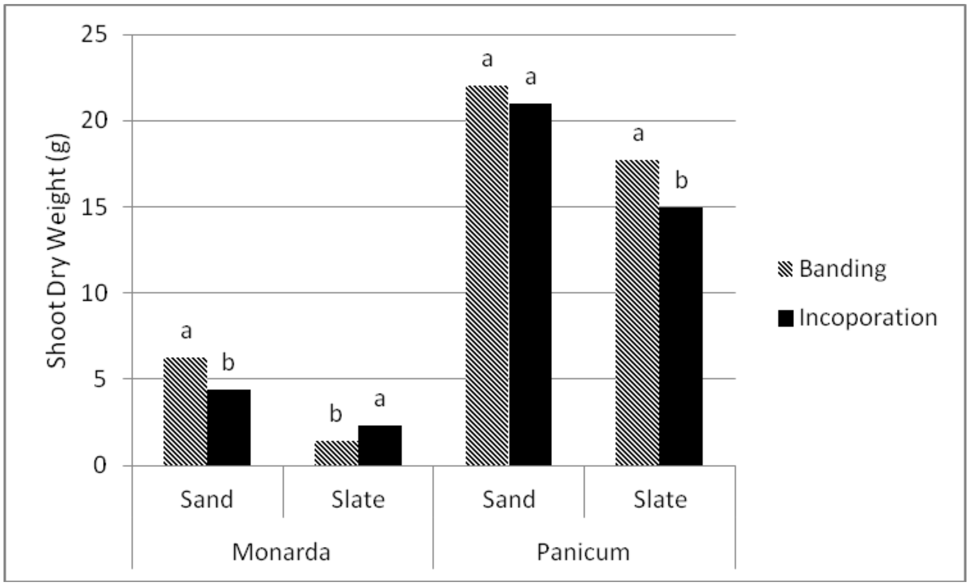

Figure 2. Effect of combination method (banding or incorporation) and filter bed substrates (sand and slate) on shoot dry weights of *Monarda fistulosa* and *Panicum virgatum* 'Shenandoah' for the November 6, 2012 harvest. Means between substrate compositions within a species with different letters are significantly different from each other based on lsd means separation procedures (p>0.05).

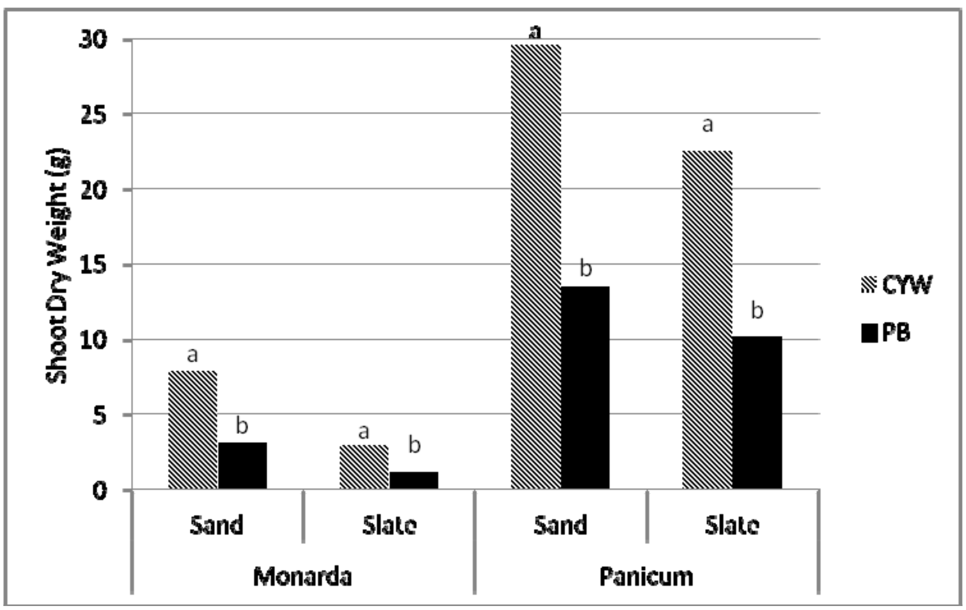

Figure 3. Effect of organic matter amendments [composted yard waste (CYW) and pine bark (PB)] and filter bed substrates (sand and slate) on dry weights of *Monarda fistulosa* and *Panicum virgatum* 'Shenandoah' for the November 6, 2012 harvest. Means between substrate compositions within a species with different letters are significantly different from each other based on lsd means separation procedures (p>0.05).

National Ornamental Grass Trial - University of Florida, Ft. Pierce 1st Year Results

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Index Words: native, variety trials, low input, switchgrass, little bluestem

Significance to Industry: This study assesses the landscape performance of 12 *Schizachyrium scoparium* and *Panicum virgatum* selections for plant growth, visual quality and flower impact in Fort Pierce, Florida as part of a large national trial that includes 15 locations around the United States. The data generated from the first year identifies initial establishment success, growth, and ornamental landscape potential of the selected cultivars under low input conditions.

Nature of Work: In addition to use in home landscapes and botanic gardens, low input ornamental/native grasses has become increasingly popular for erosion control, conservation plantings and low maintenance areas such as median strips and parking lot borders. Variety trials generate important data for not only assessing ornamental value for novel selections, but for tolerance to a large range of environmental conditions, invasive potential, and even bioenergy potential (Aitken, 1995; Corley and Reynolds, 1994; Meyer and Tchida, 1999; Ruter and Carter, 2000; Thetford et al., 2011; Wilson and Knox, 2006). As part of a larger nation-wide trial led by Dr. Mary Meyer of the University of Minnesota, Florida is one of 10 states trialing a variety of ornamental grass cultivars. A dominant plant of the tallgrass prairies and native throughout eastern North America, switchgrass (*Panicum virgatum*) has enormous variety in foliage color, form, and growing preference (Grounds, 1998). A clumping warm-season prairie grass from eastern North America, little bluestem (*Schizachyrium scoparium*) is admired for its ability to flourish in poor soils and for the way it changes color through the seasons (Grounds, 1998). Both species grow well in poor to fertile soils.

Within Florida, 4 distinct sites (Fort Lauderdale, Fort Pierce, Wimauma, and Quincy) were included in the national trial, covering northern to southern climates (USDA Hardiness zones 8B to 10A). Only Fort Pierce data is presented herein. Plugs of twelve cultivars (Table 1) were finished in 1 gallon pots in the greenhouse prior to transplanting to the field. Three ft wide, slightly raised landscape beds were prepared by herbiciding, disking, and covering with semi-permeable landscape fabric. Soil samples were taken at each location and analyzed for pH, electrical conductivity (EC),and initial nutrients. Plants were installed 14 June 2012, 3 ft on center using a randomized complete block with 4 single plant replications. Plants were drip irrigated 3 times/wk for 45 minutes until established (4 weeks) and then reduced to once per week for the remainder of the trial. Plants were not fertilized or sprayed during the field study. Plants were evaluated monthly for visual quality and flowering. Visual quality was based on a scale from 1 to 5 where 1=poor quality, not acceptable, severe leaf necrosis or yellowing, 2= fair quality, marginally acceptable, some areas of necrosis or yellowing, fair form, 3=average quality, adequate and somewhat desirable form and color, 4=good quality, very acceptable, nice color, good form, desirable, and 5=excellent quality, very desirable. Flowering was based on a scale of 1 to 5 where 1=no flowers present (0%), 2=25%, 3=50%, 4=75%, and 5=maximum canopy coverage (100%). Plant size was assessed by measuring height (from the base to the natural break of the foliage) and the width (the average of the east to west and north to south widths), at weeks 0 and 20. Rainfall and minimal and maximal temperatures were recorded daily with an automated weather system. Data is presented monthly with mean separation at week 18 generated by DMR test within SAS.

Results and Discussion ‘Jazz’ was the most compact cultivar evaluated growing less than 12 cm high and wide by the end of the season (data not presented). The Florida ‘Stuart’ ecotype grew up to 100 cm high and wide (data not presented). At week 18 and throughout most of the trial, ‘Stuart’, and ‘Cloud Nine’ had the highest visual quality ratings (between 4 and 5) whereas ‘Dust Devil’, ‘Prairie Fire’, and ‘Jazz’ had the lowest ratings (between 1 and 3). ‘Miami’, and ‘Jazz’ and ‘Prairie Blues’ typically had narrower flowering periods and lower flower ratings than the other cultivars.

Between September and October the minimum temperature dropped from 69.6°F to 48.2°F (data not presented). By November, plant quality had declined for all cultivars except the ‘Stuart’ ecotype. All grasses were cut back in the spring (February 26, 2013) and will continue to be evaluated at each of the 15 sites. The results of this trial will assist growers and landscapers in selecting from a variety of ornamental grasses best suited to their area’s conditions with the desired landscape effect.

Acknowledgements
We acknowledge Mary Meyer for leading this national trial and extend our gratitude to Jim Aldrich, Patricia Frey, Keona Nolan and Nancy Calderone Ripak for providing technical assistance. We thank Emerald Coast Growers (FL), Hoffman Nursery, Inc (NC), Walters Gardens, Inc. (MI) and the USDA-Plant Materials Center (FL) for providing the plant material.

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Table 1. List and descriptions of the 10 *Panicum virgatum* selections (8 cultivars and 2 ecotypes) and 2 *Schizachyrium scoparium* cultivars included in the 2012 Florida grass trials (4 sites).

Grass	Cultivar	Common Name	Description[z]
Panicum virgatum	'Cheyenne Sky'	Cheyenne Sky switchgrass	Hybridized in Michigan. Blue green foliage grows in a vase shaped clump about 3ft (without flower) foliage turns red in the summer. Flowers in late summer, likes full sun, low water needs.
Panicum virgatum	'Cloud Nine'	Cloud Nine switchgrass	Introduced by Bluemount Nursery in Maryland. Metallic blue foliage grows in narrow erect clump up to 6ft. Flowers in summer through winter, likes full sun, low to medium water needs.
Panicum virgatum	'Dust Devil'	Dust Devil switchgrass	Native cultivar bred in Michigan. Blue green foliage grows in a tight upright clump 4ft, foliage tips turn red in the fall. Flowers in late summer, likes full sun, low water needs.
Panicum virgatum	'Heavy Metal'	Heavy Metal switchgrass	Introduced in Maryland. Metallic blue foliage grows in tight erect clump up to 3ft, foliage turns yellow in the fall. Flowers in summer through winter, likes full sun, medium water needs.
Panicum virgatum	'Hot Rod'	Hot Rod switchgrass	Introduced by Emerald Coast Growers in Florida. Blue green foliage that turns red as it matures, grows in a tight erect clump about 3ft. Flowers in late summer, likes full sun, low to average water needs.
Panicum virgatum	'Miami'	Miami switchgrass	Florida native ecotype, collected in southern Miami, green foliage turns red at tips of blades as it matures, grows in a vase shaped clump about 6ft with the blades folding out. Flowers in late summer or fall, likes full sun, low to medium water needs, salt tolerant.
Panicum virgatum	'Prairie Fire'	Prairie Fire switchgrass	Hybridized in Michigan. Blue green foliage turns red at tips in summer grows in erect clump about 4-5ft. Flowers in late summer to early fall, likes full sun, low water needs.
Panicum virgatum	'Rotstrahlbusch'	Rotstrahlbusch switchgrass	Green with red tips grows in erect clump 4-5ft. Flowers in late summer to winter, likes full sun, low to medium water needs.
Panicum virgatum	'Shenandoah'	Shenandoah switchgrass	Developed in Germany and reintroduced to North America. Green foliage with red tips grows in erect clump about 3ft. Flowers in late summer to early fall, likes full sun, low water needs.
Panicum virgatum	'Stuart'	Stuart switchgrass	Florida native ecotype, light green foliage grows in vase shaped erect clump to about 7ft. Flowers in summer into fall, likes full sun, low to average water needs.
Schizachyrium scorparium	'Jazz'	Jazz little bluestem	Selected at the University of Minnesota. Grey blue foliage hint of pink in fall grows narrow erect leaves to 2ft. Flowers in late summer to early fall, likes full sun, low to medium water needs.
Schizachyrium scorparium	'Prairie Blues'	Prairie Blues little bluestem	Released by a German seed company. Grey blue foliage turns pink in fall, grows narrow erect leaves to 3ft (with flowers). Flowers in late summer to early fall, likes full sun, low to medium water needs.

[z] A combination of web resources was utilized to compile the botanical descriptions including: www.bluestem.ca, hoffmannursery.com, www.missouribotanicalgarden.org, www.perennialresource.com, perennials.com, United States Department of Agriculture Natural Resources Conservation Services (2006).

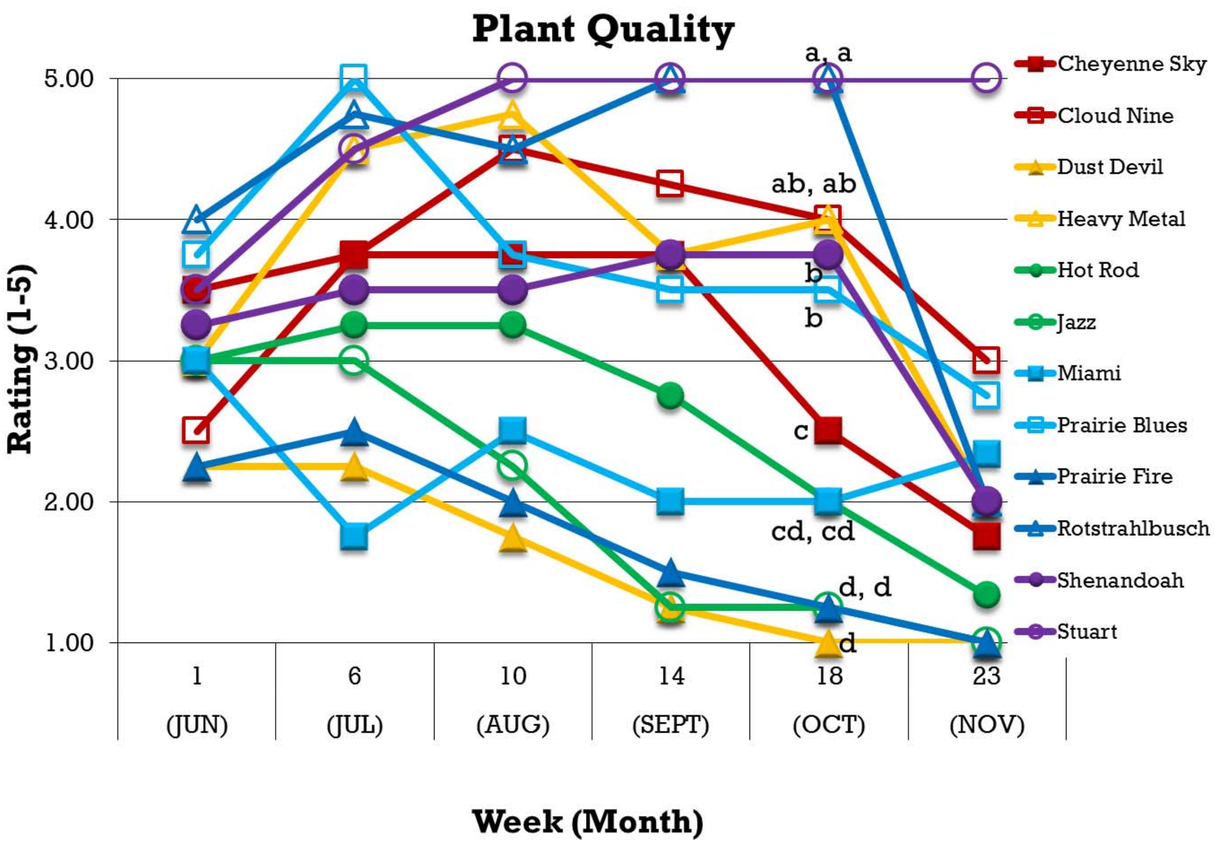

Figure 1: Monthly visual quality of grass selections at weeks 1 and 23 in Fort Pierce, FL. Mean separation shown at week 18 prior to winter decline.

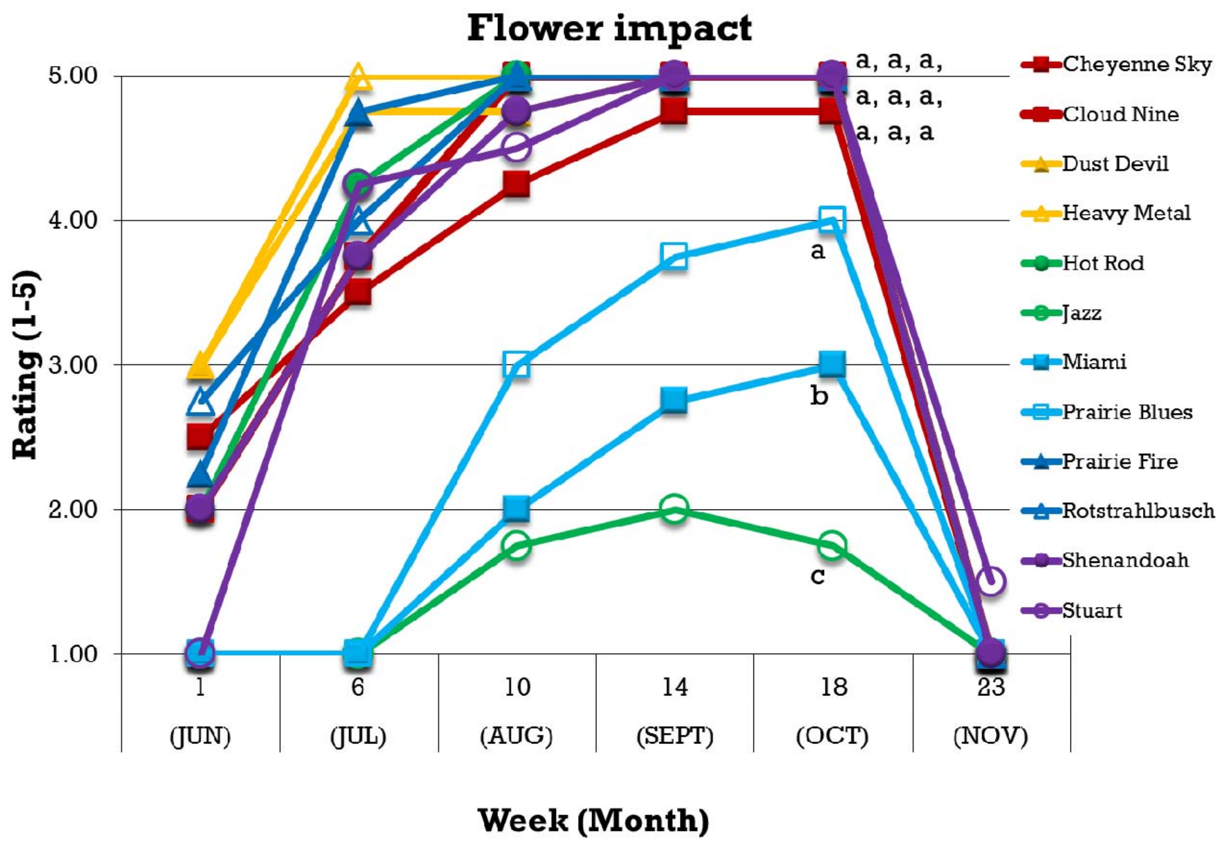

Figure 2: Monthly flower coverage of grass selections at weeks 1 and 23 in Fort Pierce, FL. Mean separation shown at week 18 prior to winter decline.

Growth and Flowering of Four Texas Coastal Species With Commercial Landscape Potential in Response to Varied Solar Irradiance

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Index words: *Borrichia frutescens, Erigeron procumbens, Oenethera drummondii*, *Sesuvium portulacastrum*, irradiance, groundcover, shrub, hanging baskets

Significance to Industry: Gulf coastal landscapes offer substantial challenges including exposure to salinity, near constant winds, and heat. Soils can vary from droughty sand dunes to heavy clay flats (Arnold, 2008). Relatively few plant materials options are available for dune restoration or more conventional landscapes along the Gulf Coast. Another challenge with these environments is the tendency for many well adapted exotic species to become potentially invasive, presenting a threat to sensitive coastal ecosystems. Developing native taxa with desirable aesthetic characteristics as alternatives to exotic landscape plants could reduce the potential for invasion of sensitive ecosystems and native taxa should be well adapted to growth with minimal inputs in their regional climate. Plants for varied shade conditions are needed.

Nature of Work: Taxa tested under varied solar irradiances included *Borrichia frutescens* (L.) A.P. de Candolle (sea marigold), *Oenethera drummondii* W.J. Hooker (beach evening primrose), *Erigeron procumbens* (Houst. *ex* Mill.) G.L. Neesom (Corpus Christi fleabane), and *Sesuvium portulacastrum* (L.) L. (sea purslane). Clonal shoot tips approximately 10 cm (4 in) long were dipped 2.5 cm (1 in) on the basal end in Hormodin 1 (E.C. Greiger Inc., Rte. 63 Box 285, Harleysville, PA 19438), inserted in rooting flats (Kadon Corp., 2920 Kreitzer Rd., Dayton, OH 45401) filled with coarse perlite (SunGro Horticulture, 15831 N.E. 8th Street Suite 100, Bellevue, Washington 98008) and then placed under an intermittent mist from dawn to dusk. In late May to early June as cuttings rooted, they were transplanted to 10 cm (4 in.) diameter pots (T.O. Plastics, Clearwater, MN) filled with SunGro Metro-Mix (SunGro Horticulture Canada Ltd., Seba Beach, AB TOE 2BO Canada).

During the last two weeks of June 2011, *B. frutescens* and *O. drummondii* were planted outdoors in three raised planting beds. Portable ventilated shade structures as previously described in Arnold et al. (2010) placed in three raised beds [3.4 m (11 ft) wide and 11.3 m (37 ft) long] containing a sandy loam soil were used to provide three separate replicates of each of the two, 33% and 66% light exclusion, shade treatments. Three adjacent non-shaded areas in the same raised beds served as the full sun, 0% light exclusion controls. One of each shade treatment was randomly assigned within each bed. Three plants each of *B. frutescens* and *O. drummondii* were planted in the soil under each shade treatment. The liners of *E. procumbens* and *S. portulacastrum* were planted in 25.4 cm (10 in) diameter hanging baskets and suspended beneath the shade structures at approximately 1.2 m (4 ft.) above the ground. There were three baskets per species in each shade treatment in each of the three beds. Plants were irrigated to avoid wilting and weeds removed by hand as needed.

On approximately weekly intervals the height, spread in two perpendicular directions, inflorescence number and survival were recorded. A pseudo-volumetric plant index was calculated as height x width 1 x width 2. Length of trailing stems from the hanging baskets was also recorded for *E. procumbens* and *S. portulacastrum*. Data were analyzed as a randomized complete block design for each species with three blocks and 3 replicates per block.

Results and Discussion: Significant ($P \leq 0.05$) interactions were seen for all growth measures, except survival, for all four species among shade levels and date. Survival was 100% among all species except *O. drummondii*, which was found to be exceptionally susceptible to *Phytophthora* crown and stem rot when soils remained wet under the 66% shade, resulting in reduced survival. Survival of *O. drummondii* was near 100 % until late in the season in full sun and 33% shade, whereas survival declined from mid-season for *O. drummondii* under the denser 66% shade to about 30% by the end of the growing season.

Plant indices (Fig. 1), which were representative of the vegetative growth measures, and flowering (Fig. 2) are presented herein. *Erigeron procumbens* grew rapidly in all treatments early in the season, then lagged in the heat of summer (Fig. 1A). During the heat of mid-summer, light shade slightly increased plant indices relative to *E. procumbens* in full sun (Fig. 1A). *Erigeron procumbens* grown in 66% shade were affected by *Myrothecium* blight, causing stem dieback in denser shade but not death of the plants (Fig. 1A). Flowering of *E. procumbens* was greatly reduced in mid-summer compared to cooler portions of the year as was previously observed in the nursery, while late season flowering was best in full sun and decreased by increasing shade (Fig. 2A).

Borrichia frutescens was slower to establish than the other three species (Fig. 1). Shade slightly increased vegetative growth of *B. frutescens* (Fig. 1B), but reduced flowering (Fig. 2B). Flowering of *B. frutescens* appeared to be somewhat episodic in full sun with three pronounced peaks, whereas flowering barely occurred in shade (Fig. 2B). Flowering of *B. frutescens* was generally low in this study compared to previous field and container trials.

As stated previously survival of *O. drummondii* was low in dense shade, but vegetative growth was enhanced by light shade (Fig. 1C) with a concomitant increase in flowering (Fig. 2C).

Vegetative growth of *S. portulacastrum* was slightly greater in 66% shade than in 33% shade or full sun after July but plant indices declined slowly over time (Fig. 1D).

However, this was somewhat misleading in that trailing stems from the pots continued to elongate, in some cases actually reaching the ground by the end of the growing season (data not presented). Flowering of *S. portulacastrum* increased over the season, with a brief cessation in mid-summer (Fig. 2D). Shade slightly reduced flowering of *S. portulacastrum* (Fig. 2D). Although the small flowers were fairly numerous, *S. portulacastrum* is grown primarily for its vegetative texture and rapid spread rather than its flowers.

Conclusions: Light shade enhanced vegetative growth of *O. drummondii* substantially and slightly increased vegetative growth of *B. frutescens* and *E. procumbens* on some dates, however only *O. drummondii* had improved flowering under light shade. Heavy shade negated flowering and vegetative improvements in *O. drummondii* and caused a large increase in mortality. Shade was detrimental to flowering of *E. procumbens*, *B. frutescens*, and *S. portulacastrum* at one or more times during the growing season and dense shade reduced both vegetative and floral development of *E. procumbens*. Flowering of *E. procumbens* was reduced in the heat of summer, while *B. frutescens* appeared to have episodic flowering tendencies.

Literature Cited

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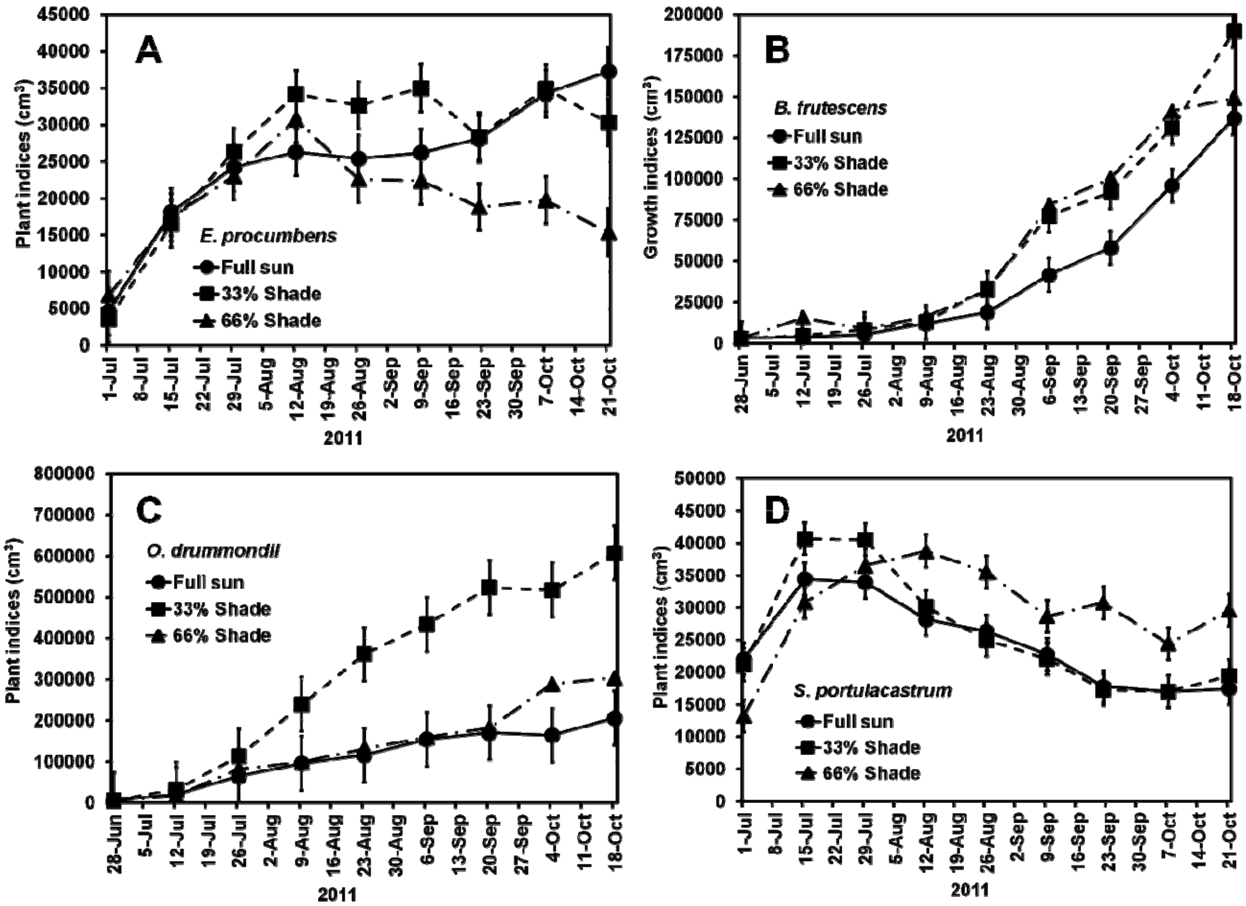

Figure 1. Growth indices of *Erigeron procumbens* (A), *Borrichia frutescens* (B), *Oenethera drummondii* (C), and *Sesuvium portulacastrum* (D) grown in full sun (●), 33% shade (■), or 66% shade (▲). Each data point represented the mean (± standard error) of nine observations.

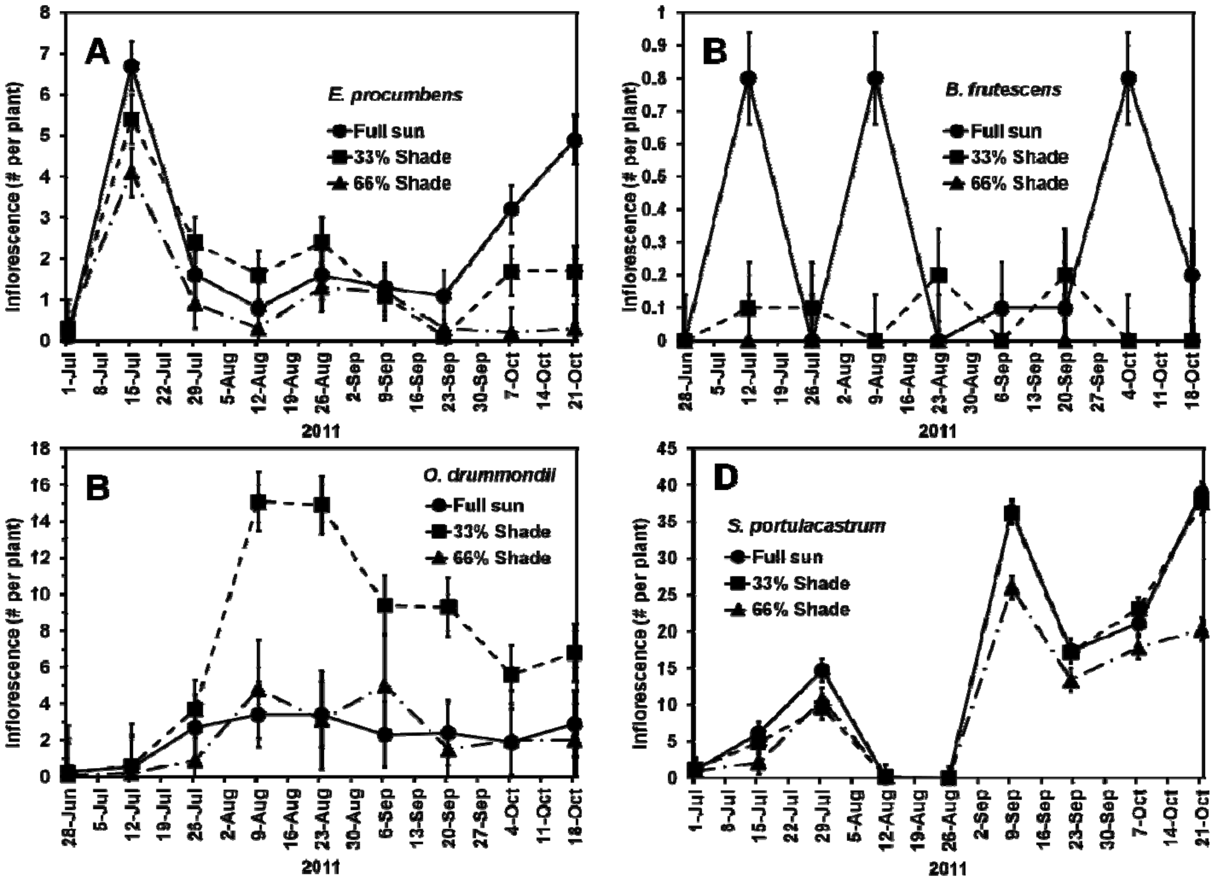

Figure 2, Flowering of *Erigeron procumbens* (A), *Borrichia frutescens* (B), *Oenethera drummondii* (C), and *Sesuvium portulacastrum* (D) grown in full sun (●), 33% shade (■), or 66% shade (▲). Each data point represented the mean (± standard error) of nine observations.