Landscape

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Green Ash Growth Was Unaffected By Interactions Between Drip Irrigation Placement And Pine Bark Mulch Applications

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Index Words: *Fraxinus pennsylvanica*, Irrigation Methodology, Landscape Establishment

Significance to Industry: Recent studies are yielding beneficial information concerning interactions between planting depths of container-grown trees and shrubs and various mulch treatments (1, 3, 4). This work addresses concerns about the inference of these results to situations in which irrigation water was delivered by drip tubing either above or below the mulch applications. Results of this work suggest that irrigation tube placement is not likely to change our interpretation of these studies (1).

Nature of Work: Studies (1) with green ash (*Fraxinus pennsylvanica* Marsh.) and bougainvillea goldenraintree (*Koelreuteria bipinnata* Franch.) found that below grade planting in combination with pine bark mulch reduced transplant survival of both species. Planting at grade or 7.6 cm (3 in) above grade generally improved survival and growth over below grade plantings, but mulching tended to accentuate problems associated with below grade plantings, perhaps due to poor penetration of water with increasing mulch thickness (1). Increasing mulch thicknesses from 0 cm to 22.9 cm (0 in to 9 in) did not improve growth or survival of those trees grown above grade (1). However, positive effects were reported on shoot and root growth of mountain laurel (*Kalmia latifolia* L.) planted above graded (4) with mulch applications compared to those without mulch. Positive effects of above grade planting in combination with various mulch treatments were also reported (3) for waxmyrtle [*Myrica cerifera* (L.) J.K. Small]. One might question whether placement of drip tubes above or below the mulch is affecting the observed responses? The objective of this research was to determine if irrigation drip tube placement interacts with mulch thickness to influence the growth of green ash.

Fraxinus pennsylvanica were grown from seed in flats and transplanted to 9.3 L (#3) black plastic containers as previously described (2). In May 2003, trees were transplanted from the containers to a field site (Boonville Series, Boonville fine sandy loam, fine, montmorillic thermic ruptic-vertic albaqualfs) in College Station, TX. Root collars were maintained at grade. A 0.74 m^2 (8 ft^2) area around each tree was mulched to a depth of 0, 7.6, 15.2, or 22.9 cm (0, 3, 6, or 9 in) with a bagged mixed particle size commercial shredded pine bark mulch (All

American Stone and Turf, College Station, TX). Two drip tube treatments were imposed in a factorial combination with planting depth; either the T-Tape® (T-Systems International Inc., San Diego, CA) with a 10 psi pressure regulator and 0.5 gpm flow rate and emitters 12 in (30.5 cm) apart was placed above the mulch or on the soil beneath the mulch. Weeds were controlled in the treatment plots using glyphosate and hand weeding. Treatments were arranged in a completely random design in the field with seven single tree replicates per treatment combination. During the 2004 growing season, plants with each mulching thickness and drip tube combination treatment were randomly chosen to monitor soil water potentials adjacent to the rootball using tensiometers (Model 2725 JetFill Tensiometers, Soil Moisture Equipment Corp., Santa Barbara, CA). Soil water potentials were recorded monthly for 2004, and used to determine irrigation timing throughout the three growing seasons. Plots were irrigated to field capacity when control plots (bare soil) reached -15 kPa (-15 centibars). Tree heights and trunk diameters at 15.2 cm (6 in) were measured 12 December 2003, 17 December 2004, and 20 October 2005, and cross-sectional trunk diameter was calculated.

Results and Discussion: As reported previously (1), soils with a pine bark mulch application tended to have less negative water potentials than bare soil (Table 1). As previously seen (1), soil water potentials tended to be less negative (moister soil) with light [7.6 cm (3 in)] rather than thick mulch applications (Table 1). Most importantly, placement of the irrigation tubes above versus below the mulch had no significant ($P \leq 0.05$) effect on soil moisture tension among the pine bark mulch treatments tested, only in comparison to the bare soil treatment (Table 1), suggesting that the effects on soil moisture were associated with the presence or absence of mulch rather than the placement of the irrigation tube. Similarly, there were no significant ($P \leq 0.05$) effects of mulch thickness or irrigation tube placement on green ash trunk diameter or cross-sectional trunk area (data not presented). The only significant growth differences were in green ash heights between the 7.6 cm (3 in) and 15.2 cm (6 in) mulch treatments, both with drip tubes below the mulch (Table 1). Thus, these growth differences were not associated with the location of the irrigation tubes. Survival was 100% for all mulch treatments regardless of irrigation tube placement. Mulch thickness and irrigation placement did not interact with time in the field on any measured variable ($P \leq 0.05$). These results suggest that interactions reported by Arnold et al. (1) among planting depths and mulch application thicknesses were not affected by the placement of the irrigation tubes above the mulch.

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Table 1. Soil moisture tension and height for *Fraxinus pennsylvanica* grown from spring 2003 to fall 2005 in a field site following transplant from 9.3 L (#3) black plastic containers with the root collar placed at grade and a 0.74 m^2 (8 ft^2) area around each tree was covered to a depth of 0, 7.6, 15.2, or 22.9 cm (0, 3, 6, or 9 in) with a mixed particle size commercial shredded pine bark mulch. Values represent the means of 7 observations per mulch treatment and 14 on the bare soil control.

Irrigation tube placement	Mulch thickness (cm)	Soil moisture (kPa)	Tree height (cm)
On bare soil	0	-10.6 b[xy]	193 ab[z]
Above mulch	7.6	-2.9 a	197 ab
	15.2	-4.7 ab	184 ab
	22.9	-3.6 a	208 ab
Below mulch	7.6	-4.8 ab	166 b
	15.2	-6.3 ab	217 a
	22.9	-6.0 ab	194 ab

[x]Means followed by the same letter are not statistically different at $P \leq 0.05$ using least squares means comparisons.
[y]Means of monthly soil moisture measurements during the growing season.
[z]Mean height of trees after three growing seasons in the field.

Above-grade planting encourages post-transplant root growth of native woody shrubs

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Index Words: Horhizotron™, Landscape, *Illicium floridanum*, *Kalmia latifolia,* organic matter

Significance to Industry: *Illicium floridanum* (Florida anise tree) and *Kalmia latifolia* (mountain laurel) were planted above grade with the lower half of the root ball in field soil (sandy loam) and the upper half in 100% pine bark, peat moss, cotton gin compost, or more field soil (traditional at grade planting without organic matter). Results indicate that when planting these species above grade and mounding organic matter on and around the rootball, more post-transplant root growth occurs in pine bark and peat compared to cotton gin compost or no organic matter. Utilizing organic matter with the above grade planting technique can increase post-transplant root growth of native woody shrubs over traditional planting in 100% soil.

Nature of Work: Development of a root system into the surrounding soil is essential for survival of transplanted container-grown plants. Until this occurs, a plant must rely on the water and nutrient supplies in the transplanted container substrate, which may be limited due to the tendency of surrounding soils to pull moisture from the root ball because of differences in texture and moisture gradients (5). Urban soils with compaction, restricted rooting space, poor aeration, and inadequate drainage are not typically optimal rooting environments (3). The need for more reliable planting techniques that encourage root growth in adverse conditions has prompted research into planting above grade with mounded organic matter, which has proven successful with woody shrubs (9). In this planting practice, the plant is planted with the upper portion of the root ball above the finished soil grade, organic matter is mounded around and on top of the above grade portion of the root ball, and the surrounding soil is covered in a shallow mulch application. This method is in contrast to prior studies performed on trees (1, 2) in which the root ball was planted above grade with native soil mounded around the above grade portion of the root ball with a shallow mulch application sufficient to suppress weeds.

The objective of this study was to utilize the Horhizotron™ to determine the effect of planting grade and organic matter source on root growth of *Illicium floridanum* (Florida anise tree) and *Kalmia latifolia* (mountain laurel) when grown with the lower half of the root ball in field soil and the upper half in either 100% pine bark (PB), 100% peat (P), 100% cotton gin compost (CGC), or more field soil (at grade, unmulched). The Horhizotron provides a nondestructive method for measuring root growth over time and observing the development of roots from the same plant into different rhizosphere conditions (10). Pine bark and peat are common amendments in landscapes and production, and composted cotton gin trash has been shown to be a good horticultural production substrate (4) so therefore may have potential for use in the landscape. Experimenting with different woody shrub species and sources of organic matter may determine what technique encourages post-transplant root growth most effectively for many landscape species.

On June 6, 2006, and January 3, 2007, respectively, five *I. floridanum* [11.3 L (3 gal)] and five *K. latifolia* [19 L (5 gal)] plants were removed from their containers, and the root ball of each plant was placed in a separate Horhizotron on greenhouse benches at the Paterson Horticulture Greenhouse Complex, Auburn University, Auburn, AL [day/night temperatures set at 79/70°F (26/21°C)]. Each Horhizotron had four wedge-shaped quadrants made from two glass panes that extended away from the root ball and could be filled with a different substrate (treatment). Each of the Horhizotron's four quadrants was filled with field soil (Marvyn sandy loam) in the lower 10 cm (3.9 in). The upper 10 cm (3.9 in) of the quadrants in each Horhizotron were randomly filled with either: 1) PB, 2) P, 3) CGC (sifted through a 15mm screen for debris removal), or 4) more field soil. This study was a randomized complete block design with each Horhizotron representing an individual block and five blocks for each species. Horhizotrons were hand watered as needed, and pH and EC measurements were performed on six leachate samples (8) of each substrate on the first and last day of the study. Once per week, the horizontal root lengths (length measured parallel to the ground, HRL) of the five longest roots visible along each glass pane (two panes per quadrant) were recorded. When roots began to reach the maximum length at the end of the quadrant [26 cm (10.2 in)], the experiment was terminated. Roots in each quadrant were cut from the original root ball, washed to remove substrate, dried for 48 hours at 66°C (150°F), and weighed. Data were analyzed using GLM procedures, regression analysis, and means separation using PDIFF at P = 0.05 (7).

Results and Discussion: *I. floridanum* horizontal root length (HRL) increased linearly in all treatments (Table 1, Fig. 1A). HRL in PB and P was similarly higher than other treatments from the first measurement date until 71 DAP when HRL in PB surpassed that in P and all other treatments (Fig. 1A). Root lengths in P were significantly higher than those in CGC and 100% soil on all measurement dates (Fig. 1A). Root lengths in CGC and 100% soil were similar until 63 DAP when root lengths in CGC surpassed those in 100% soil (Fig. 1A). For *K.latifolia*, HRL increased linearly in all treatments except CGC, in which very limited root growth made a trend difficult to ascertain (Table 1, Fig. 1B). On every measurement date, HRL was highest in P, followed closely but with significantly lower HRL by PB. Though roots grew into the soil portion of each quadrant, in most quadrants the majority of roots were in the organic matter layer (visual observation). Additionally, the fact that more root growth occurred in the PB and P treatments than in 100% soil for both species suggests that more root growth could be expected in organic matter than in soil. Results indicate that CGC is not the best organic matter to use when transplanting *I. floridanum* or *K. latifolia*. Root dry weights for *I. floridanum* (data not shown) reflected HRL measurements, while dry weights for *K. latifolia* were not obtained due to the fibrous nature of the root system and the inability to wash organic matter and soil from such root systems. This illustrates the importance of measuring HRL to determine the rate of root growth over time and extent of root development laterally into the surrounding substrate or backfill of slow growing and fibrous root systems. In solutions extracted from substrates, EC was highest in CGC (data not shown). pH and bulk density (data not shown) were lowest in PB and P, which also had the highest HRL of the treatments and in both species. Consequently, this modified above grade planting technique with organic matter may be effective since it simulates the upper organic layer found in natural environments, providing more ideal physical and chemical environments for root growth than 100% soil. Plants grown with this natural organic layer present can have nearly double the root:shoot ratio of those grown in cultivated landscapes (6). This experiment provides strong evidence that utilizing the above-grade planting practice with organic matter will encourage root growth most effectively, yielding high transplant survival rates and attractive, low-maintenance landscapes.

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Table 1. Effect of mulch type (treatment) on final horizontal root length (HRL[z]) of *I. floridanum and K. latifolia*
(97 and 138 DAP[y], respectively) growing in Horhizotrons in Auburn, AL, regression equations for change in
HRL over time with corresponding R^2 term and significance of regression equation (P-value), significance of
treatment main effects and interactions for HRL. *I. floridanum* were grown June 6 - October 6, 2006 and *K.*
latifolia January 3 - May 24, 2007.

	I. floridanum			
Treatment[x]	HRL (cm)	Equation[w]	R^2	P-value
Pine bark	22.04a[v]	y = 0.272x - 1.824	0.92	<0.0001
Peat	20.12b	y = 0.247x - 1.179	0.86	<0.0001
Cotton gin compost	11.34c	y = 0.138x - 0.546	0.76	<0.0001
No mulch	8.96d	y = 0.090x + 1.215	0.24	<0.0001
Significance	P-value			
Treatment	<0.0001			
DAP	<0.0001			
Treatment x DAP	<0.0001			
	K. latifolia			
Treatment[x]	HRL (cm)	Equation[x]	R^2	P-value
Pine bark	15.92b	y = 0.135x - 2.100	0.79	<0.0001
Peat	17.52a	y = 0.122x + 1.186	0.81	<0.0001
Cotton gin compost	1.28d	y = 0.011x + 0.009	0.06	<0.0001
No mulch	5.14c	y = 0.040x - 0.298	0.14	<0.0001
Significance	P-value			
Treatment	<0.0001			
DAP	<0.0001			
Treatment x DAP	<0.0001			

[z]HRL = root length measured parallel to the ground.
[y]DAP = days after planting in Horhizotron.
[x]Treatments were soil in bottom 10 cm (3.9 in) and pine bark, peat, or cotton gin compost in upper 10 cm (3.9
in) or 100% soil (no mulch).
[w]y = HRL, x = DAP.
[v]Lowercase letters denote mean separation (n=50) among treatments within location by PDIFF at P<0.05.

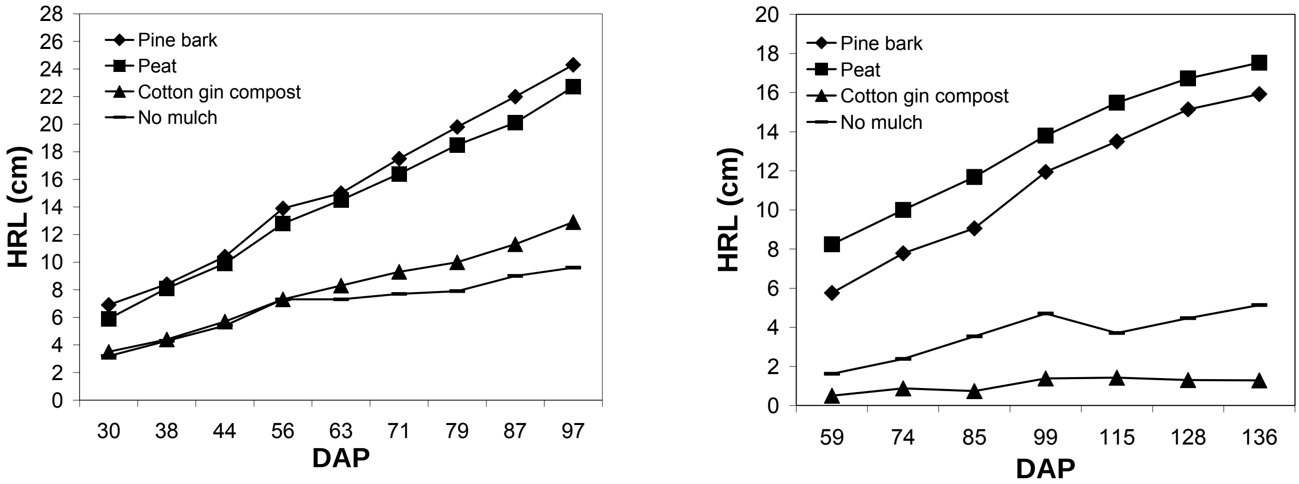

Figure 1. Effect of organic matter type on horizontal root length (length measured parallel to the ground, HRL) of **(A)** *Illicium floridanum* measured 30 to 97 days after planting (DAP) and **(B)** *Kalmia latifolia* measured 59 to 136 DAP. Plants were planted June 6, 2006 and January 3, 2007, respectively, in a greenhouse at Auburn University in Auburn, AL.

Evaluation of *Gaillardia* (Blanketflower) Cultivars and Ecotypes for Landscape Performance in North-Central Florida

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Index Words: *Gaillardia aristata*, *Gaillardia pulchella*, *Gaillardia* x *grandiflora*, variety trials, native

Significance to Industry: Twenty-three blanketflower cultivars or ecotypes were evaluated for 10 weeks at the University of Florida trial gardens in north-central FL. Plants were evaluated bi-weekly based on vigor, uniformity, flowering and landscape impact. 'Torch Red Ember' received the highest ratings for uniformity. 'Arizona Sun', 'Double Lorenziana', and 'Lollipop Gold' received the highest ratings for flowering, and 'Torch Red Ember' and the St. Lucie Co. ecotype received the highest ratings for landscape impact.

Nature of Work: Blanketflower (*Gaillardia pulchella* Foug.) is an herbaceous annual in the Aster family. It is native throughout most of the U.S. (3), and cultivated varieties are grown world-wide. Cultivars with varying floral attributes, flowering time, vegetative characteristics, cold tolerance, and landscape performance are generally selected directly from *G. aristata* or *G. pulchella* or from hybrid progeny (*G*. x *grandiflora*) of these parents. *G.* x *grandiflora* has some cold-hardiness inherited from *G. aristata* and some heat and humidity tolerance inherited from *G. pulchella* (2). In addition to using novel cultivated selections, there is also increased interest in using local or regional ecotypes (natural populations that have adapted to the local or regional environment) for landscape plantings. Uncultivated Florida ecotypes tend to have a looser growth habit and fewer ray florets that are horizontally oriented compared to cultivated blanketflower varieties (1). The objective of the following study was to determine the performance of 23 blanketflower cultivars or ecotypes in the north-central Florida trial gardens.

Twenty three blanketflower cultivars or ecotypes were obtained as seed or un-rooted cuttings from commercial growers or natural populations (Table 1). Cuttings were rooted or seeds were sown in 72-cell trays containing Fafard #2 media (Fafard Inc., Apopka, FL) and maintained under intermittent mist until rooting or germination occurred. Trial beds located in Gainesville, FL (AHS Heat Zone 10;USDA Cold Hardiness Zone 8b) were prepared by tilling the existing soil, incorporating mushroom compost, and covering with 7.6 cm (3 in) of organic mulch. Within a single row, nine of each blanketflower variety or ecotype was evenly spaced in a plot 96 cm (38 in) wide by 112 cm (44 in) long. Drip tape provided water and liquid fertilizer as needed. During the study (9 June 2004 to 18 August 2004), the average daily temperature was 25.9 C (78.6 F) (min.= 18 C [64.4 F]/ max.= 36 C [96.8 F]), the average weekly rainfall was 4.1 cm (1.6 in), and the average daily solar radiation was 222 watts/m^2.

After a 5-week establishment period, vigor, uniformity, flowering and landscape impact ratings were conducted bi-weekly based on the visual average of all nine plants in each plot. Vigor ratings were based on a scale of 0 to 3, where 0=dead plants, 1=low vigor, 2=medium vigor, and 3=high vigor. Uniformity was rated on a scale of 1 to 3, where 1=low uniformity, 2=medium uniformity, and 3=high uniformity. Flowering was based on a scale of 0 to 2, where 0=no flowers, 1= $<$ 20% fully open flower coverage, and 2= $\geq$20% fully open flower coverage. The landscape impact rating was based on a scale of 1 to 3, where 1=not pleasing, 2=somewhat pleasing, and 3=very pleasing. To assess flower time and longevity, plants were separated into three groups based on the time of their peak performance. Plants were considered early performers if their landscape impact ratings were 2 or 3 during weeks 5 to 9, and late performers if their landscape impact ratings were 2 or 3 during weeks 11 to 15. Plants were considered long season performers if their landscape impact ratings were 2 or 3 throughout the study.

Results and Discussion: On average, ‘Torch Red Ember’ had the highest overall uniformity rating (3.00) and ‘Burgundy’ had the lowest uniformity rating (1.67) (Table 2). Uniformity ratings of seed propagated blanketflower generally were much lower than that of vegetatively propagated blanketflower. On average, ‘Arizona Sun’, ‘Double Lorenziana’, and ‘Lollipop Gold’ had the highest overall flowering rating (2.00), whereas ‘Torchlight’, ‘Burgundy’, and ‘Monarch’ all received flowering ratings less than 1 (Table 2). On average, ‘Torch Red Ember’ and the St. Lucie Co. ecotype had the highest overall landscape impact rating (2.83), whereas ‘Torchlight’ and ‘Burgundy’ had the lowest overall landscape impact rating (1.33) (Table 2). Based on landscape impact (which included flower coverage), ‘Sundance’, ‘Double Lorenziana Mix’, ‘Lollipop Gold’, ‘Red Plume’, TX wild-grown, and ‘Fanfare’ were considered early season performers whereas ‘Bijou’, ‘Indian Yellow’, Okaloosa Co. ecotype, TX farm-raised, ‘Yellow Flame’, ‘Dazzler’, ‘Gold Goblin’, ‘Grandiflora Mix’ and ‘Monarch’ were considered late season performers (Table 3). ‘Arizona Sun’, ‘Goblin’, Leon Co. ecotype, St. Lucie Co. ecotype, and ‘Torch Red Ember’ were considered long season performers (Table 3). The Volusia Co. ecotype, ‘Burgundy’ and ‘Torchlight’ could not be classified as long, early or late season performers because they received landscape impact ratings $\leq$ 2 throughout the study. It is possible that they may have needed additional time to reach their peak. Our results emphasize that blanketflower is a superb landscape plant with enough cultivars or ecotypes available to meet a multitude of individual preferences.

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Table 1. List of cultivar or ecotype, source, species, propagation method, flower description and plant description of blanketflower trialed in north-central Florida.

Cultivar or ecotype	Source	Species	Propagation	Flower description	Plant description
'Arizona Sun'	Benary Seed (Sycamore, IL)	*G. aristata*	Seed	Single, red with yellow tips	Compact
'Bijou'	Proven Winners (Sycamore, IL)	*G. aristata*	Vegetative	Single, red with yellow tips	Compact
'Goblin'	Thompson & Morgan (T&M) Seed (Jackson, NJ)	*G. aristata*	Seed	Single, red with yellow tips	Semi-compact
'Indian Yellow'	T&M Seed (Jackson, NJ)	*G. aristata*	Seed	Single, large yellow	Upright
Leon Co., FL	Jeff Norcini (Quincy, FL)	*G. aristata*	Seed	Single, red with yellow tips	Spreading
'Sundance'	T&M Seed (Jackson, NJ)	*G. aristata*	Seed	Double, red with yellow tips	Spreading
'Torchlight'	Benary Seed (Sycamore, IL)	*G. aristata*	Seed	Single, red with yellow tips	Compact
Okaloosa Co., FL	Jeff Norcini (Quincy, FL)	*G. pulchella*	Seed	Single, red with yellow tips	Spreading
'Double Lorenziana'	Stokes Seed (Buffalo, NY)	*G. pulchella*	Seed	Double, many colors	Spreading
St. Lucie Co., FL	SB Wilson (Ft. Pierce, FL)	*G. pulchella*	Seed	Single, red with yellow tips	Spreading
'Lollipop Gold'	Sahin Seed (The Netherlands)	*G. pulchella*	Seed	Double, yellow	Spreading
'Red Plume'	T&M Seed (Jackson, NJ)	*G. pulchella*	Seed	Double, dark red	Spreading
TX (Farm-raised)	DR Bates (Loxahatchee, FL)	*G. pulchella*	Seed	Single, red with yellow tips	Spreading
TX (Wild-grown)	DR Bates (Loxahatchee, FL)	*G. pulchella*	Seed	Single, red with yellow tips	Spreading
'Torch Red Ember'	Ball FloraPlant (W Chicago, IL)	*G. pulchella*	Vegetative	Double, bright red	Spreading
Volusia Co., FL	The Natives, Inc. (Davenport, FL)	*G. pulchella*	Seed	Single, red with yellow, orange or white tips	Spreading
'Yellow Flame'	R.H. Shumway (Randolph, WI)	*G. pulchella*	Seed	Single, large yellow	Upright
'Burgundy'	T&M Seed (Jackson, NJ)	*G.* x *grandiflora*	Seed	Single, dark red	Semi- compact
'Dazzler'	Proven Winners (Sycamore, IL)	*G.* x *grandiflora*	Vegetative	Single, red with yellow tips	Semi-compact
'Fanfare'	PlantHaven, Inc. (Santa Barbara, CA)	*G.* x *grandiflora*	Vegetative	Single, red tubular ray florets with yellow tips	Compact
'Gold Goblin'	T&M Seed (Jackson, NJ)	*G.* x *grandiflora*	Seed	Single, large yellow	Upright
'T&M Reselected'	T&M Seed (Jackson, NJ)	*G.* x *grandiflora*	Seed	Single, all red or red with yellow tips	Spreading
'Monarch'	Stokes Seed (Buffalo, NY)	*G.* x *grandiflora*	Seed	Single, red with yellow tips	Semi-compact

Table 2. Uniformity, flowering, and landscape impact frequencies of blanketflower after a 5 week establishment period. Data represents the number of times each cultivar or ecotype (9 plants per plot) received a specific rating in each category for six bi-weekly evaluations. For uniformity, 1=low, 2=medium, and 3=high uniformity. For flowering, 0=no flowers present, 1=less than 20% of the plants were covered in flowers, and 2=greater than 20% of plants were covered in flowers. For landscape impact, 1=negative aesthetic impact, 2=slightly positive aesthetic impact, and 3=highly positive aesthetic impact on the landscape.

Cultivar or ecotype	Uniformity Overall[z]	Flowering Overall	Landscape impact Overall
‘Arizona Sun’	2.67	2.00	2.50
‘Bijou’	2.67	1.17	2.33
‘Goblin’	1.83	1.50	2.50
‘Indian Yellow’	2.50	1.50	2.50
Leon Co., FL	2.17	1.50	2.67
‘Sundance’	2.83	1.83	2.17
‘Torchlight’	1.83	0.00	1.33
Okaloosa Co., FL	2.67	1.50	2.50
‘Double Lorenziana’	2.00	2.00	2.50
St. Lucie Co., FL	2.83	1.67	2.83
‘Lollipop Gold’	2.67	2.00	1.83
‘Red Plume’	2.33	1.83	2.17
TX (Farm-raised)	2.50	1.00	2.33
TX (Wild-grown)	2.00	1.33	1.67
‘Torch Red Ember’	3.00	1.83	2.83
Volusia Co., FL	1.83	1.50	2.00
‘Yellow Flame’	2.17	1.50	2.00
‘Burgundy’	1.67	0.17	1.33
‘Dazzler’	2.50	1.67	2.67
‘Fanfare’	2.67	1.83	2.67
‘Gold Goblin’	2.33	1.50	2.50
‘T&M Reselected’	2.50	1.00	2.17
‘Monarch’	2.50	0.50	2.17

[z] Overall figures are an average of all 6 bi-weekly evaluations.

Table 3. Long, early and late season classification of blanketflower cultivars and ecotypes based on landscape impact ≥ 2 in north-central FL bedding trials.

Long season performers (weeks 5 to 15)	Early season performers (weeks 5 to 9)	Late season performers (weeks 11 to 15)
‘Arizona Sun’	‘Sundance’	‘Bijou’
‘Goblin’	‘Double Lorenziana Mix’	‘Indian Yellow’
Leon Co., FL	‘Lollipop Gold’	Okaloosa Co., FL
St. Lucie Co., FL	‘Red Plume’	TX (Farm-raised)
‘Torch Red Ember’	TX (Wild-grown)	‘Yellow Flame’
	‘Fanfare’	‘Dazzler’
		‘Gold Goblin’
		‘Grandiflora Mix’
		‘Monarch’

Does Fertilization at Planting Speed Establishment of Landscape Trees?

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Index words: nitrogen, soil compaction, transplanting, urban soil

Significance to Industry: Results from a compendium of five experiments indicate that fertilizing at planting does very little or nothing to speed transplant establishment of landscape trees, regardless if they were transplanted from containers, B&B, or bare root. Investment in soil compaction alleviation, wide planting holes, or regular irrigation will likely pay much larger dividends.

Nature of Work: Newly planted trees, until they have established and put on significant growth, provide few of the economic, environmental and aesthetic benefits expected from landscape trees. Poor site conditions, such as those typically found on graded (cut over) sites in urbanized areas can greatly retard establishment. In this study, we considered whether fertilization at planting could hasten the establishment process in such difficult sites, thus accelerating a newly planted tree's entry into the more environmentally productive phases of its life. Tree fertilization has been studied for many years, but with ambiguous results (2). Fertilization research to date does not provide the definitive answers needed to make fertilization recommendations for newly transplanted trees, especially those planted in the less-than-ideal soils found in urban areas. Five separate experiments, encompassing 276 trees, tested if fertilization at planting increased post-transplant growth for field-grown, container-grown, and bare-root trees that were planted into a variety of landscape sites and fertilization rates in and near Virginia Tech's main campus in Blacksburg, VA. The experimental design was completely random for all 5 experiments, and each species was analyzed separately. Trunk diameter growth was followed for three years (unless noted otherwise) and data were analyzed in the GLM and REG procedures of SAS (vers. 9.1, Cary, NC). The experiments are described in more detail below:

Experiment 1: 15-gal *Quercus bicolor* (swamp white oak), *Quercus imbricaria* (shingle oak), *Pyrus calleryanna* 'Cleveland Select' (pear), and *Acer* X *freemanii* (Freeman maple) trees were obtained from Dewis Nursery (Bedford, VA) and planted 10 feet apart in uncompacted silt loam soil in nursery rows at Virginia Tech's Urban Horticulture Center in early November 2001. Planting holes were dug with at the same depth and twice the width of the original rootball. Rootballs were sliced on opposides, approximately 1-inch deep and along the entire height.

Fertilizer was a 27-3-12 lawn fertilizer and was applied at 0, 1, 3, or 6 lbs. of actual nitrogen (N) per 1000 ft^2 over a 3 ft. X 3 ft. area centered above the rootballs on top of the ground after planting. This fertilization area was selected because it fully encompassed the rootball and also included some surrounding soil. All trees were mulched with a 2-inch deep layer of shredded hardwood bark after fertilization. Trees were irrigated at planting and twice a week for the following month. Irrigation was withheld thereafter. Trunk diameter was measured 6 inches above the ground at planting for the following three years. There were 6 replications of each treatment X species (= 96 trees total).

Experiment 2: 15-gal *Acer rubrum* 'October Glory' (red maple) were grown in the Urban Horticulture Center nursery and planted 10 ft. apart in a single row along the adjacent roadside ditch in early May, 2004. The soil at this site is cut-and-fill from the road and drainage ditch and was originally a clay subsoil. Planting holes and rootball handling were the same as described in Experiment 1. Fertilizer was 19-4-8 Polyon® Controllable Release and was scattered within and just outside of the planting hole as the trees were being backfilled at amounts equal to rates of 0, 3, 6, 12, and 24 lbs. of actual N per 1000 ft^2 over a 3 ft. X 3 ft. area. All trees were mulched with a 2-inch deep layer of shredded hardwood bark after fertilization. All trees were irrigated at planting and twice a week for the following month. Irrigation was withheld thereafter. Trunk diameter was measured 12 inches above the ground at planting and for the following three years. There were 5 replications of each treatment (= 25 trees total).

Experiment 3: 5-gal *Liquidambar styraciflua* (sweetgum) and red maple were obtained from Lancaster Farm Nursery (Suffolk, VA) and planted along the Virginia Tech spots practice field in early April 2003. Planting holes and rootball handling were as described in Experiment 1. The soil at this site was a moderately compacted cut-and-fill clay subsoil. Fertilizer was a 27-3-12 lawn fertilizer that was evenly spread within and outside of the planting hole as the trees were being backfilled at amounts equal to rates of 0 or 6 lbs. of actual N per 1000 ft^2 over a 3 ft. X 3 ft. area (i.e. fertilized or not). All trees were mulched with a 2-inch deep layer of shredded hardwood bark after fertilization. Trees were irrigated soon after planting and irrigated sporadically for the following month. Irrigation was withheld thereafter. Trunk diameter was measured 6 inches above the ground at planting and for the following 3 years. There were 10 replications of each treatment for both species (= 40 trees total).

Experiment 4: Industry grade 3-in caliper *Acer saccharum* 'Green Mountain' (sugar maple) and red maple trees were field grown at the Urban Horticulture Center nursery and transplanted B&B with 36-in wide, machine-dug rootballs in early April 2003. The planting site was along the Virginia Tech baseball field and approaching roadway. The soil type was a compacted clay loam. Planting holes were equal in depth and twice the width of rootballs. Fertilizer was a 27-3-12 lawn fertilizer that was spread over a 3 ft. X 3 ft. area within the excavated planting hole and over the rootballs when the holes were 2/3 filled in with backfill at rates of 0 or 6 lbs. of actual N per 1000 ft^2 (i.e. fertilized or not). All trees were mulched with a 2-inch deep layer of shredded hardwood bark after fertilization. Trees were irrigated soon after planting and irrigated regularly with drip irrigation bags (i.e. “Gator” bags) for the following three months. Irrigation was withheld thereafter. Trunk diameter was measured 12 inches above the ground at planting and for the following three years. There were 10 replications of each treatment for both species (= 40 trees total).

Experiment 5: *Quercus alba* (white oak), *Quercus prinus* (chestnut oak) and *Quercus velutina* (black oak) were grown at the Urban Horticulture Center nursery and transplanted bare root in mid April 2003. Calipers averaged 1.5 in and rootballs met the minimum trade standards. The site was an understory of mature hardwoods, dominated by white oak, at the Virginia Tech amphitheater. The soil was an uncompacted silt loam forest soil. Planting holes were the same depth and twice the width of the rootballs. Fertilizer was a 27-3-12 lawn fertilizer and was applied at 0, 1, 3, 6, or 12 lbs. of actual N per 1000 ft^2 over a 3 ft. X 3 ft. square on top of the ground after planting. All trees were irrigated soon after planting and irrigation was withheld thereafter. There were 5 replications of each treatment for each species (= 75 trees total).

Results and Discussion: Fertilizing at planting does not appear to be an effective aid for speeding establishment of landscape trees (Figs. 1-5, Table 1). These experiments covered the common production types (container, B&B, bare root) and a range of site types. Three sites could be considered very common to urban areas (topsoil removed, compacted) and generally inhospitable to tree establishment, whereas two sites could be considered to be similar to reasonably good residential sites (nursery and forest soil) for tree growth. The post-transplant growth period studied (3 years for 4 of the 5 experiments and 2 years for the other) is the period generally considered adequate for full establishment of trees of these sizes (3).

Although data mostly indicated no apparent growth response to fertilization at planting, small but distinct growth increases were found on the 15-gal red maples along a ditch in cut-and-fill subsoil (Fig. 2, Table 1), although rate of application did not appear to have an effect, and on B&B sugar maple on the roadside planting (Fig. 4, Table 1). An effect of N *rate* was only evident for bare-root chestnut oak (Fig. 5, Table 1), although the relationship did not define much of the response (R^2= 0.275). Mortality was 44% on these trees, perhaps a combination of species’ difficulty with transplanting bare root and drought, so results should be interpreted with caution. Survival was 100% for the 4 other experiments. Even though the 15-gal red maple and B&B sugar responded to fertilizing at planting with a small increase in growth (Figs. 2 and 4), these results probably do not warrant prescribing fertilizer at planting as a general practice. The ovwerall results of these 5 experiments agree with our earlier report on B&B red maple and linden (*Tilia cordata*) (1). Instead of fertilizing at planting,

loosening the surrounding soil and planting in wide planting holes so as to allow new roots to grow unimpeded by compacted soil and diligent post-transplant irrigation is likely the best strategy to speed establishment of landscape trees.
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Table 1. *P*-values from 5 separate experiments testing the effectiveness of fertilizing landscape trees produced in the ground and transplanted bare root or balled and burlapped (B&B) or produced and transplanted from containers on post-transplant trunk growth. Growth measurements are for 3 growing seasons after transplanting unless noted otherwise.

		P-values		
Container grown	Experiment	Fert vs. not fert	Linear	Quadratic
15-gal swamp white oak	1	0.761	0.766	NA
15-gal shingle oak	1	0.718	0.867	NA
15-gal pear	1	0.835	0.553	NA
15-gal Freeman maple	1	0.696	0.622	NA
15-gal red maple	2	0.033	0.232	NA
5-gal sweetgum	3	0.163	NA	NA
5-gal red maple	3	0.251	NA	NA
Balled and burlapped				
Sugar maple	4	0.021	NA	NA
Red maple		0.593	NA	NA
Bare root[z]				
White oak	5	0.968	0.731	NA
Chestnut oak	5	0.107	0.024	0.021[y]
Black oak	5	0.814	0.467	NA

[z]Trunk growth measured 2 growing seasons after transplant
[y]R^2=0.275

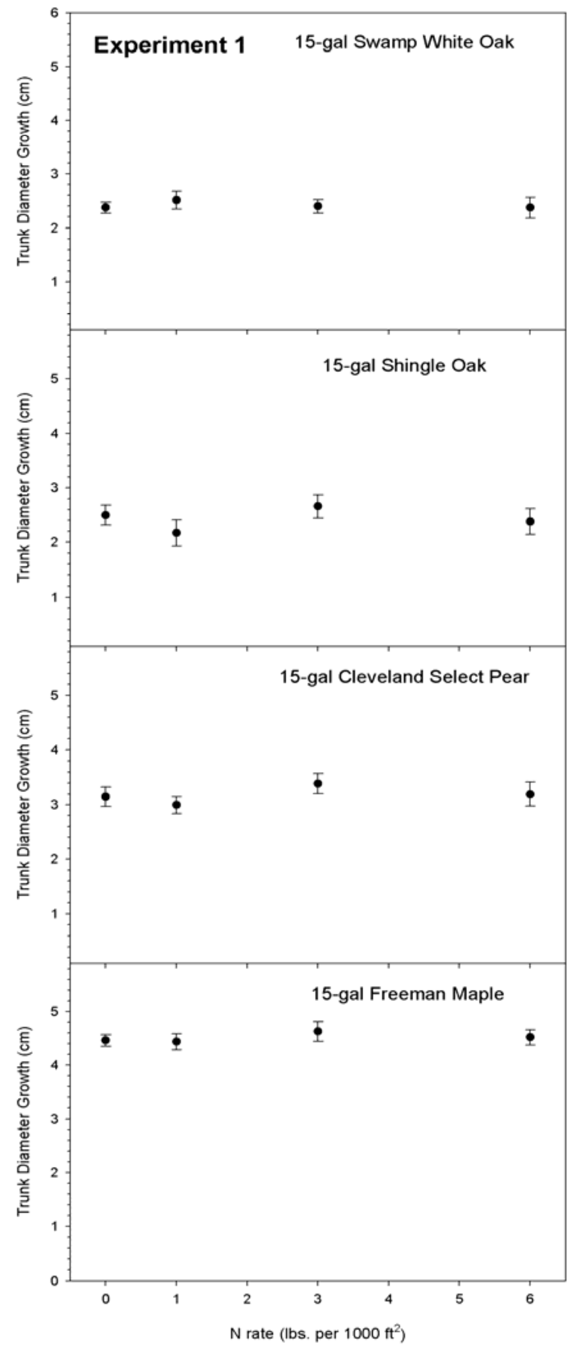

Figure 1. Trunk growth of 4 species of landscape trees 3 years after transplanting from 15-gal nursery containers. Trees were fertilized at one of four rates at planting and not fertilized again. N=6.

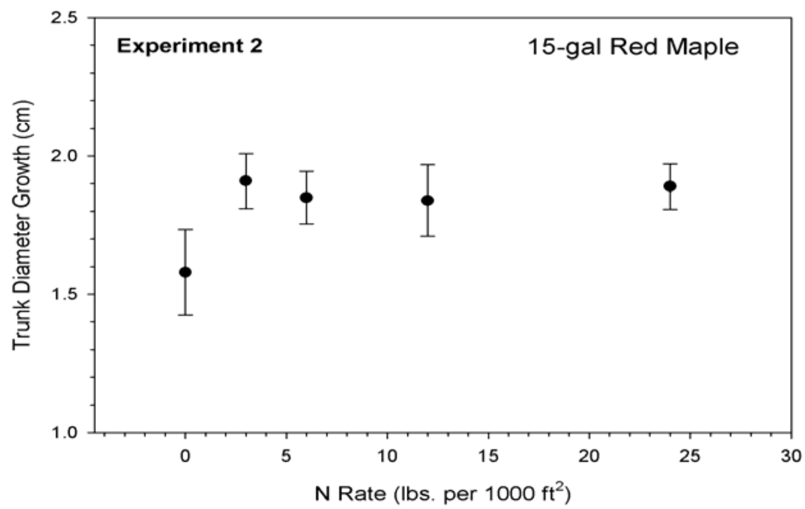

Figure 2. Trunk growth of red maple trees 3 years after transplanting from 15-gal nursery containers. Trees were fertilized at one of five rates at planting and not fertilized again. N=5.

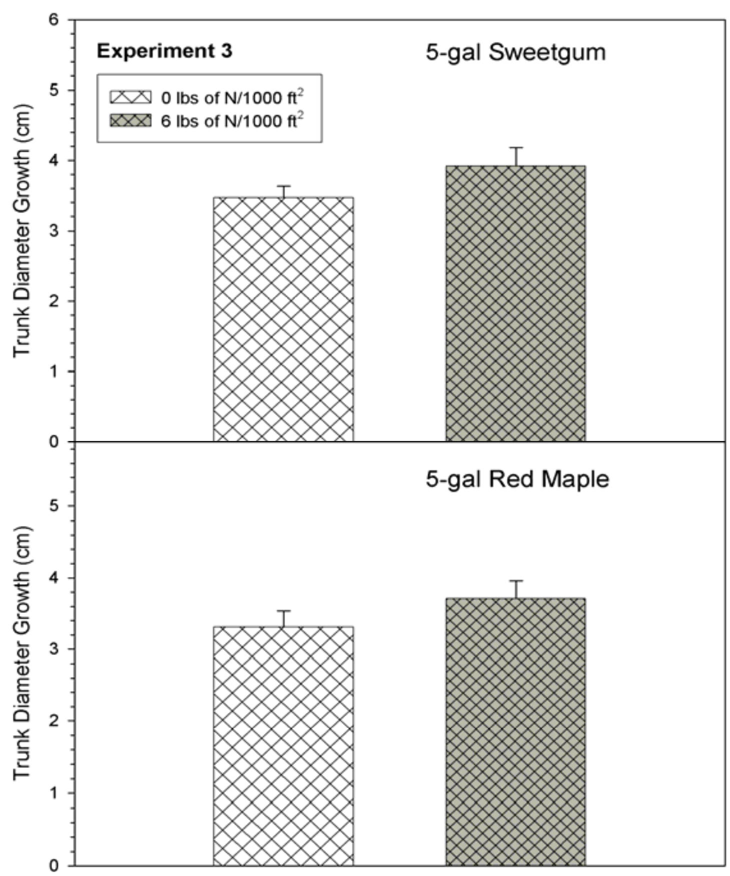

Figure 3. Trunk growth of sweetgum and red maple trees 3 years after transplanting from 5-gal nursery containers. Trees were fertilized or not at planting and not fertilized again. N=10.

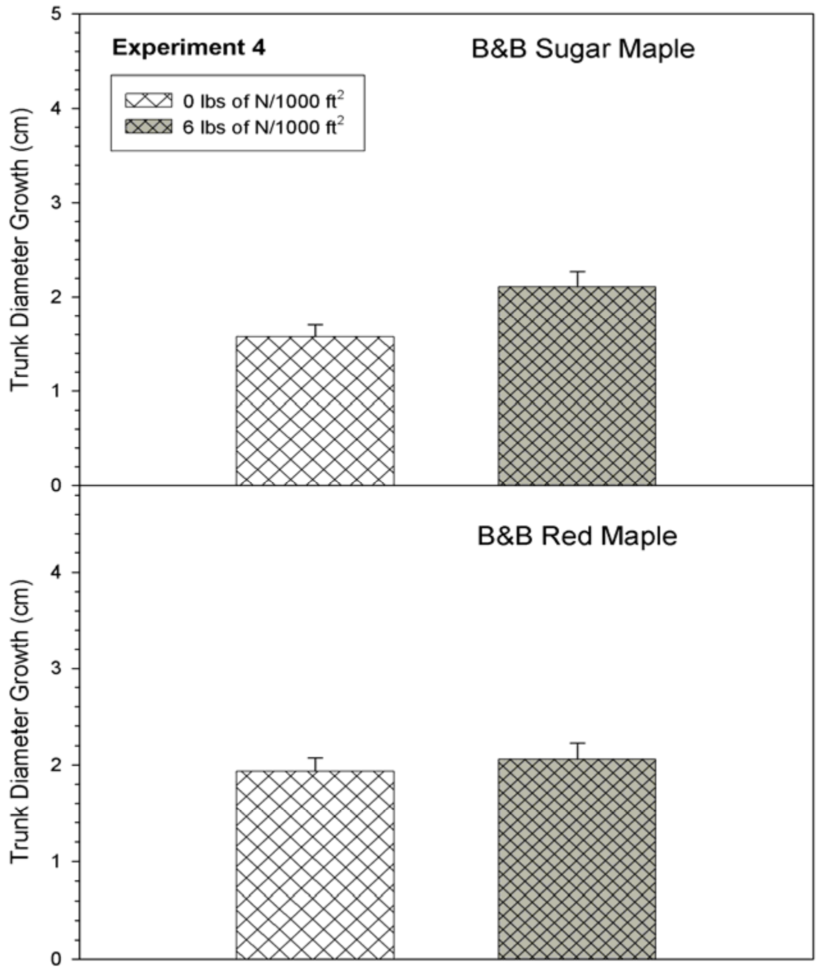

Figure 4. Trunk growth of sugar maple and red maple 3 years after transplanting B&B. Trees were fertilized or not at planting and not fertilized again. N=5.

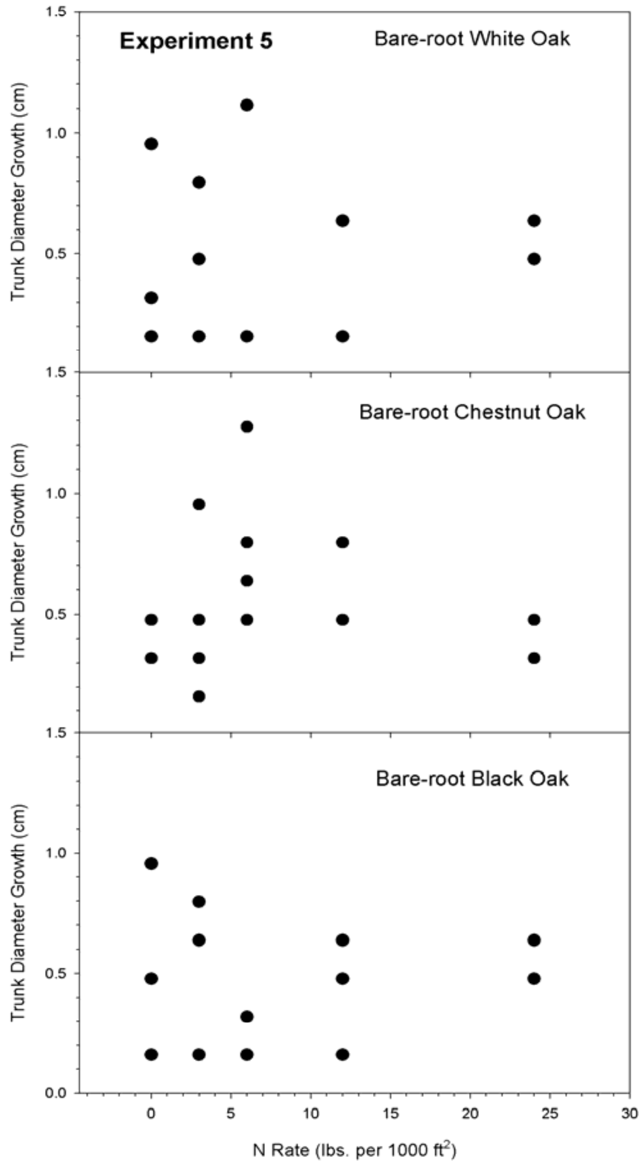

Figure 5. Trunk growth of three species of oaks 2 years after transplanting bare root. Trees were fertilized at one of five rates at planting and not fertilized again. N=5.

Landscape performance of miniature and dwarf crape myrtle (*Lagerstroemia* spp.) cultivars in North Texas

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Key words: Crape myrtle. *Lagerstroemia*, dwarf, miniature

Significance to Industry: One of the most popular flowering woody ornamentals is *Lagerstroemia* due to its distinctive and lengthy show of flowers during the summer months. Besides the assortment of colors and long lasting summer blooms, the release of many new cultivars in a wide range of sizes has broadened their popularity. However, knowing which cultivars to choose and plant, and/or which ones are better adapted to the soil and climatic conditions of a given region can pose a real challenge to both landscapers and homeowners. In this multi-year cultivar trial we are evaluating 47 miniature and dwarf crape myrtle cultivars under low maintenance conditions in North Texas. Data to date has shown that the top performers have been *L. indica* cultivars, whereas the popular *L. indica* x *L. fauriei* interspecific hybrids have had widely spread out (good, intermediate and poor) landscape performances.

Nature of Work: Without much doubt, crape myrtle (*Lagerstroemia* spp.) is one of the most popular flowering woody ornamentals in the Southern U.S. (1, 4). This popularity stems from its distinctive and lengthy show of flowers during the summer months. While *L. indica* has been the most cultivated ornamental crape myrtle species, in the 1950's the US National Arboretum introduced the Japanese crape myrtle, *L. fauriei*, into their pioneering breeding program (1, 4). In the last three decades this breeding program has released superior cultivars that combine the colorful and dense flowering of *L. indica*, as well as its range of sizes and shapes, with the vigor, cold hardiness, outstanding bark character and disease resistance of *L. fauriei* (2, 6). Besides the assortment of colors and long lasting summer blooms, the release of many new cultivars in a wide range of sizes has widened their popularity. In recent years other breeders and crape myrtle enthusiasts have begun to release a new crop of cultivars, particularly in the miniature, dwarf and small sizes. The wide range of available options now challenges landscapers and homeowners with the question of which cultivars to choose and plant, and/or which ones are better adapted to the soil and climatic conditions of a given region. Plants in the North Texas region can experience a wide range of stresses, including heavy clay soils with high pH (typically 8), alternating and sudden drought and flood conditions, lengthy and oppressive summer heat, wildly fluctuating winter temperatures, high winds and hail. Therefore, the objective of this study was to evaluate the immediate and long-term performance of miniature and dwarf crape myrtle cultivars in this region.

A collection of 47 dwarf and miniature *Lagerstroemia* cultivars was established, on summer of 2003, at The Texas A&M University Research and Extension Center in Dallas, Texas (Table 3 shows the complete list). The plants were acquired in #1 to #3 containers and were transplanted into an Austin silty clay soil (fine silty, carbonatic, thermic, Udorthentic Haplustoll; pH: 7.6-8.0; CEC: 35-40; organic carbon 2.0-2.6%; EC: 0.3-0.8 dS/m) with a coastal Bermuda grass cover. The miniature cultivars (5 foot or less in mature height) were planted in 7 by 10 foot row spacing and the dwarf/small -sized cultivars (5 to 10 foot in mature height) were planted in 12 by 18 foot row spacing. Each cultivar was replicated five times, and they were arranged in a complete randomized block design. Three to four weeks prior to transplant the plant rows were roto-tilled twice with a tractor-operated 30" wide tiller. After transplant, 0.5 inch polyethylene irrigation lines were laid along each row and pressure compensated Netafim drippers were fitted with spaghetti tubing, one per plant. Two weeks following transplant, mulch from chipped local hardwood trees was spread around each plant (1-2 feet diameter and 1-2 inches deep). Plants were periodically irrigated the first year and thereafter only as needed. Weeds have been controlled mechanically, and occasionally with glyphosate (spot applications). The grass cover has been mowed as needed to maintain a maximum height of less than 2 inches. With the exception of a single fertigation event (water soluble fertilizer applied in irrigation water) in the summer of 2006, the plants have not received fertilizer nor pesticide applications. This low maintenance approach for the collection is patterned after the Earth-Kind™ philosophy used in previous landscape plant performance studies (5). Formal observations and ratings for this crape myrtle collection have been made only in 2006 and 2007, and include date to fist flower, flower density, winter die-back, growth index, rabbit damage, foliage quality and chlorophyll (SPAD) readings.

Results and Discussion:

In general, *Lagerstroemia* is considered a typically rugged and disease and insect free ornamental genus (1, 3, 4). The few insects reported to affect crape myrtle appearance are aphids, Japanese beetles, Florida wax scale, and flea beetles (1, 3). In our cultivar trial we have found that miniature and dwarf cultivars can also suffer from rodent herbivory damage. In recent years the urban surroundings in and around our Research and Extension Center have become a natural haven for cottontail rabbits (*Sylvilagus floridanus* Allen), which during the droughty 2005-2006 seasons became a significant nuisance and pest in our research and demonstration plots and gardens. Besides frequent and significant damage to irrigation lines, the rabbits also inflicted herbivory damage to the crape myrtle collection (Table 1). At first we thought that the damage was concentrated to plants close to the areas where the rabbits nested and hid during the daytime hours. Mapping of the plants with rabbit damage showed two things, 1) the damage was throughout the entire collection, and 2) it showed a distinctive pattern of feeding preferences. The cultivars with more noticeable rabbit damage were, in general, those with smaller sizes, suggesting better access to the rodents. The Razzle Dazzle^{TM} cultivar series were added to the collection in the fall of 2006, and given their relative small size, as a group they suffered rabbit damage their first winter (2006/07). Interestingly, the *L. indica* cultivar ‘White Chocolate’, among the tallest in this collection, also showed some feeding damage, suggesting it was fairly palatable to the rabbits. The dwarf trait in crape myrtles is believed to be conferred by the *L. indica* parent, and therefore leads to pose the question of whether plants with a stronger *L. fauriei* genetic background would be as palatable as apparently are those with a stronger *L. indica* background. As a precedent, existing information on the feeding preference of the *Altica* flea beetles suggests palatability differences associated with the genetic background of the crape myrtle cultivars (3). However, the damage observed on the interspecific hybrids ‘Pokomoke’ and ‘Chickasaw’ suggests size is a more critical factor for rabbit herbivory damage.

The late fall and winter months in North Texas (USDA Hardiness Zone 7b-8a) can be fairly mild and not produce environmental cues that lead to deep dormancy conditions in deciduous woody ornamentals like *Lagerstroemia*. In fact, widely fluctuating winter temperatures and sudden cold fronts are often responsible for significant winter damage in many woody ornamental taxa in the region. The 2005-06 winter caused a high percentage of crape myrtle winter die-back in the 2006 spring season, not only in our miniature-dwarf cultivar collection (Table 2, data shown only for the worst affected cultivars), but also in all medium-standard size cultivars throughout the entire region (personal communication with growers and landscapers). The 2006-07 winter was not as stressful as the previous one, but dieback damage was still observed in a selected group of cultivars (Table 2). It was observed that a *L. indica* cultivar series that originated in Louisiana, mainly ‘Houston’, ‘Bayou Marie’, ‘Sacramento’, ‘Delta Blush’ and ‘World’s Fair’, were among the most susceptible to winter damage. In a dwarf crape myrtle cultivar performance evaluation trial similar done in Louisiana by Owings et al. (7), they also found that substantial winter damage in ‘ Orlando’, ‘Houston’ and ‘World’s Fair’. Interestingly, several of the US National Arboretum interspecific hybrids, thought to be fairly winter hardy, also suffered considerable winter damage in our trial; these included ‘Pecos’, ‘Chickasaw’, NA69851 and NA62917. Owings et al. (7) also reported significant winter damage in ‘Chickasaw’. Based on these observations, and those of local landscapers and nursery growers, we contend that lack of proper winter hardening and/or significant mid-winter de-hardening conditions in North Texas are a major stress and selection factor to be considered in the identification of crape myrtles and other plants recommended for the region.

There are many characteristics and traits that are desirable in a landscape plant, particularly those of the ornamental or aesthetic type. Therefore, flower color, density and longevity, foliage color and texture and plant size and form are of primary consideration. Plant landscape performance is, however, more that aesthetic/ornamental characteristics under well- or intensively-managed cultural conditions, and therefore should also consider those traits under stress conditions, including low maintenance management and poor or extreme environments and soils. Given the challenging and often stressful nature of weather and soils in the North Texas region, plant evaluations in our research facility have been conducted under low maintenance management programs (i.e. Earth-Kind^{TM} philosophy; see George *et al*., (5)), intended to highlight both the most stress-resistant plants that meet ornamental/aesthetic expectations. We monitored and rated the crape myrtle collection during 2006 and 2007, specifically for date to fist flower, flower density (season), foliage quality (density, texture, color) and chlorophyll (SPAD) readings, winter damage, insect/disease/rodent damage and plant growth index. To obtain an overall plant performance index, the ratings or units of each individual parameter, except plant growth index, were normalized on a 1 to 5 scale (1= poor, 5= best). These normalized ratings were then added (six categories, for a maximum score of 30) to yield the landscape performance index (LPI) for each plant (repetition) and then averaged to yield the average for each cultivar. These data are shown in Table 3. Interestingly, based on this approach, the results indicate that eight of the best ten overall performers were *L indica* cultivars, with the top five being ‘Pink Ruffles’, ‘Petite Pinkie Monkie’, ‘Petite Embers’, ‘Delta Blush’ and ‘Snow’. In their trial, Owings et al. (7) reported ‘New Orleans’, ‘Orlando’, ‘Sacramento’ and ‘Houston’ as the top performers, cultivars that that at best only had intermediate ratings in our study. We should point out that in contrast to our study, Owings et al. (7) grew their plants in raised beds amended with pine-bark and rice hulls, as well as providing them with spring and summer fertilization. ‘Hopi’ and ‘Zuni’ were the only *L. indica* x *L. fauriei* interspecific hybrids among the top ten performers in our study. In fact, as a group, the interspecific hybrids, which have been widely popular in recent years, and which in the intermediate to tall classes have been reported as top or superior performers in other regions (1, 4), were widely spread out in the overall rankings of our trial. While the overall rating and landscape performance of these hybrid cultivars may change over time, we believe that the purported hardy nature and good to outstanding performance reported elsewhere for these hybrids still requires further evaluation under stressful environments and under low maintenance conditions.

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Table 1. Percentage of winter die-back in dwarf and miniature crape myrtles in North Texas. Ratings were taken after leafing out in the spring. Data is presented only for the cultivars with the worst winter damage ratings.

2005/06 Winter		2006/07 Winter	
50% - 70% Dieback	**80 - 90% Dieback**	**50% - 70% Dieback**	**80 - 90% Dieback**
Delta Blush	Bayou Marie	Bayou Marie	Moned Chica Red
Houston	Moned Chica Red	Chickasaw	NA62917
Tonto	Chickasaw	Houston	Pecos
White Chocolate	Pecos	NA69851	
Orlando	NA62917	Snow Dazzle	
Zuni (40-50)	NA69850		
Petite Orchid Monhid			
Snow (Dwarf White)			
World's Fair			
NA63872			
NA67620			
NA68973			
NA69849			
NA69850			

Table 2. Rabbit herbivory damage in dwarf and miniature crape myrtles in North Texas. Data represents percentage of plants (replications) showing rabbit damage. Data were collected before spring bud break.

	Damaged Plants (%)	
Cultivars	**2006**	**2007**
Bayou Marie	20%	60%
Cherry Dazzle	---	100%
Chickasaw	40%	60%
Dazzle Me Pink	---	40%
Moned Chica Red	20%	40%
NA62917	40%	40%
NA63872	40%	40%
NA67620	0%	60%
NA69849	80%	80%
NA69850	40%	80%
NA69851	20%	20%
New Orleans	20%	20%
Pocomoke	20%	60%
Raspberry Dazzle	---	80%
Sacramento	20%	40%
Snow Dazzle	---	60%
White Chocolate	0%	20%

Notes: The NA series are non-released interspecific hybrid cultivars from the US National Arboretum. The Razzle Dazzle™ series were added in the fall of 2006 to the crape myrtle collection (originally established in 2003).

Table 3. Overall landscape performance index (LPI) and growth index (GI) of dwarf and miniature crape myrtle cultivars in North Texas. LPI is a composite index of flowering length and density and foliage greenness (chlorophyll readings); larger LPI values denote better landscape performance. Growth index was calculated as (height + width1 + width2)/3.

Cultivars	Overall LPI	GI (inches)	Cultivars	Overall LPI	GI (inches)
Pink Ruffles (Dwarf Pink)	23	41	Royalty	19	41
Petite Pinkie Monkie	23	37	Pink Velour	19	29
Petite Embers	23	33	Prairie Lace	19	25
Delta Blush	22	23	Acoma	19	65
Snow (Dwarf White)	22	36	Houston	19	18
Hopi	22	44	Petite Plum Monum	18	40
Low Flame	22	26	NA67620	18	18
Baton Rouge	21	24	White Chocolate	17	32
Petite Snow	21	30	Orlando	17	20
Zuni	21	33	Pocomoke	17	16
World's Fair	21	27	NA63872	16	20
Petite Red Imp Monimp	20	25	NA69849	16	12
Petite Orchid Monhid	20	24	NA69850	15	10
NA68973	20	25	Moned Chica Red	15	8
NA68972	20	31	Pecos	15*	16
Tightwad	20	18	NA69851	15	10
Bourbon Street	20	28	Bayou Marie	15	18
Christiana	20	25	Chickasaw	15	8
Mandi	20	23	NA62917	12	11
Peppermint Lace	20	27	Dazzle Me Pink™	--	8
Tonto	20	33	Raspberry Dazzle™	--	11
Victor	19	24	Snow Dazzle™	--	8
New Orleans	19	23	Cherry Dazzle™	--	10
Sacramento	19	20			

Notes: The NA series are non-released interspecific hybrid cultivars from the US National Arboretum. The Razzle Dazzle™ series were added in the fall of 2006 to the crape myrtle collection (originally established in 2003). ***The extensive winter damage on Pecos made the calculation difficult of its growth index.

Drought Tolerance of Four Oleanders

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Index words: landscape irrigation, landscape plants, water conservation

Significance to Industry: Drought is one of the critical environmental stresses that affect the establishment or survival, growth and performance of shrubs and trees after being transplanted to urban and suburban landscape environments (2, 4). Watering restrictions, which are becoming more common in many parts of the world, exacerbate the effect of drought stress on the establishment and survival of these plants. The best strategy to improve the landscape performance may be the selection of drought tolerant plants. Limited research-based information exists in drought tolerance of numerous oleander cultivars. This study compared the growth response to drought stress in four oleander clones.

Nature of Work: Variations exist in characteristics of drought tolerance among cultivars (7), seed sources (3), and provenance (1, 6). These variations in response to stress among genotypes offer opportunities for selecting plants with optimal characteristics. Oleander (*Nerium oleander* L.), native to Southern Asia and Mediterranean region, is a fast-growing evergreen shrub commonly used in landscapes, parks, and along roadsides. About 400 cultivars have been named representing a wide variety of flower colors (5). The objective of this study was to determine and compare the drought tolerance of two representative commercial cultivars, 'Hardy Pink' and 'Hardy Red' and two breeding lines, EP1 and EP2. EP1 and EP2 were selected because these plants were still surviving after being un-watered for 8 years in a desert climate.

Vegetative cuttings of EP1 and EP2 were taken in July 2005 from the field plants planted in 1992 and not watered since 1997 and the cuttings of 'Hardy Pink' and 'Hardy Red' were taken the following week. All cuttings were treated with NAA at 2000 ppm and rooted in a 1:1 (v:v) mix of perlite and vermiculite. Rooted cuttings were transplanted on 17 Aug to 1.8-L round plastic pots filled with a 1:1 potting mix of Sunshine Mix No. 4 (SunGro Hort., Bellevue, WA) and composted mulch (Western Organics, Inc., Tempe, AZ) amended with 5 $kg \cdot m^{-3}$ dolomite limestone (Carl Pool Earth-Safe Organics, Gladewater, TX) and 1 $kg \cdot m^{-3}$ Micromax (Scott, Marysville, OH). The plants were transplanted again on 2 Feb 2006 to 12-L plastic pots filled with the same medium.

Mild drought stress, initiated on Jun 25, was created by withholding irrigation until a predetermined container weight was reached, which corresponded to a predawn leaf water potential of ~ -1.2 MPa. Plants were weighed daily and irrigated individually according to container weights. Before ending the drought treatment, a severe drought stress was imposed from 6 Sept until severe drought stress was reached (predawn water potential of – 2.0 MPa or lower). Main stem diameter (10 cm above the medium surface), shoot number and total length of all shoots per plant were recorded both at the beginning and at the end of the experiment. Plants were destructively harvested at the end of the experiment. Fresh weights of shoots, leaves, stem diameter, and roots, and leaf length and width of three youngest, fully expanded leaves per plant, and total leaf area per plant were determined. Dry weights of shoots, leaves, and roots were determined after oven drying.

Results and Discussion: There were no differences in main stem diameter in the drought-treated plants and in the increases in diameter among the four clones (Fig. 1). In the control plants, EP1 had the thickest stems. At the beginning, there were no differences in total shoot length and number among clones. However, after the drought treatment, EP2 had the smallest shoot growth. Also, there was no new shoot developed in EP2 under drought stress. ‘Hardy Pink’ had more new shoots and had the greatest shoot growth or elongation in the drought treatment than any of other clones.

Drought reduced shoot DW by 52%, 41%, 11%, and 34% in EP1, EP2, ‘Hardy Pink’, and ‘Hardy Red’, respectively, compared to the control (Fig. 2). The order of reduction percentage in total DW was the same as that in shoot DW. Drought stress also reduced the root DW by 17%, 15% and 22% in EP1, EP2, and ‘Hardy Red’, respectively. However, root DW was increased by 20% in ‘Hardy Pink’. Root to shoot DW ratio was higher for the drought-treated plants than the control regardless of clone. The increased percentage in root to shoot ratio compared to the control was highest in EP1, EP2, ‘Hardy Pink’, and ‘Hard Red’, in descending order.

Drought stress reduced leaf size and area in all clones (Fig. 3). For the control plants, EP1 had the largest leaf area and all others had similar leaf area. In drought-treated plants, leaf area was largest in EP1, followed by ‘Hardy Pink’, ‘Hardy Red’ and EP2, respectively, in descending order. Without drought stress, EP2 and ‘Hardy Pink’ had highest specific leaf mass, followed by EP1 and ‘Hardy Red’. In the drought treated plants, EP2 and ‘Hardy Pink’ had greater specific leaf mass than EP1 and ‘Hardy Red’ but no differences were found among ‘Hardy Pink’, ‘Hardy Red’, and EP1. ‘Hardy Pink’ had the smallest leaves, followed by ‘Hardy Red’, compared to EP1 and EP2 (Fig. 3). For the drought-treated plants, EP1 had the longest leaves, followed by EP2, ‘Hardy Pink’ and ‘Hardy Red’. Both leaf width and length were reduced by the drought stress in all clones. By comparing the control plants, ‘Hardy Pink’ had the least growth reduction (shoot and root dry weight and leaf area) due to drought stress.

In summary, the growth of all clones responded to drought stress differently: EP2 had the highest root to shoot ratio with least shoot elongation and no development; EP1 kept shoot growth, had a lower ratio of root to shoot than EP2 but higher than the other clones; 'Hardy Pink' had the largest shoot growth and development with smallest leaves. Therefore, we concluded that 'Hardy Pink' may be more tolerant, followed by 'Hardy Red' in terms of productivity. However, EP1 and EP2 may be more tolerant to drought stress when survival is concerned because they had a larger root to shoot ratio, which indicates a large root system.

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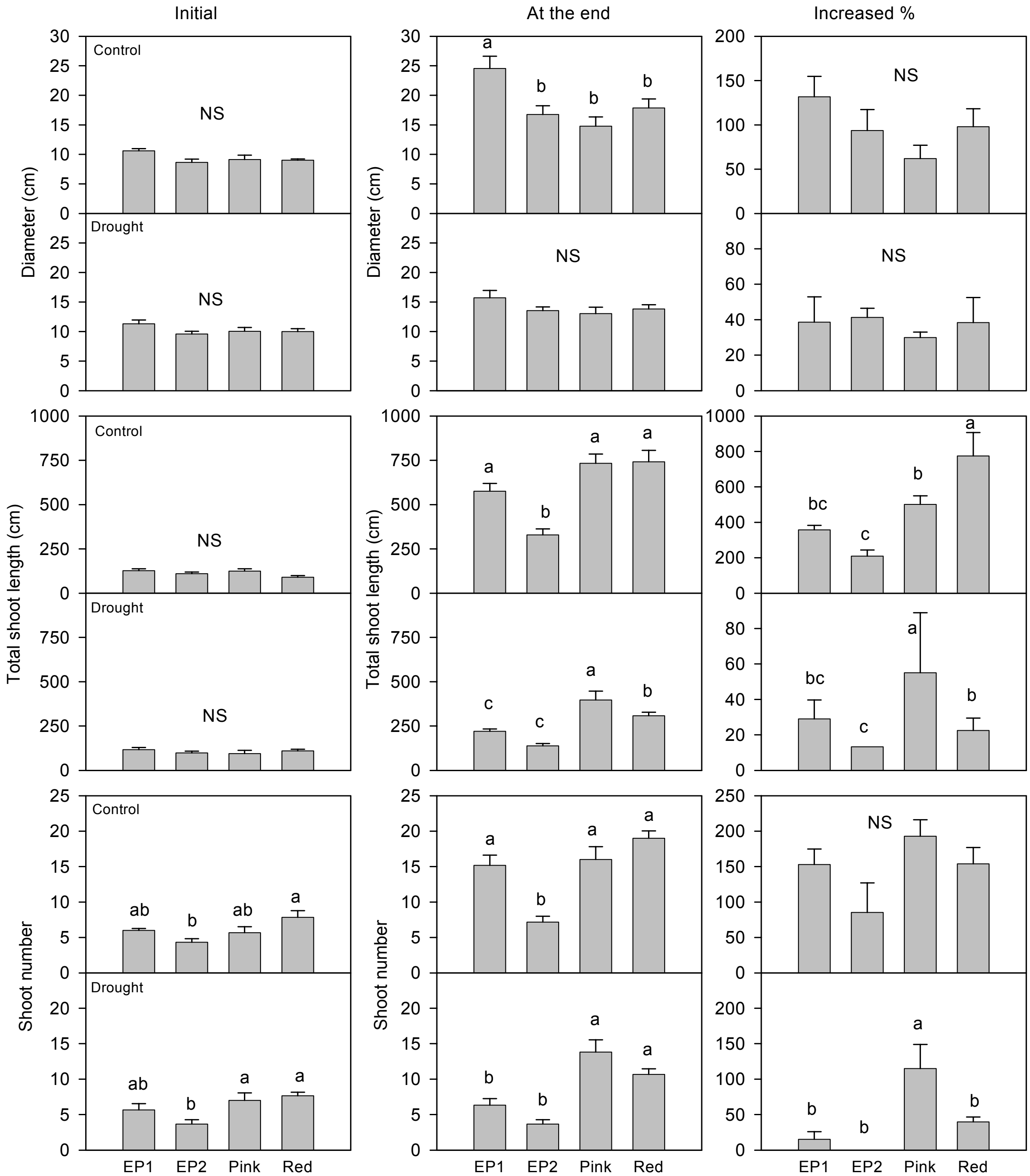

Figure 1. Effect of drought stress on stem diameter, total shoot length and number of EP1, EP2, 'Hardy Pink' (Pink), and 'Hardy Red' (Red) of *Nerium oleander*. Vertical bars represent standard errors. For the same treatment, means followed by the same letters are not significantly different among the cultivars tested by Student-Newman-Keuls multiple comparison at P = 0.05 (n=6).

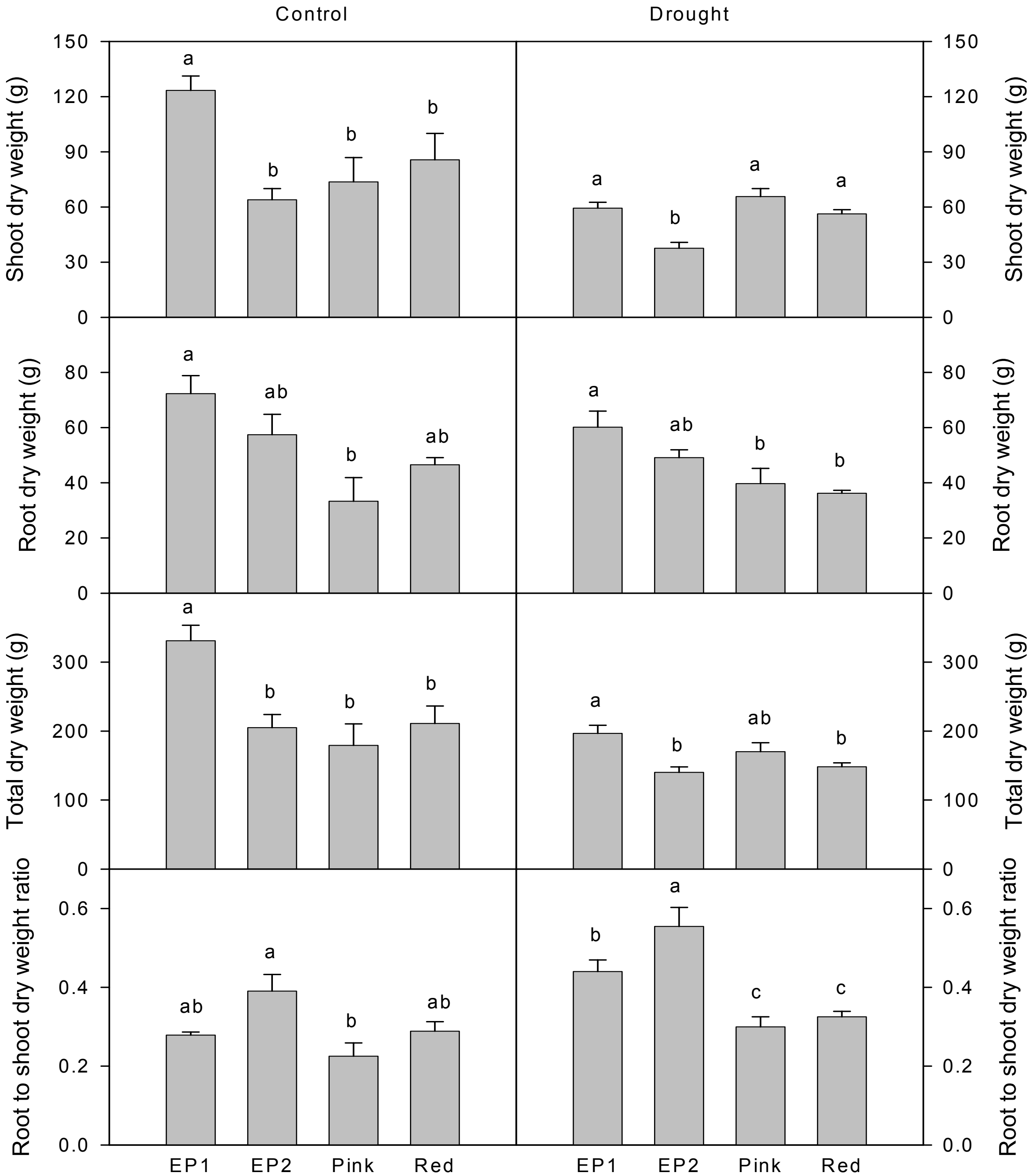

Figure 2. Effect of drought stress on shoot and root dry weight, total dry weight, and root to shoot dry weight ratio of EP1, EP2, 'Hardy Pink' (Pink), and 'Hardy Red' (Red)of *Nerium oleander*. Vertical bars represent standard errors. For the same treatment, means followed by the same letters are not significantly different among the cultivars tested by Student-Newman-Keuls multiple comparison at $P = 0.05$ (n=6).

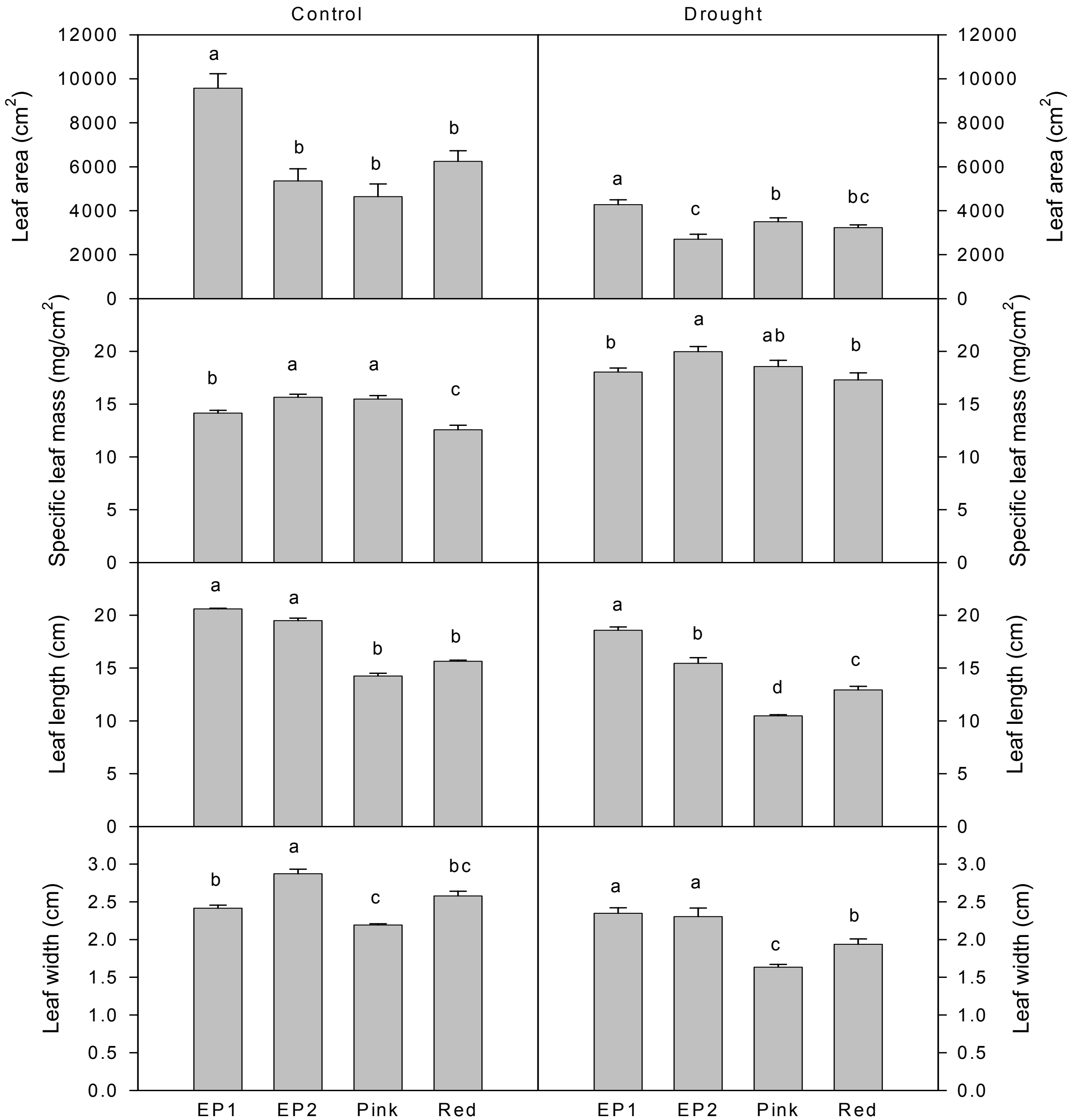

Figure 3. Effect of drought stress on leaf area, specific leaf area, leaf length, and leaf width of EP1, EP2, 'Hardy Pink' (Pink), and 'Hardy Red' (Red) of *Nerium oleander*. Vertical bars represent standard errors. For the same treatment, means followed by the same letters are not significantly different among the cultivars tested by Student-Newman-Keuls multiple comparison at P = 0.05 (n=6).

Landscape Performance of Recently Released Landscape Shrub Roses – Initial Observations

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Index Words: Landscape Performance, Roses, Blackspot

Significance to Industry: The introduction of new modern landscape shrub rose cultivars in the past ten years has been significant. Landscape shrub roses are also taken a much larger percentage of the market share in rose sales over the past few years. Many of these new rose cultivars are being compared to the industry standard (‘Knock Out’) but very limited evaluations comparing side-by-side performance have been conducted or reported. Preliminary data at the LSU AgCenter shows ‘Home Run’ to be comparable to ‘Knock Out’ in disease resistance and flowering while ‘Wild Thing’ does not flower as well and has increased blackspot susceptibility.

Nature of Work: A landscape evaluation of several popular shrub roses was initiated at the LSU AgCenter’s Burden Center, Baton Rouge, LA in April 2006. The main purpose of this study, which will continue through 2008, is to compare the landscape performance of ‘Knock Out’, ‘Home Run’, and ‘Nearly Wild’ to the new Jackson and Perkins shrub rose for 2007 – ‘Wild Thing’.

Roses (#1 grade bareroot) were planted in early April. Plants were spaced 5’ apart in 48” wide raised (8”) rows consisting of native soil (Olivier silt loam, pH 6.4) and were located in full sun. Plants were fertilized with StaGreen Nursery Special 12-6-6 at the rate of one pound nitrogen per 1000 square feet bed area at planting and in July. The planting was a randomized complete block design with two five plant blocks of each cultivar. Plants were irrigated via a drip system as needed to prevent stress and mulched with 3” baled pine straw. Fungicide and insecticide were not applied. Amaze and spot applications of Roundup were used for weed control. Plants were not pruned or deadheaded during the 2006 growing season.

Visual quality ratings (based on a scale from 1 to 5 where 1=dead; 2=below average landscape performance; 3=average landscape performance; 4=above average landscape performance; 5=superior landscape performance) were taken twice monthly starting in mid-June and continuing through mid-October.

Results and Discussion: ‘Home Run’ from Weeks Roses has been comparable in performance, flowering and disease resistance to ‘Knock Out’ (Tables 1 and 2). Weeks Roses is promoting ‘Home Run’ as their equivalent to ‘Knock Out’. It is being grown at several wholesale nurseries in Louisiana and several major landscape plantings in Baton Rouge have recently included ‘Home

Run' roses. 'Nearly Wild', a floribunda rose released in 1942 and widely used by landscape contractors prior to the release of new roses in the past 5-7 years, had visual quality ratings in 2006 that we would typically consider above average (Table 1). 'Wild Thing' had the lowest visual quality ratings of the four cultivars being compared (Table 1) and flowering performance was below average (data not shown). It is classified as a landscape shrub rose and grows wider than it does tall. 'Wild Thing' and 'Nearly Wild' showed blackspot susceptibility by the fall months (Table 2).

Table 1. Visual quality ratings of shrub rose cultivars in a landscape comparison study – 2006

	6/15	7/1	7/15	8/1	8/15	9/1	9/15	10/1	10/15
'Wild Thing'	3.58	3.50	3.76	3.66	3.50	3.45	3.42	3.16	3.37
'Knock Out'	3.80	3.93	4.10	4.38	4.35	4.40	4.40	4.80	4.40
'Home Run'	4.10	4.45	4.10	4.20	4.30	4.20	4.20	4.25	4.10
'Nearly Wild'	3.85	3.90	3.90	4.05	3.95	3.45	3.75	3.85	3.80

Note: Visual quality ratings based on a scale from 1 to 5 where 1=dead; 2=below average landscape performance; 3=average landscape performance; 4=above average landscape performance; 5=superior landscape performance. Evaluation criteria included foliage color, flowering, uniformity, and overall aesthetics.

Table 2. Blackspot ratings of shrub rose cultivars in a landscape comparison study – 2006

	Summer	Fall
'Wild Thing'	1.5	2.4
'Knock Out'	1.0	1.0
'Home Run'	1.0	1.0
'Nearly Wild'	1.5	3.0

Note: Blackspot ratings based on a scale from 1 to 6 where 1 = 0% foliage with disease, 2 = 1-10% foliage with disease, 3 = 11-25% foliage with disease, 4 = 26-50% foliage with disease, 5 = 51-75% foliage with disease, and 6 = 76-100% foliage with disease.

Landscape Evaluation of Pansy and Viola Cultivars – 2006/2007

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Index Words: Landscape Performance, Pansy, Viola

Significance to Industry: With numerous pansies and violas on the market and the continued introduction of improved cultivars within series and the continued introduction of new series, landscape trials evaluating these plants are beneficial. Based on season long visual quality rating averages, 'Majestic Giant', 'Dynamite' and 'Rocky' were better landscape performers when considering all cultivars trialed in the series.

Nature of Work: A landscape trail evaluating the performance of pansy and viola cultivars was conducted by the LSU AgCenter at Burden Center in Baton Rouge, LA from November 2006 – May 2007. Pansy and violas evaluated in this cool season trial included nine cultivars of 'Dynamite' pansy, 10 cultivars of 'Majestic Giant' pansy, 4 cultivars of 'Crown' pansy, '15 cultivars of 'Rocky' viola and 13 cultivars of the 'FamaX' hybrid pansy.

Twenty-four plants from 606 cell packs of each cultivar were planted in landscape beds in mid-November 2006. The raised beds are enclosed by landscape timbers and are composed of pine bark planting mix on top of an Olivier silt loam native soil. The planting was located in full sun and plants received overhead irrigation via spray stake risers as needed to prevent stress during the evaluation period. Plants were spaced on one foot centers and received uniformly applied topdressings of StaGreen Nursery Special 12-6-6 (Pursell Industries) at the rate of 1 lb N/1000 square feet at planting and in early March. Plants were not deadheaded or pruned during the study season and no pesticides were applied for insect or disease control. Weed control was accomplished via hand removal and two applications of benefin + oryzalin (Amaze® from Green Light) at the label recommended rate in early December 2006 and in early March 2007.

Visual quality ratings based on a scale from 1 to 5 where 1=dead; 2=below average landscape performance; 3=average landscape performance; 4=above average landscape performance; 5=superior landscape performance were taken twice monthly starting January 15, 2007 and continuing through May 15, 2007. Evaluation criteria included foliage color, flowering, uniformity, and overall aesthetics.

Results and Discussion: 'Famax' hybrid pansies from Benary and 'Rocky' series violas from S & G Flowers lasted two weeks longer into the spring than did the three pansy series evaluated. Acceptable visual quality ratings were achieved until May 15 for the aforementioned series and acceptable visual quality ratings for the other three series were only achieved until early May.

Top performing cultivars in the ‘Dynamite’ series were ‘Cream’, ‘Purple’ and ‘Blue w/Blotch’ (Table 1). The poorer performers among the ‘Dynamite’ pansies were the mixes. ‘Rose Shades’ was the poorest performing among the ‘Majestic Giant’ pansies while ‘Yellow w/Blotch and ‘Sherry” had the highest visual quality ratings in the group. ‘Azure’ was the top performing ‘Crown’ series pansy cultivar.

In the ‘Rocky’ viola series, ‘Lavender Blush’, ‘Yellow with Blotch’, ‘Blue w/Purple Wing’, ‘Golden Yellow’, and ‘Cream w/Yellow Lip’ had the highest visual quality ratings based on season long performance (Table 1). ‘Neon Violet’ and ‘Pure Orange’ were the two poorest performers among the ‘Rocky’ series. ‘FamaX Golden Yellow’ and ‘FamaX White w/Blotch’ were the top performers in the series.

Table 1. Visual quality ratings of pansy and viola cultivars - 2007.

	1/15	2/1	2/15	3/1	3/15	4/1	4/15	5/1	5/15	Season Long Average
'Dynamite'										
Blue w/Blotch	3.2	3.2	3.7	3.7	3.8	3.7	3.7	3.2	----	3.53
Cream	3.2	3.7	3.8	4.0	3.8	3.5	3.7	3.3	----	3.66
Pure White	3.2	3.3	3.3	3.7	3.5	3.7	3.8	3.0	----	3.41
Yellow	3.0	3.0	3.3	3.5	3.5	3.5	3.5	3.3	----	3.33
White w/Blotch	3.3	3.3	3.3	3.5	3.5	3.5	3.5	3.3	----	3.40
Blue and White	2.8	3.2	3.2	3.7	3.5	3.5	3.3	3.3	----	3.31
Purple	3.5	3.8	4.2	4.2	3.8	3.8	3.5	3.3	----	3.76
Clear Mix	3.0	3.0	3.0	3.3	3.3	3.2	3.2	3.0	----	3.13
Blotch Mix	2.7	2.7	3.0	3.2	3.0	3.0	3.0	2.7	----	2.91
'Majestic Giant'										
Sherry	3.3	3.8	4.0	4.0	3.5	3.2	3.7	3.3	----	3.60
Yellow w/Blotch Imp	3.2	3.5	3.7	3.7	3.7	3.2	3.5	3.3	----	3.48
White w/Blotch	3.0	3.5	3.7	3.7	3.8	3.2	3.3	3.3	----	3.44
Yellow w/Blotch	3.5	3.8	4.0	4.2	3.8	3.5	3.7	3.3	----	3.73
Blue White w/Blotch	2.8	3.3	3.5	3.5	3.5	3.8	3.5	3.5	----	3.43
Rose Shades	2.8	2.8	3.2	3.2	3.2	3.0	2.7	3.2	----	3.01
Deep Blue w/Blotch	3.0	3.2	3.3	3.7	3.5	3.2	3.3	3.3	----	3.31
Blue Shades	3.0	3.0	3.3	3.5	3.5	3.3	3.3	3.2	----	3.26
Purple	3.2	3.3	3.7	3.7	3.7	3.5	3.5	3.2	----	3.48
Blue w/Blotch	3.0	3.2	3.5	3.8	3.5	3.2	3.2	3.2	----	3.33
'Crown'										
Azure	3.2	3.5	3.7	3.8	3.5	3.7	3.8	3.5	----	3.59
Purple	2.8	3.0	3.5	3.5	3.3	3.3	3.3	3.0	----	3.21
Yellow Splash	3.0	2.8	3.5	3.5	3.5	3.5	3.7	3.3	----	3.35
Formula Mix	3.0	2.8	3.0	3.2	3.2	2.8	3.0	3.0	----	3.00
'Rocky'										
Blue for You	3.0	3.0	3.2	3.3	3.5	3.3	3.3	3.3	3.0	3.21
Pure White	3.0	3.3	3.3	3.3	3.2	3.2	3.2	3.3	3.0	3.20
Ruby w/ Yellow Face	2.8	3.0	3.2	3.3	3.3	3.5	3.5	3.3	2.8	3.19
Cream w/ Yellow Lip	3.2	3.5	3.5	3.5	3.7	3.5	3.5	3.5	2.5	3.38
White w/Purple Wing	2.8	3.0	3.3	3.5	3.3	3.0	3.3	3.0	2.2	3.04
Pure Orange	3.0	3.2	3.3	3.3	3.2	3.2	3.2	2.8	1.8	3.00
Deep Purple	3.0	3.2	3.2	3.3	3.3	3.0	3.3	3.0	2.3	3.07
Pink	3.0	3.3	3.5	3.7	3.5	3.0	3.2	2.8	2.5	3.17
Yellow w/Blotch	3.2	3.2	3.5	3.7	3.7	3.7	3.8	3.3	3.0	3.43
Blue w/Purple Wing	3.0	3.2	3.3	3.5	3.7	3.5	3.7	3.7	3.3	3.43
Golden Yellow	3.0	3.0	3.3	3.3	3.5	3.7	3.7	3.7	3.3	3.39
Skyscape	2.8	3.0	3.0	3.2	3.3	3.5	3.5	3.5	3.3	3.23
Lavender Blush	3.0	3.0	3.3	3.3	3.7	3.8	3.8	4.0	3.3	3.47
Lemon Yellow	2.8	3.0	3.0	3.3	3.5	3.3	3.3	3.2	2.7	3.12
Neon Violet	2.8	2.8	3.0	3.2	3.2	3.0	3.2	3.0	2.2	2.93

Table 1 (continued).

	1/15	2/1	2/15	3/1	3/15	4/1	4/15	5/1	5/15	Season Long Average
'FamaX'										
Purple and White	2.2	2.2	2.5	3.0	3.0	3.0	3.7	3.7	2.3	2.84
White w/Blotch	2.7	2.7	2.7	3.0	3.0	3.0	3.7	3.5	2.8	3.01
Primrose Improved	2.7	2.7	2.7	3.0	3.0	3.0	3.5	3.5	2.8	2.93
Peach Shades	2.7	2.7	2.8	3.2	3.0	3.0	3.5	3.5	2.7	2.66
White	2.5	2.7	2.7	3.0	3.0	2.8	3.2	3.2	2.3	2.82
Silver Blue	2.5	2.5	2.5	2.7	2.8	2.7	3.2	3.2	2.8	2.77
Yellow w/Blotch	2.5	2.7	2.8	3.0	2.7	2.7	3.0	2.8	2.3	2.72
Purple	2.5	2.5	2.5	2.7	2.7	2.7	3.0	3.0	2.5	2.68
Golden Yellow	2.7	2.8	2.8	3.0	3.2	3.5	3.8	3.7	2.7	.13
Deep Orange	2.7	2.7	2.7	2.7	2.8	3.0	3.2	3.2	2.3	2.72
Ruby	2.5	2.7	2.8	3.0	2.8	2.8	2.8	2.7	2.2	2.70
Blue w/Blotch	2.7	2.7	2.8	3.0	3.2	3.0	3.3	3.0	2.5	2.91
Golden Yellow Improved	2.5	2.7	2.8	2.7	2.7	2.5	3.0	3.0	2.5	2.71
LSD (alpha=0.05)	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.4	0.34

Note: Visual quality ratings based on a scale from 1 to 5 where 1=dead; 2=below average landscape performance; 3=average landscape performance; 4=above average landscape performance; 5=superior landscape performance. Evaluation criteria included foliage color, flowering, uniformity, and overall aesthetics.

Landscape Evaluation of Petunia Cultivars – 2006/2007

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Index Words: Landscape Performance, Petunias

Significance to Industry: Petunias are one of the bedding plant groups that have been greatly improved upon in recent years. Tremendous advances have been made in the release of seed propagated spreading petunias. Thus far, research results pertaining to landscape evaluation of these petunias has not been reported at the Southern Nursery Association Research Conference. Our studies show ‘Easy Wave’, ‘Wave’ and ‘Tidal Wave’ to be good landscape performers in Louisiana during cool seasons of the year.

Nature of Work: A landscape trail evaluating the performance of seed propagated spreading petunia cultivars was conducted by the LSU AgCenter at Burden Center in Baton Rouge, LA from October 2006 – June 2007. Petunia evaluated in this cool season trial included 9 cultivars of ‘Supercascade’, 6 cultivars of ‘Wave’, 12 cultivars of ‘Easy Wave’ and 14 cultivars of ‘Tidal Wave’.

Twelve plants from 606 cell packs of each cultivar were planted in landscape beds in late-October 2006. The raised beds are enclosed by landscape timbers and are composed of pine bark planting mix on top of an Olivier silt loam native soil. The planting was located in full sun and plants received overhead irrigation via spray stake risers as needed to prevent stress during the evaluation period. Plants were spaced on two foot centers and received uniformly applied topdressings of StaGreen Nursery Special 12-6-6 (Pursell Industries) at the rate of 1 lb N/1000 square feet at planting and at the rate of 0.5 lb N/1000 square feet in mid-March. Plants were not deadheaded or pruned during the study season and no pesticides were applied for insect or disease control. Weed control was accomplished via hand removal and two applications of benefin + oryzalin (Amaze® from Green Light) at the label recommended rate in early November 2006 and in late February 2007.

Visual quality ratings based on a scale from 1 to 5 where 1=dead; 2=below average landscape performance; 3=average landscape performance; 4=above average landscape performance; 5=superior landscape performance were taken twice monthly starting December 15, 2006 and continuing through June 1, 2007. Evaluation criteria included foliage color, flowering, uniformity, and overall aesthetics.

Results and Discussion: In the 'Wave' petunia group, 'Misty Lilac' and 'Pink' slightly out-performed the other colors in the series although all produced plants of very acceptable quality throughout the evaluation period (Table 1). 'Tidal Wave' petunias were the top performing series of all the petunias evaluated – 'Silver' was slightly better than 'Hot Pink' and 'Cherry'. The "mixes" in the 'Easy Wave' group had lower visual quality ratings than the solid color cultivars in the 'Easy Wave' series. The 'Wave' series was slightly better overall later in the evaluation period than the 'Easy Wave' series. 'Supercascade' petunias performed well in the earlier portion of the evaluation period but declined much faster than the other series. 'Supercascade' petunias begin to decline due to foliar disease in early May and were dead by late May.

Table 1. Visual quality ratings of landscape planted petunia cultivars - 2006/2007.

	12/15	1/1	1/15	2/1	2/15	3/1	3/15	4/1	4/15	5/1	5/15	6/1
'Supercascade'												
Salmon	2.8	2.5	2.5	2.5	2.5	2.7	2.8	2.8	2.8	2.7	1.7	----
Blue	2.8	3.2	3.0	3.0	3.0	3.2	3.2	3.4	3.4	2.8	2.2	----
Pink	2.3	2.2	2.2	2.5	2.8	2.8	3.0	3.4	3.0	3.0	2.0	----
Red	2.2	2.3	2.3	2.2	2.5	2.8	2.8	3.2	3.2	2.5	2.0	----
White	2.7	2.7	2.8	3.0	3.2	3.0	2.8	3.2	2.8	2.5	1.0	----
Burgundy	2.7	2.7	2.7	2.8	2.8	3.0	3.4	3.4	3.0	2.7	1.8	----
Blush	2.8	2.6	2.8	2.8	3.0	3.0	3.0	3.2	3.0	2.7	1.7	----
Lilac	2.7	2.8	3.0	3.0	3.0	3.0	3.4	3.0	2.8	2.8	2.2	----
Rose	2.5	2.5	2.7	2.7	2.8	3.0	3.2	3.0	3.0	3.0	2.2	----
'Wave'												
Misty Lilac	3.5	3.5	3.5	3.0	3.4	3.5	3.5	4.2	4.5	4.5	3.0	2.5
Blue	2.7	2.8	3.3	3.0	3.4	3.3	3.2	3.7	4.0	4.4	3.4	2.5
Purple	2.7	2.8	3.0	3.0	3.4	3.4	3.2	4.0	4.2	4.2	3.8	2.8
Lavender	2.5	2.7	2.7	2.7	2.8	3.0	3.0	3.5	4.2	3.8	3.8	3.4
Rose	3.0	3.4	3.0	3.0	3.2	3.2	3.0	3.5	4.0	4.0	3.0	2.2
Pink	3.0	3.4	3.4	3.2	3.4	3.5	3.4	3.7	3.8	4.4	3.8	3.5
'Easy Wave'												
Formula Mix	2.8	2.7	2.8	2.8	3.0	3.0	3.4	3.5	3.7	3.7	2.8	2.2
Shell Pink	2.4	2.4	2.5	2.7	3.0	3.0	3.2	3.8	3.8	4.0	2.8	2.0
Salmon	2.7	2.7	2.8	3.0	3.0	3.0	3.2	4.2	4.2	4.2	3.0	1.8
Rose Dawn	2.2	2.5	2.5	2.7	3.0	2.8	3.0	4.2	4.2	4.0	3.0	1.8
Red	2.8	2.8	2.8	2.8	3.0	3.0	3.4	4.0	4.0	4.0	2.7	2.0
Beachcomb Mix	2.7	2.7	2.8	3.0	3.0	3.2	3.2	3.7	3.8	3.8	2.7	2.0
White	2.3	2.5	2.5	2.7	3.0	2.8	3.0	3.8	4.0	3.7	2.5	1.5
Pink	2.3	2.5	2.7	2.8	3.0	3.2	3.0	3.7	4.0	4.2	2.8	1.8
Tropicana Mix	2.4	2.4	2.4	2.8	2.7	2.7	2.8	3.5	3.8	3.8	2.7	1.7
Coral Reef	2.7	2.8	2.8	2.8	3.0	3.2	3.4	3.5	4.0	4.0	2.8	1.5
The Flag Mix	2.0	2.0	2.2	2.4	2.8	2.8	2.7	3.5	3.8	3.8	2.8	2.0
Blue	1.7	2.0	2.2	2.4	2.8	2.8	2.8	3.5	3.7	3.8	3.3	2.7
'Tidal Wave'												
Silver	3.5	3.5	3.5	4.0	3.7	3.7	3.8	4.7	5.0	4.8	4.4	3.0
Cherry	3.5	3.7	4.2	4.4	4.5	4.5	4.2	4.5	4.7	4.5	3.0	2.7
Purple	3.5	3.4	3.5	3.7	3.8	4.2	4.0	4.5	4.7	3.8	2.4	1.0
Hot Pink	3.0	3.2	3.7	4.2	4.0	4.4	4.2	4.7	4.8	4.7	3.2	1.3
LSD *(alpha=0.05)*	0.6	0.7	0.6	0.7	0.7	0.7	0.6	0.8	0.8	0.7	0.6	0.4

Note: Visual quality ratings based on a scale from 1 to 5 where 1=dead; 2=below average landscape performance; 3=average landscape performance; 4=above average landscape performance; 5=superior landscape performance. Evaluation criteria included foliage color, flowering, uniformity, and overall aesthetics.

Distribution of Trunk-Injected ^{14}C Imidacloprid in *Fraxinus* Trees: A Test of the Sectored–flow Hypothesis

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Key Words: Emerald Ash Borer, Imidacloprid, Sectored Flow, Trunk Injection

Significance to Industry: Emerald Ash Borer (EAB, *Agrilus planipennis* Fairmore, Buprestidae) is a phloem boring exotic insect pest from Asia. It attacks all North American ash species (*Fraxinus spp*.). The borer arrived in the United States near Detroit, Michigan in the late 1990's and was first identified in 2002 after reports from homeowners of dead and dying ash trees. Since its arrival, it has killed over 25 million ash trees in Michigan and is now found across the Midwest and Canada. One successful treatment against EAB is imidacloprid applied systemically as a trunk injection. This study is significant to industry in that it will give arborists an understanding of the flow of pesticide through the tree and thereby enable them to improve the efficacy of trunk injection treatments.

Nature of Work: In a previous study at Michigan State University researchers used ^{14}C labeled imidacloprid to track trunk injected pesticide movement in ash trees (1). The study demonstrated that imidacloprid moves slowly but steadily through the tree over time and accumulates in the leaves but the sampling protocol did not permit a thorough examination of spatial variability of imidacloprid distribution in the trees. Orians et al (2) demonstrated that sap flow in trees may be sectored or integrated depending upon tree species. Highly sectored flow could result in an uneven distribution and variable efficacy of trunk injected pesticide.

On June 27, 2006 we trunk injected 32 trees (16 *Fraxinus americana*, 16 *F. pennsylvanica*) at a single point with 25 µCi ^{14}C labeled imidacloprid and Imicide® imidacloprid at a ratio of 1:1300 labeled to unlabeled compound. Trees were 1.5-2.0" caliper bare root planted in 25 gallon containers of pure sand. *F. americana* trees were trunk injected at 0º to the first whorl of branches (Figure 1). *F pennsylvanica* trees were injected at either 0º or 90º to the first whorl of branches. Each branch of the first three whorls of the tree was labeled 0º / 180º or L90º / R90º depending on the location of the branch in relation to the injection point. Each branch was sampled separately.

Fine roots, trunk cores, and leaves were sampled at 0, 2, 7, 21, 60, and 98 days after treatment (DAT). Stems were sampled only once at 60 DAT to minimize trunk damage. At the end of the growing season, trees were wrapped in netting and litterfall was collected. Samples were oven dried, ground with a mortar and pestle and oxidized in a biological tissue oxidizer. The resultant CO_2 was trapped in scintillation cocktail and the amount of radioactivity was determined using a scintillation counter. Total “imidacloprid equivalents” per microgram of dry weight were calculated from activity counts after accounting for oxidizer (97%) and scintillation counter (97%) efficiencies. Preliminary analysis presented here examines trees injected at both 0º and 90º (Figure 1).

Results and Discussion: Imidacloprid equivalents in leaves varied with time, orientation to the injection point, and whorl height. Trees injected at 0º to the first whorl of branches had an increase in imidacloprid equivalent concentration (IEC) throughout the growing season in leaves of branches in the plane of injection (0º) (3). Leaves of branches opposite of the injection point (180º) had lower ($p<0.05$) IEC than the 0º branches (Figure 2). Leaves of branches at right angles to the 0º injection point (L90º and R90º) had intermediate IEC when compared to the leaves on the 0º and 180º branches. Variation in IEC between the 0º and 180º branches was also different ($p<0.05$) in whorl 3 however, the difference was smaller than whorl one suggesting that flow becomes more integrated with plant height.

Branches of trees injected at 90º to the first whorl of branches had greater ($p<0.05$) IEC in leaves on branches at Right 90º when compared to leaves of branches at Left 90º. Leaves on the second whorl of branches in the plane of the injection point (0º) had higher ($p<0.05$) IEC when compared to the leaves on the branch at the 180º position.

Roots, stems, and trunk cores collected 60 DAT had lower ($p<0.05$) IEC than those found in leaves. In addition to examining different plant parts we also examined IEC differences between leaves on whorl one and leaves on adventitious shoots growing below the injection site (Figure 2). Leaves growing on adventitious shoots had lower ($p<0.05$) IEC than leaves growing on either the 0º or 180º branches. Both patterns suggest that the movement of imidacloprid occurs primarily in the xylem.

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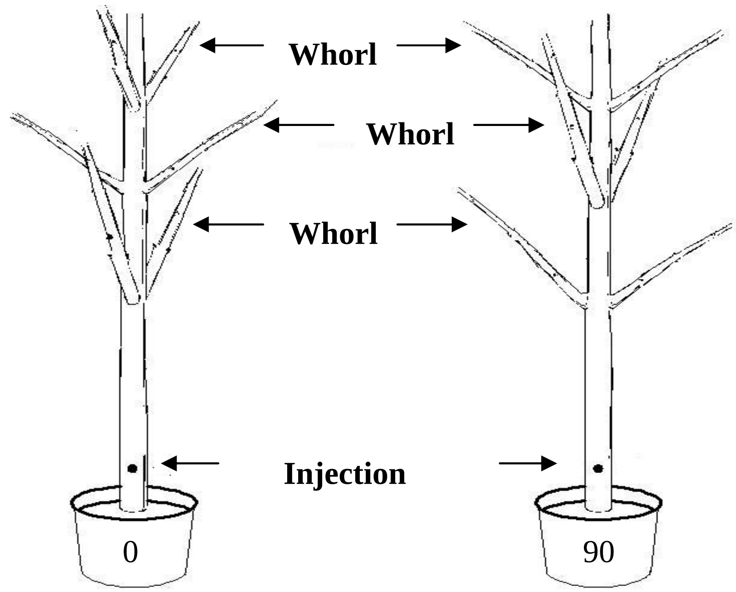

Fgure 1. Tree injected at 0º and 90º to the first whorl of branches. Mean distance from injection point to the first whorl = 1.28 m. Mean distance between whorls = 0.18 m.

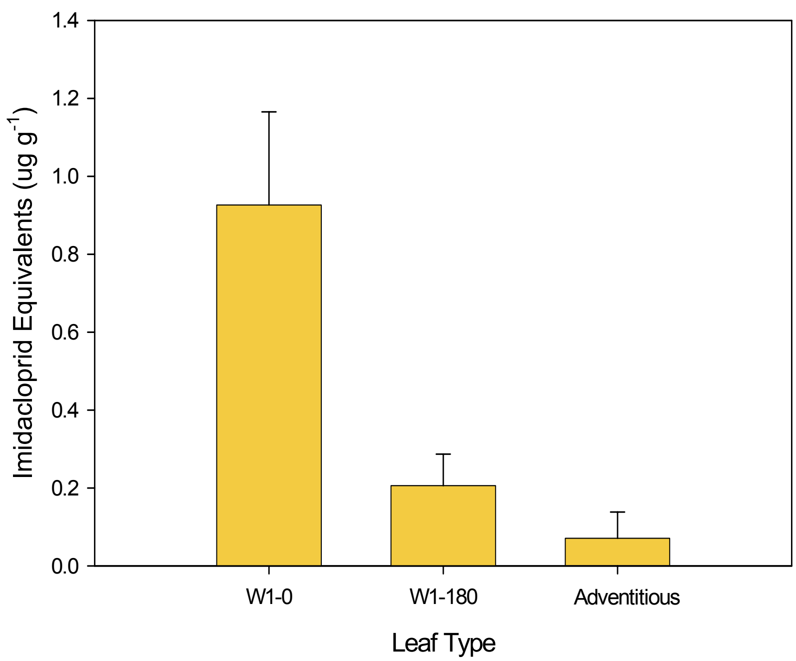

Figure 2. Imidacloprid Equivalent Concentration in adventitious shoots growing below the injection point and whorl 1 leaves in the plane of injection (0°) and leaves directly opposite the injection point (180°) of ^{14}C injected *F. americana*.

Succulents for Southern Gardens

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Index Words: *Aloe, Bulbine, Delospermum, Kalanchoe, Sedum*

Nature of Work: The production and marketing of succulents that perform well in landscapes and container gardens is an opportunity for nurserymen to expand their markets for these plants. These plants have been identified as an important component of energy conservation programs for development of vegetated roofs and have many cultural qualities that may be suitable for southern gardens (1). The risk involved in introducing these plants to a nursery is large because of intense competition in the niche nursery plant market, and the ever shifting consumer tastes in odd or unusual plants. However, there is a large and increasing demand for new and unusual material accompanied by the willingness of buyers to pay top dollar for such products. In addition, Florida's unique climate opens opportunities for growing many plants that cannot be grown economically in latitudes to our north. The objective of the succulent research project was to evaluate landscape performance of hardy and nonhardy species that perform well in Northwest Florida during the warm season.

From June to October 2006 and April 2007, plants were evaluated in garden soil 20 miles from the Gulf of Mexico at the West Florida Research and Education Center (WFREC) in Milton. Treatments were designed to explore plant performance with and without supplemental irrigation. The experiment included ten succulent species planted in a split-block design to accommodate the overhead irrigation treatment. Within each irrigation treatment, two plants of each species were planted in eight complete blocks. (16 plants per cultivar, per irrigation treatment) (Table 1). Liners of succulents were planted on June 2, 2006 on 2 ft centers. Four grams of slow release fertilizer 17-5-12 (17N-2.2P-10K) were incorporated around each plant prior to applying a 2 inch layer of organic mulch. All plants received four applications of overhead irrigation during a two week period of establishment. For the remainder of the growing season one half of the plants received no supplemental irrigation while the remaining plants received a weekly irrigation. Hand weeding and Glyphosate were used to control weeds.

Succulents were evaluated for survival, shoot growth index [mean of height (cm) and the mean of two perpendicular widths (cm)], presence of flowers (data not presented) and a subjective visual evaluation of quality following establishment (1 to 5 scale, 1 = excellent, 5 = poor) on a monthly basis. Interaction of main effects and differences between means were analyzed using the PROC GLM and LSMeans procedures of SAS.

Results and Discussion: Most succulents performed well under the two irrigation regimes (Table 1). Initial survival (2006) was 94% or greater for all species but jade plant (36 to 63%) and panda plant (50 to 63%). These two species performed very poorly regardless of irrigation treatments although nearly twice as many Jade plants survived with supplemental irrigation. However, surviving plants remained very small and many plants exhibited increasing levels of sun scald prior to plant death. For surviving jade plants visual ratings did not improve from the time of planting. Panda plant survival did not improve with supplemental irrigation and although surviving plants grew very little they did retain an attractive appearance with a visual rating near 1. Neither jade plant nor panda plant exhibited regrowth in 2007.

The remaining eight species performed very well in 2006 but Mexican poinsettia and air plant did not exhibit regrowth in 2007. Both Mexican poinsettia and air plant exhibited high survival (94 to 100%) in 2006 and received visual ratings near 1 throughout the growing season. However, although visual appearance of the plants did not differ, air plant height and width were greater in plots that did not receive supplemental irrigation. Growth did not differ among Mexican poinsettia grown with and without irrigation.

Aloe, Hallmark bulbine, ice plant, Sea Star sedum, Neon sedum and Coral Reef sedum all exhibited regrowth in 2007. Supplemental irrigation appeared to have no influence on winter survival although some numerical differences in survival are noted. Although aloe plants survived winter freezes, the small portions of surviving plants are performing poorly and received visual ratings of 3 to 3.5. Additionally, plants in irrigated plots were smaller and had higher visual ratings indicating these plants exhibited more necrotic tissue.

Hallmark bulbine, ice plant, Sea Star sedum, Neon sedum and Coral Reef sedum were the best performers in this trial regardless of irrigation. Only ice plant exhibited notable losses at transplant and these occurred primarily in the irrigated plots. For all six of these species there was no additional plant death following the October 2006 rating.

Significance to Industry: Succulent trials have confirmed the potential to use these plants as a component of the southern landscape. Plants have been identified that are tolerant of both irrigated and nonirrigated landscape positions. In addition, specific recommendations for selection of annual and potentially perennial succulents for irrigated and nonirrigated landscapes have been identified.

Appreciation is given to The Friends of the Milton Gardens for supplying stock plants, Emerald Coast Growers, Inc for liners and Kat Campbell and Melvin Gramke for technical support.

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Table 1. Landscape performance of 10 succulents with and without supplemental irrigation.

	October 2006			April 2007		
Species	non-irrigated	irrigated	significance	non-irrigated	irrigated	significance
Aloe (*Aloe vera*)						
survival (%)	100.0	93.8	ns	88.0	63.0	ns
index	38.9	34.6	0.0093	12.3	8.1	0.0243
visual	1.0	1.0	ns	2.9	3.5	0.0121
Bulbine (*Bulbine frutescens* 'Hallmark')						
survival (%)	93.8	93.8	ns	75.0	88.0	
index	65.6	63.4	ns	43.8	46.9	ns
visual rating	1.3	1.1	ns	1.0	1.0	ns
Ice Plant (*Delospermum cooperi*)						
survival (%)	94.0	75.0		94.0	75.0	ns
index	39.5	34.6	ns	52.1	10.1	ns
visual rating	1.1	1.2	ns	1.0	1.0	ns
Turkish Sedum (*Sedum bithynicum* 'Sea Star')						
survival (%)	81.0	94.0	ns	81.0	94.0	ns
index	15.1	13.5	ns	27.4	26.6	ns
visual rating	1.7	1.5	ns	1.5	1.1	ns
Neon Sedum (*Sedum spectabilis* 'Neon')						
survival (%)	94.0	94.0	ns	94.0	94.0	ns
index	20.5	20.4	ns	31.5	36.7	ns
visual rating	1.4	1.8	ns	1.0	1.0	ns
Coral Reef Sedum (*Sedum tectractinum* 'Coral Reef')						
survival (%)	94.0	100.0	ns	94.0	100.0	ns
index	22.6	24.0	ns	33.0	38.0	0.0031
visual rating	1.0	1.1	ns	1.0	1.0	ns
Mexican poinsettia (*Synadenium grantii*)						
survival (%)	100.0	100.0	ns	-	-	
index	52.5	47.7	ns	-	-	
visual rating	1.2	1.3	ns	-	-	

Table 1 (cont.). Landscape performance of 10 succulents with and without supplemental irrigation.

	October 2006			April 2007		
Species	non-irrigated	irrigated	significance	non-irrigated	irrigated	significance
Jade Plants (*Crassula argentea*)						
survival (%)	37.5	68.0	0.0443	-	-	
index	8.8	9.8	ns	-	-	
visual rating	2.7	2.1	ns	-	-	
Air plant (*Kalanchoe pinnata*)						
survival (%)	94.0	100.0	ns	-	-	
index	43.1	36.1	0.0237	-	-	
visual rating	1.1	1.3	ns	-	-	
Panda Plant (*Kalanchoe tomentosa*)						
survival (%)	62.5	50.0	ns	-	-	
index	7.6	7.0	ns	-	-	
visual rating	1.2	1.1	ns	-	-	

Index = [mean of height (cm) and the mean of two perpendicular widths (cm)].

Visual rating = (1 to 5 scale, 1 = excellent, 5 = poor).

Soil moisture affects post-transplant root growth of native landscape shrubs

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Index Words: Horhizotron™, *Illicium floridanum*, Root Growth, Establishment

Significance to the industry: Understanding the effect of drying soil on root growth of native landscape shrub species can provide information related to irrigation requirements and relative drought tolerance. *Illicium floridanum* (Florida anise tree) plants were grown such that each root ball experienced four different soil moisture conditions, ranging from watered daily to unwatered. Although less root growth occurred in the two drier treatments, results from this experiment suggest that roots of *I. floridanum* can continue to grow, from all sides, as long as some portion of the root ball is receiving some amount of water.

Nature of Work: With the global environment changing, it is important to understand drought stress on crop yield (3), since restricted water availability is in an important environmental constraint to plant productivity (1). Thus, it becomes necessary to use irrigation practices that use available water more efficiently (3) or choose more drought tolerant species for the landscape.

Past studies have shown that generally, root growth into the surrounding substrate or soil decreases with drying soil (5, 2). In order for successful landscape establishment to occur, post-transplant root exploration into the surrounding soil must occur, since root growth is crucial for plants to obtain water and nutrients needed for proper growth and development (6). More research into post-transplant root growth in moisture limiting conditions is needed to select more drought tolerant species for the landscape. The objective of this study was to utilize the Horhizotron™ to evaluate root growth of *I. floriadanum* (Florida anise tree) when portions of the root system are exposed to different levels of soil moisture. The Horhizotron is a type of split root technique used for non-destructively evaluating root growth over time under a variety of rhizosphere conditions (7).

On June 15, 2006, five *I. floridanum* plants were removed from 11.3 L (3 gal) containers, and one plant was placed in the center of each of five separate Horhizotrons. Horhizotrons were placed on greenhouse benches at the Patterson Horticulture Greenhouse Complex, Auburn University [day/night temperatures set at 79/70°F (26/21°C)]. Each Horhizotron had four quadrants extending away from the root ball of each plant. Quadrants were filled with Greens Grade™ Profile™ (Profile Products, Buffalo Grove, IL.), a calcined clay material, that had been amended with 9.48 kg/yd^3 (16 lbs/yd$^{3)}$ 17N-5P_20_5-11K_20

(Pursell Industries, Sylacauga, AL), 1.18 kg/m^3 (2 lbs/$yd^{3)}$ dolomitic limestone, and 0.89 kg/m^3 (1.5 lbs/yd^3) Micromax™ (The Scotts Co., Marysville, OH). Physical and chemical properties of Profile™ are similar to those of soil, and it is easily removed from roots at harvest. Treatments were four different irrigation frequencies randomly assigned to quadrants within each Horhizotron. Treatments included: substrate watered daily (~20% moisture), substrate rewatered once dried to 15% moisture, substrate rewatered once dried to 10% moisture, and substrate that remained unwatered throughout the study. Treatments were initiated on June 28, 2006 (14 days after planting, DAP). Substrate percent moisture (by volume) was measured daily using a Theta probe (Delta-T Devices Ltd., Cambridge, England). When watered, quadrants received 400 mL water. Daily, 400 mL water was also applied directly to the original container root ball. The experimental design was a randomized complete block design, with five blocks and one Horhizotron equaling one block. Weekly root growth measurements were taken by measuring the horizontal root length (measured parallel to ground, HRL) of the five longest roots visible along the glass panes that formed each side of a quadrant (two glass panes per quadrant). At the end of the study roots that had grown into each quadrant were removed from the original root ball and substrate was gently rinsed from those roots. Roots were dried for 48 hours at 150°F (66°C), and dry weights were recorded. Data were analyzed using GLM procedures and regression analysis, and means were separated using Least Significant Difference ($P<0.05$).

Results and Discussion: Horizontal root length (HRL) increased linearly over time in the watered daily substrate and substrate rewatered once dried to 15% moisture and quadratically in the substrate rewatered once dried to 10% moisture and the substrate that remained unwatered throughout the study (Fig.1). Thirty-six DAP was the first date significant differences in HRL were observed for the driest treatment; on this day HRL in the unwatered substrate was lower than all other treatments. At 44 DAP, HRL was higher in the well watered substrate and the substrate rewatered at 15% moisture than in the substrate rewatered at 10% moisture and the unwatered substrate. This trend was followed from this point until the end of the experiment (107 DAP). Since HRL did not differ for the well watered substrate and that rewatered at 15% moisture (Fig. 1, Table 1), it could be suggested that a substrate or soil containing at least 15% moisture would not restrict root growth. Although root growth slowed in the substrate rewatered at 10% moisture and the unwatered substrate, by the end of the experiment, root growth managed to extend to 16.6 cm (6.5 in) and 15 cm (5.9 in.), respectively. The slowing or stopping of root growth during periods of low soil moisture has been well documented (5). These data suggest plants were distributing moisture internally from areas of higher plant water potential to areas with lower plant water potential. Dry weights (Fig. 2) of roots in the unwatered substrate and that rewatered at 10% moisture were lower than that in the well watered substrate and that rewatered at 15% moisture, similar to the above results for HRL (Table 1). This experiment provides information suggesting *I. floridanum* root growth can persist as long as some portion of the root ball is receiving some water.

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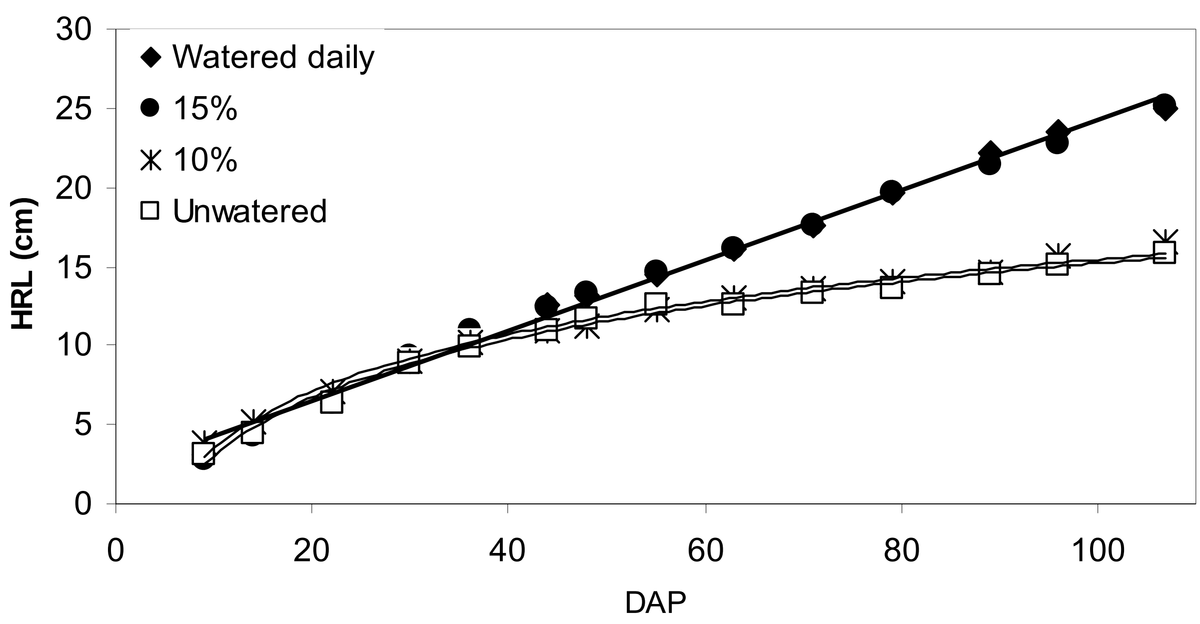

Figure 1. Effect of irrigation frequency (treatment) on horizontal root length (measured parallel to ground, HRL) of *I. floridanum* grown from June 15-Sept 28 in Horhizotrons in a greenhouse in Auburn, AL. Treatments began 14 days after planting (DAP). HRL increased linearly for substrate water daily and substrate rewatered once dried to 15% (P<0.0001), and quadratically for substrate rewatered once dried to 10% and substrate that remained unwatered throughout the study (P< 0.0001). Points are means of 50 observations.

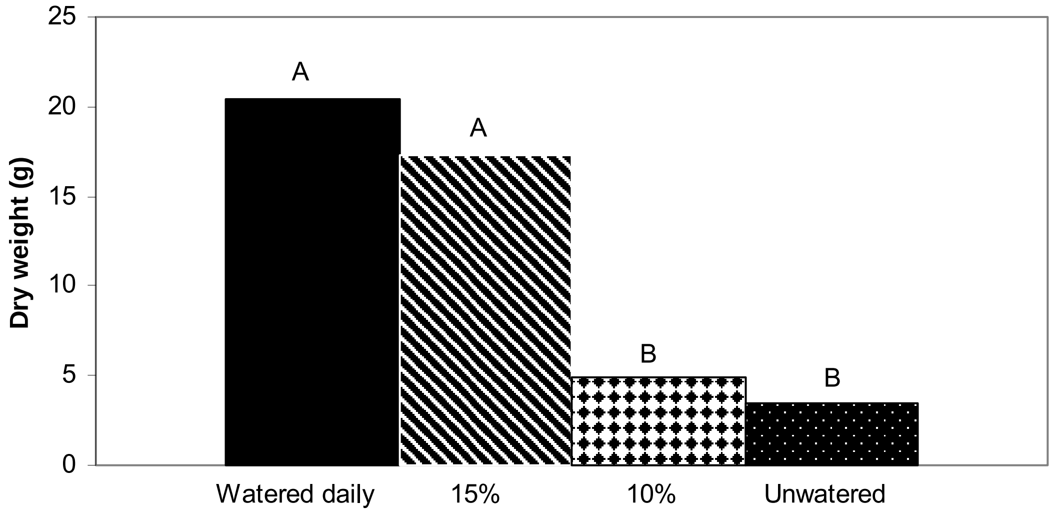

Figure 2. Effect of irrigation frequency (treatment) on root dry weight of *I. floridanum* grown from June 15-Sept. 29 in Horhizotrons in a greenhouse in Auburn, AL. Treatments began 14 days after planting. Treatments included: substrate watered daily (~20% moisture), substrate rewatered once dried to 15%, substrate rewatered once dried to10% moisture, and substrate that remained unwatered throughout the study. Means separated using LSD (P < 0.05). Means followed by the same letter are not significantly different (P<0.0001).

Table 1. Effect of irrigation frequency (treatment) on final horizontal root length (HRL[z]) of *I. floridanum* growing in Horhizotrons (107 DAP[y]), regression equations for change in HRL over time with corresponding R^2 term and significance of regression equation (P-value), and significance of treatment main effects and interactions for HRL. Plants were grown in a greenhouse in Auburn, AL (June 15 - September 29).

Treatment	HRL (cm)	Equation[x]	R^2	P-value
Watered Daily	24.9 a[w]	$y = 0.22x + 2.08$	0.93	<0.0001
15%	25.1 a	$y = 0.23x + 1.67$	0.54	<0.0001
10%	16.6 b	$y = -0.001x^2 + 0.21x + 2.92$	0.64	<0.0001
Unwatered	15.8 c	$y = -0.001x^2 + 0.28x + 1.18$	0.75	<0.0001

Significance	P-value
Treatment	<0.0001
DAP	<0.0001
Treatment x DAP	<0.0001

[z]HRL = root length measured parallel to the ground

[y]DAP = days after planting in Horhizotron

[x]y = HRL, x = DAP

[w]Lowercase letters denote mean separation (n=50) among treatments by LSD at $P < 0.05$