

Landscape

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Landscape Rose Breeding Lines Evaluation

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Index Words: *Rosa*, shrub rose, disease resistance, black spot, *Diplocarpon rosae* Wolf

Significance to Industry: New cultivars are introduced annually by breeders for the popular shrub, landscape rose market. These new cultivars might exhibit resistance to black spot, *Diplocarpon rosae* Wolf, in one part of the United States, but not in other areas with different environmental conditions. Therefore, evaluation of rose cultivars is needed for the various areas of the U.S. This research project evaluated advanced lines from the Jackson & Perkins rose breeding program in humid environmental conditions of northern Mississippi.

Nature of Work: Numerous field evaluations of landscape roses have been conducted on landscape rose cultivars as they are available in the market (Mackay, et al., 2008; Owens, et al., 2005; Owens, et al., 2007; Sloan et al., 2008). New cultivars are released each year by rose breeders, however, that should be evaluated in various environments. Different races of black spot are found across the U.S. emphasizing the need for regional cultivar evaluations (Wenefrida and Spencer, 1993; Whitaker and Hokanson, 2007). The objective of this study was to plant advanced breeding lines from the Jackson & Perkins rose breeding program in field beds at the North Mississippi Research & Extension Center in Verona, MS in order to evaluate disease and landscape performance in the humid summer of northern Mississippi. The landscape performance and disease resistance characteristics of these breeding lines were compared to those of 'Knock Out', considered to be the standard by which other landscape, shrub roses is compared.

Forty seven and 52 lines were planted on raised field beds in 2007 and 2008, respectively. The plants were spaced three feet within the row. Each of these plantings was fertilized with 0.5 lb 8-8-8 fertilizer per bush shortly after planting and then weekly with 200 ppm N from Peter's 20-20-20 at a rate of 24 lb/ac during the growing season. No fungicides were applied to these trials. The roses were rated monthly for landscape qualities of bloom coverage and vigor. The ratings ranged from 1–5, where 1 = poor and 5 = excellent. They were also evaluated for incidence and severity of black spot using the Horsfall-Barrett rating system. Incidence of black spot was a measurement of the number of leaves infected while the severity rating reflected the amount of disease on infected leaves. The weather during 2007 was hot and dry; humidity was relatively low (Miss. St. Univ. Dept Geosciences, 2008 a; Miss. St. Univ. Ext. Serv. 2008). Therefore, these ratings represent bloom and vigor during above historical average temperatures and below average precipitation. Black spot pressure was relatively low in 2007 as

evidenced by disease incidence ratings averaged over the growing season for 'Knock Out' of 1.7 in 2007 and 2.9 in 2008. June and July 2008 experienced above average temperatures with below average precipitation while September and October 2008 experienced below average temperatures and above average precipitation (Miss. St. Univ. Dept Geosciences, 2008 b; Miss. St. Univ. Ext. Serv. 2008). Data collected during the trial were analyzed by SAS PROC GLM and PROC CLUSTER (SAS Institute Inc, Cary, NC). Mean separation was conducted with Fisher's protected least significant difference (LSD) at the 0.05 significance level.

Results and Discussion:

The breeding lines in this trial were rated for bloom, vigor, disease incidence, and disease severity in 2007 and 2008. While there was some repetition of breeding lines in both years, primarily different lines were evaluated each year. Each year was evaluated separately, and then the number of lines that performed as well or better than 'Knock Out' was determined. In May and July 2007, 47% and 42%, respectively, of the breeding lines had bloom ratings \geq 'Knock Out' (Fig. 1). This percentage decreased to 19% in August, but increased to 64% in October 2007. In May 2008, 84% of the lines exhibited bloom ratings \geq 'Knock Out'. The percentage of breeding lines in 2008 with bloom ratings \geq 'Knock Out' was lowest in July, 31%, and then higher in August and September, 44%. Cluster analysis shows that 18 cultivars and breeding lines in 2008 were closely grouped with 'Knock Out' with respect to bloom ratings over four months (Fig 2). The percentage of breeding lines showing vigor ratings \geq 'Knock Out' in 2007 was low (Fig. 3). The greatest percentage of breeding lines with vigor ratings \geq 'Knock Out' in 2007 occurred in September. Ninety percent of the breeding lines in May 2008 exhibited vigor ratings \geq 'Knock Out'. This percentage declined to 6 and 8% in August and September, respectively. Six cultivars and breeding lines were closely grouped with 'Knock Out' with respect to vigor ratings over four months in 2008 (Fig. 4). Disease incidence ratings reflect the percentage of leaves on a plant manifesting black spot symptoms. In 2007, 42% of the breeding lines in June and 83% of the lines in October showed disease incidence ratings \geq 'Knock Out' (Fig. 5). Only 13% of the lines in July 2007 showed comparable disease incidence ratings to 'Knock Out'. In 2008, the percentage of breeding lines with disease incidence ratings \geq 'Knock Out' in June, July, and October were 52, 36, and 69%, respectively. Seven cultivars and breeding lines were closely grouped with 'Knock Out' with respect to disease incidence ratings over three months in 2008 (Fig. 6). Disease severity ratings reflect the severity of black spot symptoms on affected leaves. In both 2007 and 2008, the disease severity ratings in September for the breeding lines were 96% and 83% \geq 'Knock Out', respectively (Fig. 7). In July 2007, 13% of the lines exhibited disease severity ratings \geq 'Knock Out', but in July 2008, 71% of the trial entries exhibited disease severity ratings \geq 'Knock Out'. Six cultivars and breeding lines were closely grouped with 'Knock Out' with respect to disease severity ratings over three months in 2008 (Fig. 8).

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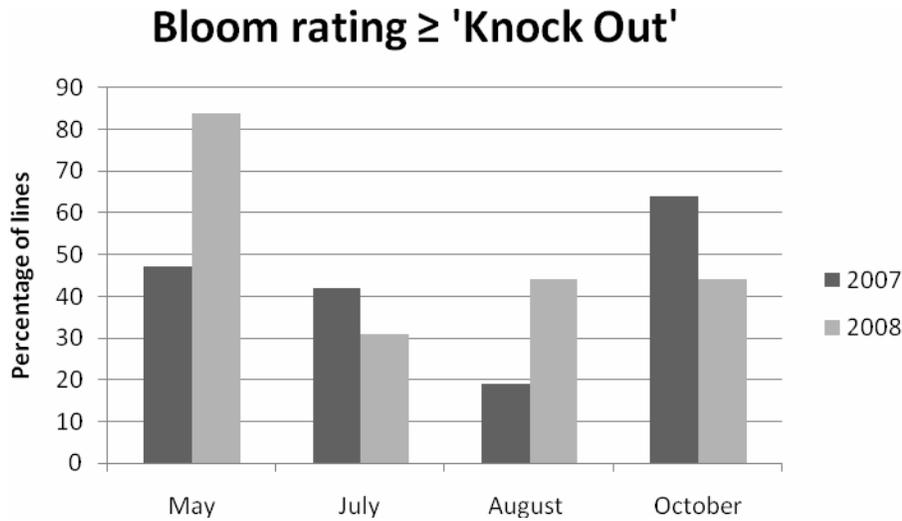


Figure 1. The percentage of breeding lines with bloom ratings equal to or greater than the ratings of 'Knock Out' was determined for 4 months in 2007 and 2008.

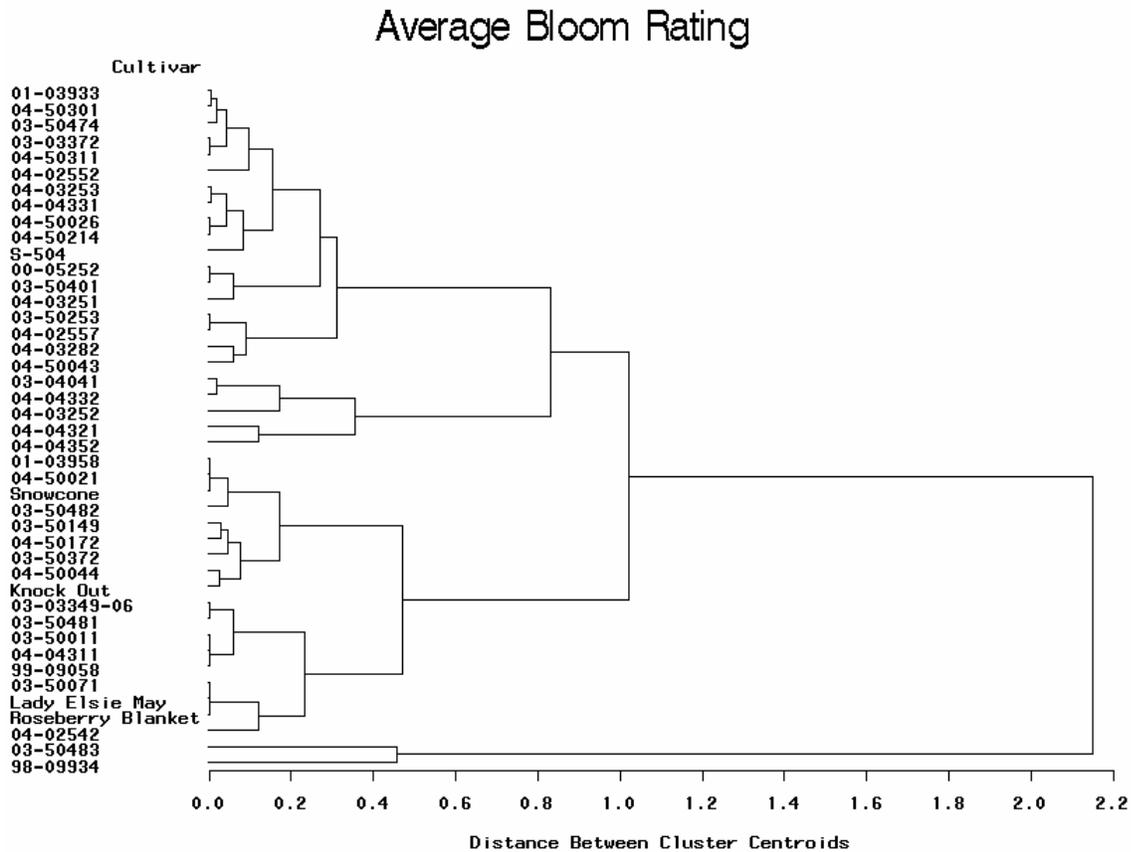


Figure 2. Cluster analysis of bloom ratings, averaged over 4 months in 2008, shows the major groupings of cultivars and breeding lines in this trial.

Vigor ratings \geq 'Knock Out'

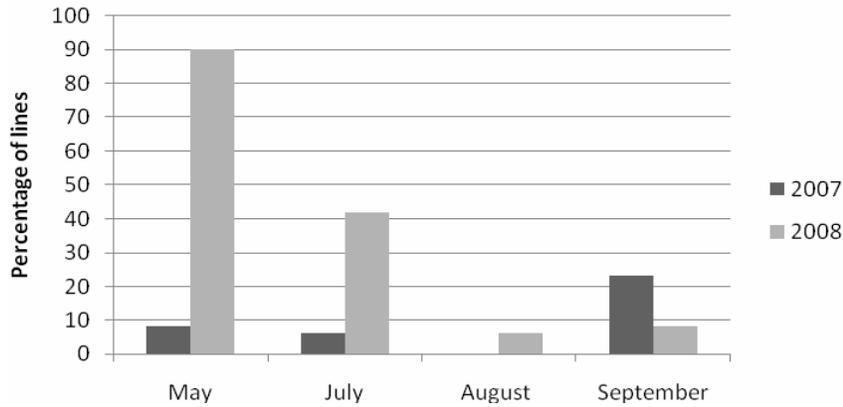


Figure 3. The percentage of breeding lines with vigor ratings equal to or greater than the ratings of 'Knock Out' was determined for 4 months in 2007 and 2008.

Average Vigor Rating

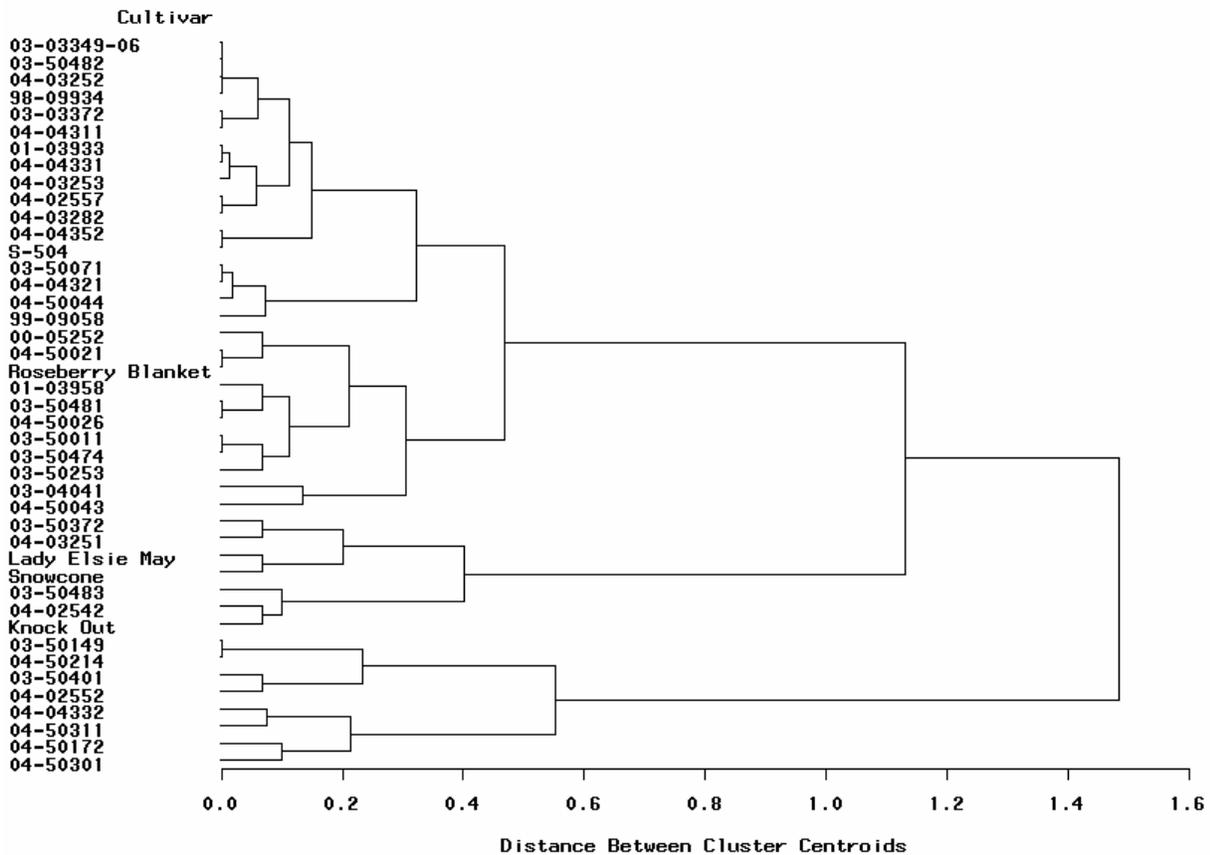


Figure 4. Cluster analysis of vigor ratings, averaged over 4 months in 2008, shows the major groupings of cultivars and breeding lines in this trial.

Disease incidence ratings \geq 'Knock Out'

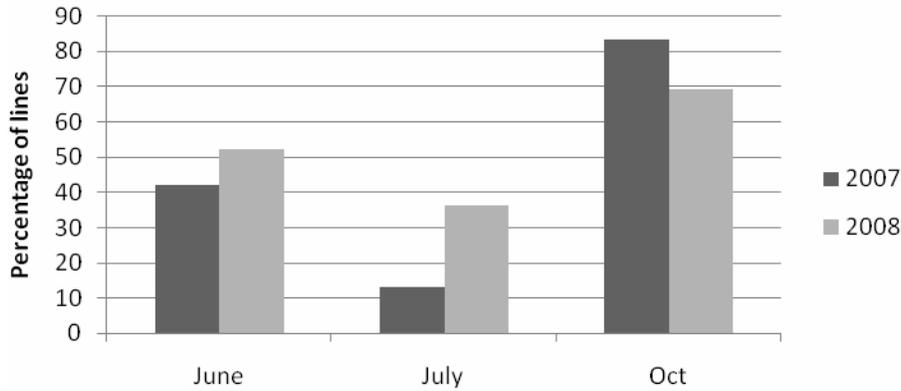


Figure 5. The percentage of breeding lines with disease incidence ratings equal to or greater than the ratings of 'Knock Out' was determined for 3 months in 2007 and 2008.

Average Disease Incidence Rating

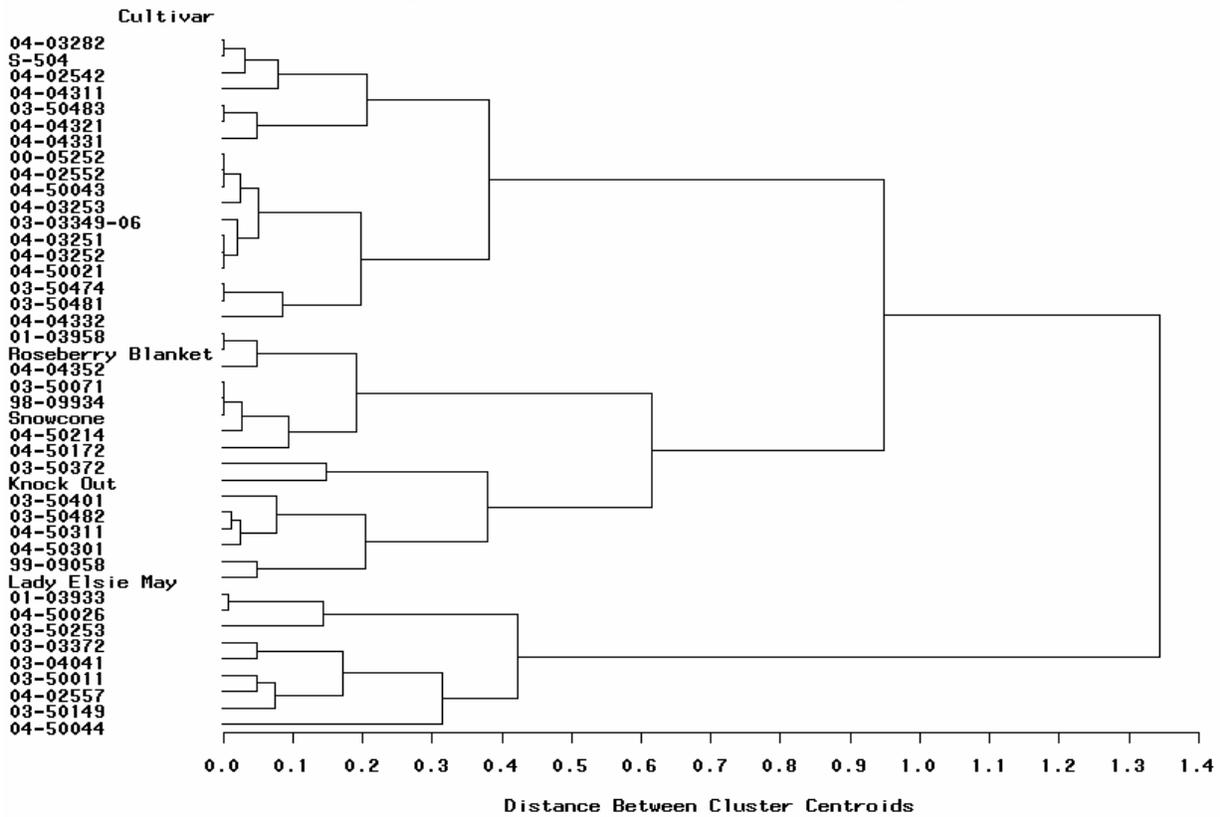


Figure 6. Cluster analysis of disease incidence ratings, averaged over 3 months in 2008, shows the major groupings of cultivars and breeding lines in this trial.

Disease severity ratings \geq 'Knock Out'

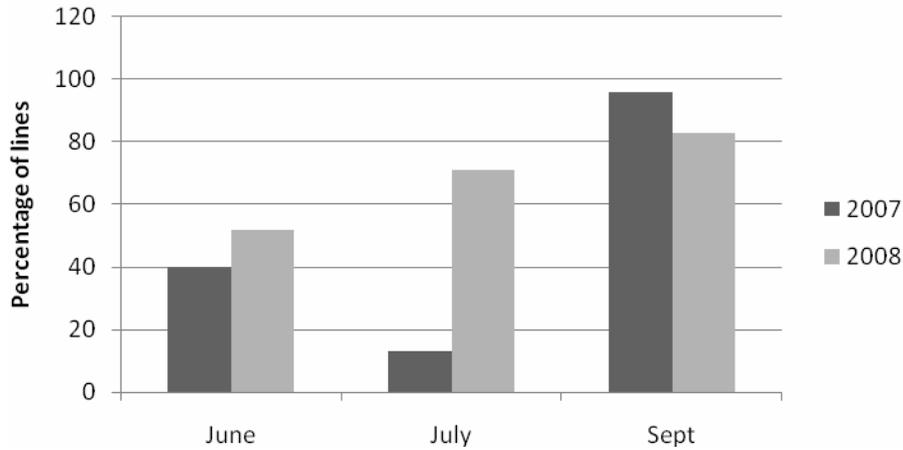


Figure 7. The percentage of breeding lines with disease severity ratings equal to or greater than the ratings of 'Knock Out' was determined for 3 months in 2007 and 2008.

Average Disease Severity Rating

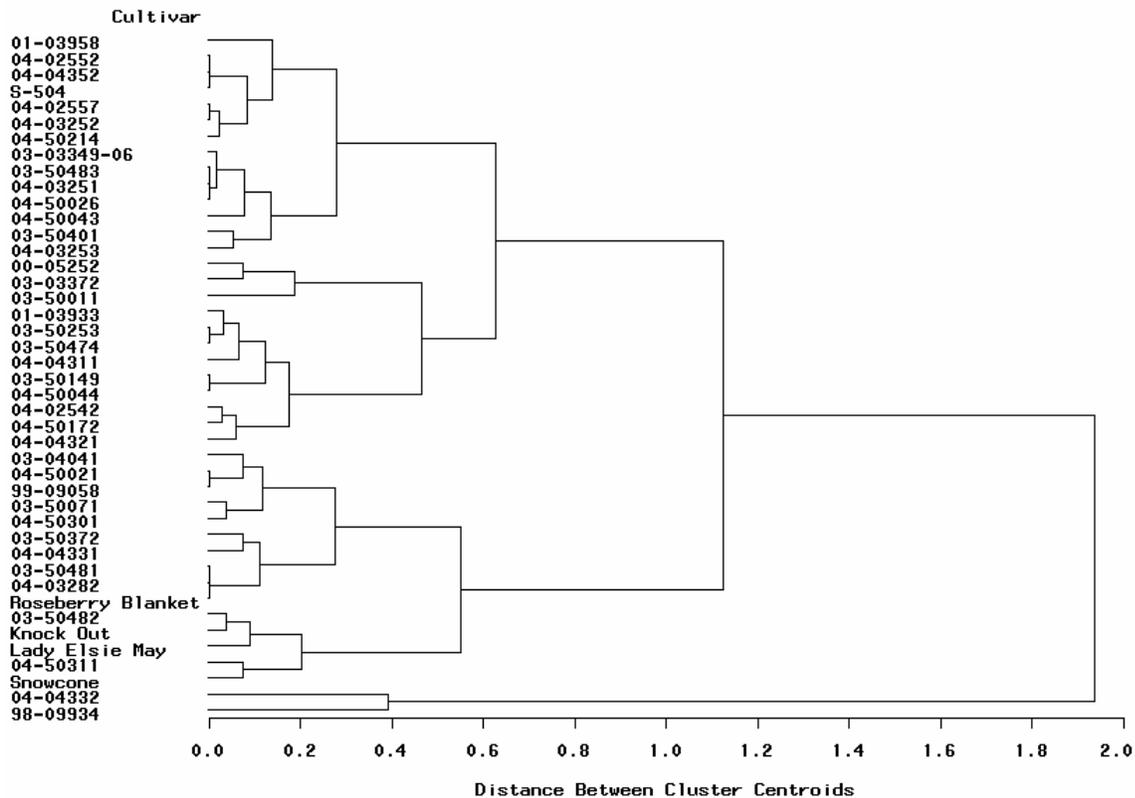


Figure 8. Cluster analysis of disease severity ratings, averaged over 3 months in 2008, shows the major groupings of cultivars and breeding lines in this trial.

Performance of Ornamental Groundcovers and Perennials in Texas Green Roof Gardens

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Index Words: Asian Jasmine, Delosperma, succulents

Significance to Industry: Local, state, and federal governments are becoming increasingly interested in the use of green construction techniques that make buildings more efficient. Green roofs can significantly reduce summer cooling costs by absorbing incoming radiation and using it for photosynthesis and water evaporation. Unfortunately, green roofs in southern United States are unable to use plant species commonly used in the cooler climates of the northern U.S., Europe, and Japan. Previous studies by Harp and Pulatie (2008) described the challenges facing green roof gardens in the warm, sub-tropical climates. In this study, we were able to identify ornamental species commonly grown in the southern U.S. that perform extremely well in Texas green roof gardens.

Nature of Work: Green roofs are used as an environmentally friendly roofing strategy. First, green roofs intercept incoming radiation, decreasing the heat load on the building and ameliorating the urban heat island effect (U.S. EPA, 2003; Onmura et al., 2001; Osmundson, 1999). Green roofs also increase insulation for buildings, decreasing utility costs and reducing energy consumption (Theodosiou, 2003).

While the benefits of green roofs have been realized, little research can be found evaluating suitable taxa for rooftop gardens in the southern U.S. (Monterusso et al., 2005). These plants must be capable of withstanding the harsh environmental conditions frequently present on rooftops (Dunnnett and Kingsbury, 2004; Dunnnett and Nolan, 2004). Green roofs in Europe, Canada, and cooler climates of the U.S. have been very successful using various species of *Sedum*, along with native grasses and forbs (Monterusso et al., 2005; Rowe et al., 2005; VanWoert et al., 2005; Durhman et al., 2004; Boivin et al., 2001). However, these plants are not suitable in the southern U.S. where summer high temperatures exceed 100°F for several months. Designers in warmer areas of the U.S. are forced to rely on anecdotal evidence and landscape experience that may or may not translate effectively to the unique conditions found on urban rooftops.

Ten species were evaluated during 2008: Hardy Ice Plant (*Delosperma cooperi*), Beaufort West Ice Plant (*Delosperma* 'Beaufort West'), New Gold Lantana (*Lantana X hybrida* 'New Gold'), White Sedum (*Sedum album*), Stonecrop (*Sedum kamtschaticum*), Frogfruit (*Phyla nodiflora*), Green Santolina (*Santolina virens*), Gray Santolina

(*Santolina chamaecyparissus*), Katie's Dwarf Ruellia (*Ruellia brittoniana* Katie), and Asian Jasmine (*Trachelospermum asiaticum*). The Sedums were chosen for their performance in prior studies in Texas. (Harp and Pulatie, 2008). Frogfruit was chosen as one of the species identified in previous work in Texas (Gardiner, 2008; Harp and Pulatie, 2008). The two species of Santolina, Ruellia, Lantana, and Asian Jasmine were chosen as they are known performers in Texas xeriscape gardens.

Four plants of each species were planted in 4" deep, 24" x 24" green roof modules in a commercially provided green roof planting mix (GreenGrid, ABC Supply Co, Inc. Vernon Hills, IL) on the roof of the Texas A&M University – Commerce Science building. Plants were watered on an as-needed basis and topdressed with Osmocote 15-9-12 slow-release fertilizer. Each module was considered an experimental unit. Modules were arranged in a randomized complete block design. Quantitative plant data was collected every two weeks and included plant height, width, and mortality.

Results and Discussion: Weather in 2008 was fairly typical in north Texas with average daily high temperatures in the mid to low 90s and average daily low temperatures in the mid to low 70s (Figure 1). Extreme high temperature for summer 2008 occurred on August 3 with a high temperature of 104.7°F recorded. Daily high temperature exceeded 100°F six times during the summer, all during the last week of July and first week of August.

For the purposes of our study, wind speed and gusts were much more important during the early stages of the study. During April, May and June 2008, wind gusts in excess of 30 mph were recorded on over 60 different days. Gusts above 40 mph were measured on 10 different days, with 2 days of gusts above 50 mph. These high winds were responsible for the loss of *Santolina virens* from the study as plants were blown out of the planting medium. Several specimens of *Santolina chamaecyparissus* were similarly lost, but sufficient numbers remained to continue in the study.

In terms of growth, frogfruit far exceeded growth of other species tested, increasing in width by over 30 inches, on average. Lantana and Hardy Ice Plant also demonstrated effective growth, increasing by 13 and 9 inches respectively (Table 1). All plants except White Sedum and Gray and Green Santolina were successfully grown during Summer 2008. Gray and Green Santolina were damaged by high winds early in the growing season, but have performed well in earlier trials (Harp and Pulatie, 2008). White sedum declined as summer temperatures increased and was completely absent from the modules by the end of the study, indicating it is a poor choice for green roof gardens in Texas. Based on results from this study, Hardy Ice Plant, Beaufort West Ice Plant, Frogfruit, New Gold Lantana, Katie's Dwarf Ruellia and Asian Jasmine may be successfully used in green roofs in the southern U.S.

Leaf temperatures for all plants were significantly lower than surrounding roof temperatures (Table 2). The greatest differences were found in April, July, and August. Leaf temperatures in April were 54.3°F lower than the surrounding roof surface. Temperatures were 47°F and 36.4°F lower in July and August, respectively. The ability

to reduce surface temperatures contributes to a reduced urban heat island effect and may contribute to lower temperatures inside the building, significantly lowering building energy usage for summer cooling.

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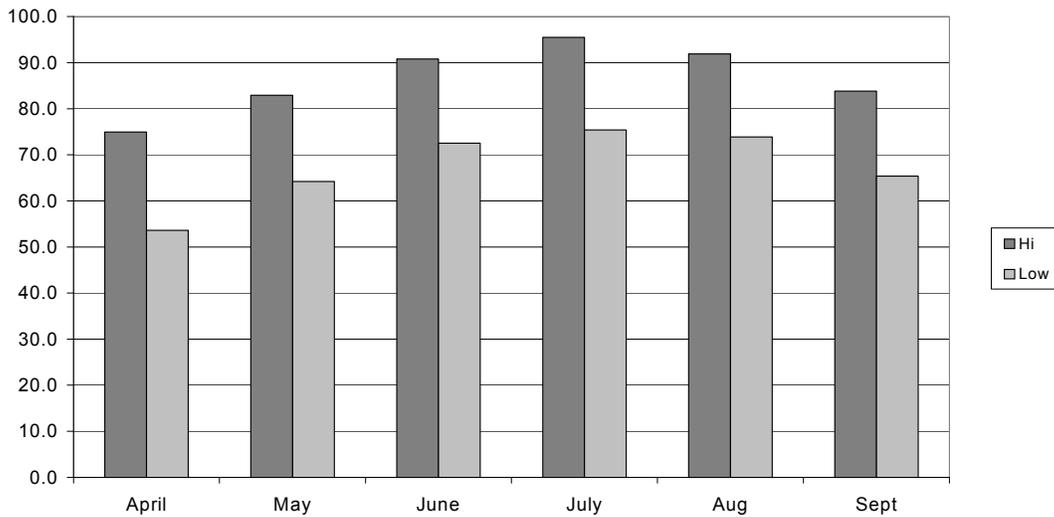


Figure 1. Average monthly high and low temperature (°F) during spring and summer 2008 on the Texas A&M – Commerce green roof.

Table 1. Average increase in plant width in ten species grown on a green roof in north Texas during spring and summer 2008.

Species	Average width increase (in.)
<i>Delosperma cooperi</i>	8.63
<i>Delosperma</i> 'Beaufort West'	2.45
<i>Lantana x hybrida</i> 'New Gold'	13.04
<i>Sedum album</i>	0.00
<i>Sedum kamtschaticum</i>	6.29
<i>Ruellia brittoniana</i> 'Katie'	3.27
<i>Phyla nodiflora</i>	34.03
<i>Santolina virens</i>	0.00
<i>Santolina chamaecyparissus</i>	1.65
<i>Trachelospermum asiaticum</i>	0.10

Table 2. Average leaf and roof surface temperatures on a green roof in north Texas during spring and summer 2008.

Month	Roof Temperature (°F)	Leaf Temperature (°F)
<i>May</i>	140.3	86.0
<i>June</i>	94.8	85.6
<i>July</i>	157.0	110
<i>August</i>	126.5	90.1

Initial Performance of 12 Roses Grown in North, Central and South Florida under Low Maintenance Conditions

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Significance to Industry: Sales and use of shrub roses has increased dramatically but information on performance in Florida is lacking, especially under low maintenance conditions. An evaluation of 12 shrub rose cultivars is ongoing at 3 sites in Florida. After 40 weeks, Knock Out received the highest average cumulative visual quality ratings in north and central Florida, and Knock Out and Home Run had the highest ratings in south Florida. The largest average cumulative flowering occurred with Knock Out in south Florida, Knock Out, Home Run and 'Bailey Red' in central Florida, and Knock Out and Home Run in north Florida. Ratings in central Florida declined in late summer and fall in association with damage from chilli thrips (*Scirtothrips dorsalis*). Peak flowering of most cultivars occurred in July in south and central Florida and Aug. through Nov. in north Florida.

Nature of Work: Shrub roses have become extremely popular in recent years. Within the classification of "modern roses," which includes hybrid tea and shrub roses, sales of shrub roses increased from 7% in 2000 to 17% in 2005 and are estimated to grow to 45 – 50% by 2010 (Shanklin, pers. comm.). Recent or ongoing rose evaluations in the southeastern U.S. include those in Texas (Mackay et al., 2008), Mississippi (Sloan and Harkness, 2008) and Louisiana (Owings et al., 2007) but little information is available for comparative shrub rose performance across Florida.

A landscape evaluation of shrub roses was initiated in three sites in Florida in 2008. Twelve shrub rose taxa were selected for this study based on availability and plant performance in other locations in the southeastern U.S. (Table 1). Clonally propagated, own root cultivars were obtained as bare root plants (Star Roses, Cutler, CA; The Antique Rose Emporium, Brenham, TX; Weeks Roses, Cucamonga, CA) or in #1 containers (Petals From the Past, Inc., Jemison, AL). Six uniform plants of each taxon were installed on 23 Jan. 2008 in south Florida (Fort Pierce; USDA Hardiness Zone 9b), central Florida (Plant City; USDA Hardiness Zone 9a) and north Florida (Quincy; USDA Hardiness Zone 8b). Plants were placed 8.0 ft on center in rows 8.0 ft wide with a 4.0 ft wide strip of black landscape fabric down the center of each row. Prior to planting,

composted cow manure (Black Gold Compost Co., Oxford, FL) was applied to a depth of 3.0 in in a swath 2.0 ft wide down the center of each row and subsequently tilled into the upper 6 in of soil.

After planting, each 8.0 ft wide row was mulched to a depth of 3 – 4 in with locally used mulches (chipped yard waste, pine bark nuggets and pine straw in south, central and north Florida, respectively). Roses were drip irrigated after planting with 0.5 gal per plant daily for 2 weeks, 0.5 gal per plant every other day for the next 3 months, and 0.5 gal per plant weekly for the next 3.5 months. Plants were fertilized 8 weeks after planting with 0.16 oz (4.54 g) of 6-month Osmocote Plus 15-9-12 (Scotts Co., Marysville, OH) in the area 6 in from the crown. Plants in south, central and north Florida received an additional 0.33 oz (9.49g), 0.25 oz (7.12g), 0.17 oz (4.75g), respectively, on 9 June and 0.50 oz (14.03g), 0.41 oz (11.66g), and 0.33 oz (9.29g), respectively, on 9 Sept. to accommodate nutrient needs proportional to the length of growing season at each site. Plants were not pruned or sprayed with pesticide; weeds were hand pulled as needed.

Visual quality was assessed monthly by three individuals for each cultivar independently at each location. Assessments were performed on a scale from 0 to 5 where 0=dormant, no foliage present, 1= poor form and quality, not acceptable, extremely susceptible to disease, 2=fair quality, marginally acceptable, susceptible to disease (while complete defoliation is unlikely, infection may be severe), 3= adequate and somewhat desirable form and color, average disease resistance (some disease is likely, but the plant should grow and flower acceptably without sprays), 4= very acceptable form, desirable, resistant to disease (while a few leaf spots may be found occasionally, most leaves will be healthy), and 5=excellent quality, very desirable form (rounded shape, well-branched, dense canopy) and landscape performance, extremely resistant to disease (leaf spots are virtually never seen). Monthly flowering was rated from 1 to 5 where 1=no flowers and 5=flowers found on 76-100% of the plant canopy.

The field experiments were conducted similarly in south, central and north Florida. A randomized complete block experimental design was used with 12 taxa placed in two-plant plots replicated three times (blocks). Visual quality and flowering data were collected monthly for each replication. At 40 weeks, growth data (height and 2 widths) were collected. Each experiment was subjected to analysis of variance (ANOVA) and significant means separated by least significant difference (LSD), $P=0.05$ level.

Results and discussion: Rose growth after planting was delayed up to 8 weeks in north Florida due to cool temperatures (data not shown). Knock Out received the highest average cumulative visual quality ratings in north and central Florida, and Knock Out and Home Run had the highest ratings in south Florida (Table 2). At the other extreme, 'Belinda's Dream' and 'Old Blush' had lowest average cumulative visual quality ratings in north Florida while 'Perle d'Or' performed the poorest in central Florida. 'Old Blush' and 'Perle d'Or' had the lowest average cumulative visual quality ratings in south Florida.

The greatest average cumulative flowering occurred with Knock Out in south Florida, Knock Out, Home Run and 'Bailey Red' in central Florida, and Knock Out and Home Run in north Florida (Table 2). Ratings in central Florida declined in late summer and fall in association with damage from chilli thrips (*Scirtothrips dorsalis*). Dates of peak flowering in south Florida occurred in July for all cultivars except 'Perle d'Or' (Apr.), 'Bailey Red' (Sept.) and 'Mrs. B.R. Cant' (Nov.). Peak flowering in central Florida occurred in July for all cultivars except 'Mutabilis' and 'Spice' (both in Oct.). Except for 'Louis Philippe', peak flowering in north Florida occurred much later: Carefree Beauty, 'Duchesse de Brabant' and Home Run peaked in Aug., Knock Out and 'Mrs. B.R. Cant' peaked in Sept., 'Perle d'Or' peaked in Oct., and remaining cultivars peaked in Nov. Rose performance among cultivars and sites will continue to be assessed throughout 2009, with additional emphasis on disease and insect susceptibility.

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Table 1. Plant description of 12 shrub rose taxa evaluated during the study. Form, foliage and inflorescence descriptions are based on observations in Florida.

Name	Class	Year Introduced	Flower Description	Flower Color	Comments
'Bailey Red'	Found	Unknown	repeat, single	Red	Clusters of true red flowers with bright yellow stamens contrast nicely with medium green foliage
'Belinda's Dream'	Shrub	1992	repeat, very double	Pink	Seedling of 'Tiffany' crossed with 'Jersey Beauty' by Dr. Robert Basye; large flowers
Carefree Beauty™ ('BUCbi')	Shrub	1977	repeat, semi-double	Medium pink	Developed by Dr. Griffith Buck
'Duchesse de Brabant'	Tea	1857	repeat	Light pink	Large, cabbage-like, nodding flowers are light pink fading with time
Home Run® ('WEKcisbako')	Shrub	2006	repeat, single	True red	Bred by Tom Carruth; derived from Knock Out® and more resistant to powdery mildew and downy mildew
Knock Out® ('RADrazz')	Shrub	2000	repeat, semi-double	Neon red	Developed by William Radler; famous for its free-flowering nature and resistance to blackspot; new foliage is maroon
'Louis Philippe'	China	1834	repeat, double	Red	Centers of flowers often are a deep pink
'Mrs. B.R. Cant'	Tea	1901	repeat, double	Pink	Thought to be one of the 4 roses instrumental in modern breeding
'Mutabilis'	China	Prior to 1894	repeat, single	Yellow-orange fading to yellow and pink	Salmon-orange buds open to yellow-orange flowers, fading to yellow and changing to pink; flowers of all colors are often present at the same time
'Old Blush'	China	1752	repeat, double	Dark pink	Buds open to nodding, light pink flowers that fade to dark pink
'Perle d'Or'	Polyantha	1884	repeat, double, pom-pom	Pale peach	Clusters of blush-colored buds open to blush-white flowers that fade to pale peach
'Spice'	Bermuda	Unknown	repeat	Blush white	Blush-colored buds open to nodding, blush-white flowers

Table 2. Visual quality and flowering of 12 rose cultivars grown in north, central, and south Florida for 40 weeks under low input conditions.

Name	North Florida				Central Florida				South Florida			
	Ave. cumulative flowering ^v	Ave. cumulative visual quality ^{w,x}	Highest flower rating ^v	Peak flower month(s)	Ave. cumulative flowering	Ave. cumulative visual quality	Highest flower rating ^v	Peak flower month(s)	Ave. cumulative flowering	Ave. cumulative visual quality	Highest flower rating ^v	Peak flower month(s)
'Bailey Red'	2.47	2.44	3.83	Nov	2.14	2.20	4.00	July	2.21	2.32	3.50	Sept
'Belinda's Dream'	1.83	1.95	2.83	Nov	1.80	2.15	2.83	July	1.94	2.62	4.17	July
Carefree Beauty™	1.97	2.20	2.83	Aug, Sept, Nov	1.76	1.89	2.33	July	1.89	2.67	3.33	July
'Duchesse de Brabant'	2.06	2.32	3.33	Aug	1.91	2.44	3.00	July	1.79	2.33	2.83	July
Home Run®	2.74	2.82	4.17	Aug	2.23	2.56	4.00	July	2.36	3.24	3.83	July
Knock Out®	2.71	3.08	4.50	Sept	2.38	3.21	4.00	July	2.80	3.42	4.67	July
'Louis Philippe'	1.82	2.35	2.83	July, Nov	1.88	1.95	2.33	July, Aug, Sept	1.70	2.42	2.50	July, Oct
'Mrs. B.R. Cant'	1.76	2.44	2.83	Sept	1.70	2.58	2.83	July	1.68	2.39	2.33	Nov
'Mutabilis'	1.95	2.41	3.50	Nov	1.88	2.08	2.67	Oct	1.74	2.17	2.67	July
'Old Blush'	1.86	1.98	3.00	Nov	1.89	1.82	2.83	July	1.61	1.65	2.00	July, Oct
'Perle d'Or'	2.00	2.30	4.00	Oct	1.94	1.48	2.50	July	1.79	1.39	2.83	April
'Spice'	1.91	2.67	3.17	Nov	1.85	2.23	2.67	Oct	2.32	2.64	3.83	July
LSD (0.05) ^z	0.23	0.22	0.74		0.27	0.32	0.78		0.20	0.27	1.04	

^v Flowering was rated 1(no flowers) to 5 (many flowers).

^w Visual quality was rated 1 (poor quality) to 5 (excellent).

^x Average rating was derived by dividing the cumulative monthly quality rating by 11 months.

^y Growth index was calculated as [height + width1 + width2]/3

^z Least significant difference at $P=0.05$ level.

Post-transplant Irrigation Scheduling for Two Native Deciduous Shrub Species

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Index Words: Establishment, landscape, *Itea virginica*, *Rhododendron austrinum*

Significance to Industry: The effect of five irrigation scheduling treatments on shoot growth and photosynthetic rates of *Itea virginica* L. 'Henry's Garnet' ('Henry's Garnet' sweet spire) and *Rhododendron austrinum* Rehd. (florida flame azalea) were studied. Plants were planted at grade in field plots and irrigated based on root ball or backfill soil moisture. Photosynthetic rates were not significantly different among species or irrigation scheduling. *I. virginica* 'Henry's Garnet' grew almost twice as much as *R. austrinum*. *I. virginica* 'Henry's Garnet' had the most shoot growth when plants were well-watered; plants that were irrigated when backfill soil dried to 25 cb had less shoot growth than well-watered plants but more than all others. *R. austrinum* had the most shoot growth if plants were irrigated when the root ball dried to 75 cb or 50 cb or if well-watered. For species with slower rates of root growth, such as *R. austrinum*, scheduling irrigation based on root ball moisture is critical. *I. virginica* benefited from irrigation scheduling based on backfill soil moisture.

Nature of Work: Water use efficiency research is aimed at optimizing irrigation efficiency and scheduling (2). Because of the impact soil moisture has on root growth (6), proper irrigation scheduling can directly impact the post-transplant root growth critical for plant establishment and survival (8). The most common cause of death of recently transplanted container-grown plants is water stress (1, 5). Percent moisture in the root ball can be very different from the surrounding soil (1, 5), and in fact, the root ball may experience drought conditions even when soil is well-watered (1, 5). Soil moisture sensors can be used to accurately quantify water availability in the root ball or soil and can be used to efficiently control irrigation scheduling (6). Moreover, soil moisture monitoring aids in quantifying plant water use, thereby reducing water usage and lowering direct costs associated with irrigation (6). The objective of this research was to determine how the moisture content of the surrounding soil differs from that of the original root ball and how these should be used to schedule post-transplant irrigation.

On 13 March 2008, twenty-five 11.4 L (3 gal) plants of *I. virginica* 'Henry's Garnet' and *R. austrinum* were planted in a sandy clay loam at soil grade level in holes dug twice the width of the root ball and backfilled with soil, with the remaining soil used to create a berm around each plant beginning at the outer edge of root ball. Plants were planted 4 feet on center in field plots on the Auburn University campus in Auburn, AL. *I. virginica* 'Henry's Garnet' was grown under 30% shade and *R. austrinum* was grown under 47% shade. A 7.6 cm (3 in) layer of pine straw (*Pinus taeda* L., loblolly pine) was applied

around each plant and to the ground between plants and rows. All plants were irrigated with overhead irrigation (#4 Nozzle mini-Wobbler®, Senninger Irrigation, Inc., Clermont, Fla) until treatments began on 1 April 2008. Five irrigation scheduling treatments were used: (1) root ball and surrounding soil maintained at or above 25 cb (centibar) (Well-watered, WW); (2) root ball and surrounding soil re-watered when root ball moisture reached 50 cb (50 RB); (3) root ball and surrounding soil re-watered when root ball moisture reached 75 cb (75 RB); (4) root ball and surrounding soil re-watered when surrounding soil moisture reached 25 cb (25 S); (5) root ball and surrounding soil re-watered when surrounding soil moisture reached 50 cb (50 S). Soil water potential was measured using Watermark® sensors (model 900M) (Irrometer Company, Inc., Riverside, California), installed in the root ball and surrounding soil of each plant in three blocks per species. When irrigated, plants were hand watered with 2.5 cm (1 in) of water applied in a 30.5 cm (12 in) radius around the plant [7.4 L water (1.9 gal)]. Initial soil tests did not indicate the need for any addition of fertilizer to plots. The experimental design was a randomized complete block design with five blocks per species. Growth index (GI) [(widest width + width perpendicular + height)/3] was measured for each plant at the beginning of the experiment and at the end of the first growing season (7 October 2008). Relative growth index (RGI) was calculated [(final GI – initial GI)/initial GI] for all plants. Photosynthetic rates of each plant were measured using the LI-COR 6400 (LI-COR Biosciences, Inc., Lincoln, Nebraska). Data were analyzed using generalized linear models with means separation using LSD ($P < 0.05$) (7).

Results and Discussion: Shoots of *I. virginica* 'Henry's Garnet' grew almost twice as much as those of *R. austrinum* (Fig. 1). In *I. virginica* 'Henry's Garnet', RGI was highest when plants were WW and re-watered at 25 S moisture followed by those re-watered at 50 S, 75 RB, and 50 RB moisture (Fig. 1). *R. austrinum* RGI was greatest in 75 RB, 50 RB, and WW treatments and lowest for plants in the 25 S and 50 S treatments (Fig. 1). Initial GI of *I. virginica* 'Henry's Garnet' and *R. austrinum* were 45 cm (18 in) and 58 cm (23 in) at planting, respectively. The fact that *I. virginica* 'Henry's Garnet' grew more during the first growing season could be attributed to the fact that it was initially smaller than *R. austrinum*, which grew less by comparison. *I. virginica* 'Henry's Garnet' plants in the WW treatment and the treatments based on soil moisture received the most irrigation due to the fact that roots were growing into the surrounding soil, likely at a faster rate than roots of *R. austrinum*. In greenhouse studies *I. virginica* 'Henry's Garnet' had faster rates of root growth than *R. austrinum* (unpublished data). At planting *I. virginica* 'Henry's Garnet' had fewer roots in the original root ball than *R. austrinum* in which the root ball was completely filled with roots. This explains why the *I. virginica* 'Henry's Garnet' in treatments based on root ball moisture were irrigated less frequently than *R. austrinum* in treatments based on root ball moisture. Photosynthetic rates were not significantly different between species or among treatments (Fig. 2). Growth of a species often declines before photosynthetic rates of that species when under stress (4). The similar photosynthetic rates between *I. virginica* 'Henry's Garnet' and *R. austrinum* are consistent with this, since photosynthetic rates were similar and growth continued for both species (4). Results from this research are consistent with

others which found that frequently irrigated plants grew more quickly than those irrigated infrequently (3). Additionally, these results show the importance of monitoring both root ball and soil moisture for effective post-transplant irrigation scheduling.

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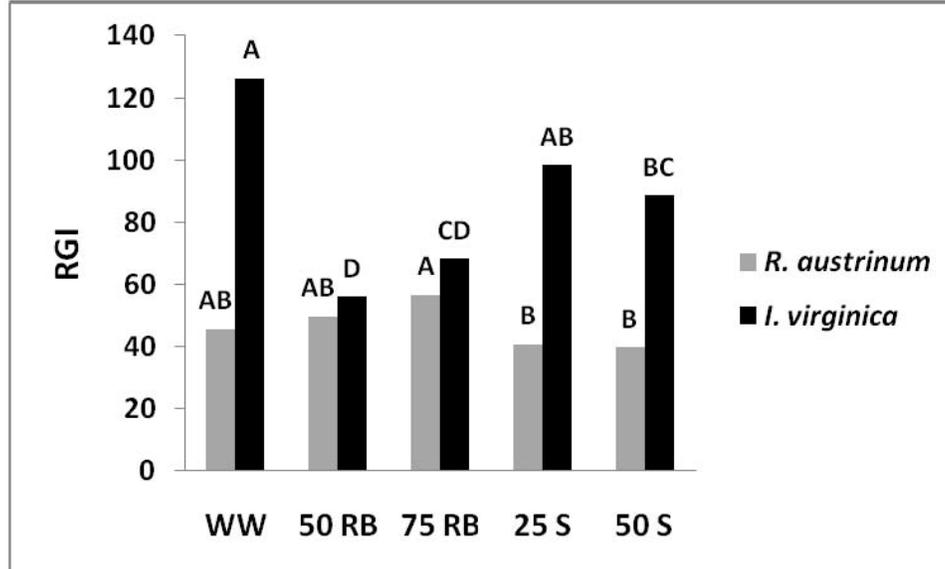


Figure 1. Effect of irrigation scheduling on shoot growth of *Itea virginica* 'Henry's Garnet' and *Rhododendron austrinum* grown in field plots. Initial and final shoot growth index was measured for each plant (13 March and 7 October 2008). Relative growth index (RGI) was calculated [(final GI – initial GI)/initial GI] for all plants. Treatments include: root ball and surrounding soil maintained at or above 25 cb (Well Watered, WW); root ball and surrounding soil re-watered when root ball moisture reached 50 cb (50 RB); root ball and surrounding soil re-watered when root ball moisture reached 75 cb (75 RB); root ball and surrounding soil re-watered when surrounding soil moisture reached 25 cb (25 S); root ball and surrounding soil re-watered when surrounding soil moisture reached 50 cb (50 S). Letters represent means separation among treatments within species using LSD ($P < 0.05$).

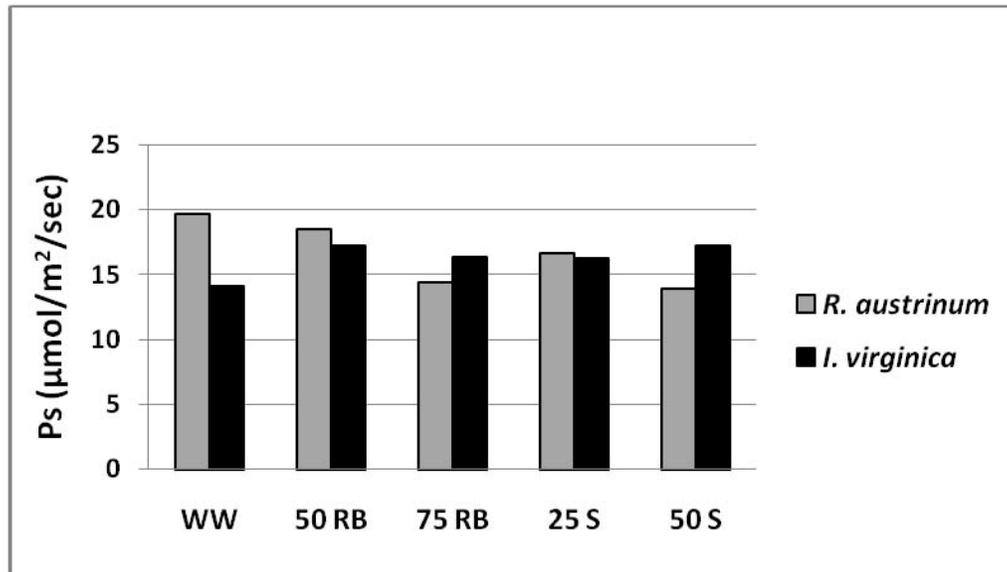


Figure 2. Effect of irrigation scheduling on photosynthetic rates (Ps) of *Itea virginica* 'Henry's Garnet' and *Rhododendron austrinum* grown in field plots from 13 March – 7 October 2008. Treatments include: root ball and surrounding soil maintained at or above 25 cb (Well Watered, WW); root ball and surrounding soil re-watered when root ball moisture reached 50 cb (50 RB); root ball and surrounding soil re-watered when root ball moisture reached 75 cb (75 RB); root ball and surrounding soil re-watered when surrounding soil moisture reached 25 cb (25 S); root ball and surrounding soil re-watered when surrounding soil moisture reached 50 cb (50 S).

Growth Regulation of Loropetalum and Azalea in Landscape Beds

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Index Words: landscape maintenance, plant growth regulator, flurprimidol, *Loropetalum chinenses rubrum* 'Merlot Lace', *Rhododendron Carla Hybrid* 'Sunglow',

Significance to Industry: In commercial and residential landscapes, a compact shape is highly desirable for foundation plantings such as loropetalum and azalea. Pruning foundation shrubs is a landscape maintenance task requiring intensive labor, the largest single cost contributor in landscape business. Plant growth regulators that break apical dominance and promote lateral branching may result in a similar effect as hand pruning and reduce labor cost in landscape maintenance.

Nature of Work: Loropetalum (*L. chinense rubrum*) is an evergreen flowering shrub that has gained popularity in southern landscapes. Because of its spreading growth habit, plants often require multiple pruning during nursery production and after being planted in the landscape to maintain a compact and full canopy. Similarly, many azalea varieties used as border or hedge plants need to be pruned to maintain plant size and shape. Hand pruning is labor intensive and less uniform than chemical control. Even though mechanical pruning requires less labor, chemical control can reduce possible die-back and disease problems associated with wounding the plant. Plant growth regulators (PGR), especially gibberellic acid biosynthesis inhibitors can effectively regulate shoot growth and branching of many shrub species.

Cutless (flurprimidol, SePRO Corporation, Carmel, IN) is a PGR to reduce unwanted plant growth, while enhancing the quality of ornamentals. The granular formulation for landscape use is effective on azalea and loropetalum in container production (1). However, few research studies have been conducted on its effectiveness in landscape, especially when applied above organic mulches such as pine straw. Mulching is a common practice in landscape maintenance. Granular materials are usually applied prior to mulching to avoid potential retention of the chemical by organic mulch. Because of the convenience of applying treatment to landscape beds where mulch is already laid down, it is of interest to landscapers if the material is effective when applied over the mulch. The objective of this study was to evaluate the growth regulation effect of Cutless 0.33 G as an alternative to mechanical pruning for loropetalum and azalea growth control in landscape beds that are either mulched or un-mulched at the time of application, and compared the control effect of Cutless to Atrimmec (dikegulac-sodium, PBI Gordon Corporation, Kansas City, MO) as an industry standard.

Sixty raised landscape beds, each of 10' (L) x 6' (W) were set up at the LSU AgCenter Hammond Research Station in September 2007. Soil in this area is a sandy loam with 1% organic matters, 38 mg·l⁻¹ P, 53 mg·l⁻¹ K, 499 mg·l⁻¹ Ca, and 123 mg·l⁻¹ Mg with soil pH at 5.3 (Soil Testing and Plant Analysis Laboratory, LSU). About two inches pine bark was incorporated into the top six inches of soil to increase drainage. Dolomitic limestone was incorporated at 70-lb/1000 ft² to adjust pH. A two-foot alley way was made in between every two raised plots to avoid plants intruding into other plots. Experimental design was a completely randomized block design with ten treatments and six blocks arranged along the direction of field drainage. Sunglow azalea and Merlot Lace loropetalum were chosen because they are often used as foundation plants in landscapes. One loropetalum plant and one azalea plant were transplanted from 3-gallon pots to each landscape bed on October 30, 2007. Two Osmocote Plus 7.5 gram tablets (16-8-12) were placed in each planting hole before the transplant. Plants were irrigated overhead with micro sprinklers every the other day during the first month of landscape establishment and every three days there after. Plant height and width measured on 28 February 2008 indicated that all plants established well and were of similar size within each cultivar (data not shown). On 22 April, all plants except those in the unpruned control plots were pruned with a box frame to a uniform size 2' x 2'. This resulted in about 0% and 12% reduction in the height and canopy diameter of azalea plants, respectively, and about 30% and 20% reduction in the height and canopy diameter of loropetalum plants, respectively (data not shown). On 30 April, Cutless 0.33 G was applied at 0.5, 1.0 or 2.0 pounds a.i. per acre either before or after the plots were mulched with 6-inch thick pine straw. A circular area at about a foot wide outside the irrigation ring under each plant was treated with the granular material. Atrimmec was applied as foliar spray at 0, 1600, and 3200 mg·l⁻¹ at the same time.

Plant height and canopy diameter were measured monthly from June to September 2008. Visual overall plant quality ratings were given to each plant in a scale of 1 to 10, where 10 represents the premium quality. Also in September, length of three primary shoots in loropetalum plants, and average number of lateral branches growing on each primary shoots were counted. Inter-node length of primary shoots was then calculated by dividing the length of a shoot by the number of lateral branches. Changed in leaf color was assessed by SPAD meter readings taken from five youngest fully expanded leaves randomly selected from the lateral branches. Data were analyzed with analysis of variance (ANOVA) by using SAS General Linear Models. Differences between treatment means were compared by Fisher's LSD.

Results: Sunglow is a slow growing azalea cultivar that grows an average of 2.5 to 4.7 cm in height per month from June to September (Table 1, unpruned untreated plant). After pruning, regardless of the PGR treatments, plants were similar in canopy diameter from June to September (Table 1). Plant height of those treated with 3200 mg·l⁻¹ Atrimmec were 13.6% shorter than pruned untreated plants in September, while those treated with 2.0 pounds a.i. per acre Cutless 0.33 G, either under or above pine straw had 15.6% and 7.8% growth reduction, respectively (Table 1). Merlot Lace loropetalum grew about 42.7 cm in height from June to August and grow in width for about 54 cm in

September (Table 2, pruned untreated plants). Because of its fast growing nature, pruning alone did not control plant width by June and was only effective on height by July. Pruning combined with 3200 mg·l⁻¹ Atrimmec resulted in plants smaller than the pruning only treatment by a growth reduction of 12% in height and 14% in canopy diameter. Cutless 0.33 G combined with pruning was effective to control plant height for two month (15 to 16% growth reduction in June and July when used above pine straw) but had no effect on canopy diameter (Table 2). Higher rates (1 or 2 pounds a.i. per acre) provided longer control than 0.5 pound rate, and the effect of 2 pound was similar to the 1 pound rate on plant height. Treatments applied under the mulch resulted in similar control effects as applied above although in July, applying above mulch resulted in smaller canopy than pruned untreated and those applied under the pine straw had similar canopy diameter as pruned control. By September, planted treated with 1 or 2 pounds a.i. per acre Cutless above the pine straw were 24.2% shorter and 18.3% smaller in canopy than pruning alone. Quality ratings of these plants were significantly higher than others in September because of their compact shape (data not shown). As indicated by September primary shoot measurements, the growth reduction effects of Cutless at 1 or 2 pounds were not through shortened inter-node, but shorter primary branch length (reduced plant height) as a result of slower growth and lower number of lateral branches (reduced canopy diameter). Primary shoot diameter was only affected by 1 pound a.i per acre applied above the pine straw.

Compared to Amtrimmec which is applied as a foliar spray, granular formulation of flurprimidol provided prolonged control effect on fast-growing loropetalum but not on slow-growing Sunglow azalea. Based on the results from this study, we recommend 1 pound a.i. per acre Cutless 0.33G for loropetalum chemical pruning in the landscape. More than one application of Atrimmec may be needed for longer lasting control effect which may not be cost effective.

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Table 1. Effects of pruning, and the combination of pruning and Cutless 0.33 G at 0.5, 1.0 and 2.0 pounds active ingredient per acre and Atrimmec at 1600 and 3200 mg·l⁻¹ on plant height and diameter of evergreen Azalea Sunglow from June to September 2008. Plants were treated in April.

<i>Treatment</i>		<i>June</i>		<i>July</i>		<i>August</i>		<i>September</i>	
		Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)
Pruning + Cutless 0.33G (lb a.i./acre)									
Rate	Mulch								
0.5	Under	50 b	68.7 b	47.8 b	67.8 b	47.2 b	63.7 b	50 bcd	73.2
	Above	56.8 b	74.7 b	53.8 b	72.5 b	53.3 b	70 b	55.3 bc	77.2
1.0	Under	52.7 b	77.4 b	51.2 b	75.8 b	49 b	65 b	52.5 bcd	80.7
	Above	52.2 b	76.1 b	50.3 b	72.8 b	51 b	71.1 b	55.3 bc	81.6
2.0	Under	48.8 b	69.2 b	47 b	68.1 b	45.2 b	65 b	47.2 d	74.2
	Above	51 b	73.1 b	51.8 b	69.8 b	50 b	68 b	51.5 cd	78.7
Pruning + Atrimmec Folia Spray (mg·l⁻¹)									
	1600	53.2 b	73.7 b	54 b	73.8 b	53.7 b	69.7 b	55.7 b	81.2
	3200	49 b	75.1 b	49 b	74.5 b	49.7 b	69.9 b	48.3 cd	80.2
	Pruned	49 b	77.9 b	48 b	76.8 b	48 b	73.8 b	55.9 b	84.9
	Untreated								
	Unpruned	67.8 a	89.5 a	72.5 a	89.5 a	75 a	93.5 a	78.3 a	94.8
	Untreated								
	LSD_{0.05}	9.2	10.6	12.5	11.3	14.7	13.9	9.1	NS

*Differences in treatment means were estimated by Fisher's LSD with P = 0.05.

Table 2. Effects of pruning, and a combination of pruning and Cutless 0.33 G at 0.5, 1.0 and 2.0 pounds active ingredient per acre and Atrimmec at 1600 and 3200 mg·l⁻¹ on plant height and canopy diameter of Ioropetalum Merlot Lace from June to September 2008. Plants were treated in April.

<i>Treatment</i>		<i>June</i>		<i>July</i>		<i>August</i>		<i>September</i>	
		Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)
<u>Pruning + Cutless 0.33G (lb a.i./acre)</u>									
Rate	Mulch								
0.5	Under	68.3 bcd	96.1 b	76 cd	110.4 abc	103.5 abc	119.3 abc	114.2 ab	177.6 abc
	Above	64.2 d	91.4 b	76.3 cd	107.8 abc	107.3 ab	119.7 abc	114.8 a	169.6 bcd
1.0	Under	63.5 d	90.2 b	73.5 cd	103.9 bc	91.5 bcd	118 abc	108.2 ab	166.7 bcde
	Above	63 d	89.9 b	69.8 cd	97.9 c	85.2 cd	103.4 d	93.7 bc	152.5 de
2.0	Under	61.7 d	88.3 bc	69 cd	105.3 bc	84.7 cd	109 bcd	102 abc	156.9 cde
	Above	64.2 d	85.8 bc	65.7 d	99 c	83.7 d	105.7 cd	87.5 c	146.7 e
<u>Pruning + Atrimmec Folia (mg·l⁻¹)</u>									
	1600	73.5 bc	88.2 bc	80 bc	103.7 bc	118.8 a	128.9 a	114.2 ab	170.5 abcd
	3200	66.3 cd	80.3 c	79 bc	103.7 bc	108 ab	122.3 ab	114 ab	172.7 abcd
Pruned		75.3 b	93.1 b	90.8 b	114.3 ab	118 a	129 a	119.5 a	183 ab
Untreated									
Unpruned		108.2 a	119.1 a	129 a	121.3 a	147.8 a	151.7 a	158.5 a	190.7 a
Untreated									
LSD_{0.05}		7.7	8.8	12.4	14	19.6	14.79	20.7	20.8

*Differences in treatment means were estimated by Fisher's LSD with P = 0.05.

Table 3. Average length of three primary shoots, number of lateral branches, and inter-node length of these primary branches measured in September of loropetalum plants that were unpruned, pruned, or pruned and treated with various PGR treatments in April 2008.

<i>Treatment</i>		<i>Average of Three Primary Branches</i>			
		Length (cm)	Diameter (cm)	No. of Lateral Shoots	Inter-node Length (cm)
Pruning + Cutless 0.33G (lb a.i./acre)					
Rate	Mulch				
0.5	Under	78.1 abc	0.643 a	24.1 bc	3.35
	Above	77.5 abc	0.655 a	23.7 bc	3.35
1.0	Under	69.2 bc	0.617 ab	19.6 cd	3.73
	Above	52.8 e	0.493 c	15.3 d	3.7
2.0	Under	66.8 cd	0.582 abc	19.2 cd	3.82
	Above	56 de	0.549 bc	17.4 d	3.38
Pruning + Atrimmec Folia Spray (mg·l⁻¹)					
	1600	79.7 ab	0.587 ab	23.8 bc	3.42
	3200	78.5 abc	0.536 bc	23 c	3.45
	Pruned Untreated	89.5 a	0.612 ab	30.2 a	3.02
	Unpruned Untreated	87.5 a	0.673 a	28 ab	3.2
	LSD _{0.05}	12.7	0.0924	4.9	NS

*Differences in treatment means were estimated by Fisher's LSD with P = 0.05.

Organic Matter Type Affects Growth and Physiology of Selected Native Shrubs Planted Above Grade

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Index Words: Landscape, establishment, substrate, *Chionanthus virginicus*, *Hydrangea quercifolia* 'Alice', *Rhododendron austrinum*

Significance to Industry: *Chionanthus virginicus* L., *Rhododendron austrinum* Rehd., and *Hydrangea quercifolia* Bartr. 'Alice' were transplanted into field plots, with root balls at soil grade level or with one-third of the root ball above soil grade. The planting hole was backfilled with existing field soil to soil grade level. Peat moss, ground pine tree substrate, coconut coir, or pine bark substrate was mounded around the exposed rootball portion of above-grade plantings. Above ground growth was similar among substrates. After one season of growth, planting these taxa in this modified above-grade planting technique and utilizing organic matter produced a post-transplant shoot growth response comparable to planting at grade in field soil. While there were no significant differences among treatments after one growing season, it is expected that there may be greater observable differences in both root and shoot growth and long-term establishment among treatments after the plants go through a winter dormant cycle, spring shoot flush, and another season of growth.

Nature of Work: Soils, especially in urban settings, are often compacted and lack organic matter (4, 11). Planting above grade with organic matter is one way to remediate these poor soil conditions and increase post-transplant root and shoot growth for shrubs and trees (16, 2, 6). In this modified, above-grade planting technique, plants are planted such that the top one-third of the root ball remains above soil grade, and organic matter is mounded on and around the above-grade portion of the root ball. The mounded organic matter replaces the organic matter layer that would accumulate naturally from leaf litter and other debris in upper soil horizons (14). This organic layer prevents soil compaction and has a low bulk density that promotes root growth after transplanting (10). When altering the planting depth, some species are more sensitive to changes in planting depth than others, so it is important to determine species-specific responses to this modified, above-grade planting technique (15). While pine bark and peat moss are common landscape soil amendments, other organic substrates may be suitable for use in this technique, as substrate performance varies with site conditions and species cultural requirements (3, 8). Coconut coir is one substrate demonstrating potential to replace peat because of its similar rewetting properties, and ground loblolly pine tree substrate is also suitable for horticultural use (1, 5, 12, 17). Determining which substrates encourage the most post-transplant growth for a variety of taxa could lead to increased utilization of this planting technique. Therefore, the objective of this study was to evaluate organic matter substrates for use in above-grade planting with three native deciduous shrubs.

On 17 March 2008, *Chionanthus virginicus* (white fringetree), *Rhododendron austrinum* (Florida flame azalea), and *Hydrangea quercifolia* 'Alice' ('Alice' oakleaf hydrangea) were planted in field research plots on the campus of Auburn University. Twenty-five 11.4 L (3 gal) plants of each taxa were planted 4 feet on-center and assigned to one of five treatments. The control treatment had no organic matter added and was planted at soil grade, while the other four treatments were planted approximately 10.2 cm (4 in) above soil grade, with 100% pine bark (PB), 100% peat moss (PM), 100% coconut coir (CC), or 100% ground pine tree (PT) substrate mounded around the above-grade portion of the root ball, extending to a radius 30.5 cm (12 in) outward from the main stem. Treatments were arranged in a randomized complete block design with five blocks. *R. austrinum* was grown under 47% shade, while *C. virginicus* and *H. quercifolia* 'Alice' were grown under 30% shade. All plots were mulched with 7.6 cm (3 in) pine straw for weed control, improved infiltration of irrigation water, and reduced soil evaporation. Physical and chemical analysis of the soil (Marvyn sandy loam) indicated that no fertilizer amendments were necessary.

A ML2X Theta Probe (Houston, TX) was used to measure soil and substrate volumetric percent moisture, and treatments were watered individually by hand when the volumetric moisture content of the mounded organic substrates reached 20%. Approximately 2.5 cm (1 in) water was applied at each irrigation, covering a radius of 30.5 cm (12 in) from the main stem. As plants grew and were exposed to higher heat and humidity levels of the summer, Theta Probe readings indicated that all treatments required 2.5 cm (1 in) irrigation every 2-3 days (data not shown), so overhead irrigation was initiated. In this and previous experiments, pine bark dried out faster than other substrates and field soil (data not shown). Field plots were therefore monitored and irrigated separately by taxa, when average percent moisture of pine bark substrate dropped below 20% within a taxa.

Net photosynthesis was measured (PS) on one leaf of each plant using a LI-COR 6400XT (Lincoln, NE) during the summer growing season, between 10:00 a.m. and 2:00 p.m., when photosynthesis was highest. Growth indices [GI, (widest width measurement + perpendicular (\perp) width measurement + height)/3] of all plants were recorded at experiment installation (initial) and at the end of the first growing season (final), and these were used to calculate relative growth index [RGI, (final GI - initial GI)/initial GI]. Data were analyzed using general linear models procedures and least significant difference means separation at $\alpha = 0.05$ (13).

Results and Discussion: Growth indices increased between initial and final measurements, yet there were no significant differences for RGI among treatments. Although all plants for the experiment were purchased as 11.4 L (3 gal) containers, *H. quercifolia* 'Alice' and *R. austrinum* plants had larger canopies and a more developed root system than *C. virginicus* plants at planting. Significantly lower RGI for *H. quercifolia* 'Alice' and *R. austrinum* reflect the greater initial GI (44 and 66, respectively), compared to the smaller *C. virginicus* plants (22) (Table 1). Final GI was lowest for *C. virginicus* (58), yet RGI for this taxa is highest because of its lower initial GI (Table 1). Photosynthesis rates were not different among treatments, but were different among taxa (Table 2). Large decreases in PS indicate that plant growth has stopped and the

plant is under stress, so similar positive PS rates among treatments correspond with the lack of growth differences among treatments (9). While these rates remained positive for all taxa, there were significant differences between taxa, likely related to inherent genetic photosynthetic capabilities. In this first growing season, all taxa survived. Following a dormancy period, it is expected that these taxa may demonstrate larger differences among treatments during their second growing season, particularly in root growth which can only be quantified at experiment termination. Previous research found that planting *Morella cerifera* L. and *Kalmia latifolia* L. utilizing this modified above-grade planting technique with PB or PM substrates reduced post-transplant stress, and improved root growth and establishment compared to planting at grade with no organic matter (7). Continued evaluation of this above-grade planting technique for a range of native shrubs and a variety of substrates will hopefully contribute to the successful implementation of native, sustainable landscapes.

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Table 1. Initial growth index (GI), final GI, and relative growth index (RGI), [(final GI – initial GI)/ initial GI] of *Chionanthus virginicus*, *Rhododendron austrinum*, and *Hydrangea quercifolia* 'Alice'. Initial and final GI were recorded 17 Mar. 2008 and 23 Oct. 2008, respectively.

Taxa	Initial GI	Final GI	RGI
<i>C. virginicus</i>	22 c	58 c	1.7 a
<i>H. quercifolia</i> 'Alice'	44 b	78 b	0.8 b
<i>R. austrinum</i>	66 a	105 a	0.6 b
Significance ^z	***	***	***

^z*** represents significance at P<0.001 (13).

Table 2. Net photosynthesis rates (PS, $\mu\text{molCO}_2 \text{ m}^{-2} \text{ s}^{-1}$) of *Chionanthus virginicus*, *Rhododendron austrinum*, and *Hydrangea quercifolia* 'Alice'. Plants were planted in Auburn University field plots. PS measurements were recorded on 19 Sep. 2008, between 10:00am and 2:00pm.

Taxa	Net PS ($\mu\text{molCO}_2 \text{ m}^{-2} \text{ s}^{-1}$)
<i>C. virginicus</i>	16 b
<i>H. quercifolia</i> 'Alice'	6 c
<i>R. austrinum</i>	19 a
Significance ^z	***

^z*** represents significance at P<0.001 (13).

EarthKind™, A National Evaluation of Garden Roses in Minimal Input Conditions

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Index Words: *Rosa*, drought tolerance, pest tolerance, disease resistance

Significance to Industry: “EarthKind™” is an important horticulture designation used by the Texas AgriLife Extension Service (part of the Texas A&M System) to identify species, cultivars, and landscape practices that maximize garden enjoyment and environmental stewardship. The greatest success to date has been the identification of rose cultivars with outstanding landscape performance, coupled with remarkable disease and insect tolerance. This designation is awarded based on multi-year scientific research studies, combined with extensive, regional field trials, conducted by or in collaboration with Texas A&M horticulturists.

EarthKind™ is based on the idea that it is possible to identify beautiful plants that can be successfully grown in minimal input conditions, without fertilizers, pesticides, and other agricultural chemicals along with a significant reduction in irrigation. This effort is the most popular and fastest growing, research-based environmental university program of its kind in the U.S. and directly benefits all sectors of horticulture: growers, retailers, landscapers, and consumers. EarthKind™ rose research is underway in 25 states and four foreign countries, including Bermuda, Canada, India and New Zealand.

Nature of Work: The rose is the most popular garden plant in the world as well as one of the most important commercial cut flowers (Horst 1995). No other species provides the range of plant, flowering and blossom traits (Buck, 1964). They combine the color and fragrance characteristics of annuals and perennials, but with a greater variety of flower forms, colors and scents, along with plant forms and habits that few other plants can provide (Buck, 1978). Gardeners’ demand for low maintenance roses is growing as (a) more gardeners are eschewing the use of pesticides, (b) municipalities restrict landscape irrigation, (c) legislation restricts pesticide usage, and (d) the price of commercial fertilizers and rose care products skyrocket (Zlesak, 2006).

Candidate cultivars undergo a preliminary evaluation process before being entered into EarthKind™ rose trials. Researchers consult studies conducted across the U.S. and Canada that evaluate roses according to winter hardiness, disease incidence, and/or susceptibility to insect damage. EarthKind™ researchers also consult noted rosarians, looking to identify cultivar limitations prior to inclusion in an EarthKind™ trial. Roses that

are not everblooming or recurrent and hybrid rugosas are currently omitted from consideration.

The first phase of EarthKind™ evaluation is a four-year, university based evaluation trial. Roses are planted in landscape beds, which may or may not be amended with compost, depending on initial soil conditions. Following planting, beds are covered with 3 inches of organic mulch. No specific mulch is demanded, but mulch available from local sources is recommended. Mulch should be added on a twice-yearly basis to maintain a mulch depth of 3 inches. Irrigation is provided freely during year one for establishment purposes and on an as-needed basis during year two. During years three and four of the trial no supplemental irrigation is provided except during periods of extreme and unique drought. No fertilizers, pesticides, fungicides, bactericides or other agricultural chemicals are used to enhance growth or control disease or insect damage. Herbicides may be used on a limited basis to control weeds.

Experimental design is a randomized complete block design, with one specimen from at least 20 cultivars randomly planted within each block. Data collected include quantitative measures such as plant height, width (averaged across two measurements, perpendicular to each other), number and size of blossoms, and chlorophyll content using a SPAD 502 meter (Konica Minolta Sensing, Inc., Osaka, Japan). Leaf tissue analysis is used to confirm plant nutrient status. Pressure bomb readings and gravimetric measures are used to quantify plant moisture status. Tensiometer readings, or other appropriate measures of soil water tension, should be used to quantify soil water tension at each recording interval. Qualitative measures include visual assessment of foliage coverage, foliage color, blossom coverage, growth form, disease incidence and pest activity, including notation of diseases or pests present (Table 1). Individuals trained in insect identification and plant pathology collect disease and pest data on a monthly basis during the growing season. Unidentifiable diseases and pests are sent to state plant pathologists and entomologists for identification purposes.

During phase 2, cultivars deemed successful in phase 1 are planted in demonstration gardens across several different environments including temperature, precipitation, and soil type. Plants are grown and monitored for three years before a final evaluation. Only those cultivars that meet or exceed expectations are designated as EarthKind.

Results and Discussion: The initial study evaluated 119 cultivars in north-central Texas (Mackay et al., 2008). The highest performing cultivars were Knockout (Rosa x Radrazz), Caldwell Pink, Sea Foam, Perle d'Or, and The Fairy. Across rose categories in all trials, polyanthas outperformed all others. Hybrid tea roses, while capable of producing beautiful individual blossoms, performed poorly in minimal input conditions, usually succumbing to black spot or insect damage. Subsequent evaluations have increased the number of EarthKind™ recognized cultivars to 19 (Table 2).

Current trials include an evaluation of 20 rose cultivars known to perform well in USDA Hardiness Zone 4. These roses are in evaluation at 10 locations in six states: Minnesota, Iowa, Nebraska, Kansas, Colorado, and Texas. Roses for these evaluation

sites were planted in 2007 and, at the time of this writing, all cultivars have survived year one in all locations. Further evaluations are being conducted in 10 states and four countries including Bermuda, India, Japan, and Mexico.

The EarthKind™ program has proven capable of identifying roses and landscape techniques that provide the aesthetic appeal demanded by today's gardeners while reducing the impact our gardens have on the environment.

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Table 1. Monthly rating scale used to evaluate EarthKind™ trial roses during the growing season in years two through four.

Rating	Foliage Cover	Foliage Color	Blossom Coverage*	Growth Habit	Disease	Pest
5	100% coverage	Dark Green	90% or more	Symmetrical in all directions, branches consistent in size	No disease	No pest
4	90% coverage or more	Green, No chlorosis	75 to 90% coverage	Symmetrical in most directions, branches consistent in size	<10% of leaves or blossoms infected	<10% of leaves or blossoms with insect damage
3	75 to 90% coverage	Green, up to 25% of leaves chlorotic	50 to 75% coverage	Symmetrical in one direction only, one branch with irregular growth	10 to 25% of leaves or blossoms infected	10 – 25% of leaves or blossoms with insect damage
2	25 to 50% coverage	Lt. Green, 25 to 50% chlorotic	25 to 50% coverage	Asymmetrical growth, two or more branches with irregular growth	25 to 50% of leaves or blossoms infected	25 to 50% of leaves or blossoms with insect damage
1	<25% leaf coverage	Yellow, >50% chlorotic	<25% coverage	Inconsistent and irregular growth over entire plant	<50% of leaves or blossoms infected	<50% of leaves or blossoms with insect damage
0	Plant dead	Plant dead	Plant dead	Plant dead	Plant dead	Plant dead

*One point is added to blossom coverage for those cultivars with fragrant blooms.

Table 2. The 19 EarthKind™ roses designated for the Southern region of the US.

Cultivar ^a	Horticultural class	Year of introduction
Souvenir de St. Anne's	Bourbon	1950
Ducher	China	1869
Mutabilis	China	<1894
Spice	China	unknown
Climbing Pinkie	Climbing polyantha	1952
Else Poulsen	Floribunda	1924
New Dawn	Large flowered climber	1930
Caldwell Pink	Polyantha	unknown
La Marne	Polyantha	1915
Marie Daly	Polyantha	unknown
Perle d'Or	Polyantha	1884
The Fairy	Polyantha	1932
Belinda's Dream	Shrub	1992
Bucbi (Carefree Beauty™)	Shrub	1977
RADrazz (Knock Out®)	Shrub	1999
Sea Foam	Shrub	1964
Duchesse de Brabant	Tea	1857
Georgetown Tea	Tea	unknown
Mme. Antoine Mari	Tea	1901

^a Trademark or exhibition name, if different from cultivar name, is listed in parenthesis.

Week Long Practicum Course to Teach Landscape Contracting Skills

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Index Words: Arboriculture, hardscape, irrigation, water garden construction, green roofs, pest management, skill-building, hands-on training

Significance to Industry: The combination of teaching landscape contracting fundamentals as well as skills in a four-to-five day course has given students in our program practical knowledge and experience which are impacts unrealized in a traditional classroom setting. Students armed with these skills are better prepared for their landscape contracting careers.

Nature of Work: College and university curricula often offer courses via the traditional classroom format. Due to the nature of a landscape contracting curricula, courses are most effective when they combine fundamental information of a classroom format with practical experience garnered in an “on-site” or a lab setting. Landscape contracting topics such as planting techniques, irrigation, and hardscape materials and installation are examples where a “real world” exposure to the subject material is invaluable. Landscape contracting industry leaders, in an annual Landscape Contracting Advisory Council Meeting at Virginia Tech, have emphasized the need for students to have “hands on” exposure and skill-building exercises in landscape contracting courses. Thus, to better prepare students for careers in landscape contracting, we developed a yearly landscape contracting practicum course. A practicum is defined as “a course of study designed especially for the preparation of teachers and clinicians that involves the supervised practical application (as in a classroom or clinic) of previously studied theory” (Webster’s New Collegiate Dictionary). The goal of the practicum courses is to expose students to the fundamental concepts as well as the hands-on aspects of a range of landscape contracting topics. In addition to meeting the subject matter and experiential needs of our students, the practicum is especially relevant because approximately 80 percent of our horticulture students are registered in the landscape contracting concentration (one of four concentrations).

Beginning in the fall of 1997 and every year thereafter, we offer a four-to-five day practicum course that is held the week prior to the fall semester. The course, one-credit pass/fail, is held from 8:30 am to 4:30 pm from Monday to at least Thursday. The practicum topic is selected in the winter prior to the course being offered so that it is listed and advertised for the fall semester preregistration which occurs in March. In the 12 years we have offered the practicum, the topics were: water garden construction, irrigation design and installation, and arboriculture (each taught three times); green roofs, hardscape materials and installation, and landscape pests (each taught once). In each of the courses, the fundamentals of the subject matter are taught in the traditional classroom setting and the hands-on portion was conducted on campus or at a private

nearby residence. In an effort to maximize the experiential portion of the class, the classroom time does not exceed 30 percent of the total class time. For each course, the objective is to give students a thorough “real world” exposure of the subject matter. For example, in the irrigation design and installation course, the classroom subject matter included hydrology and irrigation fundamentals, and designing the irrigation system to be installed. The on-site hands-on portion covered everything from trenching, to installing pipes, valves, and spray heads, to trouble shooting and system maintenance.

Because of the hands-on portion of the class, we limit enrollment to approximately 22 students per course. This limitation is imposed to maximize participation and to minimize students standing around and just observing. The practicum courses are quite popular, and we generate a sizable waiting list each year for those students who do not successfully enroll in the course. The courses are well advertised at least three weeks in advance of spring preregistration by posters and email. Students are notified that enrollment is on a first-come first-serve basis on the first day of preregistration. In addition to horticulture students, courses are advertised to landscape architecture, two-year agriculture technology, turf, and urban forestry students.

The instructors for most of the courses are individuals from landscape contracting businesses; most of these donate their time, equipment use, and materials to the courses. When out-of-town personnel teach a course, departmental funds are obtained to pay for lodging expenses. In a few cases a nominal honorarium was given to instructors. An exception to sequestering business personnel instructors was the landscape pest course in which university faculty members served as instructors.

Results and Discussion: Student feedback has been very positive about the subject matter and skills obtained during the courses. The overall student evaluation of each course has been at least a 3.7 (out of 4.0) for the 12 courses. Due to the popularity of these practicum courses, the number of students who register for each course exceeds the number of allowable students. Students also abbreviate their summer break to attend these courses which is a testimony to the impact of the courses. A distinct advantage to the week-long class format, in contrast with a weekly three-hour lab, is the continuity of the subject matter and start to finish project format.

Validating Nitrogen Requirements for Florida Landscape Plants- Warm Season Bedding Plants

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Index Words: Fertilizer, recommendations, BMPs, Florida Yards and Neighborhoods, annual plants, Vinca, Zinnia, Melampodium, growth indices, chlorophyll, quality ratings, nitrogen rates.

Significance to Industry: The increased emphasis on BMP's in landscapes has created a demand for increasingly sophisticated fertilizer recommendations. The basis for current nitrogen (N) fertilizer recommendations for ornamental plants in Florida is unclear and focuses on the needs of trees and shrubs. Trees and shrubs may have different fertilization requirements than do perennials, annuals, vines and groundcovers. Therefore, the current fertilizer recommendations need to be validated. Knowledge of specific fertilizer requirements will allow plants to be zoned based on their fertilizer requirements. Fertilizer zoning will result in more efficient fertilizer application, thus reducing nutrient losses to the environment.

Nature of Work: Trials were conducted at UF-IFAS Gulf Coast Research and Education Center in Wimauma, FL. Plants were selected based on anecdotal evidence of high, moderate, and low fertilization needs for evaluation across a range of N fertilization regimes. Nitrogen rates were determined for the following warm season bedding plants: *Melampodium* 'Golden Globe', *Vinca* 'Cora White', and *Zinnia* 'Profusion Cherry'. The plants were fertilized at five different N rates based on current recommendations for landscape fertilization. These rates were, 0 lb N/1000 ft²/yr (0.0g N/ m²/yr), 2 lb N/1000 ft²/yr (9.8 g N/m²/yr), 4 lb N/1000 ft²/yr (19.6 g N/ m²/yr), 6 lb N/1000 ft²/yr (29.4 g N/ m²/yr), 12 lb N/1000 ft²/yr (58.8 g N/ m²/yr) of slow release nitrogen (polymer coated ammonium sulfate, 21-0-0, Honeywell Nylon LLC, Seffner, FL) . These rates were based upon current N fertilization recommendations for Florida landscapes (Florida Department of Environmental Protection, 2002; Florida Yards and Neighborhoods Program, 2006). Plots were 10 feet by 40 feet raised beds filled with soil from a deep horizon, St. John's Fine Sand, which is commonly used in central Florida for construction areas as 'fill' (USDA, 2009). This material had little nutrient content. Drip irrigation was applied as needed. No mulch was added to beds in order to minimize outside nitrogen contributions.

Data collected were: plant growth (including height, widest width and perpendicular width), aesthetic quality ratings (1-5) (considerations included canopy density, flowers, and general form), and chlorophyll measurements (using a SPAD chlorophyll meter). Plant measurements and fertilizer applications occurred at six-week intervals.

Results and Discussion:**Zinnia**

Growth index differed significantly ($p \leq 0.05$) among treatments at 6 weeks after planting (WAP). Fertilization at 4 lb N/1000 ft²/yr had the most growth followed by 12 lb N/1000 ft²/yr and 6 lb N/1000 ft²/yr (Figure 1). At 12 WAP the results showed that there were significant differences ($p \leq 0.05$) among treatments, with fertilization at 6 lb N/1000 ft²/yr providing the most growth followed by 4 lb N/1000 ft²/yr and 12 lb N/1000 ft²/yr (Figure 2). Again, at 18 WAP there were significant differences ($p \leq 0.05$) among treatments. Fertilization at 4 lb N/1000 ft²/yr had the most growth followed by 6 lb N/1000 ft²/yr, and 12 lb N/1000 ft²/yr (Figure 3).

Results for quality ratings for Zinnia at 6 WAP indicate that there were significant differences ($p \leq 0.05$) among treatments. As nitrogen increased, quality rating increased (Figure 4). At 12 WAP again differences were significant ($p \leq 0.05$). However, the quality did not increase with the addition of more nitrogen. The fertilization treatment of 12 lb N/1000 ft²/yr showed lower quality ratings than the fertilization treatments of 4 lb N/1000 ft²/yr and 6 lb N/1000 ft²/yr. This suggests that perhaps the nitrogen sped up the plants life cycle and forced it into an early decline. This would be an undesirable result (Figure 5). Quality ratings for Zinnia at 18 WAP again showed significant differences ($p \leq 0.05$). There was a severe drop in quality in all treatments particularly the treatments with the higher level of nitrogen. On this week, the treatment of 4 lb N/1000 ft²/yr showed the best results and the higher treatments fell to unsatisfactory levels (Figure 6).

SPAD measurements for Zinnias at 6 WAP, 12 WAP, and 18 WAP differed among treatments. As expected, an increase in N produced an increase in chlorophyll. Even at the highest N fertilization rate, chlorophyll content was not maximized (Figures 7-8).

Overall, a fertilization rate of 4 lb N/1000 ft² is recommended for Zinnias. Both the Growth index and Quality analysis suggested this treatment over all others. Although there were significant differences in chlorophyll these differences were very small and perhaps not obvious to the eye.

Vinca

Growth index for Vinca differed significantly ($p \leq 0.05$) among treatments at 6 WAP. Growth increased along with fertilization treatment. Fertilization at 12 lb N/1000 ft²/yr had the most growth followed by fertilization at rates of 6 lb N/1000 ft²/yr and 4 lb N/1000 ft²/yr (Figure 9). At 12 WAP differences were significant ($p \leq 0.05$) and growth again increased along with nitrogen. Fertilization at 12 lb N/1000 ft²/yr had the most growth (Figure 10). At 18 WAP results were similar to 6 WAP and 12 WAP. Growth increased with increased nitrogen. Fertilization at 12 lb N/1000 ft²/yr again had the most growth (Figure 11).

Results for quality ratings for Vinca at 6 WAP indicated that there were significant differences ($p \leq 0.05$) among treatments. An increase in nitrogen produced an increase in quality rating (Figure 12). At 12 WAP differences between treatments were more pronounced. No fertilization, or 0 lb N/1000 ft²/yr, had strong negative effects on quality.

Fertilization of 4 lb N/1000 ft²/yr, 6 lb N/1000 ft²/yr, and 12 lb N/1000 ft²/yr yielded 100% of the plants at satisfactory levels or above. The number of plants rated above average or outstanding (4 or 5) increased along with nitrogen levels (Figure 13). At 18 WAP, 100% of the highest fertilization treatments, (6 lb N/1000 ft²/yr, and 12 lb N/1000 ft²/yr), were rated above average or outstanding (4 or 5). Over 75% of the plants at the fertilization level of 2 lb N/1000 ft²/yr received satisfactory or above quality ratings. Results suggested that Vinca did require nitrogen fertilization. However, the increase in nitrogen level may only have quickened the rate at which the plants reached higher quality ratings, but plants that received lower fertilizer rates may reach the higher quality ratings more slowly (Figure 14).

SPAD measurements of Vinca at 6 WAP, 12 WAP, and 18 WAP differed among treatments. As expected, an increase in N produces an increase in chlorophyll. The differences among treatments decreased over time. Even at the highest N fertilization rate, chlorophyll content was not maximized (Figure 15-17).

Overall, a fertilization rate of 6 lb N/1000 ft²/yr is recommended for Vincas. Although growth, quality and chlorophyll levels increased with nitrogen in the earlier weeks, all three parameters were comparable between the highest two levels. Therefore the lower of the two rates was chosen.

Melampodium

Growth Index for Melampodium differed significantly ($p \leq 0.05$) among treatments at 6 WAP. Fertilization at 4 lb N/1000 ft²/yr provided the most growth followed by 12 lb N/1000 ft²/yr, then 2 lb N/1000 ft²/yr (Figure 18). At 12 WAP the fertilization rate that produced the most growth was 2 lb N/1000 ft²/yr followed by 4 lb N/1000 ft²/yr and 12 lb N/1000 ft²/yr (Figure 19). By 18 WAP the majority of plants had reached the end of their life cycle and growth measurements were irregular. Overall, lower N fertilization rates were comparable to higher N fertilization rates in terms of plant growth. Nitrogen may have played a role in accelerating the life cycle of the plant, therefore, a lower nitrogen rate may be preferred (Figure 20).

Quality ratings for Melampodium at 6 WAP indicated that there was a general increase in quality with nitrogen. The plants with the highest quality ratings were 12 lb N/1000 ft²/yr, 6 lb N/1000 ft²/yr, and 4 lb N/1000 ft²/yr (Figure 21). At 12 WAP there was a severe decline in quality which indicated that the plants may have been approaching the end of their life cycle. Fertilization treatments with the highest quality ratings were 6 lb N/1000 ft²/yr, 2 lb N/1000 ft²/yr, and 4 lb N/1000 ft²/yr (Figure 22). By 18 WAP nearly all of the plants on every fertilization treatment schedule were below satisfactory levels. The plants had reached the end of their life cycle and were no longer of aesthetic value (Figure 23).

Results for chlorophyll readings for Melampodium at 6 WAP demonstrated a general increase in chlorophyll along with nitrogen. However, chlorophyll content seemed to reach a maximum at 4 lb N/1000 ft²/yr. For 12 WAP there were again significant

differences ($p \leq 0.05$), however, the differences are smaller and not in order of N rate. This is true even for the control treatment. This indicates that by 12 WAP plant phenology may have a larger effect on the chlorophyll content than the fertilization rate (Figure 24-25).

Overall, nitrogen recommendations for *Melampodium* are 4 lb N/1000 ft²/yr. It was evident from the results of the growth indices and quality ratings that *Melampodium* did require the addition of some nitrogen and it was also apparent that the higher rates did not seem to have a significant advantage over the lower rates. Furthermore, fertilization at the rate of 4 lb N/1000 ft²/yr seemed to have a slight advantage over the other treatments both in terms of growth and quality. 18 WAP data was not considered because plants of all treatments reached the end of their life cycle.

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Figure 1. Growth Index for *Zinnia* 'Profusion Cherry' at 6 WAP at five different N fertilization rates.

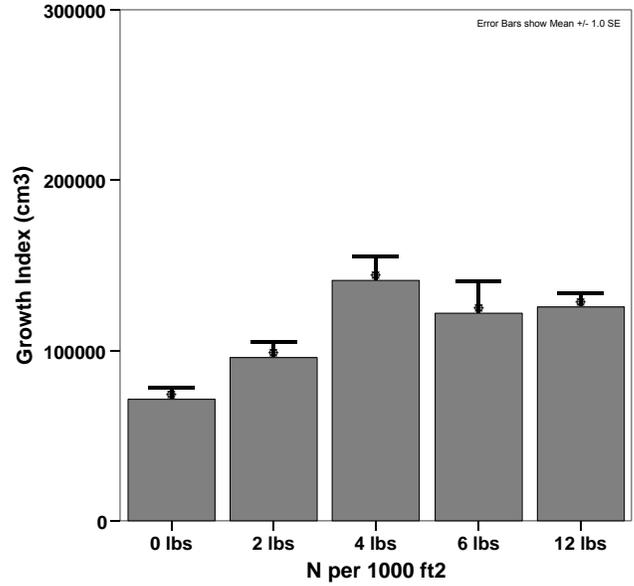


Figure 2. Growth Index for *Zinnia* 'Profusion Cherry' at 12 WAP at five different N fertilization rates.

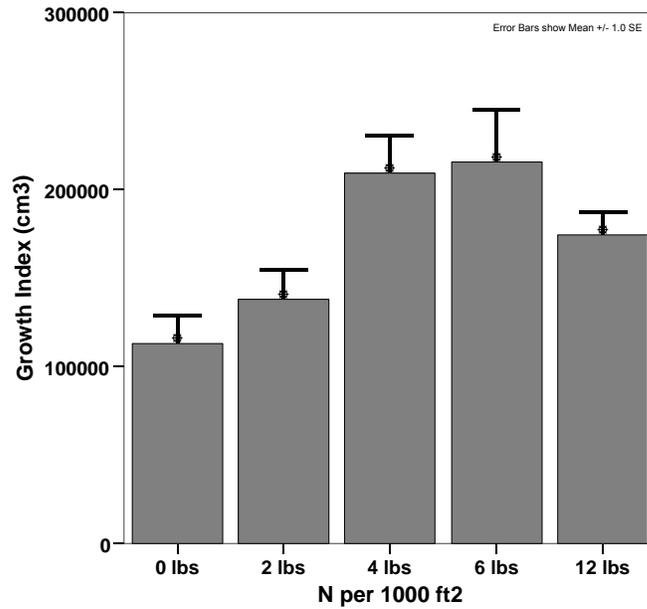


Figure 3. Growth Index for *Zinnia* 'Profusion Cherry' at 18 WAP at five different N fertilization rates.

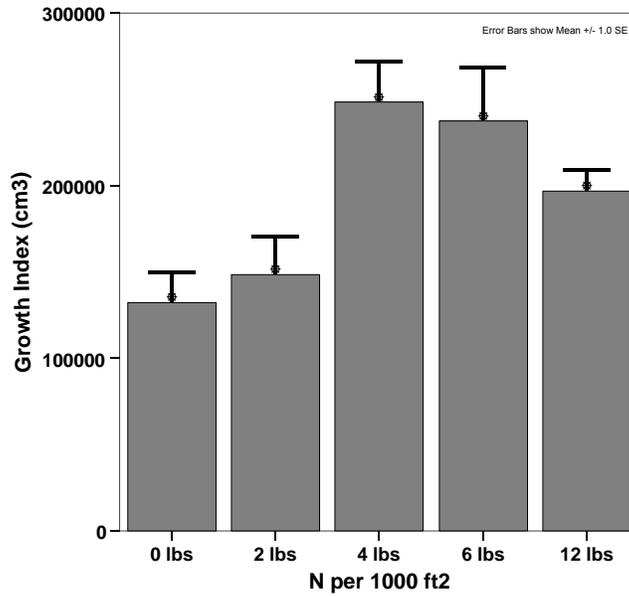


Figure 4. Quality rating for *Zinnia* 'Profusion Cherry' at 6 WAP at five different N fertilization rates.

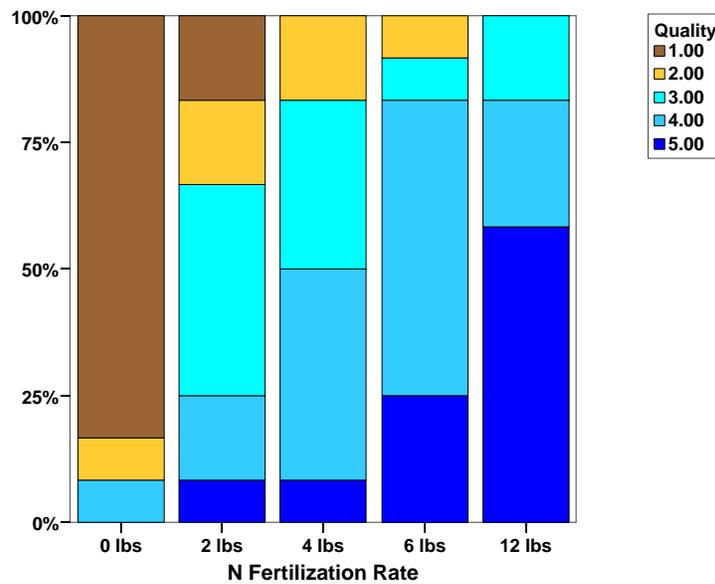


Figure 5. Quality ratings for *Zinnia* 'Profusion Cherry' at 12 WAP at five different N fertilization rates.

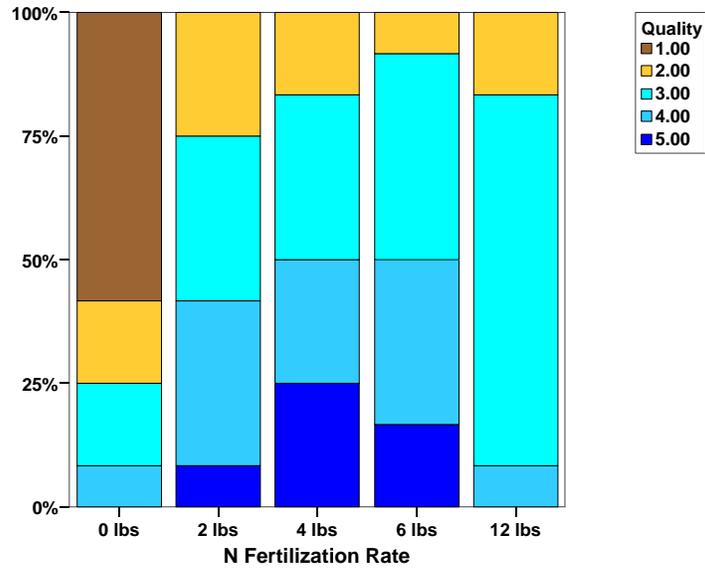


Figure 6. Quality ratings for *Zinnia* 'Profusion Cherry' at 18 WAP at five different N fertilization rates.

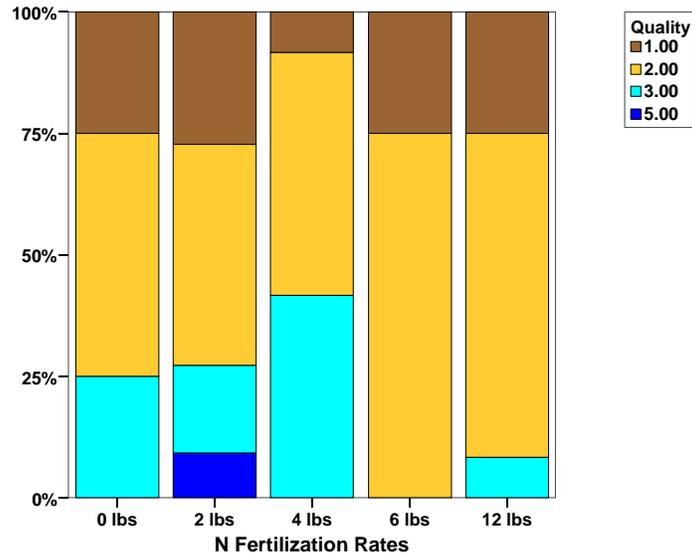


Figure 7. SPAD measurements for *Zinnia* 'Profusion cherry at 6 WAP at five different N fertilization rates.

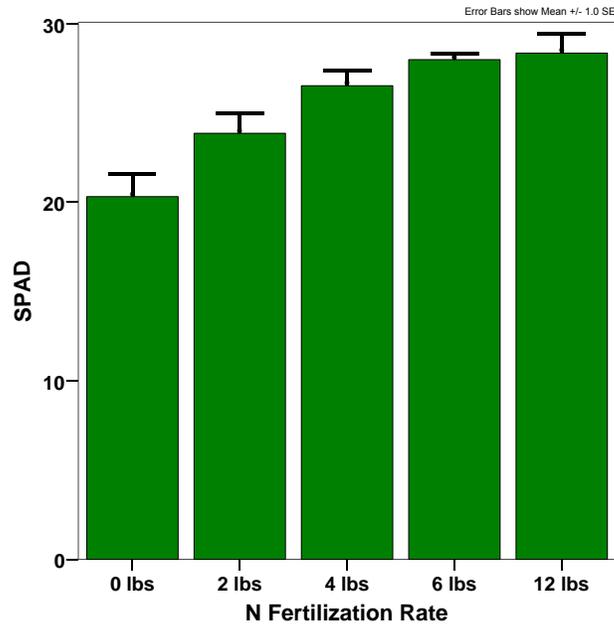


Figure 8. SPAD measurements for *Zinnia* 'Profusion cherry at 12 WAP at five different N fertilization rates.

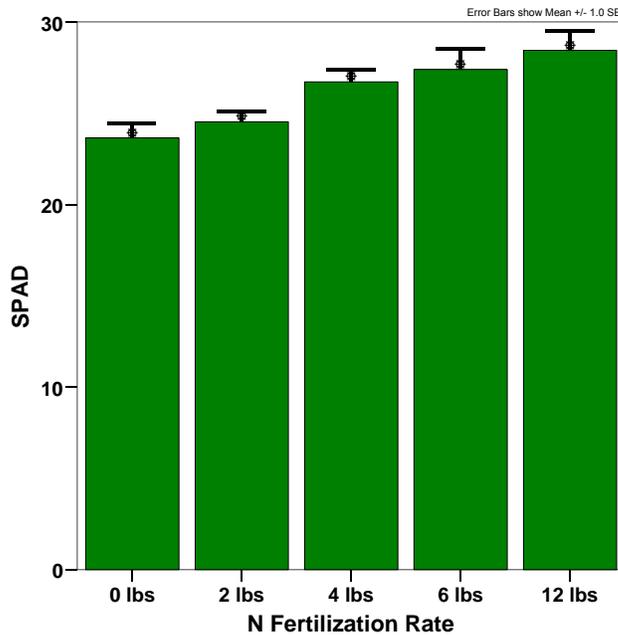


Figure 9. Growth Index for *Vinca* 'Cora White' at 6 WAP at five different N fertilization rates.

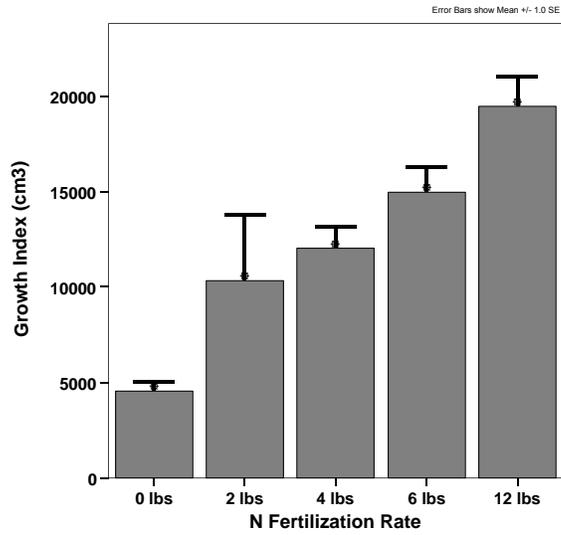


Figure 10. Growth Index for *Vinca* 'Cora White' at 12 WAP at five different N fertilization rates.

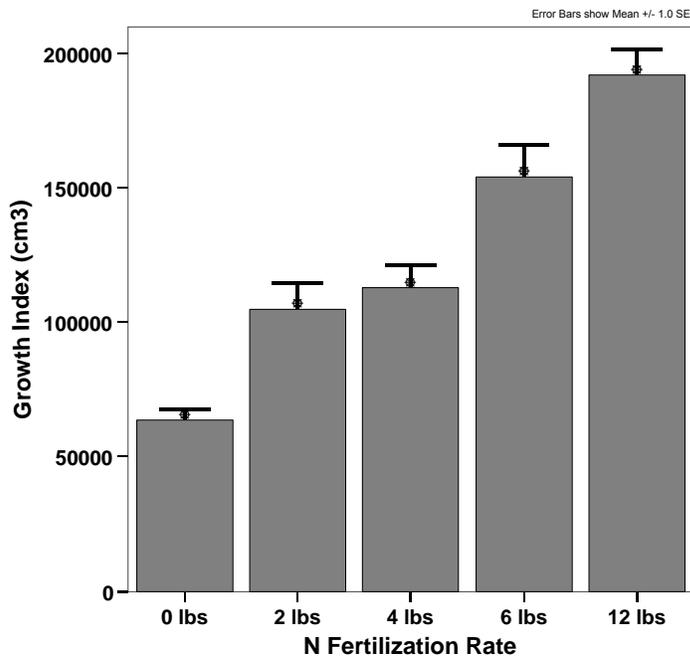


Figure 11. Growth Index for *Vinca* 'Cora White' at 18 WAP at five different N fertilization rates.

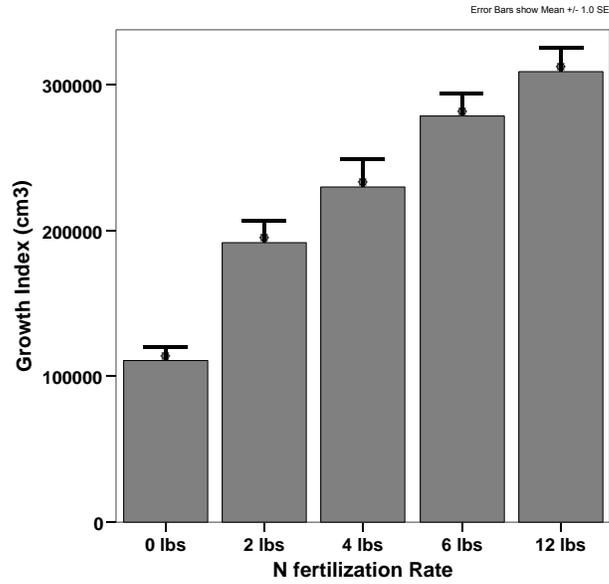


Figure 12. Quality ratings for *Vinca* 'Cora White' at 6 WAP at five different N fertilization rates.

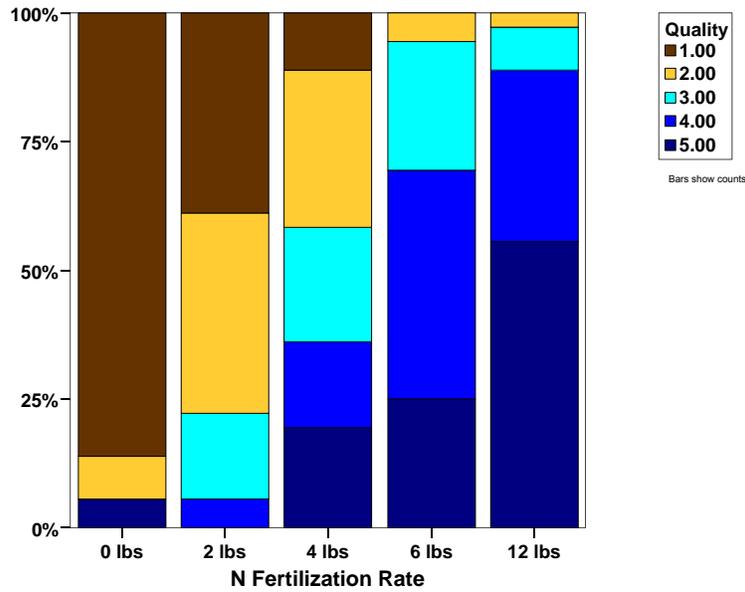


Figure 13. Quality ratings for *Vinca* 'Cora White' at 12 WAP at five different N fertilization rates.

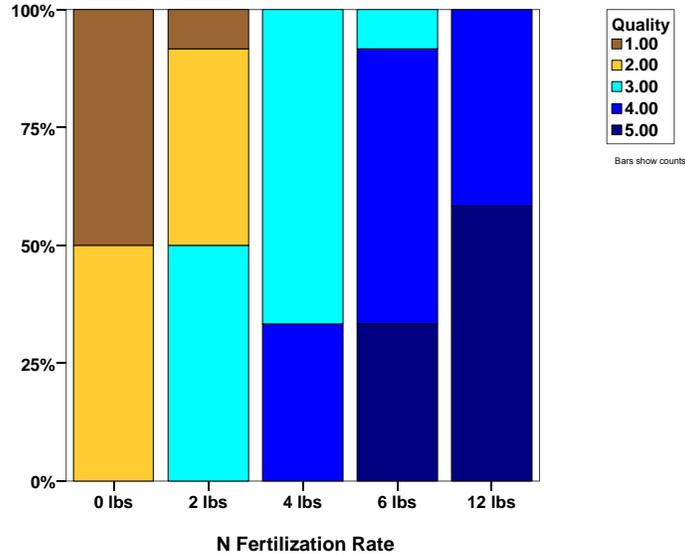


Figure 14. Quality ratings for *Vinca* 'Cora White' at 18 WAP at five different N fertilization rates.

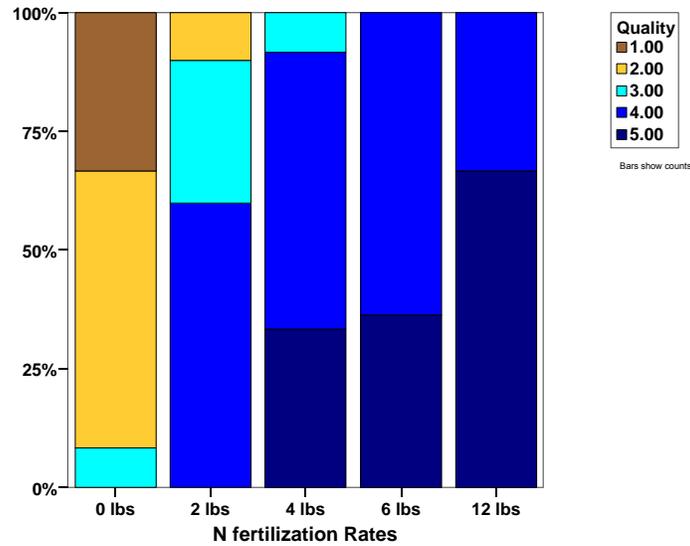


Figure 15. SPAD Measurements for *Vinca* 'Cora White' at 6 WAP at five different N fertilization rates.

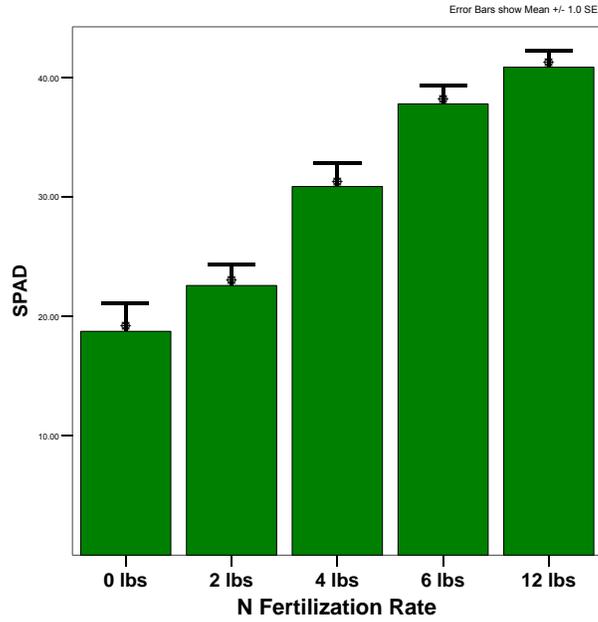


Figure 16. SPAD Measurements for *Vinca* 'Cora White' at 12 WAP at five different N fertilization rates.

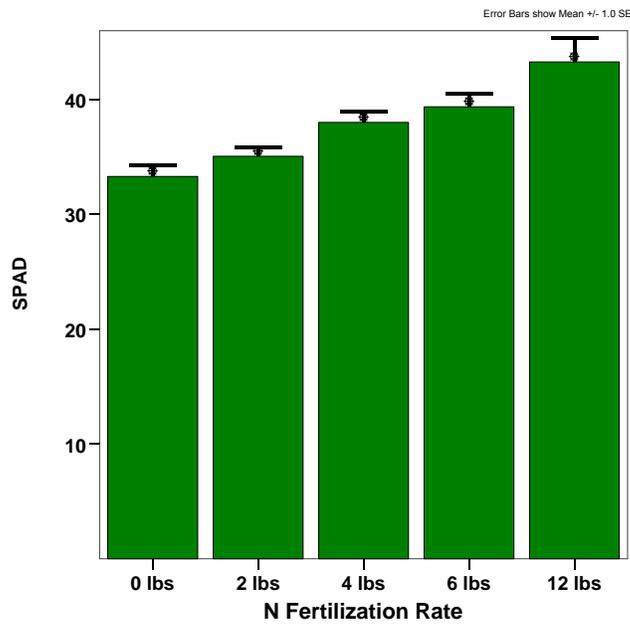


Figure 17. SPAD Measurements for *Vinca* 'Cora White' at 18 WAP at five different N fertilization rates.

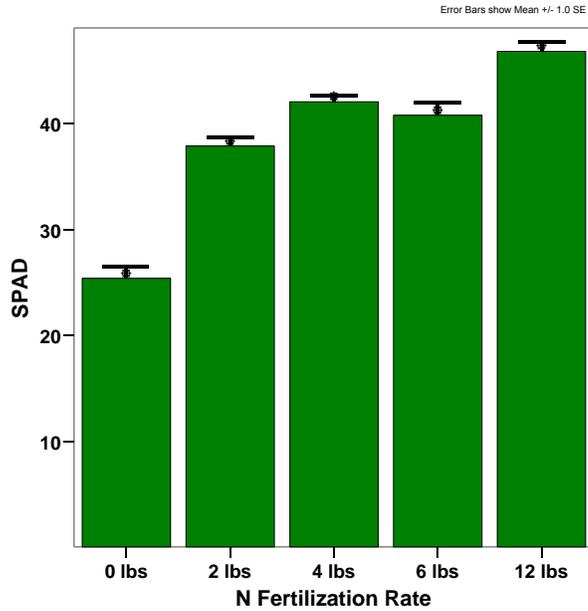


Figure 18. Growth Index for *Melampodium* 'Golden Globe' at 6 WAP at five different N fertilization rates

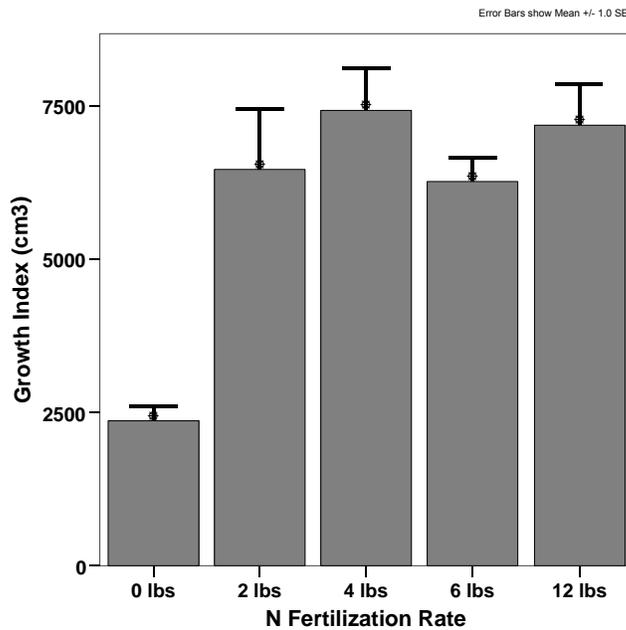


Figure 19. Growth Index for *Melampodium* 'Golden Globe' at 12 WAP at different N fertilization rates

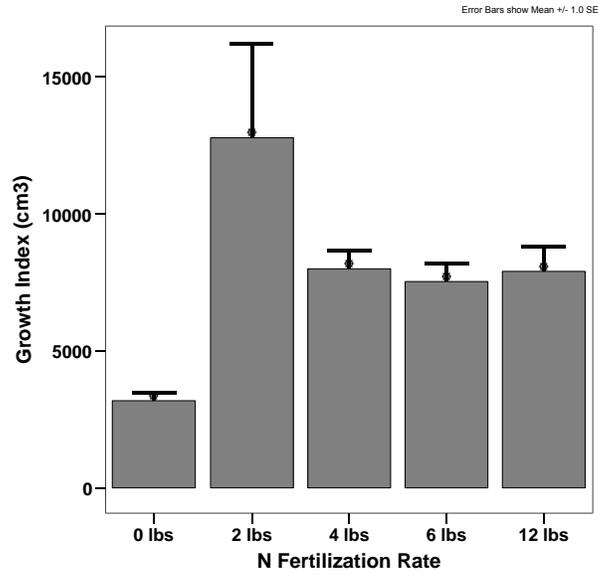


Figure 20. Growth Index for *Melampodium* 'Golden Globe' at 18 WAP at five different N fertilization rates.

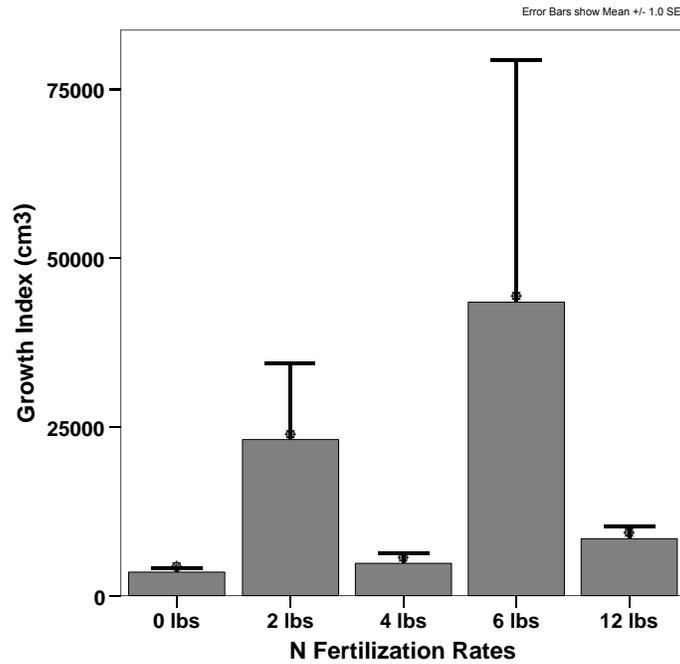


Figure 21. Quality ratings for *Melampodium* 'Golden Globe' at 6 WAP at five different N fertilization rates.

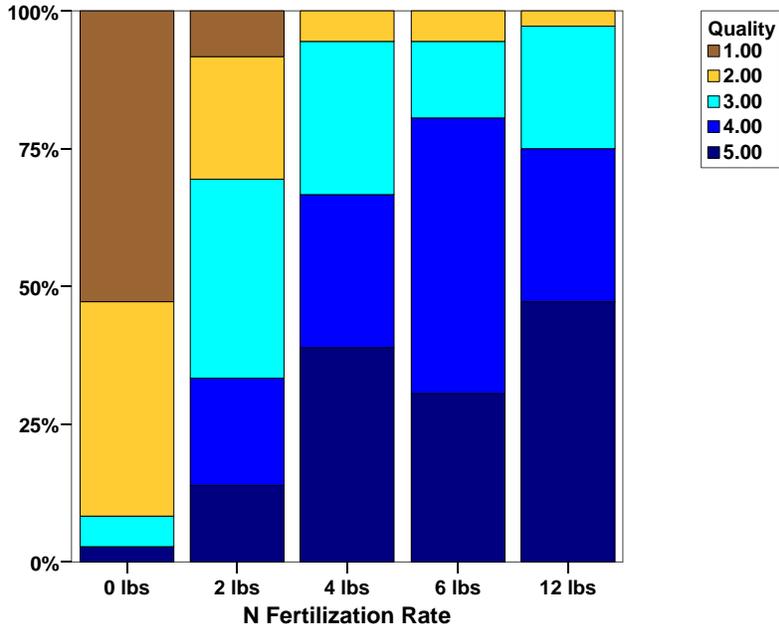


Figure 22. Quality ratings for *Melampodium* 'Golden Globe' at 12 WAP at five different N fertilization rates.

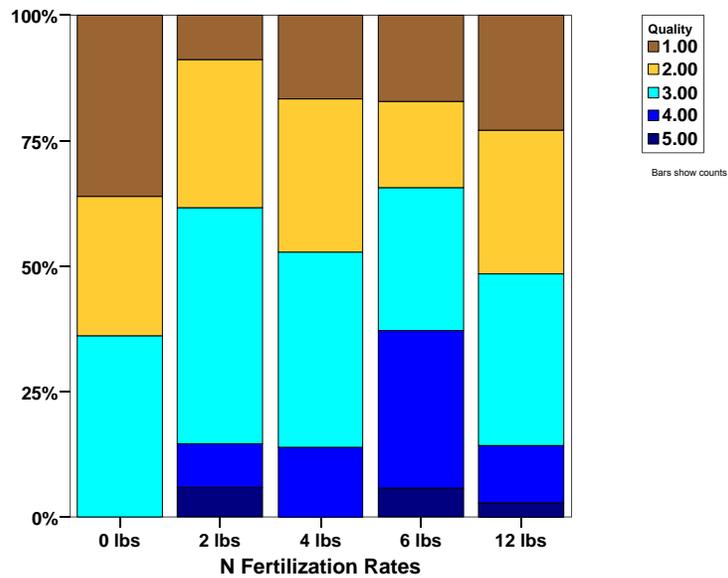


Figure 23. Quality ratings for *Melampodium* 'Golden Globe' at 18 WAP at five different N fertilization rates.

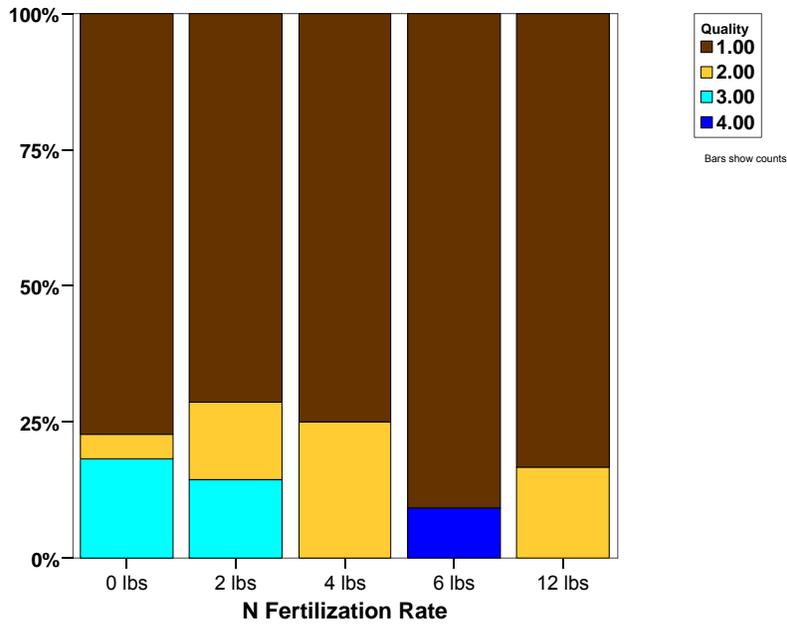


Figure 24. SPAD measurements for *Melampodium* 'Golden Globe' at 6 WAP at five different N fertilization rates.

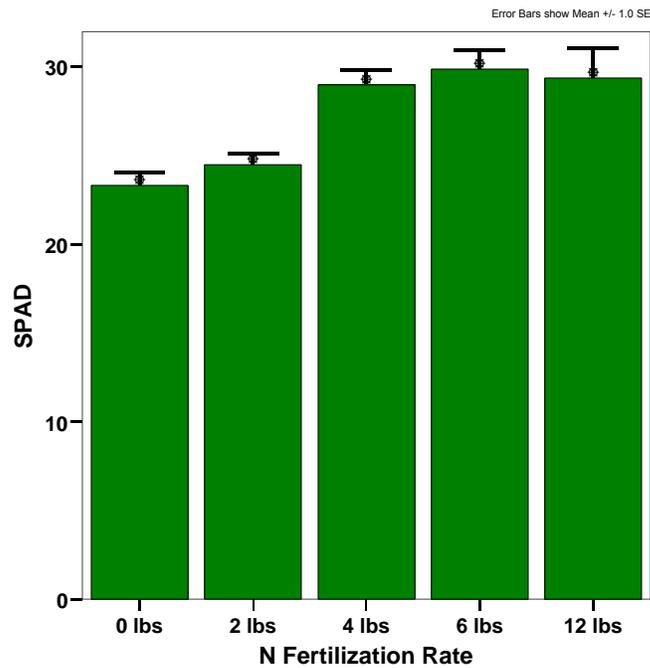
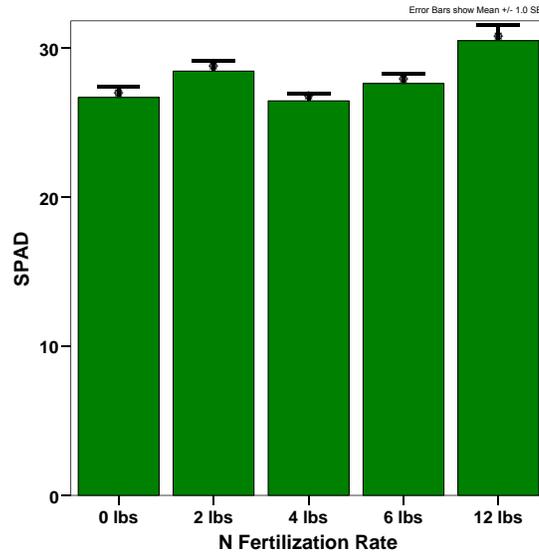


Figure 25. SPAD measurements for *Melampodium* 'Golden Globe' at 12 WAP at five different N fertilization rates.



Effects of Short Interval Cyclic Flooding on Growth and Survival of Selected Native Shrubs

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Index Words: Rain garden, wetland, flood tolerance, landscape

Significance to Industry: *Itea virginica* 'Henry's Garnet', *Ilex glabra* 'Shamrock', *Clethra alnifolia* 'Ruby Spice', and *Viburnum nudum* 'Winterthur' were evaluated for use in rain gardens by subjecting plants to repeated short-term flooding events. Root dry weight (RDW) and shoot dry weight (SDW) were highest in *I. virginica* 'Henry's Garnet' and lowest in *C. alnifolia* 'Ruby Spice' with *I. glabra* 'Shamrock' and *V. nudum* 'Winterthur' being intermediate. Results suggest that *I. virginica* 'Henry's Garnet', *I. glabra* 'Shamrock', and *V. nudum* 'Winterthur' are suitable native plant selections for use in rain gardens, however *C. alnifolia* 'Ruby Spice' may not be as tolerant of repeated flooding.

Nature of Work: Rain gardens and constructed wetlands are considered a best management practice (BMP) in the collection of storm water allowing it to seep into the ground while filtering out harmful pollutants (2, 3, 4). Rain gardens are self sustaining environments that only receive irrigation during a precipitation event and usually contain plants that are indigenous to low lying areas. Plants that are adapted to moist conditions are often able to withstand periods of drought (3). Research regarding rain gardens and constructed wetlands has concentrated on the removal of nitrates, phosphates, and pesticides rather than plant evaluations for use in these systems (2). The objective of this research was to determine the physiological and growth effects of short interval cyclic flooding on four native taxa recommended for use in rain gardens.

On 16 June 2008, 30 rooted stem cuttings liners (Spring Meadow Nursery, Grand Haven, Mich.) in 0.25 L (2.25 in) pots of *Viburnum nudum* 'Winterthur' (possumhaw), *Ilex glabra* 'Shamrock' (ink berry holly), *Itea virginica* 'Henry's Garnet' (sweetspire), and *Clethra alnifolia* 'Ruby Spice' (summer sweet) were planted in 2.5 L (trade gal) pots. All four taxa appear on multiple plant lists as tolerant of moist conditions (3, 6, 8, 9). Plants were arranged on greenhouse benches at the Patterson Greenhouse complex on the Auburn University campus in Auburn, AL. Substrates used were 1:1 pine bark (PB) : peat (P) or a calcined clay material (Profile Products, Buffalo Grove, Ill.). Both substrates were amended with 1.2 kg/ m³ (2 lbs/ yd³) dolomitic limestone and 8 kg/ m³ (13.8 lbs/ yd³) 15N-2.6P-10K; (8 month, Polyon®, Pursell Industries, Sylacauga, Ala.). Plant growth indices (GI) [(height + widest width + width perpendicular to widest width)/3] were recorded at planting and experiment termination. Plants were irrigated as needed until treatments began on 21 July 2008.

Treatments were based on days of flooding. Plants were flooded repeatedly for 0 (control), 3, or 7 days. Flooded conditions were simulated by nesting a 2.5 L (trade gal) pot with holes inside of a 2.5 L (trade gal) pot without holes. Water level in pots of flooded plants was raised by adding approximately 1 L tap water at initial flooding and adding approximately 50 mL tap water on each flood day to maintain water table at the substrate level. At the end of each flood cycle, flooded plants were allowed to drain for one week and did not receive irrigation until the next flood cycle. Plants in 3 day and 7 day flooding treatments experienced a total of 7 and 5 flooding cycles, respectively. Substrate percent moisture was measured every six hours using ECH₂O soil moisture sensors (model EC-5) (Decagon Devices, Inc., Pullman, WA). Control plants were irrigated with 500mL tap water when substrate percent moisture reached 25% or lower. Photosynthesis (Ps) rates were measured for *V. nudum* 'Winterthur' and *I. virginica* 'Henry's Garnet' using LI-COR 6400 during flooding and draining cycles in plants flooded for 3 and 7 days. Ps rates of control plants were measured each time photosynthesis in treatment plants was measured. At experiment termination (10 Oct. 2008) shoots were removed from the root ball, and substrate was removed from the roots. Roots and shoots were dried at 66°C (150°F) for 48 hrs and RDW and SDW were recorded. Treatments were in a 2 substrate x 3 flood treatment x 4 taxa factorial arrangement; experimental design was a randomized complete block design. Data were analyzed using generalized linear models and regression analysis with means separation using LSD ($P < 0.05$) (7).

Results and Discussion: The interaction between substrate and flood treatment for growth measurement was significant for taxa in this experiment, however the interaction was quantitative rather than qualitative, therefore main effects of treatment and substrate are presented. *C. alnifolia* 'Ruby Spice' GI, RDW, and SDW were higher in calcined clay than in PB: P substrate, and there was not a significant difference among treatments (Figs. 1, 2, 3). *I. virginica* 'Henry's Garnet' GI and SDW were higher for control plants than for those flooded for 3 or 7 days (Figs. 1, 3). RDW for *I. virginica* 'Henry's Garnet' was highest for control plants and followed by plants flooded for 3 days and lowest in plants flooded for 7 days (Fig. 2). GI, SDW, and RDW for *I. virginica* 'Henry's Garnet' were similar between substrates. *I. glabra* 'Shamrock' GI, SDW, and RDW were higher in calcined clay than in PB: P. *I. glabra* 'Shamrock' GI was lower in plants flooded for 3 and 7 days than in control plants (Fig. 1); SDW was similar in control plants and 3 day flood plants and higher than in 7 day flood plants (Fig. 3). *V. nudum* 'Winterthur' GI, RDW, and SDW was higher in calcined clay than in PB:P substrate; there was not a significant difference among treatments (Figs. 1, 2, 3).

In both flooding treatments, *V. nudum* 'Winterthur' Ps rates were higher during flooding (18.5 $\mu\text{mol}/\text{m}^2/\text{sec}$) than draining (13.8 $\mu\text{mol}/\text{m}^2/\text{sec}$). *V. nudum* 'Winterthur' Ps rates were higher in control plants (17.7 $\mu\text{mol}/\text{m}^2/\text{sec}$) than in flooded plants (16.4 $\mu\text{mol}/\text{m}^2/\text{sec}$). In both flooding treatments, *I. virginica* 'Henry's Garnet' Ps rates were higher during flooding (14.5 $\mu\text{mol}/\text{m}^2/\text{sec}$) than during draining (10.4 $\mu\text{mol}/\text{m}^2/\text{sec}$). Ps rates were higher in control plants (14.5 $\mu\text{mol}/\text{m}^2/\text{sec}$) than in flooded plants (11.9 $\mu\text{mol}/\text{m}^2/\text{sec}$). Plants subjected to flooded conditions often show a reduction in stomatal conductance and net photosynthesis compared to non-flooded plants (5). As flooding ceases, photosynthesis rates can increase due to the reopening of stomata; the rate at

which photosynthesis recovers is based on species and duration of flooding (5). However in our study, the lower rates of Ps during draining were likely due to the drying substrate that was not receiving irrigation.

In previous research flooded baldcypress plants showed photosynthesis rates comparable to that in non-flooded plants, which may be related to baldcypress being classified as a wetland indicator (1). Rates of Ps for *I. virginica* 'Henry's Garnet' and *V. nudum* 'Winterthur' indicate the ability of these native taxa to adapt to flooded conditions and maintain Ps. Although growth was typically lower in flooded plants than control plants, flooded plants of *I. virginica* 'Henry's Garnet', *V. nudum* 'Winterthur', and *I. glabra* 'Shamrock' maintained some growth and relatively good visual quality. Thus, the ability of these three taxa to maintain growth and Ps suggest that these taxa, but likely not *C. alnifolia* 'Ruby Spice', are appropriate selections for rain gardens.

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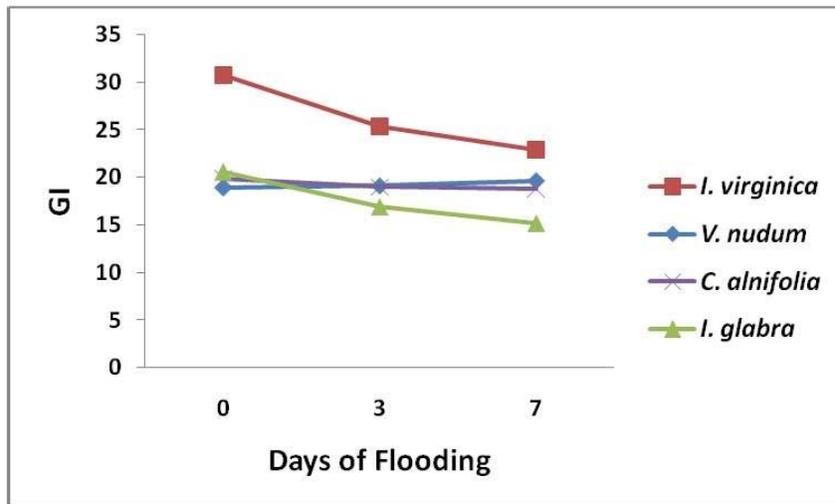


Figure 1. Effect of length of flooding cycle on growth index (GI) of *Itea virginica* ‘Henry’s Garnet’, *Viburnum nudum* ‘Winterthur’, *Ilex glabra* ‘Shamrock’, and *Clethra alnifolia* ‘Ruby Spice’. Plants in 3 day and 7 day flooding treatments completed a total of 7 and 5 flooding cycles, respectively. At the end of each flood cycle, flooded plants were allowed to drain for 7 days and did not receive irrigation until the next flood cycle.

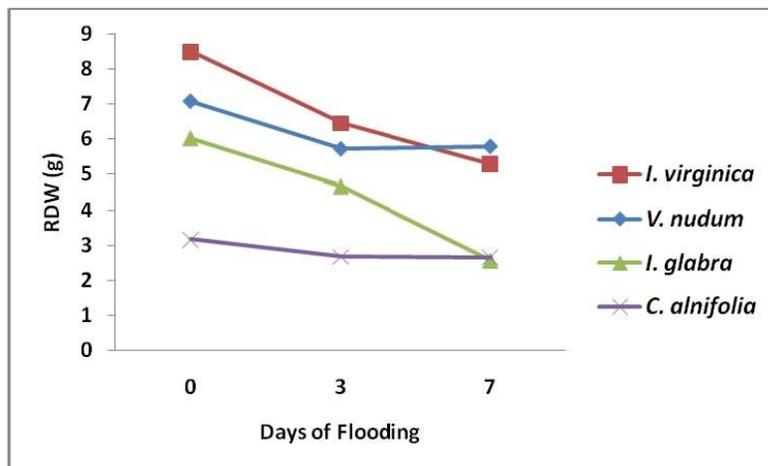


Figure 2. Effect of length of flooding cycle on root dry weight (RDW) of *Itea virginica* ‘Henry’s Garnet’, *Viburnum nudum* ‘Winterthur’, *Ilex glabra* ‘Shamrock’, and *Clethra alnifolia* ‘Ruby Spice’. Plants in 3 day and 7 day flooding treatments completed a total of 7 and 5 flooding cycles, respectively. At the end of each flood cycle, flooded plants were allowed to drain for 7 days and did not receive irrigation until the next flood cycle.

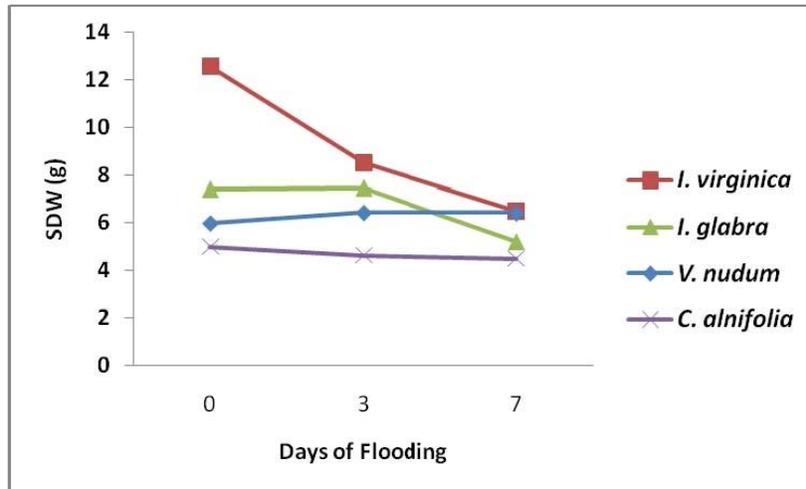


Figure 3. Effect of length of flooding cycle on shoot dry weight (SDW) of *Itea virginica* 'Henry's Garnet', *Ilex glabra* 'Shamrock', *Viburnum nudum* 'Winterthur', and *Clethra alnifolia* 'Ruby Spice'. Plants in 3 day and 7 day flooding treatments completed a total of 7 and 5 flooding cycles, respectively. At the end of each flood cycle, flooded plants were allowed to drain for 7 days and did not receive irrigation until the next flood cycle.

New *Liriope* Cultivars: Landscape Observations from 2008

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Index Words: *Liriope*, landscape performance, cultivar trials

Significance to Industry: Many new *Liriope* and *Ophiopogon* cultivars have been released from nurseries over the past 5 years. Most of these have not been trialed under landscape growing conditions in the southeastern United States. Growers and landscapers want improvements over existing cultivars in terms of growth habit uniformity, disease resistance, and winter aesthetics. This study evaluated seven new cultivars and three Louisiana green industry standard cultivars for seasonal landscape performance by measuring visual quality, plant height, plant spread, flowering characteristics and disease presence. Initial 2008 results indicated best performance from ‘Super Blue’, ‘Cleopatra’, ‘New Blue’, and ‘Emerald Goddess’. Observations reported here are preliminary. Data collection on this project will continue through 2010.

Nature of Work: A landscape evaluation of new *Liriope* and *Ophiopogon* cultivars was initiated at the LSU AgCenter’s Hammond Research Station, Hammond, LA (USDA hardiness zone 8B) in fall 2007. New *Liriope* cultivars and standard cultivars available in Louisiana being evaluated were ‘Cleopatra’, ‘New Blue’, ‘Marc Anthony’, ‘Emerald Goddess’, ‘Super Blue’, ‘Odom’s Big Blue’, ‘Evergreen Giant’, ‘Jeanerette’, and ‘Doug Young Nursery Big Blue’. A new *Ophiopogon* included was ‘Crystal Falls’.

‘Marc Anthony’ is a new release from Plant Development Services, Inc. (PDSI), Loxley, AL. It is an “improved” variegated foliage cultivar with new foliage originating as golden yellow and green. Foliage becomes white and green when maturing. Lavender blooms peak in mid-summer. It is reported to reach 16” tall, is recommended for USDA hardiness zones 5-9, and is recommended for full sun to partial shade.

‘Cleopatra’ is a new release from PDSI. It is a clumping *liriope* with foliage spreading up to 15 inches, and in mid-summer, lovely lavender spikes rise from the dark green foliage to create a wonderful accent. It is reported to reach a height of 24” and is recommended for USDA hardiness zones 5-9 and for full sun to partially shaded locations.

‘New Blue’ is a new *liriope* from PDSI. ‘New Blue’ sports a truly clumping growth habit and deeper foliage (dark green) and bloom (lavender) colors. ‘New Blue’ is reported to reach heights of 15”. It is recommended for USDA hardiness zones 5-10 and full sun to partial shade plantings.

‘Emerald Goddess’ is from Rode Groundcovers in Florida and is a *liriope* with lavender flowers. The mature height is 12-15”. It is faster growing than most other cultivars. It is

reported to have superior resistance to common fungal and bacterial plant pathogens. Dark green foliage is retained in winter. Floral display is advertised to have better intensity, height, uniformity and duration than other liriopae cultivars. It is recommended for USDA hardiness zones 5-10.

'Super Blue' is a new phenotypic selection from 'Big Blue'. Has much more vigorous growth than other 'Big Blue' selections. This cultivar is available from KPS Sales, Apopka, FL.

Other *Liriope* cultivars included in this study are 'Jeanerette' (a commonly sold cultivar in Louisiana), 'Odom's Big Blue' (a new selection of 'Big Blue' from Country Pines Nursery, Forest Hill, LA), and 'Doug Young Nursery (DYN) Big Blue' (from Doug Young Nursery, Forest Hill, LA). 'Evergreen Giant' was also included. The new *Ophiopogon* included in this study was 'Crystal Falls' from Head Ornamentals, Seneca, SC.

Other new *Liriope* not included in these studies include 'Supergreen' from PDSI and 'Mayan Blue' from KPS Sales.

One gallon containers of these cultivars were planted in late fall 2007 in a randomized complete block design with two replications of five plants each. Spacing was 18 inches between plant centers. Beds were located in full sun and were a Cahaba fine sandy loam soil amended with incorporations of fine pine bark. Plants were mulched to a depth of 2" with baled pine straw and mulch is refreshed twice annually to maintain depth of coverage. Plants were fertilized with StaGreen Nursery Special 12-6-6 at the recommended rate in early spring and mid-summer 2008. A drip irrigation system is used on an "as needed" basis to prevent drought stress. No insecticides or fungicides have been applied. Weeds have been controlled with selective hand removal, spot applications of glyphosate, and pre-emergent applications of pendimethalin.

Twice monthly visual quality ratings were taken on plants January through December 2008. Visual quality ratings were based on a scale from 1 to 5 (1=dead, 2=below average landscape performance, 3=average landscape performance, 4=above average landscape performance, 5=superior landscape performance) using 0.5 increments. Height measurements from the soil line to the tallest plant were taken in October. Spread measurements representing the average of the visually widest portion of the plant canopy and the measurement perpendicular to the widest portion were taken in October (data not shown). Anthracnose ratings based on a scale from 1 to 5 (1=no leaf spotting, 3= moderate leaf spotting, 5=high leaf spotting) were taken in December.

Results and Discussion: The best performing *Liriope* cultivar in 2008 trials was 'Super Blue'. 'Cleopatra', 'New Blue', and 'Emerald Goddess' were above average performers. 'Odom's Big Blue', 'DYN Big Blue', 'Marc Anthony' and 'Jeanerette' did not perform as well as the other cultivars listed. 'Evergreen Giant' had below average landscape performance due to root rot presence through most of the year. 'Crystal Falls' *Ophiopogon* had good quality ratings in winter, spring and fall but quality ratings in the summer were low due to sun scorch damage to the foliage. 'Super Blue' was the tallest

cultivar. Anthracnose ratings (data not shown) indicated no disease on 'Super Blue', 'Emerald Goddess' and 'Evergreen Giant'. Slightly susceptible cultivars were 'Odom's Big Blue' and 'Crystal Falls'. Cultivars moderately susceptible to anthracnose were 'Marc Anthony', 'Jeanerette', and 'Cleopatra'. Highly susceptible cultivars at the end of 2008 were 'DYN Big Blue' and 'New Blue'.

Table 1. Plant height and seasonal visual quality ratings of *Liriope* and *Ophiopogon* cultivars evaluated in LSU AgCenter (Hammond Research Station, Hammond, LA) landscape trials, 2008.

	Plant Height ^z	Visual Quality Ratings ^y			
	(in)	March	June	Sept	Dec
<i>New Cultivars</i>					
Cleopatra	12.5	3.0	3.8	4.0	3.8
Crystal Falls	15.5	4.3	3.1	3.8	4.2
Emerald Goddess	19.5	3.5	4.1	4.8	4.5
Marc Anthony	10.5	2.5	3.5	3.6	3.3
New Blue	12.5	3.0	4.1	4.1	4.0
Odom's Big Blue	13.5	2.9	3.5	3.6	3.5
Super Blue	21.2	4.6	4.8	4.9	4.6
<i>Industry Standards</i>					
DYN Big Blue	14.0	2.9	3.6	3.6	3.5
Evergreen Giant	17.2	2.7	2.8	1.9	2.3
Jeanerette	11.0	2.6	3.4	3.5	3.5

^z Plant height were taken in October 2008 and measured from soil line to tallest plant part.

^y Visual quality ratings based on a scale from 1 to 5 (1=dead, 2=below average landscape performance, 3=average landscape performance, 4=above average landscape performance, 5=superior landscape performance) were taken twice monthly from January – December 2008. Included in this rating were plant foliage color and appeal, uniformity, flowering and overall growth habit. Means of visual quality ratings for March, June, September and December are presented.

Landscape Evaluation of Coleus Cultivars - 2008

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Significance to Industry: The last few years has seen a tremendous increase in the number of coleus cultivars available for growers and landscapers. New coleus from Proven Winners and Ball Horticulture have been introduced in the past couple years. The best landscape performers from these coleus groups over the past year in LSU AgCenter trials have been ‘Henna’, ‘Indian Summer’, ‘Mint Mocha’, ‘Big Red Judy’, ‘Red Hot Rio’, ‘Ruby Ruffles’, ‘Pineapple Splash’, ‘Royal Glissade’, ‘Zen Moment’, ‘Mariposa’, ‘Lancelot’, and ‘Fishnet Stockings’.

Nature of Work: A landscape trial evaluating the performance of sun coleus cultivars was conducted in 2008 at the LSU AgCenter’s Hammond Research Station, Hammond, LA (USDA hardiness zone 8B). Cultivars evaluated included vegetatively propagated coleus from Proven Winners and Ball Horticulture. Considerable coleus cultivar evaluations have been done in the Gulf States over the past ten years, but additional work has been needed to evaluate new releases (1, 2, 3).

Three inch pots of rooted coleus liners were planted in early April 2008 in raised beds located in the “sun garden” landscape plant evaluation area. Raised beds consisted of 6-8 inches of Nature’s Best landscape bed builder soil placed on top of a Cahaba fine sandy loam native soil. Raised bed media pH was 6.6. The beds were located in full sun. Plants received irrigation as needed to prevent stress during the growing season via a micro-irrigation system with spray stake emitters. Ten to fifteen plants of each cultivar were included and spaced 24” apart in the beds. Plants were individually spaced 24 inches apart and included 10-15 plants per cultivar. Beds were mulched with 2 inches of baled pine straw immediately after planting. StaGreen Nursery Special 12-6-6 at the rate of 1 lb N/1000 ft² was applied at planting and at the rate of 0.5 lb N/1000 ft² in late June. Plants were lightly dead-headed in early June to remove flower spikes. No insecticides and fungicides were applied for insect and disease management, respectively. Weed control was accomplished via hand removal and a pre-plant broadcast application of pendimethalin herbicide at the recommended rate. Spot applications of glyphosate and paraquat was used to control weed growth at bed edges.

Coleus cultivars in the 2008 study included new releases from Ball Horticulture: ‘Henna’, ‘Indian Summer’ and ‘Mint Mocha’, and the following from Proven Winners: ‘Freckles’, ‘Sedona’, ‘Lancelot’, ‘Mariposa’, ‘Ruby Ruffles’, ‘Dipt in Wine’, ‘Lemon Sensation’, ‘Coco

Loco', 'Royal Glissade', 'Fishnet Stockings', 'Rustic Orange', 'Black Knight', 'Pineapple', 'Merlot', 'Gay's Delight', 'Pineapple Splash', 'Dark Star', 'Pink Chaos', 'Red Ruffles', 'Tiny Toes', 'Kingswood Torch', 'Big Red Judy', 'Life Lime', 'Red Hot Rio', 'Glennis', 'Merlin's Magic', 'Swallowtail', 'Splish Splash', 'Needlepoint', 'Electric Lime', 'Religious Radish', 'Gem', 'Quarterback', 'Zen Moment', 'Doris', and 'Curly Freckles'. The majority of these coleus cultivars from Proven Winners were in their Proven Selections plant program.

Visual quality ratings were taken late spring and mid-summer. Ratings were based on a scale from 1 to 5 (1=dead, 2=below average landscape performance, 3=average landscape performance, 4=above average landscape performance, 5=superior landscape performance) using 0.5 increments. Flowering observations were made in mid-summer (approximately 6 weeks after early June dead-heading). Flower ratings were based on a scale from 1 to 5 (1=no terminals with flower spikes, 2=1-25% terminals with flower spikes, 3=26-50% terminals with flower spikes, 4=51-75% terminals with flower spikes, and 5=76-100% terminals with flower spikes). Hurricane Gustav destroyed the trial planting in early September.

Results and Discussion: 'Henna', 'Indian Summer', and 'Mint Mocha' from Ball Horticulture were good performers. 'Henna' and 'Indian Summer' were outstanding, while 'Mint Mocha' was an above average landscape performer. These three cultivars are new to the market in 2009. 'Big Red Judy', 'Red Hot Rio', 'Ruby Ruffles', 'Pineapple Splash', 'Royal Glissade', 'Zen Moment', 'Mariposa', 'Lancelot', and 'Fishnet Stockings' were other above average landscape performers. 'Electric Lime', 'Glennis', 'Pineapple', 'Gays Delight' and 'Life Lime' would benefit from a partial sun, partial shade planting. Flowering was prolific on 'Freckles', 'Sedona', 'Dipt in Wine', 'Rustic Orange', 'Dark Star', 'Pink Chaos', 'Kingswood Torch', 'Splish Splash', 'Quarterback', 'Needlepoint' and 'Electric Lime'.

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Table 1. Visual quality ratings and flower ratings of coleus cultivars grow in a landscape evaluation study at the LSU AgCenter (Hammond Research Station, Hammond, LA), 2008.

Cultivars	Visual Quality Ratings ^z		Flower Rating ^y
	Late Spring	Mid-Summer	
<i>Ball Horticulture</i>			
Mint Mocha	3.6	4.5	1.0
Henna	4.2	4.8	1.0
Indian Summer	4.1	5.0	1.0
<i>Proven Winners</i>			
Freckles	3.1	3.4	5.0
Sedona	2.8	3.0	5.0
Lancelot	3.3	4.2	1.0
Mariposa	3.0	4.0	2.0
Ruby Ruffles	3.3	4.1	1.0
Dipt in Wine	2.7	3.1	4.0
Gem	2.5	2.8	1.0
Lemon Sensation	3.2	3.8	1.0
Coco Loco	3.3	4.3	1.0
Royal Glissade	3.4	4.3	1.0
Fishnet Stockings	3.4	4.6	1.0
Rustic Orange	2.8	3.2	4.0
Black Knight	3.4	3.6	2.0
Pineapple	3.5	4.0	2.0
Merlot	3.8	4.4	1.0
Gays Delight	3.3	3.5	1.0
Pineapple Splash	3.8	4.8	1.0
Dark Star	3.5	3.5	4.0
Pink Chaos	3.0	4.1	5.0
Red Ruffles	3.2	4.1	1.0
Tiny Toes	2.8	3.0	1.0
Zen Moment	3.4	4.5	1.0
Kingswood Torch	3.5	4.0	5.0
Big Red Judy	4.0	4.8	1.0
Life Lime	3.8	3.5	1.0
Red Hot Rio	3.7	4.6	1.0
Glennis	3.3	3.0	1.0
Merlin's Magic	2.6	3.0	1.0
Swallowtail	3.3	3.0	1.0
Splish Splash	3.5	3.4	5.0
Quarterback	3.7	3.4	4.0
Needlepoint	3.0	3.7	5.0
Curly Freckles	3.6	4.2	1.0
Doris	3.5	4.0	1.0
Electric Lime	3.8	3.0	5.0
Religious Radish	4.2	3.8	2.0

^z Visual quality ratings based on a scale from 1 to 5 (1=dead, 2=below average landscape performance, 3=average landscape performance, 4=above average landscape performance, 5=superior landscape performance) were taken late spring and mid-summer.

^y Flower ratings were taken mid-summer and were based on a scale from 1 to 5 (1=no terminals with flower spikes, 2=1-25% terminals with flower spikes, 3=26-50% terminals with flower spikes, 4=51-75% terminals with flower spikes, and 5=76-100% terminals with flower spikes).